

SOUTH DAKOTA

M

SCHOOL OF MINES
& TECHNOLOGY

2009-2010

Undergraduate
and
Graduate
Catalog

Invent Tomorrow

Academic Calendar

Fall Semester 2009

| | |
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| Registration | August 31 |
| Classes that meet on Mondays with a class start time of 4:00 p.m. or later begin | August 31 |
| All other classes begin | September 1 |
| Labor Day Holiday | September 7 |
| Last day to add or drop a course and to adjust fees | September 10 |
| Last day to submit a graduation application for fall 2009 | September 10 |
| Native American Day Holiday | October 12 |
| Midterm (first half of semester ends) | October 23 |
| Midterm deficiencies grades due by midnight | October 28 |
| Early Registration Weeks (Tentative) | November 1-20 |
| Veterans Day Holiday | November 11 |
| Last day to drop classes | November 16 |
| Thanksgiving Holiday begins at end of class day | November 25 |
| Classes resume | November 30 |
| Final examinations | December 14-18 |
| Semester ends | December 18 |
| Fall Graduation | December 19 |
| Final grades are due by midnight | December 23 |

Spring Semester 2010

| | |
|---|-------------------|
| Registration | January 13 |
| Classes that meet on Wednesdays with a class start time of 4:00 p.m. or later begin | January 13 |
| All other classes begin | January 14 |
| Martin Luther King Jr. Day | January 18 |
| Last day to add or drop a course and adjust fees | January 22 |
| Last day to submit a graduation application for spring/summer 2010 | January 22 |
| Presidents' Day Holiday | February 15 |
| Spring vacation begins at end of class day | March 5 |
| Classes resume | March 15 |
| Midterm (First half of semester ends) | March 15 |
| Midterm deficiencies grades due by midnight | March 18 |
| Easter Break begins at end of class day | April 1 |
| Classes resume | April 6 |
| Early Registration Weeks (Tentative) | March 29-April 16 |
| Last day to drop classes | April 7 |
| Final examinations | May 3-7 |
| Semester ends | May 7 |
| Spring Graduation | May 8 |
| Final grades are due by midnight | May 12 |

This calendar conforms to guidelines established by the Board of Regents, but is subject to change at its discretion.

Reservation of Rights

The information contained in this catalog is the most accurate available at the time of publication, but changes may become effective before the next catalog is printed. It is ultimately the student's responsibility to stay abreast of current regulations, curricula, and the status of specific programs being offered. Further, please note that the university reserves the right to change graduation or other academic requirements where changes are necessary to comply with Board of Regents policy directives, to meet external demands relating to accountability or accreditation standards, to reflect curriculum changes or substitutions, or to implement evolving discipline requirements in major fields.

South Dakota School of Mines and Technology does not discriminate on the basis of race, color, national origin, military status, gender, religion, age, sexual orientation, political preference, or disability in employment or the provision of service.



Mines Matters: The relationships students make at the School of Mines are as important as the world-class education they receive. Students come from 40 states and 29 countries.

Message from the President



Dear Students and Friends,

Welcome to the South Dakota School of Mines and Technology! I am honored to lead this world-class university and continue our proud heritage of excellence in preparing the best and the brightest students to serve worldwide as leaders in the professions of engineering and science.

At the School of Mines—in small, interactive classes and state-of-the-art facilities and laboratories—you'll discover more than 2,000 exceptional students eagerly collaborating with our award-winning faculty members on engineering and scientific projects of critical importance to South Dakota, the nation, and the world.

Within one year of graduation, 97 percent of 2007-08 School of Mines graduates embarked on a career or pursued graduate or professional programs in their fields. Their success rests on the School of Mines' reputation for excellence among industry leaders and the real-world experience students gain through co-ops and internships. At approximately \$56,000, starting salaries

for graduates are amongst the highest in the country, and students have about one-third less student loan debt than the national average.

Our alumni work around the globe and are held in the highest regard by their fellow leaders in industry, consulting, government, health, research, and education. In 2010, we celebrate 125 years of sending graduates out into the world to solve problems and create the future. As a Hardrocker, you contribute to this heritage of success.

Research and educational opportunities for faculty members and students at the Deep Underground Science and Engineering Laboratory in nearby Lead are opening a new and yet-to-be-imagined horizon for all of us. The School of Mines is proud to play a leadership role in the laboratory and offers you opportunities to be part of this exciting future.

I invite you to join us as we focus our energies in the year ahead on optimizing enrollment, securing resources, growing graduate programs, expanding the promise of our research enterprise, and institutionalizing a culture of continuous quality improvement in all of our endeavors. The School of Mines continues to invent tomorrow, and I salute all of you who contribute to our reputation for creativity and innovation.

Sincerely,

A handwritten signature in black ink, appearing to read "Robert A. Wharton". The signature is fluid and cursive, written in a professional style.

Robert A. Wharton, Ph.D.
President

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Degree Abbreviations

- A.A. -Associate of Arts
- B.S. -Bachelor of Science
- M.S. -Master of Science
- Ph.D. -Doctor of Philosophy

MISSION, VISION, AND GOAL

The South Dakota School of Mines and Technology serves the people of South Dakota as their technological university. Its mission is to provide a well-rounded education that prepares students for leadership roles in engineering and science; to advance the state of knowledge and application of this knowledge through research and scholarship; and to benefit the state, regions, and nation through collaborative efforts in education and economic development.

The School of Mines is dedicated to being a leader in 21st century education that reflects a belief in the role of engineers and scientists as crucial to the advancement of society. Our vision is to be recognized as a premier technological university in the United States.

Most immediately, our goal is to be recognized as the university-of-choice for engineering and science within South Dakota and among our peer group of specialized engineering and science universities.

STRATEGIC FOCUS AREAS

1. Optimizing Enrollment
2. Securing Resources
3. Growing the graduate education and the research enterprise (DUSEL)
4. Continuous Quality Improvement

STATEMENT OF PURPOSES

The South Dakota School of Mines and Technology is dedicated to being a leader in 21st century education that reflects a belief in the role of engineers and scientists as crucial to the advancement of society. Responding to the unprecedented challenges facing today's world, the School of Mines will seek opportunities to benefit the educational, civic, and economic activities of the community, state, and region. The School of Mines will maintain and expand its role in research, scholarship, and creative endeavors that advance knowledge, solve problems, develop individual potential, and explore the human condition. Through its rigorous academic programs and co-curricular activities, the School of Mines is committed to developing informed and responsible scientists and engineers who behave ethically, value a global perspective, and accept the duties and responsibilities of citizenship.

University Information

South Dakota Board of Regents

Mr. Terry D. Baloun, Highmore

Dr. James O. Hansen, Pierre

Ms. Melanie J. Jeppesen, Rapid City

Mr. Harvey C. Jewett, Aberdeen

Dr. Kathryn O. Johnson, Hill City

Mr. Dean M. Krogman, Brookings

Mr. Randall K. Morris, Spearfish

Ms. Carole Pagones, Sioux Falls

Mr. Randy Schaefer - Madison

Officers of the Board

President: Mr. Terry D. Baloun

Vice President: Dr. Kathryn O. Johnson

Secretary: Dr. James O. Hansen

Executive Director

Dr. Jack R. Warner

South Dakota Public Higher Education Institutions

Black Hills State University, Spearfish;
Dakota State University, Madison;
Northern State University, Aberdeen;
South Dakota School of Mines and
Technology, Rapid City;
South Dakota State University, Brookings;
University of South Dakota, Vermillion

Degrees

The following degrees are offered at the South Dakota School of Mines and Technology in the designated fields of study.

Associate of Arts

General Studies

Bachelor of Science

Chemical Engineering

Chemistry

Civil Engineering

Computer Engineering

Computer Science

Electrical Engineering

Environmental Engineering

Geological Engineering

Geology

Industrial Engineering and Engineering
Management

Interdisciplinary Sciences

Areas of Specialization:

1. Atmospheric Sciences

2. Pre-Professional Health Sciences

3. Science, Technology, and Society

Mathematics, Applied and Computational

Metallurgical Engineering

Mechanical Engineering

Mining Engineering

Physics

Master of Science

Atmospheric Sciences

Biomedical Engineering

Chemical Engineering

Civil Engineering

Computer Science

Construction Management

Electrical Engineering

Geology and Geological Engineering

Materials Engineering and Science

Mechanical Engineering

Paleontology

Physics

Robotics and Intelligent Autonomous Systems

Technology Management

Doctor of Philosophy

Atmospheric and Environmental Sciences

Biomedical Engineering

Chemical and Biological Engineering

Geology and Geological Engineering

Materials Engineering and Science

Nanoscience and Nanoengineering

Further information concerning the engineering and science curricula leading to the engineering and science degrees may be found in the individual program sections of this catalog.

Accreditation

The South Dakota School of Mines and

Technology is accredited by the Higher Learning Commission of the North Central Association of Colleges and Secondary Schools, the recognized accrediting agency for the north central states, through the Academic Quality Improvement Program (AQIP) process. For more information call (800) 621-7440 or visit:

<www.ncahigherlearningcommission.org>.

In addition, the curriculum in chemistry is approved by the American Chemical Society. All engineering programs with the exception of mining engineering and management, which is a new program, are accredited by the Engineering Accreditation Commission of ABET, Inc., a specialized accreditation body recognized by the Council on Post-Secondary Accreditation and the U.S. Department of Education. The computer science program is accredited by the Computing Accreditation Commission of ABET, Inc.

Equal Opportunity Policy

South Dakota School of Mines and Technology is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, creed, national origin, ancestry, religion, gender, age, sexual orientation, marital status, pregnancy, military/Veteran's status, or disability. In adhering to this policy, South Dakota School of Mines and Technology abides by all federal and state statutes and regulations for the protection of employees against discrimination. Inquiries regarding compliance may be directed to the Director of Human Resources, South Dakota School of Mines and Technology, 501 East Saint Joseph St., Rapid City, SD 57701, (605) 394-1203.

Human Resources

The Office of Human Resources provides services to School of Mines' employees and students, as well as to the general public. These services include compensation, recruitment, benefits, performance management, employee relations, and interpretation and enforcement of policies and procedures. The mission of the Office of Human Resources at the South Dakota School of Mines and Technology is to partner with employees, students, and administration to

promote a work and educational environment that is characterized by fair treatment, open communications, personal accountability, trust, and mutual respect. The director of human resources serves as the campus Title IX/EEO (Equal Employment Office) representative for human rights issues and is Co-Coordinator of ADA (Americans with Disabilities Act).

Campus Buildings

The Arch is located in the center of campus in the Quad area. The stones used in the construction of the arch were from the third building (Liberal Arts Building) constructed on campus. The first phase of that building was completed in 1901. Due to structural problems, the building was razed in the summer of 1994, and the stones used in the original "Arch" were carefully dismantled by hand to facilitate its reassembly during the 1995-96 year.

The Chemistry/Chemical Engineering Building was completed and occupied in early 1957. It is fully equipped with classrooms and laboratories and houses the Department of Chemical and Biological Engineering and the Department of Chemistry. The building is scheduled to be renovated and to receive a major addition during 2009-10.

The Civil/Mechanical Engineering Building, completed and occupied in 1951, houses three major engineering departments. They are the Departments of Civil and Environmental Engineering, Industrial Engineering and Engineering Management, and Mechanical Engineering. The building also houses the Environmental Engineering program. In 2005, a 10,000 square foot addition was added for computational mechanics. This building is equipped with classrooms, faculty and graduate student offices, computing facilities, and a wide range of engineering laboratories. Laboratory facilities include materials testing, heat transfer, composite materials, controls, robotics and integrated manufacturing, hydraulics, geotechnical, environmental and work methods, and measurements. The Center for Advanced Manufacturing and Processing, the Additive Manufacturing Laboratory, the Advanced Materials Processing and Joining

Laboratory, the Computational Mechanics Lab, the Caterpillar Student Excellence Center, and the Human Engineering Laboratory are housed in this building.

The Electrical Engineering/Physics Building, completed in 1973, provides offices and laboratory facilities for the electrical and computer engineering, nanoscience and nanoengineering, and physics departments. The Miller Laboratory offers facilities for research in applied electromagnetics and communications, including antenna anechoic chambers, vector network analyzers, and a wide range of electromagnetic material characterization equipment. This building also houses the Office of Technology Transfer, computer services staff offices, and provides technology equipped classrooms.

The McLaury Building, built in 1920, occupied in 1921, provides classrooms, laboratories, and offices for the mathematics and computer science department, the biology program, and the Office of Educational Programs and Professional Conferences.

The Mineral Industries Building was occupied in 1962. It is a three-story building of 52,000 square feet. The Departments of Geology and Geological Engineering, Materials and Metallurgical Engineering, Mining Engineering, Atmospheric Sciences, and the Institute of Atmospheric Sciences are located in this building. The Office of Research Affairs, Office of Graduate Education, Office of Sponsored Programs, Engineering and Mining Experiment Station, and South Dakota Space Grant Consortium are also housed in this building. This structure provides classroom and laboratory facilities for undergraduate and graduate study in several fields related to materials and earth systems sciences and engineering.

The Classroom Building, completed and occupied in the fall of 1989, houses the Departments of Humanities, Social Sciences, and Military Science, and distance learning classrooms including the Digital Dakota Network studios and the Governor's Electronic Classroom. This three-story building of 44,000 square feet

provides more than 20 classrooms that are used to support all programs. This structure features divisible classrooms, the APEX (art) Gallery, and Stoltz Faculty/Staff lounge.

The Darold D. "Dud" King Center for physical education building was completed and occupied in 1976. Seating for 2,100 spectators at athletic events is available. Handball/racquetball courts and one squash court, offices, training rooms, a swimming pool, a basketball court, and a wellness center are provided in this 60,000-square-foot structure. Also included are music classroom and practice areas with adjoining music offices, music library, and electronic music laboratory.

The Paleontology Laboratory opened in fall 2007 to serve the needs of the paleontology program until the Paleontology Research Center is completed in 2010. The Paleontology Lab is a multi-faceted facility designed for faculty and students to conduct paleontology research.

The Christensen Hall of Fame addition to the King Center honors past athletes, coaches, teams, athletic traditions, and contributors by permanently dedicating a place to remember the past and to look to the future with pride for what the School of Mines stands for on the playing field and in the classroom. The Christensen Hall of Fame also honors Jim and Nancy Christensen, longtime supporters of the School of Mines. The Christensens' ties to School of Mines, its athletic programs, and the Hardrock Club are deep. While Jim was a School of Mines student in the 1950s, he was a member of the Hardrocker football and track teams. He graduated from the School of Mines with a degree in General Engineering in 1957. A donation from the Christensens made the Hall of Fame possible.

The Physical Plant Building, completed in 1974, provides an excellent base for the operation of the university in the areas of electrical, mechanical, and other maintenance. This building also houses the campus mailroom.

The Old Gymnasium (Physical Training Building), first occupied in 1929, is used for intramural activities and provides faculty and staff offices.

Dunham Field at O'Harra Stadium, dedicated in 1938, is one of the most unique

athletic fields in the region. The architects took advantage of natural topographic features on three sides of the field to construct parking terraces that can accommodate approximately 300 automobiles from which spectators can view the field. An artificial turf playing field was installed in 2006 and is encircled by an all-weather running track, renovated in 2002. Recent renovations added sky boxes and athletic locker rooms.

Connolly Hall, completed in 1948, and remodeled in 1964, provides living accommodations for male and female students. Connolly Hall will be renovated during 2009-2010.

Palmerton Hall, completed in 1969, accommodates both male and female students. It is a completely carpeted five-story building with access to each floor provided by both elevator and stairs. Palmerton Hall will be renovated during 2009-2010.

Howard Peterson Hall is a 300-bed residence hall that was occupied for the first time during the fall 2004 semester. It is located adjacent to the south end of the Surbeck Center. Room configurations include suites and standard double rooms. Study lounges, a kitchen, and an exercise room are included. Since the residence hall connects to the Surbeck Center's main floor, a common front desk operation serves both complexes. The residence hall is named after Dean of Students Emeritus Howard Peterson, a School of Mines alumnus who continues his service as a volunteer to the Foundation, the Alumni Association, and other aspects of campus life.

The March-Dake Plaza, located close to the former site of March-Dake Hall, honors a former School of Mines president and a former faculty member and founder of the Alumni Association who played important roles in the institution's history.

In 2004, renovations to the **Devereaux Library** opened another floor for collections, new study areas for students, news areas for special collections, and created a friendlier atmosphere for study and research. The library, completed in 1970, includes 56,000 square feet of modern space that is carpeted and air conditioned. The

library houses the Tech Learning Center, the Testing Center, the ITS Helpdesk, Tablet Central. It also serves as a Federal Government Depository as well as the Patent and Trademark Depository for the state.

Surbeck Center, the student union for the School of Mines, provides more than just 71,000 square feet of space devoted to campus and community activities. It also provides information services, equipment check-out for students, and scheduling services for the campus. Surbeck Center's main office serves as a one-stop scheduling center that assists with the reservation and coordination of university resources for the various activities of the university — academic, student, departmental, community, and professional. Additionally, Surbeck Center staff provide assistance for all on-campus activities, events, academic, and summer conference scheduling.

Surbeck Center's main floor houses a large student lounge, the School of Mines Alumni Association office, the bookstore, a banquet-ballroom, the Career Center, conference rooms, Counseling and Student ADA Services, the Vice President for Student Affairs and Dean of Students office, Health Services, mail boxes for all students living on campus, Student Accounts and Cashiering Services, the main office for Residence Life, and the Surbeck Center offices. The dining hall, snack bar, recreation area, Student Activities and Leadership Center, Ivanhoe International Center, the Multicultural Affairs office, Veteran's information and display areas can be found in the lower level, in addition to more meeting rooms and leisure space for students. Surbeck Center includes renovated spaces completed in 2004 and the fall of 2009.

The O'Harra Memorial Building was completed in the summer of 1942 as a joint State and Federal Work Projects Administration Project. It houses the administration offices, the Office of the Registrar and Academic Services, the Office of Financial Aid, the Office of Admissions, the School of Mines Foundation, and the Museum of Geology, and is named in honor of Dr. C.C. O'Harra, president and professor of geology at the School of Mines from 1911 to his death in 1935.

The Kids Kastle Little Miner's Clubhouse

was established in 1995 to provide child-care services for students, faculty, staff, and area alumni.

History

The South Dakota School of Mines and Technology was originally established by the Dakota Territorial Legislature as the Dakota School of Mines in 1885 to provide instruction in mining engineering at a location where mining was the primary industry.

The School of Mines opened for instruction on February 17, 1887. Dr. Franklin R. Carpenter, a graduate of Ohio University, was appointed president and dean of the faculty. Degrees were initially offered in mining engineering, civil engineering, and general science. When North and South Dakota were granted statehood in 1889, the school was re-designated as the South Dakota School of Mines.

During the presidency of Dr. Robert Slagle (1896-1905), field geology was introduced, and a large collection of Badlands fossils and minerals was added to the geological museum. During that period, the third building was constructed on campus and the first School of Mines magazine was published. Faculty size and student enrollment reached a peak in 1905 that was not to be exceeded until 1920.

The university's reputation as a diversified science and engineering school was established following World War I with the rapid increase of engineering students and the termination of college preparatory courses. In 1943, the state legislature changed the name of the institution to the South Dakota School of Mines and Technology, in recognition of the school's expanded role in new areas of science and technology. Since that time, the university has expanded its curriculum to include 10 engineering and six science undergraduate degrees and graduate programs leading to the master of science degree in 13 engineering and/or science disciplines. The School of Mines offers programs leading to the doctor of philosophy degree in atmospheric and environmental sciences, biomedical engineering, chemical and biological engineering, geology and

geological engineering, materials engineering and science, and nanoscience and nanoengineering.

As the bounds of technology continue to expand, the university continues to meet the challenge of preparing students for highly technical careers in engineering and science.

Location

Rapid City, South Dakota's second largest city, is located at the base of the Black Hills in the southwestern part of the state. Directly to the west is the beautiful Black Hills region, and to the east lie the awesome White River Badlands. Mount Rushmore and Crazy Horse Memorial are within a one-hour drive from the campus, and throughout the Black Hills are attractions that focus on the Native American and early Gold Rush history of the area.

The Black Hills area is a naturalist's dream. There are many caves to explore, mountains to hike and ski, and streams to enjoy. In addition, there is a vast variety of rocks and minerals, wildlife, and plant life indigenous to the area.

The Badlands, formed by natural erosion, offer the viewer an eerie but beautiful landscape of multicolored peaks and deep ravines. The Badlands area, as well as the northwest and southwest portions of South Dakota, offer some of the world's most prolific sources of fossils. Discoveries of a Tyrannosaurus Rex skeleton, a Triceratops skull, and a mammoth butcher site have added to this reputation. More than four million visitors enjoy the Black Hills/Badlands area each year.

Campus Safety

The South Dakota School of Mines and Technology is committed to protect its students, faculty, staff, visitors and property, and to maintain an environment suitable for the orderly conduct of its educational function. In order to respond to situations that would adversely affect the ability to fulfill these responsibilities, the university has developed an Emergency Management Plan. The fundamental purpose of the plan is to establish procedures and an organizational hierarchy for the rapid and effective response to all categories of campus emergencies ranging from individual departmental or building incidents to catastrophic

events involving the entire campus and the surrounding community.

The Rapid City Police Department personnel respond to campus emergencies. Campus Safety personnel conduct functions which include securing buildings after hours and providing a campus escort service that may be utilized 24 hours a day by calling (605) 394-6100. A mass notification system is in place to provide timely communication to students, faculty, and staff. With the assistance of the Rapid City Police department, the School of Mines provides safety and security education and awareness programs. The purpose of these programs is to make the campus community aware of safety issues and techniques. The programs also cover alcohol and drug abuse control and prevention through the coordination of the Campuses Community Prevention Coalition.

Campus emergency procedures and statistics are outlined in the campus safety brochure in compliance with the Drug Free School and Communities Act of 1989 and the Jeanne Clery Disclosure of Campus Security Policy and Campus Crime Statistics Act. This information is distributed annually to all students and university personnel and is available on the School of Mines website, <<http://sdmines.sdsmt.edu/safety>> and from the Vice President for Student Affairs and Dean of Students Office.

SDSM&T Alumni Association

The South Dakota School of Mines and Technology Alumni Association promotes communication and interaction among alumni, students, faculty, and administrators of the School of Mines with the objective of strengthening the university's academic, research, and service roles. The association also provides an alumni network and support services for graduates throughout the world. Services provided by the Alumni Association include maintenance of the alumni database, a semiannual publication (the *Hardrock*) mailed to friends of the school and all alumni, a weekly electronic newsletter (the *Hardrock E-News*), a biennial *Alumni Directory*, coordination of alumni recognition programs, area meetings, class reunions and get-togethers, and an all-school reunion every five years. The next five-year

reunion is scheduled for July 7-11, 2010.

The Alumni Association also provides student support funds and mentoring, and helps promote the School of Mines Alumni Recruiting Team (SMART). The Alumni Association is a 501 (c)(3) non-profit South Dakota corporation governed by a Board of Directors. The Alumni Office is located in the Surbeck Student Center. For more information regarding the Alumni Association, please visit or contact the office at (605) 394-2347 or via e-mail at alumni@sdsmt.edu.

SDSM&T Foundation

The South Dakota School of Mines and Technology Foundation is a tax exempt 501(c)(3) charitable organization that exists solely to serve the university by seeking the resources necessary to provide exceptional intellectual, professional, and personal development opportunities. Resources provided by the SDSM&T Foundation include student scholarships and graduate fellowships, the short-term loan program, general student assistance, faculty assistance, and areas of greatest need. Assistance is also provided to faculty for faculty development and research, educational leaves, travel costs, seminars, paper presentations, and educational support.

Campaigns to solicit funds from alumni and campus staff are held annually, as well as mini-campaigns for special purposes and an ongoing approach to corporations for support. The Foundation's portfolio is professionally managed and all accounts are audited yearly. The Foundation Office is located in the lower level of the O'Harra Building.

Tech Ventures, Inc.

Tech Ventures, Inc. is a for-profit corporation wholly owned by the South Dakota School of Mines and Technology Foundation. Its purpose is to support commercialization of research projects linked to School of Mines faculty and researchers. Tech Ventures Inc. assists in all aspects from start up, to seeking venture capital, to operating the new companies. Through these partnerships, Tech Ventures generates unrestricted revenues used to support the university.

Admissions

Authorization for Individual Institutional Policies

Each university may adopt specific admission regulations, consistent with law and the requirements set by the Board of Regents, as may be required for each school or program to assure acceptable student preparation and enrollment levels. A copy of such regulations and any subsequent amendments shall be filed with the Executive Director and shall be subject to review by the Board of Regents.

New Admissions Requirements Effective Fall 2006

The Board of Regents (BOR) requires that all students meet the minimum course requirements for admission to the South Dakota School of Mines and Technology. These are described below under South Dakota Board of Regents Minimum Undergraduate Admissions Requirements.

In addition, The Board of Regents approved the following requirements for admission to the School of Mines, effective fall 2006.

School of Mines will **automatically accept** for admission students who:

- obtain an ACT composite score of at least 25 AND obtain an ACT math subscore of at least 25 (or SAT-I equivalent score)

OR

- obtain a high school GPA of at least 3.50 on a 4.0 scale AND have taken four years of mathematics

School of Mines will **review and consider for acceptance** students who meet BOR requirements **AND**

- obtain an ACT composite score of at least 21(or equivalent SAT-I score)

OR

- obtain an ACT math subscore of at least 21(or equivalent SAT-I score)

OR

- achieve a high school GPA of at least 2.75 on a 4.0 scale.

All applicants not meeting automatic

admission requirements will be reviewed by the Admissions Committee. The committee considers high school curriculum (special consideration is given to math and science course work), grades, and test scores.

South Dakota Board of Regents Minimum Undergraduate Admissions Requirements

A. Baccalaureate Degree Admissions for High School Graduates

For admission to baccalaureate degree programs, high school graduates must:

- meet the minimum course requirements with an average grade of C (2.0 on a 4.0 scale);

OR

- demonstrate appropriate competencies in discipline areas where course requirements have not been met;

AND

- rank in the top 60 percent of their high school graduating class;

OR

- obtain an ACT composite score of 18 (SAT-I score of 870) or above;

OR

- obtain a high school GPA of at least 2.6 on a 4.0 scale.

School of Mines ACT CODE - 3922

School of Mines SAT CODE – 6652

1. Minimum Course Requirements

Effective the fall of 1996, all baccalaureate or general studies students under twenty four (24) years of age, including students transferring with fewer than twenty-four (24) credit hours, must meet the following minimum high school course requirements:

- a. Four years of English - Courses with major emphasis upon grammar, composition, or literary analysis. One year of debate instruction may be included to meet this requirement.
- b. Three years of advanced mathematics - Algebra, geometry, trigonometry or other advanced mathematics including accelerated or

honors mathematics (algebra) provided at the 8th grade level; not included are arithmetic, business, consumer, or general mathematics or other similar courses.

c. Three years of laboratory science — Courses in biology, chemistry, or physics in which at least one (1) regular laboratory period is scheduled each week. Accelerated or honors science (biology, physics, or chemistry) provided in the 8th grade shall be accepted. Qualifying physical science or earth science courses (with lab) shall be decided on a case-by-case basis.

d. Three years of social studies — History, economics, sociology, geography, government — including U.S. and South Dakota, American Problems, etc.

e. At the time of admission to a South Dakota Board of Regents university, it is expected that students will have basic keyboarding skills and have had experience in using computer word processing, database and spreadsheet packages, and in using the Internet or other wide-area networks. These expectations may be met by high school course work or demonstrated by some other means. Incoming students that are assessed and found deficient in this area may be required to complete specific computer skills courses.

f. One year of fine arts effective fall 2002 for students graduating from South Dakota high schools in 2002 – Art, theatre, or music (appreciation, analysis, or performance). Documented evidence of high school level noncredit fine arts activity will be accepted for students graduating from high schools in states that do not require completion of courses in fine arts for graduation.

2. Alternate Criteria for Minimum Course Requirements

- a. Students who do not successfully complete four years of English may meet minimum course requirements through one of the following:
 - i. An ACT subtest score of 18 or above;
 - ii. An Advanced Placement Language and Composition or Literature and Composition score of 3 or above.
- b. Students who do not successfully complete three years of advanced mathematics may meet

minimum course requirements through one of the following:

- i. An ACT mathematics subtest score of 20 or above;
 - ii. An Advanced Placement Calculus AB or Calculus BC score of 3 or above.
- c. Students who do not successfully complete three years of laboratory science may meet minimum course requirements through one of the following:
- i. An ACT science reasoning subtest score of seventeen (17) or above;
 - ii. An Advanced Placement Biology, Chemistry, or Physics B score of 3 or above.
- d. Students who do not successfully complete three years of social studies may meet minimum course requirements through one of the following:
- i. An ACT Social Studies/Reading subtest score of seventeen (17) or above;
 - ii. An Advanced Placement Microeconomics, Macroeconomics, Comparative or United States Government and Policies, European or United States History, or Psychology score of 3 or above.
- e. Effective fall 2002, students graduating from South Dakota high schools in 2002 that do not successfully complete one year of fine arts may demonstrate fine arts knowledge or competency through the following:
- i. An Advanced Placement History of Art, Studio Art drawing, or general portfolio or Music Theory score of 3 or above.

Non-Traditional Students

For purposes of admission, a degree seeking student who has attained the age of 21 and has not previously attended any post-secondary institution is classified as a non-traditional student. It is the policy of School of Mines to recognize that there is a great diversity in the background and goals of non-traditional students seeking college admissions. Each individual will be evaluated for admission to School of Mines based on the minimum requirements as prescribed by the Board of Regents and the School of Mines admission standards. Additional consideration will be given to nontraditional students who do not meet the BOR undergraduate admission requirements.

- Non-traditional students who are high school graduates and meet the BOR minimum requirements will be admitted.

- Non-traditional students who are not high school graduates and have obtained an ACT composite score of 18, ACT English sub-test score of at least 18, mathematics sub-test score of at least 20, and social studies/reading and science reasoning sub-test scores of at least 17, and meet any university determined requirements for admission will be admitted.

- Non-traditional students who are not high school graduates and have completed the general equivalency diploma (GED) with a combined score of 225 and minimum of 40 on each test (paper based) or 2250 combined score and minimum of 410 on each test (computer based) will be admitted.

- Non-traditional students who do not fit within the above categories will be considered for admission based on life experience and other evidence of success. Applications will be reviewed by a review group composed of the director of retention and testing, the director of admissions, and an admissions counselor. An applicant accepted under this section will be placed on a one semester probationary status. The review group reserves the right to impose additional conditions.

Regents Scholars

Effective fall 2001, South Dakota high school graduates completing the following high school courses with no final grade below a “C” (2.0 on a 4.0 scale) and an average grade of “B” (3.0 on a 4.0 scale) shall be designated as Regents Scholars and shall be eligible to receive a Regents Scholar Diploma upon request by a high school administrator to the Department of Education and Cultural Affairs. High school graduates designated as Regents Scholars automatically are admitted to all six public universities. (Regent Scholars still need to submit the admission application.)

- **4 units of English:** Courses with major

emphasis upon grammar, composition, or literary analysis; one year of debate instruction may be included to meet this requirement.

- **4 units of algebra** or higher mathematics: Algebra, geometry, trigonometry, or other advanced mathematics including accelerated or honors mathematics (algebra) provided at the eighth grade level; not included are arithmetic, business, consumer or general mathematics, or other similar courses.

- **4 units of science including 3 units of approved laboratory science:** Courses in biology, chemistry, or physics in which at least one (1) regular laboratory period is scheduled each week. Accelerated or honors science (biology, physics, or chemistry) provided in the eighth grade shall be accepted. Qualifying physical science or earth science courses (with lab) shall be decided on a case by-case basis.

- **3 units of social studies:** History, economics, sociology, geography, government—including U.S. and South Dakota, American Problems, etc.

- **2 units of a modern (including American Sign Language) or classical language**

- **1 unit of fine arts:** Effective fall 2002 for students graduating from South Dakota high schools in: Art, theatre, or music appreciation, analysis, or performance.

- **1/2 unit of computer science:** Students will have basic keyboarding skills and have had experience in using computer word processing, database and spreadsheet packages, and in using the Internet or other wide-area networks.

Readmission Procedures

A student who has interrupted attendance by two (2) or more semesters must submit an application for readmission and

pay the application fee. Any student not under academic or disciplinary suspension will be automatically readmitted. Applications from students under suspension will be considered by the university's admissions committee. This committee may, at their discretion, request further information from the student.

Undergraduate Transfer Admission

A. Transfers to Baccalaureate Programs

Students under twenty-one (21) years of age transferring into baccalaureate degree programs with fewer than twenty-four (24) transfer credit hours must meet the baccalaureate degree admission requirements. Students with twenty-four (24) or more transfer credit hours with a GPA of at least 2.0 may transfer into baccalaureate degree programs at the discretion of the university. If students are applying for federal financial aid, they must meet federal guidelines for transfer students.

Technical Institute and Community College Credits

Technical Institute courses are designed to prepare students to enter the workforce for careers requiring less than a baccalaureate degree. Acceptance of these courses for credit at the South Dakota public universities is strictly the function of the receiving institution. Students who wish to transfer credits to a South Dakota public university for programs other than the Bachelor of Applied Technical Science degree not available through the School of Mines should contact the Admissions Office of that desired university for an evaluation of their program objectives and technical institute transcript. An individual evaluation of course credits will be made by the receiving public university in accordance with institutional and Board of Regent's policy.

Total transfer credit for work at a junior, community college (2 year), and/or two-year technical college may not exceed one-half of the hours required for completion of the

baccalaureate degree at the accepting institution. Students who have completed more than the acceptable semester hours of junior, community, or technical college work may apply completed, transferable courses to specific course requirements and thereby may not be required to repeat the courses. The semester hours of credit for those additional courses may not be applied toward the minimum credit hours required for the degree.

B. Students who Transfer to Associate Programs

Students younger than twenty-one (21) years of age transferring into associate degree programs with fewer than 12 transfer credit hours must meet the associate degree admission requirements. Students with 12 or more transfer credit hours with a GPA of at least 2.0 may transfer into associate degree programs at the discretion of the university. If students are applying for federal financial aid, they must meet federal guidelines for transfer students.

C. Students from Accredited Colleges or Universities

At the discretion of each university, students may be accepted by transfer from other colleges within or outside of the state; preferential consideration shall be given to applicants from institutions which are accredited by their respective regional accrediting association. Advanced standing shall be allowed within the framework of existing rules in each college.

D. Students from Non-Accredited Colleges

A university may refuse to recognize credits from a non-accredited college or may admit the applicant on a provisional basis and provide a means for the evaluation of some or all of the credits. The validation period shall be no less than one (1) semester and no longer than one (1) academic year.

An applicant for admission to the South Dakota School of Mines and Technology is considered a transfer applicant if he/she has enrolled for any college level work, full or

part-time, since graduation from high school. The applicant must be in good standing and eligible to return to all colleges/universities attended. In general, a “B” quality average in courses attempted at other institutions is expected. Applicants from accredited institutions ordinarily are granted credit toward their degree for work satisfactorily completed at the previous institutions, provided such courses are equivalent or comparable to those required in the program an applicant is considering at School of Mines. Credits from institutions which are not accredited by a regional accrediting association will be provisional and subject to validation. No credit is allowed for remedial courses.

E. Former Students

A student returning to the institution or a student who has attended another higher education institution in the Board of Regents system is required to pay the application fee and, he or she must also submit an application for readmission and other required documents if he or she has interrupted attendance by two (2) or more semesters. A former student shall be considered as a transfer student if he or she has attended another institution during the period of interruption of attendance.

F. Suspended Students

A transfer applicant under academic suspension from the last college attended shall not be considered for admission during the period of suspension or, if suspended for an indefinite period, until one (1) semester has passed since the last date of attendance at the previous school. A system transfer student must first be reinstated to their previous institution prior to seeking admission to the School of Mines.

G. Disciplined Students

A transfer applicant under disciplinary suspension shall not be considered for admission until a clearance and a statement of the reason for suspension is filed from the previous institution. The university shall take into account the fact of the previous suspension in considering the

application.

Special (Non-degree Seeking) Students

A prospective student at South Dakota School of Mines and Technology who wishes to be classified as a special student must complete the Application for Non-degree Seeking Students. Non-degree seeking students are ineligible for all federal financial aid programs. Non-degree seeking students must submit an official copy of their previous college transcript(s) if necessary to verify prerequisites.

Nursing at the School of Mines

South Dakota School of Mines and Technology offers courses that meet requirements for nursing at South Dakota State University (4-year baccalaureate degree B.S.N.) and the University of South Dakota (2-year associate degree A.D.N.).

Students interested in earning a nursing degree from SDSU or USD need to apply to the degree granting university. For more information visit: <<http://sdmines.sdsmt.edu/nursing>>.

Dual Enrollment of High School Students

A high school student wishing to take courses at School of Mines should begin by contacting the Admissions Office at School of Mines and then the Principal’s Office or Guidance Office at the high school he or she currently attends to receive the high school’s approval to participate. This approval should accompany the School of Mines Admissions Application. Please refer to the legislative SDCL 13-28-37, enacted by the South Dakota Legislature in 1990. This bill states the following: “Postsecondary enrollment—Responsibility for cost—Failing grade eliminates eligibility. Any student in grades ten, eleven and twelve may apply to an institution of higher education or a postsecondary vocational education institution as a special student in a course or courses offered at the institution of higher education or postsecondary vocational education institution. The student shall obtain the school district’s approval of the post-secondary course or

courses prior to enrolling. If approved, the student shall receive full credit toward high school graduation as well as post-secondary credit for each postsecondary course. The resident school district may pay all or part of the tuition and fees for a course approved for credit toward high school graduation in accordance with this section. The student is responsible for any tuition and fees not paid by the resident school district and for any other costs involved with attending a postsecondary institution. If a failing grade is received in a postsecondary course under this section, the student receiving the failure is no longer eligible to enroll for post-secondary courses under this section.”

Additional Admissions Policies and Practices

Institutions authorized by the Board of Regents to offer graduate study programs may admit students selected according to regulations established by each faculty. A graduate student will be defined as one who has been accepted into a graduate school.

Effective spring semester 2000, all entering students seeking an associate or baccalaureate degree must provide valid Enhanced ACT scores or must take the ACT COMPASS examination in the areas of writing skills, mathematics, and reading. All non-degree seeking students enrolling in English and mathematics courses must provide Enhanced ACT scores or must take the ACT COMPASS examination in the areas of writing skills and mathematics.

Students enrolled prior to spring 2000 who have already been placed into their initial mathematics and English course work, and transfer students who have completed equivalent general education course work in English and mathematics are exempt from this requirement.

Students transferring within the South Dakota Board of Regents system will be allowed to transfer their placement test scores and continue their sequence of courses in English and/or mathematics.

The placement process will be consistent for all Regental institutions.

Applications and Procedures

A. Application for Tuition and Fee Reductions and Scholarships Established by the Legislature

Students should contact the Admissions Office at each university for information on eligibility for tuition and fee reductions and scholarships established by the Legislature.

B. Application Submission

An applicant for admission must submit the required application for admission and the necessary official transcript or transcripts and other required documents to the Office of Admissions (501 E. Saint Joseph Street, Rapid City, SD 57701).

C. Records Required

Applicants who are twenty-one (21) years of age or younger must submit Enhanced ACT (or SAT-I) results, an official high school transcript, if a high school graduate, or proof of GED and an official transcript for all previous college work as part of their application. Applicants who are older than twenty-one (21) years of age and who do not have valid ACT / SAT-I exam results, or who have not taken the exams are not expected to take the exam. However, they are required to submit an official high school transcript, if a high school graduate, and an official transcript for all college work. Applicants should also submit any other records, data, or letters required to support eligibility for admission, including competency test scores. SAT scores will be converted to ACT equivalencies according to a conversion table approved by the Board of Regents. Note: An official transcript is one that bears the original seal and signature of the official in charge of records at that institution.

D. Preadmission Immunization Requirements

In accordance with state law, every student (graduate and undergraduate) who has been admitted to a post-secondary institution - either public or private – in the state of South Dakota ***who meets established criteria is obliged to demonstrate immunity to measles, mumps, and rubella.*** Relevant criteria (the key factors which

drive the need for compliance) are delineated below:

1. Age: students born on or after January 1, 1957 must comply; those born prior to this date are excused.
2. Course schedule: students who register for two or more credit-bearing classes – and at least one course involves face-to-face contact on a weekly basis for multiple weeks – are obliged to comply. This includes participation at all campuses, centers (including University Center, Capital University Center, and West River Higher Learning Center), and off-campus meeting locations.
3. Academic background: students who have completed prior collegiate course work *in the state of South Dakota* (initiated prior to July 1, 2008) are excused from compliance. Note: credits earned through distance learning, dual credit agreements, and exam/validation do not qualify.
4. Acceptable evidence of immunity *to each disease* includes:

Immunization record which specifies administration of two doses of vaccine; Medical laboratory report that verifies presence of disease-specific antibodies in the blood (i.e., positive blood titer); and /or, documentation of disease state as diagnosed by a qualified physician.

The law recognizes that special circumstances may preclude ability to demonstrate compliance as detailed above. Those students for whom vaccination presents a threat to health/well-being and those who adhere to a religious doctrine that opposes immunizations may petition for a permanent exemption or temporary waiver as appropriate. Forms are available at: <http://sdmines.sdsmt.edu/studentlife/forms>. Please note: the statute does *not* allow for philosophical objections.

Freshman Checklist

- Submit application for admission.
- Enclose non-refundable application fee with application for admission (\$20.00).
- ACT or SAT I scores must be on file in the

Admissions Office.

- Applicants must arrange to have an official copy of their high school transcript forwarded to the Office of Admissions (501 E. Saint Joseph Street, Rapid City, SD 57701) after their junior year is complete and grades have been recorded. A final transcript will also be necessary in order to verify final class rank, graduation, and satisfaction of the minimum course requirements for admission to South Dakota Public Higher Education Institutions.

- Prospective freshmen desiring scholarship consideration must be accepted for admission prior to February 1.

Transfer Checklist

- Application for admission.

- Non-refundable application fee of \$20.00.

- An official transcript from each postsecondary institution attended. (Sent by the institution attended directly to the Office of Admissions (501 E. Saint Joseph Street, Rapid City, SD 57701)

- All applicants must submit a high school transcript, or other proof of graduation from high school; or, if not a high school graduate, they must submit copies of their high school equivalency/GED scores and an official transcript of high school work completed.

- Applicants younger than twenty-one (21) who have completed less than 24 semester credits of college work must submit official copies of SAT I or ACT scores in addition to the above documents.

- Applicants who will be less than twenty-one (21) years of age at the beginning of the semester for which they are applying for admission, and who have completed less than 24 credit hours of college course work must meet the minimum course requirements for

admission to SD Public Higher Education Institutions. (See “South Dakota Board of Regents minimum Undergraduate Admission Requirements.”)

Transfer applicants will be notified of their admission status at School of Mines shortly after all of the above documents have been submitted. No transfer credit evaluation will be made until “final” college/university transcripts are on file. Transfer credit evaluation is made by the Office of Academic and Enrollment Services in consultation with the head of the academic department in which the applicant intends to major.

Undergraduate International Student Admission

To be considered for admission, international students must meet the following requirements:

1. Rank in the upper half of secondary school graduation class.
2. Have a 3.0 (B) grade average if transferring from a college or university in the United States.
3. Be proficient in English or attend an approved intensive English as a Second Language (ESL) program upon arrival.
4. Provide two letters of recommendation from teachers or professors familiar with the students’ academic work.
5. Be financially self-sustaining. (Admission to School of Mines is not dependent on the ability to show adequate financing for education, but the I-20 will not be issued without this information.)

The following items are necessary before a request for admission can be processed, acceptance granted, and the United States Department of Justice Form I-20 issued. The form I-20 is necessary for admission to the United States for college attendance. The U.S. Embassy or Consulate website in your country will supply detailed information on the application process for the required student visas. This information may also be available from an EducationUSA office, which may be located near the Embassy or Consulate <<http://www.educationusa.state.gov/>>.

The State Department offers general information on visa applications at: <<http://travel.state.gov/>>.

1. A completed application for admission to the Office of Admissions submitted prior to June 30 (fall) or November 10 (spring) and the State of South Dakota application fee of \$20.00. (The application will not be processed until the \$20.00 US fee is paid.) The deadline for the application is at least sixty (60) days prior to the beginning of the term for which admission is desired.

2. Academic credentials (translated into English). All documents submitted to School of Mines to substantiate a request for admission must be certified by an official school or governmental seal. An academic department may require submission of academic credentials to an independent credential evaluation service, the charge for which will be paid by the student. School of Mines only accepts credential evaluations from specified organizations. Please contact the Admissions Office or the Ivanhoe Center at Ivanhoe@sdsmt.edu.

3. English proficiency for students from countries in which English is not the native language must be verified by the TOEFL (Test of English as a Foreign Language) examination that is available through the Educational Testing Service (ETS). The results must be sent to the Office of the Registrar and Academic Services South Dakota School of Mines and Technology 501 E. Saint Joseph Street Rapid City, SD 57701-3995 A TOEFL score of 530 (paper-based), 197 (computer-based), or 71 (Internet based) or better is required for undergraduate applicants. Information on worldwide test centers for the TOEFL, as well as registration information, can be obtained by contacting any U.S. Embassy or Consulate or by writing to Test of English as a Foreign Language, ETS, Princeton, NJ 08540, or by visiting their website at: <www.toefl.org/>.

Other English proficiency examinations, such

as the IELTS, will be considered on an individual basis. For Norwegian students, School of Mines will accept in lieu of the TOEFL examination a favorable recommendation from a Norwegian professor who has been on a School of Mines exchange status, or who is familiar with admissions standards at School of Mines.

4. Recommendations from two (2) professors or instructors familiar with the academic performance of the applicant.

5. Affidavit of Financial Responsibility. Admission to School of Mines is not dependent on the ability to show adequate financing for education, but the I-20 will not be issued without this information. The United States Citizenship and Immigration Service (USCIS) requires that a U.S. college or university issuing form I-20 or DS-2019 establish that the person to whom the form is issued is able to pay all educational and incidental expenses. The international applicant must provide a statement of finances (in English). This includes a financial (bank) statement from the student or sponsor, which must be verified by a bank official. (The bank statement must show the actual amount—or more—that is available to the student. A statement that says “ample funds” is not acceptable.) If the student has a financial sponsor, a letter or affidavit of support must accompany the financial statement. If the sponsor is a government agency, a letter of award and instructions for invoice procedures should be sent. International students are not eligible for School of Mines or federal loan programs and should not apply for such financial assistance.

6. International students must attend the school specified on their visa or they may be refused admittance to the United States. A student entering the United States for study must maintain his/her status. More information is available at the Ivanhoe International Center. Prospective students should not enter the United States on a B-1 or B-2 visitor’s visa, as

the USCIS will not approve a change to the F-1 student visa. International students must not, under any circumstances, enter the United States with a WT if they are planning to become a full-time student. The WT status cannot be changed or extended, under any circumstances, once the student is in the United States. US government reporting requirements have been added for international students (F and J status) in recent years. As a result of the regulations that became effective on January 1, 2003, the Family Educational Rights and Privacy Act (FERPA) is waived for F and J students in respect to these specific reporting requirements. The regulations will be strictly enforced by the appropriate bureau(s) within the US Department of Homeland Security (DHS) and information will be reported electronically to DHS via Student and Exchange Visitor Information System (SEVIS). The consequences to students for non-compliance with these regulations are severe. For more information, email the Ivanhoe Center at Ivanhoe@sdsmt.edu or go to <http://international.sdsmt.edu>.

Electronic University Consortium

In fall 2000, the Electronic University Consortium (EUC) came online at: www.WorldClassEducation.org. The EUC provides a single connection point for distance education offerings from South Dakota School of Mines and Technology, as well as our sister institutions South Dakota State University, University of South Dakota, Dakota State University, Northern State University, and Black Hills State University. Students from throughout the world are able to register for and participate in classes offered via the Internet from any of these institutions. Courses offered by two-way interactive video and by correspondence are also listed on the EUC.

Current Reduced Tuition Programs for Non-Residents

The current non-resident tuition rate is 150

percent of the resident rate: \$123.85 per credit hour compared to \$82.60. For more information, contact Janelle Toman at (605) 773-3455 or send e-mail to janellet@sdbor.edu.

Reduced tuition is available for non-resident first-time freshmen, children of alumni, new transfers, and international students. Those undergraduate students will qualify for a rate of 150 percent of what residents pay. Students already enrolled in the public university system prior to summer 2006 will not be eligible for the new non-resident rate. Tuition assistance is also available to National Guard members, ROTC cadets, South Dakota State Employees, certain elementary and secondary school teachers and vocational instructors, and persons 65 years of age or older. Graduate students who hold a state contract for an assistantship or fellowship may also be entitled to special reduced tuition and should contact the Graduate Education Office at (605)394-1206. For current tuition information see the web site: <www.sdsmt.edu>.

Minnesota Reciprocity

Students from Minnesota can currently come to the South Dakota School of Mines and Technology at a comparable rate to Minnesota resident tuition under the Minnesota Reciprocity agreement. To apply, or for more information: <www.sdbor.edu/administration/policy_planning/MNSDR reciprocity.htm>

Resident and Nonresident Classification of Students

Purposes of Classification

Each person who applies for admission to a university shall be classified as a resident or a nonresident for admissions and tuition and fees purposes (See Policy 2:3 Admissions and Policy 5:5 Tuition and Fees).

Information, Burden of Establishing Residency, Reclassification

A. The decision shall be based upon information provided by the student and all other relevant information.

- B. The institution is authorized to require such written documents, affidavits, verifications, or other evidence as are deemed necessary to establish the residence of the student, including proof of emancipation, adoption, or appointment of a guardian.
- C. Students have the burden of establishing residency by clear and convincing evidence.
- D. Students may appeal the original classification decision by written petition to a reviewing body appointed by the chief executive officer of the institution within thirty (30) days after registration for that semester. The recommendation of the reviewing body shall be submitted to the chief executive officer for a decision. The decision of the chief executive officer shall be final, but students who have been classified as nonresidents retain full rights to petition the executive director of the South Dakota Board of Regents for reclassification after they have remained in South Dakota continuously for 12 months.
- E. After twelve (12) months continuous presence in South Dakota, students who were initially classified as nonresidents may petition for reclassification.
- F. Petitions for reclassification shall be filed with the Executive Director, who shall act upon them. The Executive Director shall report his disposition of such petitions to the Board at its regularly scheduled meetings. These reports shall be summarized in a manner consistent with the Family Educational Rights and Privacy Act.
- G. If a petition for reclassification is granted, the reduced tuition rate shall become effective with the first semester or session following the date on which the petition is granted. Students who fail to request resident status prior to a particular semester or session or to pursue a timely appeal shall be deemed to have waived any claim for reduced tuition for that semester or session.

- H. A student or prospective student who knowingly provides false information or refuses to provide or conceals information for the purpose of improperly achieving resident student status is subject to the full range of penalties, including expulsion, provided for by the Board of Regents.

Establishing Bona Fide Residency

For tuition purposes, residence means the place where a person has a permanent home, at which the person remains when not called elsewhere for labor, studies or other special or temporary purposes, and to which the person returns at times of repose. It is the place a person has voluntarily fixed as the person's permanent habitation with intent to remain in such place for an indefinite period. A person, at any one time, has but one residence and a residence is not lost until another is gained.

- A. The residence of an un-emancipated person younger than twenty-one (21) years of age follows that of the parents or of a legal guardian who has actual custody of the person or administers the property of the person. In the case of divorce or separation, if either parent meets the residence requirements, the person shall be considered a resident.

Students who enter the state for the predominant purpose of attending a Board institution and who are under the custody of a guardian in fact, that is, a person who has been designated in writing by the students' parents or legal guardian to serve as their attorney in fact for purposes related to the individual unemancipated student's affairs, may file a residency petition with the Board at the time of admission.

- B. A person shall be classified as a resident student if the person has continuously resided in South Dakota for at least 12 consecutive months immediately preceding the first scheduled day of classes of the semester or other session in which the individual registers in the Regental system; except that unemancipated students whose parents established their residence in South Dakota for

reasons not predominantly related to qualifying their children for reduced tuition, may be classified as residents, notwithstanding the fact that they have not resided in South Dakota for the requisite 12 months prior to the first scheduled day of classes.

If it appears that the parents of a person properly classified as a resident student under the provisions of this section have removed their residence from South Dakota, the person shall be reclassified to the status of nonresident unless the parents have been residents for the 12 months immediately preceding such removal. However, no such reclassification is effective until the beginning of a semester next following the removal.

- C. Physical presence in South Dakota for the predominant purpose of attending an institution of higher education controlled by the Board does not count in determining the 12-month period of residence. Absence from South Dakota to pursue postsecondary education does not deprive a person of resident student status.
- D. A person once properly classified as a resident student shall be deemed to remain a resident student so long as remaining continuously enrolled in the Regental system until the person's degree shall have been earned, subject to the provisions of (B) above.
- E. International students whose visas permit them to establish domiciles in the United States or its territories or protectorates may qualify for resident tuition in the same manner as United States citizens.

Factors to Be Considered When Determining Whether Students Have Entered South Dakota for the Predominant Purpose of Attending a Public University

- A. The following factors shall be considered relevant in evaluating a requested change in a student's nonresident status and in evaluating whether the person's physical presence in

South Dakota is for the predominant purpose of attending an institution of higher education controlled by the Board:

- The residence of an un-emancipated student's parents or guardians;
- The site of the source of the student's income;
- To whom a student pays taxes, including property taxes;
- The state in which a student's automobile is registered;
- The state issuing the student's driver's license;
- Where the student is registered to vote;
- The marriage of the student to a resident of South Dakota;
- Ownership of property in South Dakota and outside of South Dakota;
- The residence claimed by the student on loan application, federal income tax returns, and other documents;
- Admission to a licensed profession in South Dakota;
- Membership in civic, community, and other organizations in South Dakota or elsewhere; and
- The facts and documents pertaining to the person's past and existing status as a student.

B. The existence of one or more of these factors does not require a finding of resident student status, nor does the nonexistence of one or more require a finding of nonresident student status. All factors shall be considered in combination, and resident student status may not result from the doing of acts which are required or routinely done by sojourners in testate or which are merely auxiliary to the fulfillment of educational purposes.

C. The fact that a person pays taxes and votes in the state does not in itself establish residence.

D. Students who do not meet the requirements of this policy may still be classified as residents if their situation presents unusual circumstances and their

classification is within the general scope of this policy.

Retention of Residence While in Military Service

In determining the residence status for tuition purposes, it is presumed that persons in military service who list South Dakota as their "home of record" and who, immediately upon release, return to South Dakota to enter college shall be classified as residents.

Tuition and Fees

Tuition, Living, and Other Expenses

The following rates are effective May 11, 2009 and are subject to change by Board of Regents action. For current information see the website: <www.sdsmt.edu>.

| Tuition and Fees | Resident | Non-Resident |
|---|-----------------|---------------------|
| Undergraduate on-campus per semester credit | \$91.70 | \$137.45* |
| Graduate on-campus per semester credit | \$139.00 | \$294.25 |
| University Support Fee - per credit | \$ 89.10 | \$ 89.10 |
| General Activity Fee - per credit | \$ 32.45 | \$ 32.45 |

*New students and transfers for Academic Year 2007 or after
 * Does not include Minnesota rates. For more information, please refer to Minnesota Reciprocity information.

See accompanying text for the description of fees
for engineering and science courses as well as labs.

| Resident Hall Rent - per semester | Resident | Non-Resident |
|--|-----------------|---------------------|
| Double Occupancy | \$1081.70 | \$1081.70 |
| Single Occupancy (Connolly) | \$1473.65 | \$1473.65 |
| Double with A/C | \$1316.75 | \$1316.75 |
| Quad with A/C | \$1497.90 | \$1497.90 |
| Deluxe Quad with A/C | \$1618.65 | \$1618.65 |

* For residency information, contact the Admissions Office or refer to Board of Regents Policy at:
 <www.sdbor.edu/policy/5_FinanceBusiness/>.

Reduced tuition is available for non-resident first-time freshmen, children of alumni, new transfers, and international students. Those undergraduate students will qualify for a rate of 150 percent of what residents pay. Students already enrolled in the public university system prior to summer 2006 will not be eligible for the new non-resident rate. Tuition assistance is also available to National Guard members, ROTC cadets, South Dakota State Employees, certain

elementary and secondary school teachers and vocational instructors, and persons 65 years of age or older. Graduate students who hold a state contract for an assistantship or fellowship may also be entitled to special reduced tuition and should contact the Graduate Education Office at (605) 394-1206.

*Students from Minnesota can currently come to the South Dakota School of Mines and Technology at a comparable rate to Minnesota resident tuition under the Minnesota Reciprocity agreement. To apply, or for more information: <http://www.sdbor.edu/administration/policy_planning/MNSDReciprocity.htm>.

Typical Education Expenses for Full Time Undergraduate For One Semester

Payment Process

All tuition and fees are required to be paid in full or other financial arrangement made with the Cashier's Office no later than the third day of fall and spring semester classes and first day of summer semester classes. For the student's convenience, electronic bill and payment services are provided. If no financial arrangement is made by these dates, a late charge will be assessed on the next day. Examples of other financial arrangements may include payment plans, deferments for financial aid, or third party payments. Students who owe a balance after the end of the add/drop period due to changes in class schedules are required to pay in full or to make other financial arrangements by the 19th class day for fall and spring semester. Since summer semester add/drop periods vary, check with the Cashier's Office for final financial arrangement dates for add/drop courses. If no financial arrangement is made, enrollments shall be cancelled.

Debit Card System

The South Dakota School of Mines Debit Card is a money management system activated through each student's ID card. After money is deposited into the student's personal Debit Card Flex Account, purchases made with the card will be deducted from the balance. The Debit Card can be used at the following locations: Dining Services, Miners' Shack Snack Bar, and School of Mines Bookstore. A Debit Card Flex Account can be established by making a deposit with Student Accounts/Cashier's Office in the upper level of the Surbeck Center.

Fees

Application Fee Application Fee

Non-refundable charge upon initial application for admission. \$20 undergraduate and \$35 graduate.

General Activity Fee

A fee assessed per credit hour to cover health, student union, student organizations and activities, child care, athletics, and intramurals.

University Support Fee

A fee assessed per credit hour used to purchase equipment, materials, and services in support of the instructional programs. Also, to assist in providing services that benefit students which are not funded from other sources.

Late Payment Charge

If tuition and fees are not paid before established due dates, late payment charges will be assessed. If financial obligations are not met when due, student may be administratively withdrawn for the university.

Special Expenses for Engineering and Science

A fee of \$20.40 per credit hour is charged for courses in engineering, physics, computer science, mathematics, chemistry, paleontology, technology management, and geology.

Lab Fee

\$53.20 is charged to each lab course. These funds are used for lab supplies, materials, and equipment.

Credit by Examination

This \$90.75 fee is charged for each course in which a student seeks credit by examination.

International Student Enrollment

This one-time \$120.95 fee is assessed at the time of the international student's first semester enrollment in addition to the regular application fee.

Vehicle Registration

All motor vehicles parked on campus must be registered with the Campus Safety Office. Contact this office at (605) 394-2251 for options, amounts, and appropriate display of parking permit or <www.sdsmt.edu/services/facilities>.

Transcript Fee

A transcript of credits is an authentic copy of the student's academic record. One complete transcript of credits is provided without charge to each student upon graduation. After that the charge is \$5.00 each, and \$2.50 each copy thereafter per request.

Indebtedness

A student who is indebted to the university and does not satisfy financial obligations when due may be withdrawn after notice from the university and will not be permitted to register or receive a transcript of grades until the indebtedness is paid. This applies to indebtedness for university tuition, room, board, fees, financial aid, and fines, but not to student organizations. If a student's account is placed with a collection agency, the student will be responsible for all collection costs, attorney's fees, and any other costs necessary for the collections of any unpaid balance.

Refunds

Withdrawal Refunds Information

Students who withdraw, drop out, or are expelled from School of Mines within the add/drop period (first 10 percent of term, commonly referred to as the census date) receive a 100 percent refund of tuition and course-related fees. Students who withdraw, drop out, or are expelled from the university after the add/drop period for the enrollment period for which they are assessed charges may be entitled to a refund of tuition, fees, and other institutional charges calculated through 60 percent of the enrollment period. The refund shall be determined by computing the percentage of an enrollment period remaining after the date of withdrawal times the tuition, fees, and other institutional charges originally assessed the student.

A student's withdrawal date is 1) When the student began the withdrawal process or officially notified School of Mines of intent to withdraw by contacting School of Mines Academic and the Office of Enrollment Service, or 2) The midpoint of the period for a student who leaves without

notifying School of Mines; or 3) at School of Mines option, the student's last documented date of academically related activity.

Federal Financial Aid Recipients: The U.S. Department of Education requires institutions to use the Return of Title IV Funds policy for students withdrawing from school and who are receiving Federal Title IV student financial aid. Title IV funds refers to the federal financial aid programs authorized under the Higher Education Act of 1965 (as amended) and includes the following Federal Student Aid programs: Subsidized and Unsubsidized Stafford Loan, Parent PLUS Loan, Grad PLUS Loan, Perkins Loans, Pell Grant, Academic Competitiveness Grant (ACG), National Science and Mathematics to Retain Talent Grant (SMART), Supplemental Educational Opportunity Grant (SEOG) and any other Federal Aid program enacted by Congress. Students are advised to review the information located at:

<<http://sdmines.sdsmt.edu/finaid/withdrawal>>.

Financial Aid

The following information is intended to be a brief overview of the financial aid process and programs at the School of Mines. More up to date and detailed information is available on our website at: <<http://sdmines.sdsmt.edu/finaid>>.

With over 80 percent of our students receiving in excess of \$11.5 million in various forms of financial assistance from both within and outside the university for the 2007-08 school year, it is clear that many college students find it necessary to supplement their personal and family financial resources in order to attend college. The South Dakota School of Mines and Technology administers a comprehensive financial aid program to enable capable, qualified, and needy students to finance their college education with both need-based aid (grants, subsidized loans, and work-study) and non-need based aid (scholarships, outside agency assistance, unsubsidized loans, private alternative loans, etc.). However, the student should still be prepared to pay for a portion of college costs through savings from employment, and parents of dependent students are expected to assist with the student's cost of education to the extent to which they are able.

The School of Mines gives priority in the awarding of the Federal Perkins Loan, Federal Supplemental Education Opportunity Grant (SEOG), and Federal Work-Study (FWS) to students whose Free Application for Federal Student Aid (FAFSA) has been received by the FAFSA processor on or before our March 15th initial awarding date. The March 15th initial awarding date has no bearing on the awarding of the Federal Pell Grant, Federal Stafford Loan, Federal Grad PLUS Loan, or the Federal Parent PLUS Loan.

I. General eligibility requirements for awarding Federal Student Aid

A. Must have applied for admission in a School of Mines degree program

B. Complete a new FAFSA each year to determine eligibility for Federal Student Aid Programs.

C. Be a U.S. citizen or eligible non-citizen.

D. Not be in default on a federal student loan or owe a federal student grant repayment.

E. Male students born after December 31, 1959, must register with Selective Service.

F. Follow the steps for reviewing your award letter at:
<[://sdmines.sdsmt.edu/finaid/award.letter](http://sdmines.sdsmt.edu/finaid/award.letter)> and return the award letter and all required forms . to the Financial Aid Office.

G. Complete the School of Mines Authorization to Apply Federal Student Aid form and return with the award letter to the Financial Aid Office.

H. Report to the Financial Aid Office any aid assistance received that is not listed on the award letter, which includes, but is not limited to scholarships, Voc-Rehab, Veterans Benefits, BIA/Tribal Assistance, etc.

I. Be enrolled as a full-time student to receive full amount of aid awarded (indicate on the award letter if the planned enrollment will be less than full time and notify the Financial Aid Office if the planned and/or actual enrollment changes at any time).

J. Must maintain Satisfactory Academic Progress toward the completion of a School of Mines degree. Students who meet or exceed the standards as stated at:
<<http://sdmines.sdsmt.edu/finaid/SAP>> can be assured of continued eligibility until the completion of their degree.

II. Financial aid programs

The School of Mines is a full participant in the Federal Student Aid Programs. Specific information about each program is available at: <<http://sdmines.sdsmt.edu/finaid>>.

The student's School of Mines award letter identifies the aid he or she is being awarded and provides information for finalizing the processing of the award.

A. Grants are gift aid based on financial need.

1. The Federal Pell Grant is awarded to students who have not yet completed their first bachelor's degree and is based on a federal formula used to analyze the information provided on the FAFSA.

2. Federal Supplemental Educational Opportunity Grant (SEOG) is awarded to Pell Grant eligible students and the availability of funds.

3. Academic Competitiveness Grant (ACG) ACG is a two-year federal grant program awarded to U.S. Citizens and eligible non-citizens who have engaged in a rigorous high school course of study and are eligible for the Pell Grant program. Students who have completed 32 or more credit hours and have at least a 3.00 cumulative grade point average progress to the 2nd year of the program.

4. National Science and Mathematics Access to Retain Talent (SMART) is a two-year federal grant available to Pell Grant eligible students who have completed 64 or more credit hours and have maintained a 3.00 or higher cumulative grade point average that is evaluated at the end of each semester while a student at the School of Mines. Students progress to the second year of the program once they have completed 96 or more credit hours. Students in the following degree programs are eligible: Chemical Engineering, Chemistry, Civil Engineering, Computer Engineering, Computer Science, Electrical Engineering, Environmental Engineering, Geological Engineering, Geology, Industrial Engineering, Mathematics (Applied and Computational), Mechanical Engineering, Metallurgical Engineering, Mining Engineering and Management, and Physics.

B. Student loans provide an opportunity for students to borrow money for educationally related expenses. However, like any loan, they must be repaid according to the provisions of the promissory note. First time loan recipients are required to complete Entrance Loan Counseling as shown at:

<<http://sdmines.sdsmt.edu/finaid/loancounseling>>.

1. The Federal Subsidized and Unsubsidized Stafford Loan programs are obtained from a bank or credit union. For the Subsidized Stafford, the Federal Government pays accrued interest to the lender on behalf of the student during periods of at least half-time enrollment or other eligible deferment periods. However, with the Unsubsidized Stafford Loan, the Federal Government does not pay the accrued interest to the lender on behalf of the student while enrolled in school or during available deferment periods, with interest accrual beginning at disbursement. For both the Sub and Unsub Stafford Loans, payment on the principal balance is required to begin six months after the student graduates or is no longer enrolled at least half-time. Current interest information is available on our web site.

2. The Federal Perkins Loan is a Federal Loan program administered by the School of Mines. The interest rate is fixed at 5 percent and repayment begins nine months after graduation or at least half-time enrollment ends.

3. The Federal Grad PLUS Loan is available to graduate students (masters and Ph.D.) who have exhausted their eligibility for the Subsidized and Unsubsidized Stafford Loan programs. Monthly payments begin 60 days after the final disbursement for any academic year with a current fixed rate of 8.5 percent.

4. The Federal Parent PLUS is borrowed on behalf of the parent's dependent student. Monthly payments begin 60 days after the final disbursement for any academic year with a current fixed interest rate of 8.5 percent.

5. Short-Term Loans are offered in addition to Federal and Alternative Loan programs. The Short Term Loan program was established by alumni, relatives, friends of the university, and community organizations. Students who have completed at least one semester at the School of Mines with a satisfactory scholastic record are eligible for assistance from the Short Term Loan program. Information regarding this program may be obtained from the Financial Aid Office.

C. Work opportunities for part-time employment.

1. Federal Work-Study awards are based on financial need as determined by the results of the FAFSA and the awarding policy of the School of Mines. Employment opportunities are available both on and off campus with off-campus positions focused on community service.

2. Other employment opportunities submitted by local employers or the South Dakota Job Service are regularly posted in the Surbeck Student Center.

D. Scholarships and Fellowships from the School of Mines

In order to be considered for incoming freshman scholarships at the School of Mines, prospective students must have completed all admission application requirements no later than the first business day in February prior to the year they plan to attend. The online admission application available at:

www.GoToMines.com/admissions/apply is all that is needed for scholarship consideration. However, if the prospective student completed the common South Dakota Public Higher Education Undergraduate Application for Admission, please go to www.GoToMines.com/supplemental and complete the Undergraduate Supplemental Application for Admissions and Scholarships. At the School of Mines, students apply for and are awarded a “scholarship” without regard for specific donor funding. The Foundation Office then assigns the scholarship recipients to the

various donors based on the donor’s criteria.

1. Four-Year Support Scholarships

The most prestigious scholarship assistance on campus provides assistance for incoming freshmen with renewable support for three years provided the recipient maintains full time enrollment (at least 12 School of Mines credit hours each semester), a 3.0 or higher cumulative grade point average (based upon a 4.0 scale) and is continuing progress toward completion of their degree.

2. Annual Scholarship Support

Unless otherwise notified by the Scholarship Committee or department, current students are not required to complete an application for annual, non-renewable scholarships that are based on academic performance at the School of Mines and scholarship criteria. All scholarship recipients at the School of Mines must maintain full time enrollment (at least 12 School of Mines credit hours each semester) and maintain the grade point average as required by the scholarship. If the scholarship is major specific, the recipient must maintain enrollment in the appropriate course work needed for that major.

3. National Merit Finalists

The School of Mines offers a \$3,000 scholarship renewable for three years to National Merit Finalists who notify the National Merit Corporation via the PSAT/NMSQT that the School of Mines is their first-choice college. Full time attendance (at least 12 School of Mines credit hours each semester) and a 3.00 or higher cumulative grade point average are required for renewal.

4. Graduate Student Support

Graduate students should contact the Graduate Education Office at the School of Mines regarding available fellowships.

III. Carefully review your billing statement

The Student Accounts Office will send an e-mail notification to the student’s Mines e-mail account informing him or her of availability to

access their billing statement before each semester and whenever there is a change to the student's account. Please pay attention to the amount owed and the payment guidelines set by the Business Office. Be advised that aid that requires the student's endorsement on a check and Work-Study awards will not appear on the billing statement.

IV. Disbursement of aid

With the exception of Federal Work-Study, which is paid monthly, and some scholarships, which are paid according to the wishes of the donor, financial aid is either credited to the student's account or disbursed by check at the beginning of each semester, or after aid eligibility is determined, whichever is later. If the aid applied to the student's account exceeds institutional costs, he or she will either receive a cash disbursement (refund check) in the mail or the funds can be deposited directly to the student's bank account via Direct Deposit. Students can contact the Student Accounts Office for further information on Direct Deposit option. In the event that there are delays in disbursing of aid, students should always have available enough money to meet immediate expenses they might incur at the beginning of each semester, such as the purchase of books and supplies.

V. Multi-Institution Students

At times it may be necessary to take classes at one of the other South Dakota Board of Regents universities in order to complete the student's degree requirements. Other than to sign up for classes through their School of Mines log on to WebAdvisor, no special arrangements need to be made in order to include those classes in their enrollment status for financial aid purposes at School of Mines. However, if the student plans to take classes at a non-Board of Regents school, they must contact the Financial Aid Office to determine if classes taken there can be used to fulfill degree requirements at the School of Mines and to determine their overall semester enrollment status.

School of Mines scholarship and fellowship recipients must receive prior approval from the

Financial Aid Director in order to use non-School of Mines credit hours to meet the full time School of Mines credit hour requirement for scholarship and fellowship disbursement.

VI. Correspondence Studies

The School of Mines does not offer courses via correspondence. However, students are advised to discuss possible options with the Financial Aid Director for receiving assistance to help pay for this type of course work taken at another eligible institution.

VII. Summer financial aid and effect on eligibility for the coming school year

Students who are interested in receiving aid for the summer must have completed the FAFSA for the coming school year. Their aid award will be based on a summer, fall, and spring academic year. As a result, receiving aid for the summer will directly impact the amount of aid available for the fall and spring semesters. Generally, students must carry at least a half-time course load [6 credits for undergraduate and 4.5 for graduate students] to be eligible for summer financial aid. A School of Mines Summer Aid Application, which is available after March 31, must be completed before the student will be considered for summer aid.

VIII. Withdrawal and refunds

Due to circumstances that may or may not be beyond the student's control, it may become necessary to withdraw from all classes prior to the end of a particular semester. Depending on the withdrawal date, the student may be entitled to a full or partial refund of tuition and fees, tablet PC rental, and if contracting with the university, for room and board.

A withdrawal is considered to be official when the student comes to the Office of the Registrar and Academic Services, Room 216 of the O'Harra Building to initiate the process. If that is not possible, he or she may call (800) 544-8162, Ext. 2400 or local at (605) 394-2400. In the event that the student leaves school without notifying the Office of the Registrar and Academic Services, or simply never attends classes and receives a 0.00

GPA for the semester, the university has the option of considering the withdrawal date to be 1) the midpoint of the period of enrollment; 2) the last documented date of academically related activity; or 3) if he or she did not notify the Office of the Registrar and Academic Services due to circumstances beyond his or her control, the date relative to that circumstance, whichever is later. It is important that a student clearly state that he or she is withdrawing from all classes. Dropping a class and withdrawing from all classes have a different impact on a student's status with the university. If enrolled at more than one campus within the South Dakota Board of Regents university system, he or she must inform The Office of the Registrar and Academic Services staff whether the intent is to withdraw from all campuses, or just from the School of Mines.

Students who have requested a Financial Aid Consortium Agreement between the School of Mines and a non-Board of Regent institution and are using those credit hours to determine their enrollment status for financial aid, must be withdrawing from both institutions in order for their withdrawal from the School of Mines to result in a refund calculation. Please review the withdrawal procedures outlined elsewhere in the college catalog. Information is also available on our website at:

<<http://sdmines.sdsmt.edu/finaid/withdrawal>>.

Examples are provided regarding what refund a student could expect to receive based on when he or she withdraws.

IX. Additional Information

Requests for additional information should be directed to the Financial Aid Office, South Dakota School of Mines and Technology, 501 E Saint Joseph St., Rapid City, SD 57701-3995, or call locally (605) 394-2274, or toll free (877) 877-6044 or via e-mail at FinancialAid@sdsmt.edu.



Mines Matters: School of Mines students receive more than \$11 million annually in financial aid and scholarships. Eighty percent of School of Mines students receive some form of financial aid, with an average award of \$7,681.

Academic Information

Academic Organization

Academic organization of the South Dakota School of Mines and Technology centers around 16 departments.

Faculty and staff members of all departments work closely together to support and develop:

- quality undergraduate educational opportunities;
- focused quality graduate education;
- research and other scholarly activities in support of educational opportunities at the undergraduate and graduate levels;
- service programs for the people of the state of South Dakota, the region, and the nation.

Academic departments at South Dakota School of Mines and Technology are organized as follows:

Atmospheric Sciences
Chemical and Biological Engineering
Chemistry
Civil and Environmental Engineering
Electrical and Computer Engineering
Geology and Geological Engineering
Humanities
Industrial Engineering and Engineering Management
Math and Computer Science
Mechanical Engineering
Metallurgical Engineering
Military Science
Mining Engineering and Management
Physical Education
Physics
Social Sciences

Minors

- Minors are available in some degree-granting

departments and programs.

- No undergraduate degree program requires a minor.
- Regental undergraduate minors consist of 18-24 semester credit hours.
- No fewer than nine (9) semester credit hours in a minor must be taken at School of Mines.
- A cumulative grade point average of 2.00 or better must be attained in the course work defining the minor.
- The specific courses required for a minor in each department and program offering a minor can be found in the section of this catalog where that program is described.
- Notification of intent to seek a minor is to be in effect no later than the time of registration for the first semester of the senior year (96 or more credit hours completed) on a form available in the Office of Academic and Enrollment Services . This form must be approved and signed by the head of the department from which the degree will be awarded, and the head of the department from which the minor will be awarded.

Credit Hours Definition

The amount of academic work scheduled or “carried” by a student is measured in terms of credit hours. A credit hour is three hours of in-class time and preparation combined per week for one (1) semester. A recitation or lecture is scheduled as one fifty-minute period plus two (2) hours of preparation for an average student per week per credit hour. Each credit hour of laboratory work is scheduled as one-hundred-ten to one-hundred-seventy (110 to 170) minutes per week. Laboratories scheduled for two (2) hours per credit hour are expected to require one (1) hour of work outside of the scheduled time per week per credit hour.

Classification of Undergraduate Students

All undergraduate students will be assigned one of the following admissions categories:

1. Regular: An admitted, enrolled student, who is pursuing a degree at the School of Mines.
2. Special: An enrolled student who has not been admitted, and is not pursuing a degree, will be permitted to accumulate more than thirty (30) hours only on an exceptional basis. Special students do not qualify for federal student aid or institutional scholarships.

An Admissions Office review is required in order for a student to move from one admissions category to another.

Freshman, sophomore, junior, or senior classification of undergraduate students is based on accumulated credits for courses passed:

0 to 31.99 credits - Freshman

32 to 63.99 credits - Sophomore

64 to 95.99 credits - Junior

96 or more credits - Senior

A full-time undergraduate student is defined as a student who is enrolled in at least twelve (12) credit hours during an academic term. An academic term is defined as fall, spring, and summer. A student on a cooperative education assignment who is registered for CP (Co-Op) credit shall be considered to have full-time status.

See the graduate student general information section of this catalog for the definition of a full-time and half-time graduate student.

Course Numbering System

Tuition for courses numbered 000 through 499 will be assessed at the undergraduate rate for all students.

Pre-College Courses

001-099 Pre-college, remedial skills, special improvement (non-degree credit)

Undergraduate Courses

100-199 Freshman level

200-299 Sophomore level

300-399 Junior level

400-499 Senior level (may be dual listed with 500 level graduate course)

Tuition for courses numbered 500 through 899

will be assessed at the graduate rate for all students.

Graduate Courses

500-599: Entry level graduate (may be dual listed with a 400 level undergraduate course and may include limited enrollments by undergraduates)

600-699: Graduate level (undergraduate enrollment only by exception)

700-799: Graduate level (Graduate students only)

800-899: Doctoral and post-doctoral level (Doctoral and post-doctoral students only)

Experimental Courses

Experimental courses can be offered for a maximum of two (2) times before formal approval is received, but they must be reported through the system curriculum approval process.

Enrollment in Courses

A. Undergraduate Courses (001-499)

1. All undergraduate and graduate students enrolling at Regental universities in courses numbered 001-499 shall be admitted as undergraduate students (either-degree seeking or non-degree seeking) and registered at the undergraduate level. For all undergraduate and graduate students enrolling at Regental universities in courses numbered 001-499, the courses shall be recorded on the transcript at the undergraduate academic level and included in the calculation of all undergraduate grade point averages.

2. When an undergraduate course is used on a converted credit basis (transferred for one level to another) to meet graduate plan of study requirements at Regental universities, the course shall be recorded on the transcript at the undergraduate academic level with the credit hours approved for the course and then duplicated at the graduate level through an internal transfer policy (Refer to BOR policy 2:5.16). At the undergraduate level, the credit is included in the

calculation of the undergraduate institutional grade point average and the undergraduate cumulative grade point average at the full credit rate. At the graduate level, the credit is included in the calculation of the graduate institutional grade point average and the graduate cumulative grade point average at the converted credit rate (transferred for one level to another).

3. Undergraduate courses required as prerequisites in preparation for registration in graduate courses shall be recorded on the transcript at the undergraduate level and will not be duplicated at the graduate level because the courses are not a part of the Regental graduate plan of study.

B. Graduate Courses (500-899)

1. All undergraduate and graduate students enrolling at Regental universities in courses numbered 500-899 shall be admitted as graduate students (either degree seeking or non-degree seeking) and registered at the graduate level. For all undergraduate and graduate students enrolling at Regental universities in courses numbered 500-899, the courses shall be recorded on the transcript at the graduate academic level and included in the calculation of all graduate grade point averages.

2. When a graduate course is used on a converted (transferred for one level to another) or actual credit basis to meet undergraduate degree requirements for a Regental accelerated program, the course shall be recorded on the transcript at the graduate academic level with the credit hours approved for the course and then duplicated at the undergraduate level through an internal transfer policy (Refer to BOR policy 2:5.16). At the graduate level, the credit is included in the calculation of the graduate institutional grade point average and the graduate cumulative grade point average at the full credit rate. At the undergraduate level, the credit is included in the calculation of the undergraduate institutional grade point average and the undergraduate cumulative grade point average at the converted

(transferred for one level to another) or actual credit rate.

C. Undergraduate Students Taking Graduate Courses

Undergraduate students who have completed a minimum of 96 credit hours may enroll in a limited number of 500 level courses. The Vice President for Academic Affairs may grant an exception for enrollment in a 600 level course. The student shall pay graduate tuition and the courses shall be recorded on a graduate transcript. These graduate courses may apply to an undergraduate degree.

D. Repeated Enrollment in the Same Course

1. A student may enroll in an undergraduate course (for which credit is granted only once) no more than three times without written permission of the Vice President for Academic Affairs.

Students wishing to appeal must complete the Application for Academic Appeal form that is available at the Office of the Vice President for Academic Affairs or can be downloaded from: <http://sdmines.sdsmt.edu/studentlife/forms>.

2. A student may enroll in a graduate course (for which credit is granted only once) no more than two times without permission of the Dean of Graduate Education.

3. A student will be allowed unlimited enrollments in an undergraduate or graduate course for which credit toward graduation may be received more than once. An institution may limit the number of credit hours for courses that may be taken more than once that apply toward the requirements for a major.

Graduate Credit

Graduate credit for School of Mines seniors, per faculty adopted regulations: “An undergraduate student who has senior standing at School of Mines and is ranked in the upper one-half of the class, may petition the Dean of Graduate Education on a form provided by the Office of the Registrar and

Academic Services for the purpose that a course be recorded on his/her graduate record.”

The following conditions or limitations apply:

1. The student must attest that he/she is planning to continue work toward an advanced degree at the South Dakota School of Mines and Technology, but must understand that the university is under no obligation to credit courses so attempted toward any advanced degree until a graduate program of study has been approved.
2. The course(s) must be numbered 500-699.
3. The course(s) must not be required for his or her undergraduate degree; the hours may not count toward the 128 or 136 semester credit hours required for the Bachelor of Science degree.
4. The extra courses should not create an overload upon the student.
5. Not more than twelve (12) hours of graduate credit taken as a School of Mines undergraduate may be applied toward an advanced degree at the South Dakota School of Mines and Technology. Upon written justification by the head of the student’s major department, the Dean of Graduate Education may approve a minor variance from this limit.
6. Petitions from undergraduate students other than those defined above will not be accepted. (See graduate student general information section of this catalog for graduate policy.)

Undergraduate Grading System

Undergraduate grades will be assigned to the undergraduate academic level and to all courses and sections with course numbers ranging from 001 to 499. Plus and minus grades are not used.

A Exceptional

4.00 grade points per semester hour

B Above Average

3.00 grade points per semester hour

C Average

2.00 grade points per semester hour

D Lowest Passing Grade

1.00 grade points per semester hour

F Failure

0.00 grade points per semester hour

S Satisfactory

Does not calculate into any GPA

U Unsatisfactory

Does not calculate into any GPA

RI Incomplete (Remedial)

Does not calculate into any GPA

RS Satisfactory (Remedial)

Does not calculate into any GPA

RU Unsatisfactory (Remedial)

Does not calculate into any GPA

W Withdrawal

Does not calculate into any GPA, no credit granted

AU Audit

Does not calculate into any GPA

I Incomplete

Does not calculate into any GPA

IP In Progress

Does not calculate into any GPA

EX Credit by Exam

Does not calculate into any GPA

CR Credit

Does not calculate into any GPA

LR Lab grade linked to recitation Grade
O credit course

NR Grade not Reported by Instructor
Does not calculate into any GPA

NG No grade
O credit tracking course

TR Note for NSE/MEDT
Does not calculate into the GPA

Academic Amnesty*

Does not calculate in any GPA, no credit given
*Letter grade followed by an asterisk indicates Academic Amnesty granted.

An incomplete (I) grade may be granted only when all of the following conditions apply:

- a. A student has encountered extenuating circumstances that do not permit him/her to complete the course.
- b. The student must be earning a passing grade at the time the incomplete is necessitated. Anticipated course failure is not a justification for an incomplete.
- c. The student does not have to repeat the course to meet the requirements.
- d. The instructor must agree to grant an incomplete grade.
- e. The instructor and student must agree on a plan to complete the course work.
- f. The course work must be completed within one semester; extensions may be granted by the Vice President for Academic Affairs/Provost.
- g. If the student completes the course within the specified time, the grades that may be assigned are A, B, C, D, F, S, RS, RU, or U.
- h. If the student does not complete the course within the specified time, the grade assigned will be F (Failure) or U (Unsatisfactory) or RU (Remedial Unsatisfactory).

An in progress (IP) grade may be granted only when all of the following conditions apply:

- a. The requirements for the course (for every student enrolled in the course) extend beyond the current term.
- b. The extension beyond the current term must be defined before the class begins.
- c. The instructor must request permission to award IP grades for a course from their department head, and then approval must be obtained from the Vice President for Academic Affairs.
- d. A definite date for completion of the course must be established in the course syllabus.

An audit (AU) grade may be granted only when the student has elected the AU option on or prior to the census date of the term.

A credit (CR) grade may be granted only for non course credit that is not related to an examination or to equating transfer grades to the BOR grading system. This grade is not used for any Regental university courses.

An examination for credit (EX) grade may be granted only for non course credit validation obtained through a validation process. This grade is not used for any Regental university course.

Definition of Grade Point Averages

The following grade point averages are calculated each academic term (fall, spring, summer):

Institutional GPA-based on credits earned at a specific Regental university. Utilized to determine if degree requirements have been met and to determine honors designation at graduation.

System Term GPA-based on credits earned at any of the six Regental universities within a given academic term (fall, spring, summer). Utilized to determine minimum progression status.

Transfer GPA-based on credits earned and officially transferred from an accredited college or university outside the Regental system. When a letter grade that normally calculates into the grade point average exists for a non-academic course (e.g., credit earned via examination), it will be included in the transfer GPA.

Cumulative GPA-based on all credits earned by the student (transfer credit plus system credit). Utilized to determine minimum progression status, to determine if degree requirements have been met and to determine honors designation at graduation.

Calculation of grade point averages when undergraduate courses are repeated

When a student repeats an undergraduate course, only the last attempt (take) that received a grade (excluding AU, any amnesty grade, I, IP, NR, RI, and W) will count toward graduation and into grade point averages. Also refer to BOR policies 2:4 and 2:5.

| Class | Credit Hour Range | GPA Standard |
|-----------|-------------------|--------------|
| Freshman | 0-31.99 | 2.0 |
| Sophomore | 32-63.99 | 2.0 |
| Junior | 64-95.99 | 2.0 |
| Senior | 96+ | 2.0 |

Minimum Progression Standards

Minimum progression standards and related actions are based on the student’s cumulative grade point average and system term grade point average.

1. A student with a cumulative grade point average of 2.0 or better is considered to be in good academic standing.
2. If a student’s cumulative grade point average falls below 2.0 in any academic term (i.e. fall, spring, summer), the student is placed on academic probation the following term.
3. While on academic probation, the student must earn a system term grade point average of 2.0 or better.
4. When a student on academic probation achieves a cumulative grade point average of 2.0 or better, the student is returned to good academic standing.
5. A student on academic probation who fails to maintain a system term grade point average of 2.0 or better is placed on academic suspension for a minimum period of two academic terms.
6. Students on academic suspension will not be allowed to register for any course work at any

Regental university except when an appeal has been approved by the Regental university from which the student is pursuing a degree. An approved appeal granted by one Regental university will be honored by all Regental universities. Also refer to policy 2:3.G Probation/Suspension of Students.

7. Only Academic Suspension will be entered on the student’s transcript. Academic probation will be noted in the internal academic record only.

Progression and graduation are contingent on satisfactory performance on the Proficiency Examination. Refer to policy 2:28.

Academic Amnesty

The goal of academic amnesty is to respond to the academic needs of matured individuals as they develop newly identified potential. Through the application of academic amnesty, the student’s prior academic record can be excluded from current work under certain conditions.

Eligibility

The student must:

1. be an undergraduate, full-time or part-time, degree-seeking student at one of the universities in the South Dakota Regental system.
2. not have been enrolled in any Regental university for a minimum of three calendar years (nine (9) consecutive terms including fall, spring, and summer) prior to the most recent admission to the home institution. Exceptions may be granted in rare cases only by the Board of Regents Senior Administrator upon recommendation by the Vice President for Academic Affairs.
3. have completed a minimum of twenty-four (24) graded credit hours taken at any Regental university with a minimum grade point average of 2.0 for the twenty-four (24) credit hours after the most recent admission to the home institution.
4. not have earned a baccalaureate degree from any university.

5. not have been granted any prior academic amnesty at any Regental university.
6. submit a formal Academic Amnesty Petition to his or her home university following the procedures established by that university.

Conditions:

1. Academic amnesty does not apply to individual courses. Academic amnesty may be requested for either (a) all previous post-secondary education courses, or (b) all previous post-secondary education courses at a specific institution, or (c) a specified time period not to exceed one academic year (fall/spring).
2. Academic amnesty, if granted, shall not be rescinded.
3. Courses for which academic amnesty is granted will:
 - a. remain on the student’s permanent record.
 - b. be recorded on the student’s undergraduate transcript with the original grade followed by an asterisk (*)
 - c. not be included in the calculation of the student’s grade point average because no credit is given.
 - d. not be used to satisfy any of the graduation requirements of the current degree program.
4. Academic amnesty decisions will be made by the student’s home institution and will be honored by all other institutions within the South Dakota Regental system.
5. Universities outside of the South Dakota Regental system are not bound by the academic amnesty decisions made by the South Dakota Regental system.
6. Regental graduate programs and graduate professional schools may consider all previous undergraduate course work when making admissions decisions.

Dean’s List Designation

Undergraduate, full-time and part-time students may be designated for the Dean’s List at the end of the fall and spring terms. The Dean’s List designation is determined by the home

university and is based on a student’s total course registrations for academic credit for the term from any Regental university. The Dean’s List designation does not appear on the transcript.

According to the South Dakota Board of Regents policy, undergraduate full-time students must meet the following guidelines to be awarded Dean’s List designation:

- Students must have earned a minimum of 12 credit hours in courses numbered 100-699 during the term.
- Students must achieve a System Term GPA of at least 3.50.
- Students with F, I, U, RI, or RU grades are not eligible regardless of System Term GPA attained.

Academic Recognition for Undergraduate, Part-Time Students

Undergraduate, part-time students taking fewer than 12 credits per term may be designated for academic recognition for part-time students at the end of the fall and spring terms. The academic recognition for part-time students designation is determined by the home university. The academic recognition for part-time students designation does not appear on the transcript.

To be awarded the academic recognition for part-time students designation, students must meet the following guidelines:

- Students must have completed at least 12 credits hours prior to the current semester at one or more Regental institution.
- The student must have earned at least 3 and up to 11 credit hours of 100-699 level courses during the term.
- Students must achieve a System Term GPA of at least 3.50.
- Students with F, I, U, RI or RU grades are not eligible regardless of System Term GPA attained.

Date for a Grade of W

Undergraduate and graduate students who drop a course, or withdraw from the System, shall receive a grade of “W” if that action occurs

anytime between the day after the census day for that course and the day that corresponds with the completion of 70 percent of the class days for that course. Likewise, a student who withdraws from the system during that time period also shall receive grades of “W” for all the courses in which he/she is registered.

For standard classes, the last day to receive a grade of “W” is determined by calculating 70 percent of the class meeting days in the term, counting from the first day of classes in the term and rounding up if the calculation produces a fractional value greater than or equal to 0.5.

For any non-standard course, the last day to receive a grade of “W” is based on the number of class meeting days for the course, using the method described above.

A notation of the date of withdrawal will be included on the student’s transcript if he/she withdraws from the system.

If a student withdraws from a course after the time period specified above, a grade of “F” will automatically be assigned by the Office of the Registrar and Academic Services.

Withdrawal from the University

The effective date used for students withdrawing from the university is the date that the withdrawal process is initiated in the Office of the Registrar and Academic Services. This notice must be given by the student using the appropriate forms. Dates for withdrawing from the university will be proportionally adjusted for summer terms of instruction.

Complete withdrawal from the university from the day after registration day through 70 percent of the class meeting days in the term results in the assignment of “W” grades unless the professor-in-charge has previously assigned a final grade. A withdrawal from the university must be initiated in the Office of the Registrar and Academic Services and processed through the Director of Retention and Testing. A withdrawal from the university will be processed only when all courses at all Regental universities are being dropped by a student.

If a student withdraws from the university after completion of 70 percent of class days,

grades of “F” automatically are assigned by the Office of the Registrar and Academic Services in all courses for which the student was enrolled unless a final grade has previously been issued by the course instructor. In the event that a final grade has not been assigned, consideration may be given to extenuating circumstances that may warrant the assignment of a grade of “W.” Should such extenuating circumstances exist, students wishing to appeal must complete the Application for Academic Appeal form that is available at the Office of the Vice President for Academic Affairs or can be downloaded from <<http://sdmines.sdsmt.edu/studentlife/forms>>. Such appeal must be filed within one term after the term in which the withdrawal occurred.

Re-admission Following Withdrawal

A student who has withdrawn from the university may be readmitted in that same semester by permission of the Vice President for Academic Affairs if the student has paid the appropriate tuition and fees.

Transcript of Credits

A transcript of credits is an authentic copy of the student’s academic record from each Regental university attended. The fee is \$5.00 for one copy, and \$2.50 for each additional copy per request. A transcript must include all courses attempted. Transcripts are released only on written request with the signature of the individual concerned. This order must be placed in person, by mail, or by FAX to the Office of the Registrar and Academic Services. Upon graduation each student is entitled to one complete transcript of the credits earned without charge.

Attendance

Every student is expected to attend each lecture or laboratory session for which he or she is scheduled. The faculty has allowed no system of authorized “cuts.” A student who fails to attend classes regularly must satisfy such requirements as the instructor in a course may prescribe.

Excused Absences for School Sponsored Events

The faculty recognizes extracurricular activities to be a valued component of student development and education. When an activity results in a classroom absence, the faculty members have agreed to accommodate students involved in these activities in accordance with this policy.

Procedures:

1. Students who participate in recognized activities will notify their instructors prior to the absence.
2. Students will be given the opportunity to make-up any exams missed in the course of the absence.
3. Students will consult with their instructors regarding the make-up/submission of other graded activities that will be missed as a consequence of the absence.
4. Recognized activities are those determined by the advisor of the sponsoring School of Mines organization or the coach of the involved athletic team. If there are any questions, the advisor or coach should consult with the Vice President for Student Affairs or Athletic Director.
5. All other arrangements (if allowable) for absences not covered under this policy must be decided through consultation between the faculty member and the student, and/or under the guidelines of the class syllabus of the instructor.
6. Unresolved issues may be taken up following the established School of Mines Grievance Procedure for Students Policy III-A-31.

Recognized activities under this policy are determined by the School of Mines advisor/coach. Upon request or as a standard process the advisor/coach may send an e-mail notice verifying the event.

Campus Clearing Policy

All graduating students are responsible for return of all college property, library books, keys, etc., and payment of all financial obligations to

the college before their diplomas will be released.

Conduct

South Dakota School of Mines and Technology subscribes to the widely recognized traditions and lawful missions of tax-supported higher education in the United States. These traditions and missions work to: (1) develop students to well-rounded maturity, physically, socially, emotionally, intellectually, and vocationally; (2) develop, refine, and teach ethical and cultural values; (3) teach the practice of excellence in thought, behavior, and performance; (4) teach principles of patriotism, civil obligation, and respect for the law; and (5) transfer the wealth of knowledge and tradition from one generation to the other. The regulations established by the Regents, faculty, or administration, have been developed to enhance the opportunities for fulfilling the above purposes. Students are expected to adhere to and support such policies.

In general, students are expected to conduct themselves as responsible citizens at all times and to uphold all federal, state and local laws. Conduct that is held detrimental to the college community (composed of students, faculty, staff and administration) may result in disciplinary action.

The Regents for the state supported institutions of higher learning in South Dakota have formulated the following policy statement relating to student conduct and behavior:

The attendance of a student at one of the higher education institutions under the jurisdiction of the Board of Regents is a voluntary entrance into the academic community. By such act the student assumes obligations of conduct and performance imposed by the institution. The constitutional rights of students will not be abridged by action of the academic community. The institutions may discipline or expel the student from the academic community for any intentional act, which disrupts or prevents the accomplishment of any lawful mission, process, or function of the institution or in order to secure compliance with the obligations of conduct and performance imposed. (Regents Policy Manual, Sec. 10.1.2. June 1990)

Complete details of current policy regarding student conduct, responsibilities, and disciplinary sanctions will be found in the student code of conduct brochure. A Code of Student Rights and Responsibilities and the Board of Regents Policy on Student Conduct was adopted in January of 1995. Adopted policy serves as a basic set of guidelines for students, faculty members, and administration. School of Mines judicial process provides all members of the student body with the facilities for appeal and adjudication.

Admission and enrollment in the university obligates the student to be familiar with and to abide by the standards and the rules and regulations of the university as well as the laws of the various levels of government. Students should be aware of and familiar with such laws, rules, and regulations with respect to their status on the campus, as defined in the student code of conduct. The student code of conduct is printed annually and is available to students at registration or upon request and online. Changes in some of these rules may be desirable from time to time, and student cooperation and participation in bringing about changes through appropriate channels is encouraged. However, violations of existing regulations will not be condoned and disciplinary sanctions may be imposed for such violations.



Registration

Academic Terms Defined

The School of Mines operates a fall, spring, and summer term. Fall and spring shall operate on a semester basis. Summer term begins the day after spring semester ends and continues until the day before fall semester begins.

A semester shall consist of a minimum of 15 weeks. The number of class days in a given semester shall be inclusive of those days set aside for registration, assessment/performance testing and final examinations but exclusive of holidays and days set aside for new student orientation. New student orientation may be concurrent with or prior to registration.

Academic guidelines require that all courses offered for credit must involve a minimum of 15 contact hours over 3 instructional days for each credit hour awarded.

Courses offered by distance education should have equivalent standards, rigor, student outcomes, substance and assignments as courses offered by face-to-face means. Distance education courses may be scheduled on a semester basis and require that students complete learning experiences on a particular timeline (i.e. each week). The required length for a distance education course is determined by course expectations and scheduling. The student will conclude the course upon completion of course requirements. Typically, a one credit hour course lasting for a semester equates to 45 hours of effort by the student.

Academic Calendar

Institutions of higher education, under control of the South Dakota Board of Regents, shall operate on a common academic calendar with common periods during the summer term and the fall and spring semesters at each institution when classes are not in session. Academic calendars shall be designed a minimum of two years in advance with annual extensions recommended to the Executive Director by the Council of Presidents and Superintendents no later than the

May meeting.

Holidays

The schedule of holidays for the institutions of higher education is listed below. Classes shall not be scheduled to meet on holidays.

New Years Day

January 1*

Martin Luther King Jr. Day

Third Monday in January

Presidents Day

Third Monday in February

Memorial Day

Last Monday in May

Independence Day

July 4*

Labor Day

First Monday in September

Native American Day

Second Monday in October

Veterans Day

November 11*

Thanksgiving Day

Fourth Thursday in November

Christmas Day

December 25*

* If January 1, July 4, November 11, or December 25 fall on a Sunday, the Monday following shall be observed as the holiday; if they fall on a Saturday, the previous Friday shall be observed as the holiday.

Drop and Add Period

The drop/add period is the time period during which students may adjust their academic schedule for the term without financial or academic consequences. The last day of the

drop/add period for a course is designated as the census date for that course and is the official date for enrollment reporting. The end of the drop and add period for standard and non-standard courses offered in a semester shall be the date the first 10 percent of the term ends or the day following the first class meeting, whichever is later. When calculating 10 percent of the term, breaks of five or more days are not included when counting the total number of days but Saturdays, Sundays, and holidays are. Student registrations can only be added to courses after the end of the drop and add period by approval of the chief academic officer of the university.

Registration Changes

All students will be assigned an academic mentor/advisor upon admission; thereafter, all course registrations and changes, other than withdrawal from the university, should be approved by the assigned mentor/advisor. Students may request advisor or major changes from the Office of the Registrar and Academic Services.

Credit by Validation

Advanced Placement Program (AP)

Entering freshman students who have completed an honors course in high school and who have taken and successfully passed appropriate College Entrance Examination Board Advanced Placement test with a score of 3, 4, or 5 may receive course credit. South Dakota Board of Regents policy on specific courses for which credit is given and other requirements are found at:
<www.sdbor.edu/administration/policy_planning/ap/default.htm>

College Level Examination Program (CLEP)

The South Dakota Board of Regents and its universities encourage high school student to pursue rigorous academic programs and to take advantage of opportunities available to them to earn college credit. The College Board's College Level Examination Program (CLEP) provides an

opportunity to earn college credit. Colleges and universities award college credit for satisfactory performance on the CLEP examinations. Satisfactory performance on CLEP examinations can reduce the cost of college education by reducing the number of credits a student must take to complete the degree. CLEP tests may be retaken only following a lapse of six months. South Dakota Board of Regents policy on specific courses for which credit is given and other requirements are found at:
<www.sdbor.edu/administration/academics/documents/CLEP_guidelines_002.pdf>.

International Baccalaureate (IB)

School of Mines recognizes the rigor of IB courses and the IB Diploma Program and encourages students to complete higher level courses and exams when ready. Students who complete higher level courses and exams and obtain a score of five (5) or above will be considered for advanced placement credit in the corresponding courses. South Dakota Board of Regents policy on specific courses for which credit is given and other requirements are found at:

<<http://www.sdbor.edu/administration/academics/CredValidation.htm>>.

Credit by University Examination

The School of Mines faculty has adopted a policy to permit college credit by university examination. Any student enrolled in the college who has studied a subject independently or who has completed equivalent college level course elsewhere for which he or she is unable to get a transcript acceptable to this institution may request a special examination to establish credit under the conditions specified below:

1. The student must consult his or her advisor and the head of the department in which the course is offered, who will conduct a preliminary survey of the work in which the student claims to be prepared and will determine whether an examination is warranted, what topics it should cover, and what credit may be expected.

2. After determining eligibility to take an examination the candidate pays a per-subject fee at the Office of Student Accounts/Cashier's Office and then secures the appropriate form from the Office of the Registrar and Academic Services.
3. If the student successfully completes the examination, the permanent record will show "Credit by Examination" with a grade of "EX". No entry will be made on a permanent record if the examination is failed.
4. Credit by examination is not permitted if the student has previously completed the course for collegiate credit.

Credit by Verification

Credits earned through validation methods other than nationally recognized examinations (that is, university administered tests and verification like military credit or prior learning) are not allowed:

1. To exceed 32 credits for baccalaureate degrees
2. To exceed 16 credits for associate degrees
3. If the student previously visited or is currently registered for the class
4. For any graduate level courses (exceptions for some programs)

Dual Use of Credit

Many high school students complete college-level courses while enrolled in high school. School of Mines encourages talented high school students to extend their educational background in this manner. South Dakota law provides that students in grades 10, 11 and 12 may enroll in higher education as a special student in a course or courses offered with the school district's approval, and these courses may be applied to high school graduation requirements. See Admissions procedures for further information.

Undergraduate Pass-Fail Option

1. Any undergraduate student with a minimum cumulative GPA of 2.00 at South Dakota School of Mines and Technology is eligible to elect one free elective course per semester on a pass or fail basis. Courses taken under the Pass/Fail option cannot be used to satisfy the

sixteen (16) credit hours of humanities/social science requirement for the bachelor of science degree.

2. The student shall notify the Office of the Registrar and Academic Services in writing of his or her request that the course be graded on a pass or fail basis. Only the Office of the Registrar and Academic Services and the student's advisor are to be notified of the intention of the student to be graded on a pass or fail basis. A student will have the option during the drop and add period of each semester to change from pass or fail to traditional grading, or vice versa.
3. The instructor will report the student's grade based on the college's regular grading system. If a grade of "D" or better is recorded, the student will receive a "Satisfactory," a grade of "U" will be recorded as a "Fail," and the "U" grade will count in calculating credits attempted.
4. Credits earned under this option may be used toward a student's graduation requirements, if appropriate and applicable, but only if a grade of "S" is recorded. A passing grade will be recorded as "S" and will not be used in the calculation of the student's GPA. A course taken on a pass or fail basis will not be converted, after a grade has been recorded, to a traditional grade for the purpose of improving a GPA.
5. The pass or fail option shall apply only to the student's first registration in a course.

Registration Retake Policy

The registration retake policy defines how many times a student may register for (take) a course.

The retake policies approved by the BOR are as follows:

1. A student will be allowed a total of three takes for undergraduate courses (course numbers of 001 to 499) for which credit is only counted toward graduation once. The student must petition in writing to the Vice President for Academic Affairs to be permitted to take an undergraduate course more than three times.

Students wishing to appeal must complete the Application for Academic Appeal form that is available at the Office of the Vice President for Academic Affairs or can be downloaded from:

<<http://sdmines.sdsmt.edu/studentlife/forms>>.

At the undergraduate level only the LAST attempt (take) of the course will count toward graduation and into the grade point average calculations.

2. A student will be allowed a total of two takes for graduate courses (course numbers of 500 or above) for which credit is only counted toward graduation once. The student must petition the graduate dean for permission to take a graduate course more than two times.
3. A student will be allowed unlimited takes for an undergraduate or graduate course for which credit toward graduation may be received more than once (e.g., Independent Study, Thesis). All takes will count into grade point average calculations. Individual departments/majors may limit the number of credits allowed toward graduation in certain courses. Students should check with their mentor/advisor.
4. The Audit (AU) grade is the only grade that will not be counted as a take of a course. All other grades, including Withdraw "W" grade, will count as a take of a course.
5. Transfer courses and non-courses (CLEP, credit by exam) will also count as a take of a course.
6. The count for retakes will begin with courses in which students are enrolled fall 2003. Takes of a course prior to fall 2003 will not be counted.

Audited Courses and Registrations for No Credit

The outside preparation of auditors is entirely voluntary. Their participation in classroom discussions and examinations, and the minimum attendance requirements are subject to arrangements with the instructor of the course being audited. Failure to meet these arrangements will be cause for changing the grade in the course from "AU" to "W." An auditor is allowed neither

credit nor a grade for the course even if the auditor satisfactorily passes the final examination of the course. An audited course cannot count toward the definition of a full-time load for purposes of securing financial aid nor for establishing eligibility to compete in intercollegiate contests. An audited course may not be used to qualify for a reduced tuition rate, but will be counted toward any upper limits on the number of credit hours a student may carry, and will be counted in determining requirements for paying campus fees.

A course taken for no credit but with a grade will be treated the same as an audited course except that the student will be expected to prepare and participate in the course to the same extent as all other students. The grade awarded will not be counted in the student's grade point average.

The request to audit a course or to enroll with no credit must be made at the time of the drop and add period by written petition to the Office of the Registrar and Academic Services. The petition has no effect on the tuition charges for a course.

Overloads

A normal student load is 18 credit hours or fewer. An overload is a course load in excess of 18 credit hours.

To register for an overload, students must consult with their academic advisors. Student requests for overload enrollments should be submitted in writing to their college dean (or equivalent) at their "HOME" institution to grant the approval for registration in credits beyond the overload status. This approval will normally be granted based on a student's exceptional past academic experience.

Deadlines for Adding Courses

1. Students may add daytime or night courses to their schedules through the first 10 percent of the term. When calculating 10 percent of the term, breaks of five or more days are not included but Saturdays, Sundays, and holidays are. This date is listed in the Academic Calendar, which is on the inside front cover of this catalog.

2. In exceptional circumstances, students may add daytime or night courses with the permission of the instructor and the department head responsible for the student's proposed additional course, through the 15th day of classes.
3. Students wishing to add daytime or night courses beyond the period specified above must file a written appeal with the Vice President for Academic Affairs/Provost (or their designee); the appeal must be signed by the student and approved by the instructor of the course involved and the student's advisor.
4. Students may add summer term courses through the first 10 percent of the term. When calculating 10 percent of the term, breaks of five (5) or more days are not included but Saturdays, Sundays, and holidays are.
5. In extreme circumstances, students may add summer school courses after this period with permission of the instructor and the Vice President for Academic Affairs (or their designee).
6. No student will be permitted to attend any class unless he/she is registered and listed on the class attendance roll.
7. Following fee assessment, the students are required to pay for all additional tuition and fees at the Student Accounts/Cashier's Office. Failure to pay may result in students being dropped from the sections that they added. It is the responsibility of the instructor in each class to check the class roll carefully during the first few weeks of each semester to be certain that all students attending a given class are listed on the class roll. Any student whose name does not appear on the class roll should not be permitted to attend that class and should be referred to the Office of the Registrar and Academic Services promptly for clarification of his or her status.
8. Students can add and drop courses by using WebAdvisor, a web interface to the Colleague Student Information System.

Deadlines for Dropping a Course

Please see "Date for a Grade of W" on page 40 for information about dropping a course.

Mandatory Placement Procedure

A mandatory placement procedure for mathematics and English is used at all Regental universities in the state. The instruments and criteria used for other mandatory placement are at the discretion of each institution.



Bachelor of Science Graduation Requirements

An Application for Graduation and Commencement must be completed by the date indicated on the academic calendar which is located in the academic calendar section of the catalog. If you are completing degree requirements during the summer term you must complete the form for the preceding May graduation. Students must be actively enrolled in the semester that they graduate and meet the requirements of the degree, or they must meet the requirements that are in place at the time they request the degree be granted. This form is on-line.

Baccalaureate Degree

The institution granting the degree determines the honors designation for its graduates. To earn an honors designation at graduation, the student must meet both the following cumulative and institutional grade point averages:

Summa Cum Laude:

equal to or greater than 3.90

Magna Cum Laude:

equal to or greater than 3.70 and less than 3.90

Cum Laude:

equal to or greater than 3.50 and less than 3.70

The student must have completed a minimum of 64 credit hours at the institution granting the degree. Courses that are part of a formal collaborative agreement among Regental universities are considered to be earned from the institution granting the degree.

Associate Degree

The institution granting the degree determines the honors designation for its associate-level graduates. To earn an honor designation at graduation, an associate-level graduate must meet

both the following cumulative and institutional grade point averages:

With highest honor:

equal to or greater than 3.90

With high honor:

equal to or greater than 3.70 and less than 3.90

With honor:

equal to or greater than 3.50 and less than 3.7

An associate-level graduate must have completed a minimum of 32 credit hours at the institution granting the degree. Courses that are part of a formal collaborative agreement among Regental universities are considered to be earned from the institution granting the degree.

Two Bachelor of Science Degrees From South Dakota School of Mines and Technology

An undergraduate student who wishes to qualify for a second bachelor of science degree conferred by School of Mines must complete a minimum of thirty (32) semester hours of credit in residence beyond the credit hours used for the first B.S. degree.

Students should report their intent to pursue two (2) bachelor of science degrees to the Office of the Registrar and Academic Services. This action will initiate the assignment of an advisor in each discipline.

General Requirements

The following rules on graduation requirements apply for the bachelor of science degree in any curriculum offered by the university. Requirements that apply to many or all programs are described below. Please refer to the curriculum for an individual degree program for specific course requirements. Each candidate for a degree is personally responsible for meeting all requirements for graduation. No university official can relieve a candidate of this responsibility.

The South Dakota School of Mines and

Technology reserves the right to change any course of study or any part of a curriculum in keeping with accreditation, educational, and scientific developments.

General Education Core Requirements

General education core requirements must be completed within the first sixty-four (64) credits. Requests for exceptions to these general education requirements must be approved by the student's advisor and by the Vice President for Academic Affairs/Provost. The required core is listed below.

Goal #1

Students will write effectively and responsibly and understand and interpret the written expression of others.

Student Learning Outcomes: As a result of taking courses meeting this goal, a student will

1. Write using standard American English, including correct punctuation, grammar, and sentence structure;
2. Write logically;
3. Write persuasively, with a variety of rhetorical strategies (e.g., expository, argumentative, descriptive);
4. Incorporate formal research and documentation in their writing, including research obtained through modern, technology-based research tools.

Each course meeting this goal includes the following student outcomes:

Required: #1, #2, #3, and #4

Credit Hours: 6 hours

Courses:

ENGL 101 Composition I
ENGL 201 Composition II
ENGL 279/289 Technical Communications I and II¹

¹ Engineering and sciences students at School of Mines take this six credit sequence in the sophomore and junior years. Both courses develop written and speech communications in an

integrated fashion in the context of the major. Students must finish the entire sequence, as well as ENGL 101, to satisfy the requirements of Goal #1 and Goal #2.

Goal #2

Students will communicate effectively and responsibly through speaking and listening.

Student Learning Outcomes: Courses satisfying this goal will require students to

1. Prepare and deliver speeches for a variety of audiences and settings;
2. Demonstrate speaking competencies including choice and use of topic, supporting materials, organizational pattern, language usage, presentational aids, and delivery;
3. Demonstrate listening competencies by summarizing, analyzing, and paraphrasing ideas, perspectives and emotional content.

Credit Hours: 3 hours

Courses:

ENGL 279/289 Technical Communications I and II¹
SPCM 101 Fundamentals of Speech

¹Technical Communications I and II develop written and speech communications in an integrated fashion in the context of the major. Students must finish the entire sequence, as well as ENGL 101, to satisfy the requirements of Goal #1 and Goal #2.

Goal #3

Students will understand the organization, potential, and diversity of the human community through study of the social sciences.

Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Identify and explain basic concepts, terminology and theories of the selected social science disciplines from different spatial, temporal, cultural, and/or institutional contents.
2. Apply selected social science concepts and theories to contemporary issues;

3. Identify and explain the social or aesthetic values of different cultures. In addition, as a result of taking course meeting this goal, students will be able to demonstrate a basic understanding of at least one of the following:
 - The origin and evolution of human institutions;
 - The allocation of human or natural resources within societies;
 - The impact of diverse philosophical, ethical or religious views.

Each course meeting this goal includes the following student learning outcomes:

Required: #1, #2, and #3

At least one of the following: #4, #5, or #6

Credit Hours: 6 hours in two disciplines

Courses:

| | |
|--------------|------------------------------|
| ANTH 210 | Cultural Anthropology |
| ECON 201 | Principles of Microeconomics |
| ECON 202 | Principles of Macroeconomics |
| GEOG 101 | Introduction to Geography |
| GEOG 212 | Geography of North America |
| HIST 151/152 | United States History I/II |
| POLS 100 | American Government |
| POLS 210 | State and Local Government |
| PSYC 101 | General Psychology |
| SOC 100 | Introduction to Sociology |
| SOC 150 | Social Problems |
| SOC 250 | Courtship and Marriage |

Goal #4

Students will understand the diversity and complexity of the human experience through study of the arts and humanities.

Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Demonstrate knowledge of the diversity of values, beliefs, and ideas embodied in the human experience;
2. Identify and explain basic concepts of the selected disciplines within the arts and humanities. In addition, as a result of taking courses meeting this goal, students will be able to do at least one of the following:

- Identify and explain the contributions of other cultures from the perspective of the selected disciplines within the arts and humanities;
- Demonstrate creative and aesthetic understanding;
- Explain and interpret formal and stylistic elements of the literary or fine arts;
- Demonstrate foundational competency in reading, writing, and speaking a non-English language.

Each course meeting this goal includes the following student learning outcomes: Required:

#1, #2 At least one of the following: #3, #4, #5, or #6

Credit Hours: 6 hours in two disciplines or in a sequence of foreign language courses)

Courses:

| | |
|--------------|--|
| ART 111/112 | Drawing I and II |
| ARTH 211 | History of World Art I |
| ENGL 221/222 | British Literature I and II |
| ENGL 241/242 | American Lit I and II |
| ENGL 250 | Science Fiction |
| FREN 101/102 | Introductory French I and II |
| GER 101/102 | Introductory German I and II |
| HIST 121/122 | Western Civilization I and II |
| HUM 100 | Introduction to Humanities |
| HUM 200 | Connections: Humanities and Technology |
| LAKL 101/102 | Introductory Lakota I and II |
| MUS 100 | Music Appreciation |
| PHIL 100 | Introduction to Philosophy |
| PHIL 200 | Introduction to Logic |
| PHIL 220 | Introduction to Ethics |
| PHIL 233 | Philosophy and Literature |
| SPAN 101/102 | Introductory Spanish I and II |

Goal #5

Students will understand and apply fundamental mathematical processes and reasoning.

Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Use mathematical symbols and mathematical structure to model and solve real world problems;
2. Demonstrate appropriate communication skills related to mathematical terms and concepts;
3. Demonstrate the correct use of quantifiable measurements of real world situations.

Each course meeting this goal includes the following student learning outcomes: Required: #1, #2, and #3

Credit Hours: 3 hours

Courses:

| | |
|----------|-----------------|
| MATH 102 | College Algebra |
| MATH 115 | Precalculus |
| MATH 120 | Trigonometry |
| MATH 123 | Calculus I |
| MATH 125 | Calculus II |
| MATH 225 | Calculus III |
| MATH 281 | Statistics |

Goal #6

Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world.

Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Demonstrate the scientific method in a laboratory experience;
2. Gather and critically evaluate data using the scientific method;
3. Identify and explain the basic concepts, terminology and theories of the selected natural sciences;
4. Apply selected natural science concepts and theories to contemporary issues.

Each course meeting this goal includes the following student learning outcomes: Required: #1, #2, #3, and #4.

Credit Hours: 6 hours

Courses:

| | |
|---------------|----------------------------------|
| BIOL 151/151L | General Biology I and Laboratory |
|---------------|----------------------------------|

| | |
|---------------|---|
| BIOL 153/153L | General Biology II and Laboratory |
| CHEM 106/106L | Chemistry Survey/Laboratory |
| CHEM 108/108L | Organic Chemistry/Laboratory |
| CHEM 112/112L | General Chemistry I and Laboratory |
| CHEM 114/114L | General Chemistry II and Laboratory |
| GEOL 201/201L | Physical Geology/Laboratory |
| PHYS 111/111L | Introduction to Physics I and Laboratory |
| PHYS 113/113L | Introduction to Physics II and Laboratory |
| PHYS 211 | University Physics I |
| PHYS 213/213L | University Physics II and Laboratory |

Goal #7

Students will recognize when information is needed and have the ability to locate, organize, critically evaluate, and effectively use information from a variety of sources with intellectual integrity.

Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Determine the extent of information needed;
2. Access the needed information effectively and efficiently;
3. Evaluate information and its sources critically;
4. Use information effectively to accomplish a specific purpose;
5. Use information in an ethical and legal manner.

Each course meeting this goal includes the following student learning outcomes: Required: #1, #2, #3, #4, and #5

Credit Hours: 9 hours

Courses:

| | |
|--------------|--|
| ENGL 101 | Composition I |
| SPCM 101 | Fundamentals of Speech |
| ENGL 201 | Composition II |
| ENGL 279/289 | Technical Communications I and II ¹ |

General Education Globalization/Global Issues and Writing Intensive Requirements

In addition to the seven system-wide general education requirements described above, all students will achieve learning outcomes focused on advancing their writing skills and their knowledge of global issues. Each academic program has designated one or more classes (the equivalent of one credit hour of study) as meeting each of these requirements. The syllabi of the courses designated state the requirement(s) met and explain how student achievement of the outcomes are assessed and factored into the course grade.

Globalization/Global Issues Goal Statement

Students will understand the implications of global issues for the human community and for the practice of their disciplines.

Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Identify and analyze global issues, including how multiple perspectives impact such issues; and
2. Demonstrate a basic understanding of the impact of global issues on the practice of their discipline.

Writing Intensive Goal Statement

Students will write effectively and responsibly in accordance with the needs of their own disciplines.

Student Learning Outcomes: As a result of taking courses meeting this goal, students will

1. Produce documents written for technical, professional, and general audiences within the context of their disciplines;
2. Identify, evaluate, and use potential sources of information from within their disciplines for writing assignments that require research and study; and,
3. Use instructor feedback throughout the semester to improve the quality of their writing.

Pre General Education Courses in English and Mathematics

Pre-general education courses include ENGL 031, ENGL 032, ENGL 033, READ 041, MATH 021, and MATH 101.

Completion of Pre General Education Courses

1. Students placed in pre general education courses must enroll in and complete the courses within the first 30 credits hours attempted.
2. If a student does not complete the pre general education course(s) within the first 30 credit hours attempted, a registration hold is placed on the student's record. During the next 12 credit hours attempted, the student must enroll in and complete the pre general education course(s).
3. If the pre general education course(s) is not completed within the first 42 credit hours attempted, the only course(s) in which a student may enroll is the pre general education course(s); and the student's status is changed from degree seeking to non degree seeking.
4. Students transferring from non-Regental institutions must enroll in pre-general education courses during the first 30 attempted Regental credit hours. These students may enroll in other courses concurrently with the pre-general education courses. If the student does not complete the pre-general education courses during the first 30 Regental credit hours attempted during the next 12 credit hours attempted, the student must enroll in and complete the pre-general education course(s). If the student does not successfully complete the pre-general education course(s) within 42 attempted Regental credit hours, the only course(s) in which a student may enroll in the pre-general education course(s); and the student's status is changed from degree seeking to non-degree seeking. The Vice President for Academic Affairs/Provost may grant an exception. Credit hours for the pre general education courses are included in the total number of

credit hours attempted.

The grades assigned for courses numbered less than 100 will be RI, RS and RU.

Curricular Requirements

All bachelor of science programs require the general education core requirements as described earlier. Other requirements for each degree are determined by the faculty in each program, with approval through the university curriculum approval process. Some of these other program requirements are common to most or all programs offered at School of Mines. These include

- A. **Mathematical Sciences:** all programs, with the exception of interdisciplinary science, geology and mining engineering, require a minimum of 16 credit hours of mathematics at the level of calculus and above. To qualify for MATH 123, Calculus I, a student must have completed at least three units of mathematics in high school and must have obtained an acceptable score on the School of Mines mathematics placement examination. A student with less preparation in mathematics may register as a freshman in engineering but will be required to start the mathematics sequence at a level indicated by his or her formal preparation and all School of Mines mathematics placement examination scores or ACT placement score. Mathematics courses taken below the level of MATH 123 are not totaled in the semester hours required for each curriculum with the exception of the B.S. in Interdisciplinary Science and the A.A. in General Studies. MATH 021 and MATH 101 do not count toward any degree.
- B. **Basic Sciences:** minimum of 16 credit hours - CHEM 112, 112L, PHYS 211, and PHYS 213 are required for all engineering curricula.
- C. **Humanities and social sciences:** minimum of 15 or sixteen 16 credit hours - This subject area must include six credits in humanities and 6 credits in social sciences. The number required for each major is listed in the

department section of the catalog. Students majoring in engineering must complete at least three of these credits at an advanced level.

Humanities

Art: ART 111, 112, ARTH 211, 321, 491, 492
English: ENGL 221, 222, 241, 242, 250, 300, 330, 343, 350, 360, 374, 383, 391, 392, 468
Foreign Language: FREN 101, 102, GER 101, 102, LAKL 101, 102, SPAN 101, 102
History: HIST 121, 122
Humanities: HUM 100, 200, 291, 292, 300, 350, 375, 491, 492
Music: MUAP 200, 201, MUS 100, 110, 217, 317, 326
Philosophy: PHIL 100, 200, 220, 233
Religion: 230, 250

Social Sciences

Anthropology: ANTH 210
Business Administration: BADM 350, 360
Economics: ECON 201, 202
Geography: GEOG 101, 212, 240, 250, 400
History: HIST 151, 152, 492
Political Science: POLS 100, 350, 407, 430, 440, 453
Psychology: PSYC 101, 323, 331, 391, 392, 441, 451, 461
Sociology: SOC 100, 150, 250, 351, 391, 392, 402, 411, 420, 483, 511, 520

All courses numbered 300 and above are upper level courses.

- D. All degree candidates must complete ENGL 101, ENGL 279, and ENGL 289, which cannot be used to meet the humanities and social sciences requirements.
- E. **Physical Education:** minimum of 2 credit hours. MUEN 101, 121, 122, and MSL 101L and MSL 102L can be counted for the physical education requirement.
- F. **Electives:** Free Electives vary with the individual department. Any course may be selected which is at freshman level or higher

(i.e. 100 level or higher). ROTC credits may be accepted, depending on the number of degree electives available in each department.

- G. Science Electives: Courses may be selected — from biology, chemistry, geology, physics, or atmospheric science.

For information regarding the Associate of Arts degree requirements, see page 129.

Semester Credit and Grade-Point Average

Additional requirements are listed with each departmental curriculum found in a later section of this catalog. All curricula require passing grades in the prescribed courses and a minimum cumulative grade point average of 2.00. Each engineering curriculum requires 136 hours of credit for graduation and each science curriculum requires one 128 hours of credit.

Military Science Credits

Military Science credits may apply to all degrees as free electives. This option varies with the number of free electives available in an individual curriculum. A veteran may petition the Registrar and Director of Academic Services to receive credit for basic military science and physical education.

Transfer Credit

Articulation of credit may be allowed for previous college education if the courses are equivalent to required or elective courses at this university and if each course presented is of passing quality.

The acceptability of transfer credit is determined by the student's major department.

Credit Definitions

Credits in Residence

Credit in residence within the Board of Regents system is a course offered by any of the degree-granting Regental institutions at any approved sites using any approved method of delivery.

Institutional Credits

An institutional credit is a credit offered by the degree granting institution and includes credits that are part of a formal collaborative agreement between that institution and another Regental institution.

Validated Credits

Credit earned for college level courses by validation methods such as Credit by Exam, CLEP, AP, portfolio, and others within the Regental system will not be considered "credits in residence."

Institutional Credit Requirements for Degree-Seeking Students

1. Minimum number of credit hours that must be earned from the institution granting the degree:

| | |
|---------------|----------|
| Baccalaureate | 32 hours |
| Associate | 16 hours |

2. Number of the last credit hours earned preceding completion of the degree that must be earned from the institution granting the degree:

| | |
|---------------|-------------------------|
| Baccalaureate | 16 of the last 32 hours |
| Associate | 8 of the last 16 hours |

3. Minimum number of credit hours specified in the major or minor requirements that must be completed at the degree granting institution: 50 percent. However, this requirement may be waived for students enrolled in the set of majors offered by the system's Centers which include in the established programs of study common courses offered by one of the other Regental universities. In addition, the Vice President for Academic Affairs/Provost may make exceptions to this requirement for individuals based on the student's prior learning experiences.

Required Check-out Procedure

All graduating seniors and students terminating enrollment at School of Mines are responsible for ensuring that they have returned

all keys, library books, laboratory equipment, and other university property to the appropriate departments prior to graduation or their last day of enrollment. All financial obligations to the university or any of its departments must also be paid prior to graduation or termination of enrollment at School of Mines.

Perkins Student Loan recipients must complete an exit interview with a Business Office representative prior to graduation or termination of enrollment at School of Mines. The university reserves the right to withhold a student's diploma and/or transcript of grades for failure to meet any of the above specified requirements.

Collegiate Assessment of Academic Proficiency

CAAP Exams Required for Graduation

Effective spring semester 1998 for baccalaureate degree-seeking students and fall semester 1999 for associate degree-seeking students, the South Dakota Board of Regents has mandated that all students attending a state university in South Dakota and seeking their first undergraduate degree take and pass the Board of Regents Proficiency Examination. Baccalaureate degree-seeking students will sit for the exam on completion of 48 passed credit hours at or above the 100 level and associate degree-seeking students will sit for the exam on completion of 32 passed credit hours at or above the 100 level. Enrolled students who have already earned a baccalaureate degree are exempt from the requirement.

Testing will be offered during a two-week period during the fall and spring semesters. Students who fail to sit for the exam, when required to do so, will not be allowed to register for courses at any of the state universities for two academic terms unless the student seeks and is granted a deferment for a valid cause (i.e. co-op, internship, etc).

Students failing to achieve the minimum proficiency level on one or more components of the exam will be allowed to retest. Retesting must occur within one year of after initial testing. During that year, students may continue to enroll in courses. As preparation for retesting, students

are required to complete a development plan for remediation, within one month of notice of failure and in collaboration with the director of Retention and Testing. Students will be able to retest twice during that year and a fee of \$17.05 will be charged for each section to cover the cost of testing.

Students will be informed by the testing office when they are eligible to test. Approximately four to six weeks after a student has tested, he or she will receive the results and an explanation of how to interpret his or her achievement. Students who failed to achieve an acceptable score within one year from initial testing will not be permitted to continue their registration. An appeal process for certification of proficiency using alternate methods is available to those students.



Policies and Procedures

The policies and procedures listed in this section were established by the South Dakota Board of Regents and/or South Dakota School of Mines and Technology. For further information regarding policies in this section, please contact one of the Vice President's Offices at the university or visit:
<<http://sdmines.sdsmt.edu/sdsmt/policies>>.

Computer and Network Usage Guidelines and Policy

Students, faculty, staff and others affiliated with School of Mines are provided access to computing and networking services for use in academic pursuits and other activities that advance the goals of the institution.

All computer users must be properly registered and authorized through Information Technology Services (ITS). In accepting authorization to use computing or networking services, a user agrees to comply with all applicable federal, state and local laws and all regulations and policies of both the university and the Regents of the state of South Dakota.

Individuals should guard their electronic identity. Choose secure passwords, and never reveal them to anyone. Individuals can be held liable for activity carried out by others using their accounts. Keep all passwords and access mechanisms secure and private. Facilities and network services are provided for use only by account holders, not their family members or friends.

Theft, misuse, or other abuse of computing or networking services will not be tolerated and may result in loss of computer and/or network privileges, disciplinary action, criminal or civil prosecution.

To connect to the wireless network, we require a wireless equipped laptop and Windows XP/Vista operating system. Instructions on how to connect are located on the ITS website:
<<http://its.sdsmt.edu>>.

All guidelines and terms of use apply to ALL

computer usage, wireless as well as wired desktop and laptop.

Unacceptable activities include, but are not limited to:

- Unauthorized file access or file transfer;
- Use of another individual's identification, password, or account;
- Use of computing or networking facilities that interferes with the work of another student, faculty member, or university official, or with the normal operation of computers, terminals, peripherals, or networks at the university or elsewhere;
- Making, acquiring, or using unauthorized copies of computer software or violating terms of applicable software licensing agreements;
- Use of computer or network systems that result in violation of copyright law;
- Running, installing, or distributing any program intended to damage or to place excessive load on a computer system or network;
- Attempting to circumvent data protection schemes through any mechanism, including unauthorized access or tampering with security;
- Electronically posting or distributing materials resulting in any violation of existing laws, regulations, or university or Regental policies;
- Attempting to monitor or tamper with another person's electronic communications, or reading, copying, changing, or deleting another person's files or software without the explicit agreement of that person; and
- Providing access to computer accounts, Internet connectivity, electronic mail, or other significant services to persons not authorized for use of School of Mines facilities, resources, or network services. For example, students with computers hosted on the residence hall network may not permit family or friends to use these services. Although these guidelines cover most aspects of the policy, a full copy of the current university policy on acceptable use of

computing and network resources may be found at: <<http://its.sdsmt.edu/student/8408/>>.

Family Educational Rights and Privacy Act (FERPA) of 1974 or Buckley Amendment

The purpose of FERPA is to protect the privacy rights of students from the indiscriminate collection, maintenance, disclosure, and release of personally identifiable student information, including information regarding student status or performance.

Under FERPA each current and former student at School of Mines has the following fundamental rights:

- The right to review and inspect the student's education records.
- The right to request the amendment of the student's education records that the student believes are inaccurate or misleading, and the right to a hearing if the request for amendment is not granted.
- The right to consent to disclosures of personally identifiable information contained in the student's education records, except to the extent that FERPA authorizes disclosure without consent.
- The right to file a complaint with the U.S. Department of Education concerning alleged failures by School of Mines to comply with the requirements of FERPA.

Students should be aware that these rights and privileges are available to them. Formal notification regarding FERPA is provided annually. An announcement covering information designated as Public or Directory Information is included on posters, in the Family Matters, First Year Information and Commuter Connection newsletters and on the Academic and Enrollment Family Educational Rights and Privacy Act web page at: <<http://sdmines.sdsmt.edu/ferpa>>. Directory information includes the student's name, local and permanent address, telephone listing, electronic mail address, photograph (e.g., year book photos), date and place of birth, major field of study, dates of attendance (including graduation date), grade level, enrollment status

(e.g., undergraduate or graduate, full or part time), participation in officially recognized activities and sports, weight and height of members of athletic teams, degree, honors and awards received, and the most recent education agency or institution attended (previous to School of Mines). This information is critical to some obligations and services performed by the university. Students have the right to request that such information concerning them be withheld. For a full description of FERPA, information regarding the location of students' educational records, and procedures at School of Mines for compliance with the law, please contact the Office of the Registrar and Academic Services.

US government reporting requirements have been added for international students (F and J status). As a result of the regulations that became effective on January 1, 2003, the Family Educational Rights and Privacy Act (FERPA) is waived for F and J students in respect to these specific reporting requirements. The regulations will be strictly enforced by the appropriate bureau(s) within the US Department of Homeland Security (DHS) and information will be reported electronically to DHS via Student and Exchange Visitor Information System (SEVIS). The consequences to students for non-compliance with the new regulations are severe. Contact the director of the Ivanhoe International Center at Ivanhoe@sdsmt.edu for more information.

Final Examination Policy

The South Dakota School of Mines and Technology provides a policy for the administration of final examinations.

The faculty, recognizing that courses and programs of instruction differ substantially and that methodologies of instruction and evaluation remain the province of each instructor, does not seek to impose any mandatory final examination policy upon the constituent faculty of this institution. However, each faculty member is hereby encouraged to give the last examination (comprehensive or non-comprehensive) during the final examination week.

A five-day final examination period shall be

scheduled by the registration officer. No special individual or departmental requests will be honored in constructing the final examination schedule.

The instructor or instructors for each course shall indicate to their department head whether or not they intend to give a final examination, the number of hours for the exam, and whether additional rooms are needed for alternate seating; requests for additional rooms can be honored only if rooms are available. No additions will be permitted once the schedule has been published. All final exam requests will be due from departments at the time course registry requests are due. The final version of the exam schedule will be published in the Course Listings bulletin.

Final exams in all laboratory courses and courses of one credit or less will be given during the last regularly scheduled class period of the semester. Final examinations for evening classes meeting after 4:30 p.m. will be held at the last meeting of the class during final exam week. Final examinations for all other courses are scheduled by the registration officer according to the regular class meeting time during the semester and must be given at the scheduled time; they may not be rescheduled or given prior to the start of the final examination period. Examinations will be held in the regularly scheduled classrooms unless instructors make special advance arrangements through the registration officer.

Instructors in multi-section courses may request a “common final examination” period if requests are made in advance. Rooms must be reserved with the registration officer for such exams in order to avoid conflicts.

Final exam periods will be one hour and 50 minutes each, although instructors may request a longer final exam period (two hours and 50 minutes) if needed.

If a student is scheduled for three or more examinations on any one day, the middle examination(s) of the day shall be rescheduled for this student by the instructor(s) upon the request of the student. The student will be required to make this request between the 10th and 15th day of classes.

Other than those events approved by the

faculty of the South Dakota School of Mines and Technology, final examinations will be the only events scheduled during the week of final examinations. Students having conflicts arising from participation in such scheduled events must see their professors at least one week prior to the examinations week to determine an equitable alternative to taking the examination at the scheduled time.

Instructors will submit all grades not later than three working days after the last day of final examinations for the term.

Requests for Waivers

In extenuating circumstances students may request that a requirement stated in the academic policies of the institution or of the South Dakota Board of Regents be waived. Examples of such requirements include, but are not limited to, the limit on the number of times a course may be attempted, the time limits on completion of pre-general education and general education courses, the academic suspension policy, the proficiency exam policy, and the change of grade from an F to a W. Students wishing to appeal must complete the Application for Academic Appeal form that is available at the Office of the Vice President for Academic Affairs or can be downloaded from: <<http://sdmines.sdsmt.edu/studentlife/forms>>.

Student Academic Freedom Rights

The School of Mines and the South Dakota Board of Regents have a longstanding commitment to protecting those freedoms of inquiry and learning that are essential to the expansion of knowledge and the correction of error. This includes protections for student freedom in learning. In its relevant parts, Board of Regents policy, which applies to the School of Mines and to all other public universities, provides the following:

A. To secure student freedom in learning, faculty members in the classroom and in seminar should encourage free and orderly discussion, inquiry and expression of the course subject matter. Student performance may be evaluated solely on an academic basis, not on opinions or conduct in

matters unrelated to academic standards.

B. Students should be free to take reasoned exception to the data or views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled.

C. Each institution shall establish an academic appeals procedure to permit review of student allegations that an academic evaluation was tainted by prejudiced or capricious consideration of student opinions or conduct unrelated to academic standards. These procedures shall prohibit retaliation against persons who initiate appeals or who participate in the review of appeals.

D. Students are responsible for maintaining standards of academic performance established for each course in which they are enrolled.
<www.sdbor.edu/policy/1-Governance/documents/1-11.pdf>.

The School of Mines policy implementation of item C above reads as follows:

Student Appeals Policy

A procedure is provided for situations where a student feels that an institutional or Board of Regents policy affecting terms or conditions of enrollment or academic standing has been improperly applied. Students who believe that an academic evaluation has been unfairly applied should follow this procedure. The South Dakota Board of Regents Student Appeals for Academic Affairs policy 2:9 can be reviewed in its entirety at: <http://www.sdbor.edu/policy/2-Academic_Affairs/documents/2-9.pdf>. Students who wish to discuss their situation and how this process applies should consult with the Vice President for Student Affairs and Dean of Students.

Anti-Harassment Policy

It is the policy of South Dakota School of Mines and Technology that harassment not be tolerated. It distracts the harasser, the victim, and others from the tasks of the workplace and academic environment; it undermines morale and the psychological well-being of the victim; and it leads to expensive litigation and to possible liability. The university has no tolerance for harassment, whether it occurs on or off campus, during or after normal business hours, at work-related social functions, or during business-related travel. Any employee or student violating this policy will be subject to disciplinary action up to and including termination or dismissal. The South Dakota School of Mines and Technology Anti-Harassment policy IV-A-20, the South Dakota Board of Regents Sexual Harassment policy 1:17, and the South Dakota Board of Regents Human Rights Complaint Procedure 1:18 can be reviewed in their entirety at: <<http://sdmines.sdsmt.edu/hr/rules#>>, or contact the Affirmative Action Officer/Title IX-EEO Coordinator in the Human Resources Office.

Alcohol and Drug Policy

POLICY

The South Dakota School of Mines and Technology and the South Dakota Board of Regents (4:27 Drug Free Environment and 3:4 Student Conduct Code) are committed to providing a drug free environment.

Furthermore, the School of Mines prohibits the possession of empty alcoholic beverage containers of any kind. Likewise, being in the presence of alcohol or other illicit substances, whether on campus or in the School of Mines managed residences, is also prohibited.

BOR alcohol and other drug policy violations are cumulative throughout a student's enrollment at South Dakota Board of Regents institutions (they stay on the student's discipline record and are transferable). The alcohol and other drug policy violations are not cumulative between academic years.

This policy does not replace nor restrict the Student Conduct Code (3:4) or the Drug Free Environment policy (4:27) as established by the South Dakota Board of Regents.

PROCEDURE

Any employee violating this prohibition shall be subject to appropriate disciplinary action, which may include termination of employment.

Students found in violation of the School of Mines policy for alcohol and other drugs may or may not also be in violation of BOR policy concerning alcohol and other drugs (BOR Policy 3.4.2.B.16). Interpretation is at the discretion of the student conduct administrator on a case by case basis. In the event a student is found responsible for a second violation of the School of Mines Policy IV-A-03 within the same academic year, it will be considered a violation of BOR Policy (3.4.2.B.16.) automatically.

Recognized student organizations are expected to report underage drinking at their sponsored events or on their property to the student conduct administrator for remedial action with individual students. Failure to report via the campus student conduct process may result in action being taken against the student organization.

At a minimum, students who violate the School of Mines alcohol or other drug policy will be sanctioned as follows:

1. 1st violation—a \$50 fine, completion of the *Choices* interactive journal; if under 21, parental notification will include a copy of the letter of sanction being sent to the student's parent/legal guardian.
2. 2nd violation—a \$100 fine, completion of a brief alcohol assessment and any recommended consequences from the assessment, one-year disciplinary probation; if under 21, parental notification.
3. 3rd violation—probable suspension for at least a semester; in extenuating circumstances, student may stay enrolled but must complete an approved

treatment program; if under 21 parental notification.

Policy Governing Academic Integrity

High standards of academic honesty and intellectual integrity are essential to the success of our students and the institution. The campus community will not tolerate acts of dishonesty in any academic activities at School of Mines. Such acts jeopardize not only the individual student, but also the integrity and dignity of the institution and its members.

The South Dakota Board of Regents has clearly defined those acts that constitute violations of academic integrity (BOR Policy 3.4.2.B.1). These acts include, but are not limited to, cheating, fraud, plagiarism, or knowingly furnishing false information within the academic arena. These acts of dishonesty violate the ethical values the university works to instill in all members of the campus community.

Faculty and administrators should consistently communicate the importance of academic integrity and ethical principles to our students. In addition, all members of the campus community should take reasonable steps to anticipate, deter, and confront acts of dishonesty in all areas of academics — research, assignments, and exams. The instructor of record for each course is responsible for clarifying the academic integrity standards for that course within the course syllabus.

The penalty for any act of academic dishonesty shall be at the discretion of the instructor of record, subject to the appeals process described below. Penalties may range from requiring the student to repeat the work in question to failure in the course. To ensure fairness to all involved and to conform to South Dakota Board of Regents policies, penalties may be imposed only in accordance with the following procedure. In the following, the term “judicial officer” refers to the person appointed by the Dean of Students to consider cases of academic dishonesty, as described in BOR Policy 3:4. Among other responsibilities, the judicial officer is expected to maintain university-wide records on

all actions related to student academic dishonesty.

An instructor who intends to penalize a student for an act of academic dishonesty must provide written notification to the student and the judicial officer within ten working days of the time the alleged violation becomes known to the instructor. The written notification must include a description of the alleged violation, the penalty the instructor intends to impose, a statement notifying the student that he or she may request an informal hearing with the instructor, and a statement describing the student's right to appeal the instructor's final decision.

If the student desires such a hearing, he or she must request the hearing within 10 working days of receiving the notification or within the first 10 working days of the following semester, whichever is appropriate. If an informal hearing is held, the judicial officer shall be present. The instructor must give the student written notification of the outcome of the hearing, including a description of any penalties to be imposed. If the student accepts the instructor's decision and penalties by signing a statement to that effect, there shall be no subsequent proceedings.

If the student chooses not to participate in an informal hearing, or if the student disagrees with the outcome of the informal hearing, the student may appeal the instructor's decision by requesting a formal hearing before the university Judicial Committee. All interested parties should refer to BOR Policy 3:4 for descriptions of how hearings are to be conducted, outcomes reported, and appeals made to an appellate board appointed by the president.

Intellectual Property Statement

The South Dakota Board of Regents has developed a policy on intellectual property that sets forth the principles and procedures through which the Board will balance those interests.

South Dakota Board of Regents employees who carry out or administer such instructional, research and service activities routinely produce works or make discoveries that may be subject to legal protection as intellectual properties.

The Board recognizes and affirms the public policy principle, woven into the very fabric of the United States Constitution by its framers, that creators of intellectual properties should obtain a fair return from the fruits of their inventiveness. It also recognizes and affirms the principle that the public should have a fair return on its investment in support of such creative efforts.

For further information on intellectual property, see Board of Regents Policy 4:34. <www.sdbor.edu/policy/4-Personnel/documents/4-34.pdf>.

Software Copyright Statement

The South Dakota School of Mines and Technology has obtained licenses from a variety of vendors to use their software on computers that are owned and controlled by the school. South Dakota School of Mines and Technology does not own this software or its related documentation and, in general, School of Mines does not have the right to reproduce such software or to permit its reproduction by others. Microsoft MSDN is the only exception. Please contact the ITS Help Desk for information regarding MSDN, helpdesk@sdsmt.edu.

School of Mines students, faculty, and staff shall use all software only in accordance with applicable license agreements. Centrally managed licensing agreements are on file in the Information Technology Service Office or the Business Office. Making, acquiring, or using unauthorized copies of computer software or other copyrighted materials may result in disciplinary or legal action as the circumstances warrant.

The following statement regarding intellectual property and the legal and ethical use of software was developed by EDUCOM, a nonprofit consortium of higher education institutions, which promotes the use of computing, networking and information resources in teaching, learning, scholarship, and research. School of Mines subscribes to the spirit of this statement, and strives to promote understanding and observation of it.

Software and Intellectual Rights

Respect for intellectual labor and creativity is vital to academic discourse and enterprise. This principle applies to works of all authors and publishers in all media. It encompasses respect for the right to acknowledgment, right to privacy, and right to determine the form, manner, and terms of publication and distribution.

Because electronic information is volatile and easily reproduced, respect for the work and personal expression of others is especially critical in computer environments. Violations of authorial integrity, including plagiarism, invasion of privacy, unauthorized access, and trade secret and copyright violations, may be grounds for sanctions against members of the academic community.



Mines Matters: Information Technology Services (ITS) serves academic and administrative technology needs campus-wide. Network connections for individuals in the residence halls are also managed through ITS.

The Office of the Registrar and Academic Services

The Office of the Registrar and Academic Services is comprised of four different areas: Registration and Records, Retention and Testing, Academic and Student Success Services, and Student Information Systems/Institutional Research. The Office is responsible for the maintenance of student records, maintenance of the student database and its web interface (WebAdvisor), registration, and veteran's benefits. The Office of the Registrar and Academic Services also provides academic support services to School of Mines students through the coordination of academic orientation, undergraduate academic advising, peer advising, student assessment (including placement and proficiency testing and survey administration), student success publications, supplemental instruction and tutoring to assist students achieve gateway competencies and to increase the percentage who graduate from School of Mines. The Office of the Registrar and Academic Services provides academic support services to School of Mines faculty through advisor training, course scheduling, degree auditing, and providing institutional research services for departmental assessments, proposal writing, and accreditation visits.

Academic Orientation

Working closely with Student Services, The Office of the Registrar and Academic Services provides several registration and orientation sessions in the early spring, during the summer and one session each at the beginning of both the fall and spring semesters. The Office of the Registrar and Academic Services is responsible for the academic component of these sessions, which includes placement testing, advising, and registering for courses.

Academic Advising

The Office of the Registrar and Academic Services is responsible for assigning the appropriate faculty academic advisor to first-time students to help them in their adjustment to collegiate life. Departmental advisors are

assigned to students during their second semester. The Office of the Registrar and Academic Services publishes an advisor/mentor handbook and conducts regular training to update academic advisors on current academic requirements and course offerings, and Board of Regents and university policies and procedures.

Peer Advising

Peer advisors are upper-class students selected with the recommendation of their departments to assist first-year students with advising and registration activities, including planning class schedules, interpreting university procedures and policies, and making referrals to other university services. Peer advisors do not take the place of faculty academic advisors, but they do assist them in fulfilling their roles as academic advisors. Peer advisors assist these faculty academic advisors with the fall and spring registrations and the university orientation course.

Student Assessment

The Office of the Registrar and Academic Services is responsible for administering the COMPASS mathematics and English placement tests for new students and the Collegiate Assessment of Academic Proficiency (CAAP) tests for sophomores. The Office of the Registrar and Academic Services facilitates the midterm deficiency grade reports to identify students who may be experiencing academic difficulties and plans interventions when appropriate. Interest inventories are provided to assist student in choosing a career. The Student Satisfaction Survey is also administered to assess ways in which the school can more effectively meet student needs.

Student Success Publications

Publication of student success newsletters is a part of academic support at School of Mines. These newsletters ("FYI: First-Year Information," "The Commuter Connection," and "SDSM&T Family Matters") focus on informing students about academic requirements, policies, procedures, and available services. The Office of the Registrar and Academic Services also publishes a guidebook for the parents of first-time students.

Tutoring and Supplemental Instruction

Tutoring in all the core subjects — math, chemistry, physics, computer science, English, and more — is provided by peer tutors and is free to all School of Mines students through the Tech Learning Center, or TLC. Located adjacent to the Tablet Central in the lower level of the Devereaux Library, the TLC is open seven days/evenings a week during the regular semester and on a more limited schedule during the summer sessions. The TLC also provides computers, a television/video cassette recorder (VCR), textbooks, and other study aids for student use. For more information regarding the TLC please call (605) 394-2400 or (605) 394-2428. Supplemental Instruction is peer led study sessions in established freshmen courses with a reputation of being very difficult for some students. Currently, SI is embedded in Chemistry 112 and Math 123 Calculus I. Groups meet for recitation twice or three times a week.

Family Educational Rights and Privacy Act

(FERPA) of 1974 or Buckley Amendment
The purpose of FERPA is to protect the privacy rights of students from the indiscriminate collection, maintenance, disclosure, and release of personally identifiable student information, including information regarding student status or performance. Under FERPA each current and former student at School of Mines has the following fundamental rights:

The right to review and inspect the student's education records.

The right to request the amendment of the student's education records that the student believes are inaccurate or misleading, and the right to a hearing if the request for amendment is not granted.

The right to consent to disclosures of personally identifiable information contained in the student's education records, except to the extent that FERPA authorizes disclosure without consent.

The right to file a complaint with the U.S. Department of Education concerning alleged failures by School of Mines to comply with the requirements of FERPA.

Students should be aware that these rights and privileges are available to them. Formal notification regarding FERPA is provided

annually. An announcement covering information designated as Public or Directory Information is included on posters, in the Family Matters, First Year Information and Commuter Connection newsletters and on the Academic and Enrollment Family Educational Rights and Privacy Act web page at: <<http://sdmines.sdsmt.edu/ferpa>>.

Directory information includes the student's name, local and permanent address, telephone listing, electronic mail address, photograph (e.g., year book photos), date and place of birth, major field of study, dates of attendance (including teams, degree, honors and awards received, and the most recent education agency or institution attended (previous to School of Mines).

This information is critical to some obligations and services performed by the university. Students have the right to request that such information concerning them be withheld. For a full description of FERPA, information regarding the location of students' educational records, and procedures at School of Mines for compliance with the law, please contact the Office of the Registrar and Academic Services. US government reporting requirements have been added for international students (F and J status). As a result of the regulations that became effective on January 1, 2003, the Family Educational Rights and Privacy Act (FERPA) is waived for F and J students in respect to these specific reporting requirements. The regulations will be strictly enforced by the appropriate bureau(s) within the US Department of Homeland Security (DHS) and information will be reported electronically to DHS via Student and Exchange Visitor Information System (SEVIS). The consequences to students for non-compliance with the new regulations are severe. Contact the director of the International Center at Ivanhoe@sdsmt.edu.

Veteran Services

The Veterans Certifying Official for GI Education Benefits is located in the Registrar and. If you need help starting your Educational Benefits, please see the VA Representative in the Office of the Registrar and Academic Services.

Educational Resources and Outreach Services

Black Hills Natural Sciences Field Station (BHNSFS)

The BHNSFS serves as the residential base camp for geology and geological engineering summer programs. (See section under Geology B.S. and Minor for a full description.)

Bookstore

The School of Mines Bookstore is located in the Surbeck Student Center and is owned and operated by School of Mines. All revenues generated by the Bookstore are reinvested into the School of Mines. The School of Mines Bookstore serves the students, staff, and faculty of School of Mines by providing course materials, office supplies, Hardrockers apparel, computer software, and more. In addition, the Bookstore cashes personal checks, sends and receives personal faxes, and special orders books and software. Please call (605) 394-2374 for assistance. For additional information, visit the School of Mines Bookstore's website at: <www.minesbookstore.com>.

Information Technology Services (ITS)

Information Technology Services (ITS) serves the academic technology needs of School of Mines by acquiring, supporting, and enhancing many of the technology resources available for students, faculty, and staff engaged in scholarly activity. The mission of ITS is to provide proactive, responsive, people-oriented technologies, training, and support in the areas of multimedia, computing, and networking. In partnership with faculty members, ITS pioneers new learning technologies to provide quality educational experiences outside the traditional classroom or to enhance traditional learning environments.

ITS supports the network and communications server infrastructure for the entire campus. ITS operates and maintains the

campus Local Area Network (LAN) and all centralized computing resources, as well as gateways to external networks, and the wireless infrastructure around campus. Network connections for individuals in the residence halls are also managed through ITS. ITS supports academic computing, including computing labs, presentation classrooms, distance learning facilities, videoconferencing, the Governor's Electronic Classroom (GEC, CB110), the Digital Dakota Network studio (DDN, CB109), and traditional and cutting-edge audiovisual resources to support classroom instruction.

The ITS Software Development Team is responsible for maintaining and updating the School of Mines website while providing software development support to all departments on campus. They create specialized web software to meet the needs of our campus customers, including the Student Association, residence halls, administration, special faculty projects, etc.

All ITS staff enjoy the challenge of assisting faculty in the transfer of cutting-edge instructional technology tools into the classroom, making the learning process more efficient, effective, and exciting. On request, ITS staff members are available for short class presentations on focused technology topics to complement curriculum. In 2000-01, Technology Fellows began working with faculty in this area. ITS is working closely with the Technology Fellows to ensure coordination among services.

ITS is involved in supporting technology to enhance many School of Mines outreach efforts, including the on-campus daycare center (Kids Kastle Little Miner's Clubhouse), the Higher Education Center-West River building, the Technology Development Center, the Black Hills Business Development Center, and local service organizations. On request, ITS will provide reasonable services to currently registered students from any South Dakota institution of higher education who may be located permanently or temporarily in the Rapid City area. In partnership with the State Bureau of Information and Telecommunications, ITS also provides services to local state agencies.

For more details see: <its.sdsmt.edu>

ITS Help Desk

The ITS Help Desk assists students, faculty members, and staff with software and hardware questions and provides scheduling services for many shared resources. The Student Help Desk, (605) 394-1234, is located on the lower level of the Devereaux Library, along with the Tablet Central Assistance Center. Contact the Help Desk at helpdesk@sdsmt.edu, drop by, or check the web pages: <its.sdsmt.edu>.

Tablet PC Program

The School of Mines began a tablet PC program in fall 2006. All incoming freshmen are issued convertible tablet PCs and are required to pay the technology fee associated with the tablet program and wireless access across campus. These machines are laptops that are fully functional as a PC but also have a touch sensitive screen that allows students to write on the screen as if it were a piece of paper. This technology allows students to take notes in class in their own handwriting, allows them to highlight lectures from their instructors and allows many other test-taking functions that would not be available with a basic laptop. The tablet PCs have built-in wireless capabilities so that any classroom on campus can be used as a computer lab and students can connect to the Internet and the campus' file servers from anywhere on campus. Tablet Central (the Help Desk for the tablet PCs) is located in the basement of Devereaux Library. Find out more at: <its.sdsmt.edu/tablet>.

PC Labs

All of the PCs on campus are linked to the campus network, providing access to file servers, applications software, electronic mail, and the Internet. Approximately 90 PCs are located in campus labs, accessible to all students. An additional 62 PCs and Unix workstations are located in department labs, and these are also accessible to all students upon request. Many of the campus labs are reserved for class use much of the day but can be used as open labs otherwise. PC labs are located in

Civil/Mechanical Building: Room 310

Devereaux Library: Located throughout the building

EE/Physics Building: Room 307
Surbeck Center

In these labs, students have access to standard office productivity software, as well as electronic mail and World Wide Web/Internet. Many of the labs are also equipped with discipline-specific software packages. For current lab descriptions, software listings, and locations see: <its.sdsmt.edu/labs>.

ITS Software Development Team

The ITS information services team assists faculty members, staff and students by creating software solutions for unique campus needs. These services include database-driven Internet applications, online surveys, MS Word, MS Excel, and MS Access programming solutions.

The information services team can be contacted via the Technology Help Desk at (605) 394-1234, Vickie Bender at (605) 394-1299, or by e-mail to Vickie.Bender@sdsmt.edu.

Interactive Supplemental Materials

All faculty members at School of Mines have access to Internet and electronic mail facilities. Faculty members have the capability to use interactive videoconferencing technologies to meet with students, including Elluminate which requires no software installation on the users' computers. Some classes use list serves or chat groups to distribute additional material and for communication and discussion among students. Some course use the course management system called Desire2Learn. Students have the option of corresponding through mail, telephone, fax, and electronic mail with faculty and instructors. The course syllabus will list options for course material delivery. Distance instructors will provide contact information (e-mail address and telephone number) along with their course materials. If students have privacy concerns regarding using Internet-based communications, please contact the Help Desk at: helpdesk@sdsmt.edu or (605) 394-1234 for assistance.

Distance Education Course Delivery Systems

Distance education courses are available via Internet and various interactive media. The technology of distance education is changing as fast as technology itself, and School of Mines strives to benefit students by taking advantage of cutting-edge technologies for course delivery. As technologies become available, they will be incorporated into the offerings.

Video-based courses at School of Mines usually include segments filmed in the classroom as the lecture is being presented to the on campus students during the current semester. This is especially important in the science and engineering classes because of today's rapid advances in knowledge and technology. Most distance learning classes are "semester based." This gives distance students the opportunity to meet and work with other students who are taking the class at the same time.

Information Technology Services makes distance courses available via video streaming. To inquire about distance offerings, check the Schedule of Classes or contact the Office of the Registrar and Academic Services (605) 394-2400.

Distance Education Using Videoconferencing

The Digital Dakota Network (DDN; located in CB109, CB110, and CB106 videoconferencing facilities link all six South Dakota universities, as well as all South Dakota K-12 school districts, and many state agencies with interactive videoconferencing capabilities.

All videoconferencing sites are fully interactive, so students at every site receiving the class can see and hear the faculty member at the originating site. Students at any participating site can ask questions of the faculty member and students at the other sites, and participate in class discussion.

Other videoconferencing applications are also supported via DDN, and Internet2/REED, such as student job interviews with potential employers or meetings with research sponsors. For more information see: <its.sdsmt.edu/videoconferencing>.

Educational/Summer Programs and Professional Conferences

The office of Educational Programs and Professional Conferences (EPPC) coordinates and organizes continuing education opportunities, workshops and conferences at School of Mines that focus on science and technology. These workshops and conferences combine the expertise of faculty with the cultural and natural resources available in the beautiful Black Hills. Classes are designed for youth, adults, K-12 math and science teachers, and for alumni and other technical professionals. Conferences serve both regional and national audiences. Youth programs focus on building an interest in science, technology, engineering and math in students. Both on-campus residential and non-residential programs are offered.

Library

The Devereaux Library, located on the north side of the campus along Saint Joseph St., provides a wide variety of resources and services for students, faculty, staff, and the community. During the academic year, the library is open ninety-five (95) hours each week.

The library's main level is the location of the South Dakota Reading Room, reference collection, electronic resources, reference desk, downtime (the popular reading area), circulation desk, interlibrary loan, technical services, and administrative offices.

The lower level of the library contains the literature collection, Government Documents Collection, movies (VHS and DVD), audio book collection, an audiovisual listening and viewing room, and study areas. The Tech Learning Center, Tablet Central and the ITS Help Desk and Testing Center are also located on the lower level.

The second level of the library houses an extensive journal collection, the print versions of Abstracts and Indexes and study areas.

The library's top level houses the majority of the Main Book Collection, the Special Collections vault and study areas.

The library's collection supports the entire range of academic disciplines, with a primary

focus on science and engineering; it contains approximately 180,000 volumes. Special collections include the South Dakota Collection, audiovisual materials, extensive documents from every branch of the federal government, and patents and trademarks. Devereaux Library is an official Patent and Trademark Depository Library, the only such designation in South Dakota, as well as a participant in the Federal Depository Library Program. The library's collection includes hundreds of CD-ROMs and a growing collection of videos, DVDs, and audio books.

Devereaux Library is a "library without walls," providing electronic access to many of its resources. The Library has developed its own web home page, providing access to other library catalogs, electronic databases, and all other resources on the Internet. Patrons may use the web page to ask reference questions, order interlibrary loans, make suggestions about the library's resources and services, search the online catalog, and renew books.

Devereaux is a teaching library, offering classes that introduce patrons to the state's on-line catalog (SDLN) and to the Internet. Individual instruction in the use of electronic resources is available weekdays at the Reference Desk. To facilitate teaching an electronic classroom nicknamed I-Hub, has a 50 inch plasma screen, access to the Internet, and a DVD player. I-Hub is located near the Reference Desk.

Devereaux Library's primary mission is to support the university, but the public is also welcome to use its resources and services.

University and Public Relations

The Office of University and Public Relations provides a variety of services to the campus community including public relations, media relations, state and local government relations, photography, and graphic design. Efforts and activities are designed to assist in the recruitment of students, faculty, and staff; support fundraising activities; provide recognition for the faculty, staff, and students for their many achievements; and identify opportunities for the university to work more closely with the community and state.

Communication guidelines are available on line at <http://upr.sdsmt.edu/guides/>.

The Office of University and Public Relations acts as the hub of School of Mines overall marketing and communications efforts.

Through traditional avenues such as media relations and advertising, and through campus events and other opportunities, the Office of University and Public Relations spreads the positive message about the impact of the School of Mines on its students, the community, and the economy.

Services provided include publications, graphic design and layout, media relations, photography, and campus website management.

Publications

The publications manager coordinates the production of all major campus publications including, but not limited to, the catalog, recruitment publications, and the School of Mines and Technology *Hardrock* magazine. Staff members of the Office of University and Public Relations are available to edit and proof publications produced by campus departments and offices. Staff can also assist with the coordination of printing bids.

Graphic Design and Layout

Staff members of the Office of University and Public Relations are experienced in creating materials including advertisements, newsletters, brochures, and flyers, using industry-standard software, multiple scanning platforms, and print output formats.

Public Information and Media Relations

The public information coordinator organizes all media activities for the campus, including press releases, weekly tip sheets, and hometown releases. It is a goal of the university to provide faculty, students, and staff with recognition for their achievements. Hometown releases are sent for student achievements including Dean's List, Honors Convocation Awards, and Commencement. Students, faculty members, and staff are encouraged to notify the public information coordinator regarding newsworthy

achievements and events.

Photography

Photography services are provided to document campus events. Reprints of photos are available through the public information coordinator. Photos can be made available electronically for publications or the web.

Webmaster

The director of communications serves as the campus webmaster and manages the campus website in partnership with Information Technology Services (ITS).

Surbeck Scheduling Services

Surbeck Scheduling serves as a one-stop scheduling center assisting with the reservation and coordination of University resources for the various activities of the University — academic, student, departmental, community and professional.

As the student union for the School of Mines, Surbeck Center's main floor houses a large student lounge, the alumni office, the bookstore, banquet-ballroom, career center, conference rooms, counseling services, the dean of students office, health services, mail boxes for all students living on campus, student accounts and cashiering services office, the main office for residence life, and the Surbeck Center offices. The dining hall, snack bar, recreation area, student activities and leadership center, Ivanhoe International Center, and the office of multi-cultural affairs office can be found in the lower level in addition to more meeting rooms and "hang-out" space for students. Dedicated in 1963, Surbeck Center has been added to or renovated in 1971, 2004, and most recently in 2009.

Summer Conference Services

From mid-May through mid-August, the campus of School of Mines provides conferencing services to a variety of guests. Surbeck Center staff is available to confirm and coordinate reservation information and to assist with special event planning and logistical needs to ensure a

successful experience for summer guests.

Academic Scheduling

The Office of the Registrar and Academic Services determines the initial classroom assignments and provides this information to Surbeck Scheduling. Typically, fall and spring semesters are downloaded to the scheduling system managed by Surbeck staff before March 15 of the preceding academic year. Summer class schedules are downloaded by March 15 of the same year.

Reserving Facilities

All scheduling of campus resources begins with Surbeck Center. Scheduling and event staff for Surbeck Center process and coordinate all requests for use of University facilities, services, and equipment. Once a request is received, documentation requirements are determined; Surbeck Scheduling staff then coordinate with the appropriate authorizing and resource providing departments. Campus resources are reserved via the on-line scheduling system at < <http://sdsmt-usc.sdsmt.edu/spiisuite>>. If you have additional questions, contact Surbeck Center's scheduling and event staff by phone at 605.394.6774, by fax at 605.394.6998, and by e-mail at usc@sdsmt.edu.

Women in Science and Engineering (WISE) program

Women in Science and Engineering (WISE) is a multifaceted program that is dedicated to addressing the university's continuing concern about the under-representation of women in the Science, Technology, Engineering, and Math (STEM) disciplines nationwide. The program is based on the belief that maintaining American global competitiveness in the STEM fields can only be achieved by fully developing the intellectual capital women have to offer. The Women in Science and Engineering staff work with students, faculty, and staff to provide an inviting and supportive environment at the School of Mines for women at all levels of study.

Programs and opportunities under the WISE umbrella include the following:

- Mentor and Mentees (M&M) program at the School of Mines pairs upper-level students with underclass women to give the younger women the support they need to succeed. The mentors serve as role models, tutors, and friends who can help the mentees experience smooth transitions and college success. Students are paired by major, interests, and hobbies and participants in the program meet monthly.
- Professional mentoring and shadowing is available within the community. The M&M program has expanded into the community. Professional women offer mentoring and shadowing to upper class and graduate students as they prepare to transition into their careers.
- Students can choose from a variety of ways to become involved or enhance their academic experience. Scholarships, student jobs, community volunteering and fund raising opportunities are available throughout the year.
- Students will have opportunities to impact future generations of women in the STEM fields through outreach programs such as Girls' Day and Shadowing Minds at Mines.

For more information on the WISE program at the School of Mines, please refer to <http://wise.sdsmt.edu>.



Mines Matters: With 60 students in attendance summer 2008, the School of Mines anticipates 100 for Camp Invention® to attend the 2009 event. Camp Invention® is a hands-on science and creativity day camp that lets students learn will having fun. This day camp is offered to students going into grades 2-6.

Research Centers and Related Activities

The School of Mines is home to 17 research organizations composed of Research Centers, Labs, Institutes and other research programs including two National Science Foundation Industry/University Research Centers and the Institute of Atmospheric Sciences. The Museum of Geology is also on campus and will soon be co-located in the new Paleontology Building now being constructed. The Museum's fossil collection is the largest in the region and one of the best documented in the nation, which makes it an exceptionally valuable research tool. The centers and facilities described below give students opportunities to apply theoretical knowledge gained in the classroom. Many of these research entities are nationally prominent and include international components as well.

The School of Mines is refining policy to govern the responsible and ethical conduct of research and any publications resulting from research conducted by students or employees.

The institution places the utmost value on a free and open exchange of ideas. When that exchange results in a published contribution to the scientific and scholarly community, those involved with the creation of the publication are responsible for ensuring that appropriate credit and acknowledgment is given to all involved.

Guidelines from the relevant professional association and/or those of the publishing entity should be used as a standard for determining the appropriate attribution of credit. Assistance is available from the Office of Research Affairs to aid in the facilitation of these discussions at any point in the publication process.

Additive Manufacturing Laboratory (AML)

The Additive Manufacturing Laboratory (AML) provides manufacturing research and development in the form of material addition in size scales from microns to meters.

This laboratory houses the laser powder deposition (LPD) system that is comprised of a 3 kW Nd: YAG Laser, a Fanuc M16i Robot, a 2.5 -

D gantry motion system with a CAD/CAM interface, and four metal powder-feed systems with integrated CID and CCD cameras. The lab also contains a new M-LAM (100 micron resolution Laser Additive Manufacturing system) to support fabrication of Bio-Medical devices.

The LPD system facilitates laser cladding, solid free-form fabrication, and graded alloy development of both metallic and non-metallic materials. This lab also supports the development of laser ultrasonics for in-situ defect detect during the cladding operations. Projects include component repair, development of laser cladding wear resistance materials, material property response, thermal and stress modeling of the laser clad materials and unique component direct laser fabrication. This lab has current projects with the US Army Medical Command, US Army Armament Research, Development and Engineering Center (ARDEC), US Army Research Laboratory, HF Webster, Goodrich Sensors and Integrated Systems, Owens-Illinois, Spirex, The University of North Dakota, and Northern Illinois University in support of the Rock Island Arsenal.

The laboratory also houses state of the art Direct Write technology that includes aerosol and syringe deposition techniques. Similar to the LPD system above, Direct Write technologies also use CAD/CAM interface to add materials in a specific location. Main equipment in this facility includes, M3D (aerosol deposition), n-Script (slurry/paste syringe deposition), EFD (slurry/paste syringe deposition) and Photonic Curing (room temperature sintering system) along with associated support equipment. Projects include passive electronic device fabrication (resistors, inductors, capacitors and transformers), energetic devices, tissue engineering, optical devices and medical implant devices. This lab has current projects with the US Army Armament Research, Development and Engineering Center (ARDEC), Black Hills Nano-Systems, NASCENT, Lockheed Martin, Mitron, Control Systems Technologies (CST) and NovaCentrix.

The AML supports senior design and other student projects. The AML currently has one staff Research Scientist II, support two Bio-Medical

Engineering Graduate students, one Metallurgical Engineering grad student, and one Nano-Engineering grad student and well as several undergraduates.

Advanced Materials Process and Joining Lab (AMP)

The Advanced Materials Processing and Joining Center (AMP) was created in 2001 under a grant from the Army Research Laboratory. The latest in the state of the art Friction Stir Welding (FSW) and Friction Stir Processing (FSP) equipment was designed and installed at the School of Mines with our industrial partner, MTS Systems Corporation of Eden Prairie, Minnesota. This equipment provided AMP with the most versatile, fully instrumented FSW/FSP research and development tools found anywhere in the world. Since its inception, AMP has added state of the art ultrasonic spot welding, refill friction stir spot welding, pulsed fusion, cryogenic materials properties testing, and virtual reality joining equipment. AMP is currently staffed by two full time employees (Director and Administrative Assistant).

AMP has developed internal research programs with the academic departments at the School of Mines through funding support for graduate (MS and PhD) and undergraduate (BS) students and faculty members. Graduating students take responsible positions in the field of materials processing and joining within industry. Funding for AMP comes from the many government laboratories, collaborating university, and industry sponsored programs. Currently, AMP projects involve students from the MES, CEE, EE, ChemE, and CSE graduate programs and sponsors several undergraduate senior design projects within the ME and MET departments. Sophomore, junior, and senior undergraduate students are employed as undergraduate research assistants to support research efforts. Collaborative outreach programs have been developed with the local Oglala Lakota College through the involvement of Native American summer student interns.

The AMP Center collaborates with the Welding Group at the Western Dakota Technical Institute (WDTI) to increase our student understanding of the manual and semi-automatic fusion welding processes. Additionally, collaborative research programs have been developed with Brigham Young University, University of South Carolina, Missouri University of Science and Technology, Wichita State University, Iowa State University, Ohio State University, University of Miami – Ohio, University of North Dakota, University of Texas – Arlington, University of Nevada – Reno, and, the University of Colorado. For more information, see the Advanced Materials Processing and Joining Laboratory website located at: <<http://ampcenter.sdsmt.edu/>>.

Black Hills Business Development Center

The Black Hills Business Development Center supports all aspects of technology-based Economic Development for Rapid City and the region. This center assists faculty, students and members of the surrounding region with the commercial development of technology-based products.

Located on the campus of the School of Mines at 525 University Loop, the Center houses the Rapid City Area Economic Development Partnership, Incubator Office and Lab space. Also, located in the same facility is the West River Business Development Center which offers a full suite of business services, including those offered by the Small Business Development Center (SBDC), Senior Core of Retired Executives (SCORE), West River Small Business Administration (SBA), the SBA 504 Loan Program, Procurement Technical Assistance Center (PTAC), West River Revolving Loan Funds, Genesis of Innovation, the Rural Collaborative and the Governor's Office of Economic Development (GOED).

For information about these services available from the West River Business Development Center, please call (605) 394-1706. For the Rapid City Economic Development Partnership, Genesis

for Innovation and/or incubator Lab/Office space, please call (605) 716-0001.

Black Hills Natural Sciences Field Station (BHNSFS)

(See section under Geology B.S. and Minor.)

Center for Bioprocessing Research and Development (CBRD) - 2010 Center

The Center for Bioprocessing Research and Development (CBRD) was established in 2006 through the Governor's 2010 Initiative for Economic Development to bring together the bioprocessing research and development resources of the School of Mines and South Dakota State University (SDSU). The Director is housed on the campus of the School of Mines.

Over 20 faculty and staff and their students (over 60 members in total) representing the fields of agriculture and biosystems engineering, biochemistry, chemical and biochemical engineering, industrial microbiology, mechanical engineering, and plant science work through the CBRD on the next generation of advances required to fully realize the creation of the lignocelluloses based bioindustry.

The CBRD provides small business, entrepreneurs, and industry in South Dakota with expertise in advanced and transformative technologies, research facilities, education, training and administrative support. The Center is the leading institution in South Dakota in the development and technology transfer of new bioenergy technologies. The overall goal is to reduce the national dependence on imported fuels and petroleum-based chemicals by improving the bioprocessing of lignocellulosic biomass to biofuels and other value-added products utilizing carbon-neutral waste-free technologies that mitigate the environmental impact of greenhouse gas emissions and combat climate change.

Principle areas of research in bioprocessing of lignocellulosic biomass are 1) Feedstock development and logistics; 2) Feedstock pretreatment; 3) Enzymatic hydrolysis; 4) Biochemical conversion of feedstock to

transportation fuels and chemicals; 5) Thermo-chemical conversion of feedstock to next-generation biofuels; 6) Product recovery and downstream processing; and 7) Utilization of by-products and co-products from the chemical and biofuels industry.

CBRD has also identified two niche areas of research: 1) development of technologies for utilization of by-products and co-products from the chemical and biofuels industries; and 2) microbial and enzymatic applications of extremophiles isolated from the NSF Deep Underground Science and Engineering Laboratory (DUSEL), the former Homestake Gold Mine in Lead, South Dakota.

The expertise at the Center includes molecular biology to aid in breeding of feedstock such as native grasses for increased yields and chemical composition modifications; microbial mutagenesis and selection for improved production of bio-based chemicals and polymers; improved design of high solids bioreactors and biohydrogen reactors; mechanical, solvent-based and hydrothermal pretreatment using supercritical fluids; extraction of high-value and bioactive compounds from biomass; bioprocess design and optimization for biodiesel production; metabolic engineering of strains for improved conversion of mixed sugars and increased production of oil; anaerobic fermentation of biomass to hydrogen and methane; utilization of hemicellulose and lignin to enhance the biomass value; nano-fiber and adsorptive membranes for downstream processing; techno-economical evaluation and life-cycle analysis of bioprocesses.

Research conducted at the CBRD is linked to undergraduate, master of science (M.S.) and doctoral (Ph.D.) degree curricula at both THE SCHOOL OF MINES and SDSU. Currently over 35 undergraduate and graduate students take part in the CBRD-related research projects.

The CBRD Executive Committee (EC) consists of senior faculty from both SDSU and THE SCHOOL OF MINES. The CBRD external Advisory Board (AB) consists of distinguished academic and industrial scientists representing industries such as Poet, VeraSun Energy, KL Energy Inc, Zymetis, State Government of South

Dakota (Governor's Office for Economic Development, Department of Tourism and State Development, South Dakota Board of Regents), and federal laboratories such as Argonne National Laboratory (DOE) and National Center for Agricultural Utilization Research (USDA). Board members attend the annual CBRD meetings to discuss the direction of the Center and its programs, and to offer insights into ways the Center can best interact with industries through technology transfer.

CBRD is a partner in the recently NSF-created Industry-University Cooperative Research Center (I/UCRC) for Bioenergy Research and Development. CBRD also receives financial support through the Sun Grant Initiative (SGI), a nationwide program initiated at SDSU to jump start the bioeconomy. SDSU is one of the five SGI regional centers in US. Several million dollars of research funding obtained from USDA, DOE, and DOT are administered through SGI each year.

Center of Excellence for Advanced Manufacturing and Production (CAMP)

The School of Mines formally initiated the Center of Excellence for Advanced Manufacturing and Production (CAMP) in October of 1997. After just three years in operation, CAMP won the prestigious Boeing Company Outstanding Educator Award for year 2000 and a year later the National Science Foundation (NSF) Corporate and Foundation Alliance Award.

As part of the educational experience, the South Dakota School of Mines and Technology offers students a unique opportunity to participate in this student-centered, hands-on, engineering program called CAMP. A key part of this experience involves designing, building, testing, and competing in a variety of engineering challenges.

What makes CAMP distinctive is an approach based on voluntary, individual contributions with students organizing themselves into teams that actively encourage participation, organization, and leadership starting in the freshman year.

CAMP actively combines the classroom experience where students apply their developing technical skills in real world situations that involve fundraising, planning, deadlines, and international competitions where the teams test their mettle against engineering universities from around the world.

The success of CAMP is based on combining both the contributions of each student with the demands of working with others. To accomplish this CAMP recognizes the importance of critical values such as trust, respect, well-being, and responsibility as essential in resolving conflicts, establishing goals, and completing a project. The unique element of CAMP is a focus on the process in that it is very clear that the means used to achieve a goal determine the outcome.

Each team constructs a distinctive structure based on the dynamics of each member. By actively encouraging each student to fully contribute, CAMP teams have been able to develop a high level of intrinsic motivation where each student feels that he or she can make a constructive contribution while at the same time contribute to the success of others. The development of a winning engineering project could not be accomplished without developing the personal as well as the technical skills of each participating student.

Computational Mechanics Laboratory (CML)

Computational mechanics is concerned with the numerical simulation of advanced engineering problems. It brings together highly sophisticated methods of structural and applied mechanics, computer science and applied mathematics, and encompasses numerical methods for application to various mechanical engineering problems. It is now a well established and growing discipline which is increasingly exploited by engineers and scientists to optimize existing products and manufacturing processes and to promote the development of new technologies.

The Computational Mechanics Laboratory (CML) was established to provide the basic infrastructure required to promote, support, and perform, academic and research activities in the

field of computational mechanics at the School of Mines. The CML (built as an addition to the Civil/Mechanical Engineering Building) started its operation in January 2006 and provides much needed space for a variety of high-end computing activities. The lab supports both state-of-the-art computer hardware and software, providing School of Mines students access to the modeling capability used in industry. The lab houses specialized computer laboratories, classrooms, office space, two visualization rooms, a small meeting room, and a computer server room. Drs. Karim Muci and Michael Langerman, both in the mechanical engineering department, are co-directors of the lab.

Composites and Polymer Engineering Laboratory (CAPE)

The Composites and Polymer Engineering Laboratory (CAPE) is a fee based user facility that is open to all THE SCHOOL OF MINES students and faculty and industrial and governmental research and development scientists and engineers. To conduct novel and cutting-edge research and development the 9,000 square foot facility houses state-of-the-art equipment in rapid tooling; polymer and composite processing; and prototyping. The suite of rapid tooling and prototyping equipment includes a CNC mill, a CNC lathe, finishing tools, such as precision mold polishing tools, a drill press, saws and sanding facilities, a prototyper, and precision measurement equipment. The suite of polymer and composite processing equipment includes an autoclave, a walk-in oven, bench ovens, three temperature controlled presses, a composite fabric braider, a filament winder, a precision fabric cutting table, a z-stitching machine, two materials testing instruments with environmental chambers, two capillary rheometers, a pre-pregger, two resin transfer molding systems, a single and a twin screw extruder, a high shear mixer torque rheometer, a roll mill, two vacuum bagging systems, and, an injection molding machine, and sample cutting and polishing instruments. Combined, these capabilities provide students, faculty, and external collaborators an extensive set

of tools with which to create the prototypes for the next generation of advanced composite structures.

In collaboration with CAMP, CAPE has played a critical role in the successes of many of the student national competition projects. CAPE provides expertise and facilities that have created the first monocoque body for the Human Powered Vehicle, the unified inverted wing under-carriage for the Formula SAE vehicle, structures for several SAE Aero Design team planes, and the sub-vehicle for the Unmanned Aerial Vehicle, to name a few. The CAPE plays a critical role in supporting polymer and composite research and innovation. For example, faculty, students, and industry utilizing CAPE resources are investigating advanced nanocomposites, protective face gear for soldiers, multifunctional composite structures for energy management, novel biobased polymers, and new in-situ sensors for the health monitoring of composite structures. Funding for these projects come from the Department of Defense, the Department of Energy, and the National Science Foundation. For additional information please visit our website: <<http://cape.sdsmt.edu>>.

Engineering and Mining Experiment Station (EMES)

The Engineering and Mining Experiment Station (EMES) has provided analytical services to the public and private sectors since 1903. Analytical methods in use include a wide variety of classical and advanced instrumental techniques for the characterization and testing of minerals, ores, raw materials, and manufactured products.

EMES currently operates, maintains, and oversees training in electron microscopy (scanning and transmission electron microscopes), X-ray diffraction, atomic absorption spectroscopy, inductively-coupled plasma mass spectrometry, visible and near infrared spectroscopy, and carbon/sulfur and hydrogen/nitrogen/oxygen analyses. EMES also works closely with other departments on campus, which house additional instruments, including a gas chromatograph-atomic emission detector, an atmospheric-pressure-ionization mass spectrometer, an X-ray

fluorescence spectrometer, a laser particle size analyzer, Raman and FT-IR spectrometers, and scanning tunneling and atomic force microscopes.

Geographic Information Systems (GIS) and Remote Sensing Lab

The Geographic Information Systems (GIS) and Remote Sensing laboratory provides the campus and broader community with a facility for generating and analyzing spatially-referenced digital information, including maps and remotely-sensed data. The laboratory was developed by the Department of Geology and Geological Engineering in close cooperation with the South Dakota Space Grant Consortium and EROS Data Center in Sioux Falls, South Dakota. The lab became a NASA Center of Excellence in Remote Sensing in 1998. It served as an ESRI Authorized Learning Center from 2000-04, and continues to offer many GIS workshops every year.

Undergraduate and graduate courses in GIS are offered through the Department of Geology and Geological Engineering for the benefit of campus and off-campus users of GIS. A Minor in Geospatial Technology is offered to BS degree candidates in Interdisciplinary Sciences, Geology, Geological Engineering, Computer Science, Applied and Computational Mathematics, Civil Engineering, Environmental Engineering, and Mining Engineering.

Applications have been developed in a variety of areas, including abandoned mine inventory, archaeology, aquifer vulnerability, ecosystem classification, geology, hydrology, land cover classification, land use planning, mineral deposit modeling, mineral exploration, paleontology, wildlife habitat modeling, carbon sequestration, and remote sensing.

Institute of Atmospheric Sciences (IAS)

The Institute of Atmospheric Science (IAS) at the School of Mines has a rich history of research going back to 1959, when the emphasis was on weather modification and hail damage research. Areas of scientific emphasis have broadened today to include aspects of atmospheric studies

varying from air quality to convection in the atmosphere to ecosystem structure and the effects of climate on our earth's ecosystems.

The expanded mission of the Institute of Atmospheric Sciences is to study the physical, chemical, and biological processes that affect the composition and dynamics of the earth's atmosphere. Our research and educational programs focus on issues of regional, national, and global importance. Research conducted at the IAS is linked to undergraduate, master of science (M.S.) and doctoral (Ph.D.) degree curricula that provide a fundamental understanding of the atmosphere, biosphere, and hydrosphere. Together our research and educational programs provide opportunities for students to conduct theoretical and applied research related to earth-atmosphere systems and their interactions.

The vision of IAS is to provide opportunities for students to become colleagues with IAS faculty in the conduct of cutting edge research to determine how the earth-atmosphere system functions. As an example, information gained through linked observations and models in the Black Hills is being used to predict when and where lightning-caused fires are likely to occur. In addition, IAS scientists and students make field measurements during active fires using portable, solar-powered mesonet stations specifically deployed in the area of the fire, which are integrated with larger-scale observations and models generated and maintained by the National Weather Service in order to help deploy fire-fighting resources for maximum safety and effectiveness.

The IAS strives to improve our understanding of the earth's natural systems through observations made using instruments mounted on a variety of platforms, such as towers and aircraft. Such observations may focus on specific phenomena such as lightning and severe storms. Observations are compared to output from complex numerical models used to diagnose the underlying physical processes. These models may be used to predict short- and long-term system behavior. Current modeling studies focus on hailstorms, thunderstorm electrification (including lightning), lightning produced nitrogen oxides,

precipitation processes, and transport of smoke and dust by atmospheric circulations.

Mesoscale research has focused on the study of factors governing the initiation and organization of convective storms, mesoscale cloud systems, and topographic effects on airflow and precipitation. This research has included analysis of severe wind-producing convective storms and observational studies of bow echoes and supercell storms carried out jointly with the National Weather Service, Rapid City, to increase the understanding of these storms and to improve forecasting.

An ongoing project involves studies of lake-effect snow storms and interactions of the wintertime Great Lakes with larger-scale weather systems. Another area of continuing research is the study of the influences of surface conditions, especially moisture availability, on mesoscale weather and climate. Related numerical modeling studies include the coupling of atmospheric, surface, and subsurface hydrologic processes in mesoscale models. Work is underway on remote sensing of land surface properties and processes and the use of remotely sensed data to initialize mesoscale models. New areas of work include the application of high-resolution mesoscale models to incident meteorology (as in wildfires) and local-scale ensemble forecasting. Global cloud and aerosol properties are being retrieved from satellite data, and their influence upon the earth's radiation budget and climate change is under study. Access to the supercomputer facilities of the National Center for Atmospheric Research at Boulder, Colorado, has been of great value in running the larger cloud models. Availability of cluster computing allows most models to be run locally.

In order to leverage scientific and intellectual resources in the region, IAS scientists collaborate with partners at other institutions, including other colleges and universities in the state and region, the National Center for Atmospheric Research, and the EROS Data Center. Unique local facilities associated with these collaborations include flux towers for monitoring of heat, moisture, and carbon dioxide transport through the surface layer. Often IAS research also

involves community facilities, such as radars and aircraft in the National Science Foundation Atmospheric Sciences Division facilities pool, or research satellites launched by NASA. In addition, IAS students often serve as interns at the local National Weather Service Office, located adjacent to campus and have been employed as "weekend" weather forecasters at local TV stations.

The IAS has state of the art laboratory facilities to analyze key constituents of the atmosphere, and terrestrial and aquatic ecosystems. For example, the Biogeochemistry Core Facility is an analytical and research laboratory facility shared by IAS and the Civil and Environmental Engineering department. Additional laboratory facilities in IAS focus on measurements of atmospheric constituents that have the potential to affect the radiation and the oxidant balance of the earth system.

As IAS looks to the future we are working to develop additional unique opportunities associated with our region that leverage our historical strengths and developing expertise. For example, the T-28, a specialized aircraft designed to penetrate and investigate severe storms, operated for more than 30 years by IAS scientists, was recently retired. Plans are underway to develop a successor research aircraft, a modified A-10 "Warthog," which will have enhanced capabilities. The IAS is linked to the establishment of a Deep Underground Science Laboratory located at the former Homestake mine in Lead, South Dakota. Finally, IAS is participating in development of an Advanced Visualization Center in collaboration with the Computational Mechanics Lab established in the Mechanical Engineering Department.

Most of the Institute's scientists teach in the university's Department of Atmospheric Sciences. The Department supports a B.S. with a focus in atmospheric sciences through the Bachelor of Science in Interdisciplinary Sciences (B.S.I.S.) program, an M.S. degree in Atmospheric Sciences, and a Ph.D. degree in Atmospheric and Environmental Science. The Institute employs both undergraduate and graduate students from atmospheric sciences as research assistants.

Current IAS projects that illustrate the varied opportunities for students interested in interdisciplinary atmospheric research include the following:

- NSF and NASA projects to link models of the fundamental physics of lightning to the resultant impacts on local and regional atmospheric chemistry.
- An NSF project to study the interactions of the Great Lakes with winter storms.
- A NASA project to assess the impact of land use change on regional climate.
- An NSF project to develop a digital on-line archive of airborne in situ observations obtained during 15 years of summer thunderstorm field projects.
- An Army project to assess the role of assimilating abridged atmospheric data into incident meteorology scenarios.
- An NSF project to link science and Native American culture through the exploration of special places in the Black Hills.
- A NOAA-funded project involving collaborations with Black Hills State University, the Black Hills Center for American Indian Health, and the Western Research Alliance to establish the Great Plains Center for Atmosphere and Human Health.

MAPTEK Lab

(See Mining Engineering B.S. and Minor.)

Museum of Geology

The Museum of Geology, located on the top floor of the O’Harra Building, is an outstanding collections and research center at the School of Mines, especially since the surrounding Black Hills and Badlands region is a world-class area for scientifically important fossils, rocks and minerals. Many of these are in the Museum’s collections and exhibits.

Approximately 350,000 specimens, representing the fields of vertebrate paleontology, invertebrate paleontology, paleobotany and mineralogy, are either on public display or in the

research collections. Museum collections form the basis for staff and student research. The Museum also provides an active educational outreach program to area schools and organizations.

Undergraduate paleontology specialization is an option within the geology curriculum, and graduate education opportunities include a Master of Science degree in paleontology and a Ph.D. in geology with paleontology emphasis, all administered through the Geology and Geological Engineering Department. Museum curators and staff work with the Department by teaching paleontology and museum courses, advising student research, providing fossils and minerals for research and teaching use, and offering practical experience through summer field expeditions, laboratory preparation work, and collections management experience. Volunteer research and collection opportunities are also available. Through partnerships with Federal and State agencies, the Museum collects, conserves, researches, and manages the fossil and mineral collections.

Museum of Geology exhibits feature fossils from a wide range of formations, from Late Cretaceous marine and non-marine rocks to the Mid-Tertiary Big Badlands of western South Dakota. These exhibits provide a vivid record of Dakota life in ancient times. Spectacular minerals from throughout the world are also on exhibit. The South Dakota Hall of Minerals focuses on the tremendous diversity of Black Hills minerals. Also included are special exhibits featuring fluorescent minerals, lapidary specimens of local agates, meteorites, and native gold. Temporary exhibits are staged throughout the year.

The Museum is open to the public throughout the year. There is no admission fee, but donations are welcome. A gift shop is available. Tours for groups may be scheduled with the Museum staff. They can be reached at (605) 394-2467 or (800) 544-8162, ext. 2467.

NASA South Dakota EPSCoR Program

The South Dakota NASA Experimental Program to Stimulate Competitive Research

(NASA EPSCoR) is a separately-funded component of the South Dakota Space Grant Consortium (see section immediately following) that focuses solely on research. The goals of the South Dakota NASA EPSCoR program are to expand research capacity in science and engineering fields critical to NASA's future workforce and to promote science and technology-based economic development. This program provides about \$675,000 in annual NASA funding to the state. Research the past several years has focused primarily on land cover dynamics and nano-scaled carbon fibers for aeronautics and space applications. Additional seed grants are made available to South Dakota researchers for projects that are aligned with NASA mission directorates and state research priorities such 2010 Research Centers, new Ph.D. programs, EROS, and the interim underground science and engineering laboratory at Homestake.

NASA South Dakota Space Grant Consortium

The South Dakota Space Grant Consortium (SDSGC) was established March 1, 1991, under a grant from the National Aeronautics and Space Administration (NASA). Consortium members in addition to South Dakota School of Mines and Technology include Augustana College, South Dakota State University, the South Dakota Discovery Center and Aquarium, and the USGS Center for Earth Resources Observation and Science (EROS). SAIC, Raven Industries, and RESPEC are industrial affiliates. Educational affiliates include Black Hills State University, University of South Dakota, Dakota State University, Lake Area Technical Institute, Oglala Lakota College, Sinte Gleska University, Lower Brule Community College, Kirby Science Discovery Center, The Journey Museum, Black Hills Astronomical Society, and Badlands Observatory.

The vision of the SDSGC is to expand opportunities for all South Dakotans through education, research, and public service in the fields of aerospace, earth, and space science. As the link between NASA and the citizens of South Dakota, SDSGC's mission is to instill the spirit of

exploration and discovery in students and educators and in the general public, with a special focus on the fields of science, technology, engineering, and mathematics (STEM) that are essential for the development of the nation's workforce.

The Consortium administers a fellowship and scholarship stipend program (approx. \$150,000 in student awards per year) with the goal of offering educational and research opportunities to students from diverse backgrounds who are pursuing degrees in STEM-related fields that align with NASA's mission and those of the Consortium's membership. It also provides summer fellowships tenable at NASA Centers, industry, and EROS to help enhance interactions among member institutions and strengthen research capabilities related to aerospace, earth science, and remote sensing. The Consortium has assisted in the development of a Geographic Information Systems laboratory on campus. Other Consortium programs include support for undergraduate and graduate research projects and faculty travel to NASA Centers or elsewhere that can aid in developing enhanced research capabilities. The Consortium office on the campus is located in MI 228. The Consortium Office also maintains a K-12 informal education function to help foster wider use of earth science and aerospace-related materials in precollege educational programs throughout the state, and to improve education in the areas of STEM. Outreach activities include sponsorship of South Dakota Space Days, teacher workshops, Visiting Scientist programs in schools, and Aviation Careers Exploration Academy.

For more information, see the South Dakota Space Grant Consortium website located at: <<http://sdspacegrant.sdsmt.edu/>>.

NSF Center for BioEnergy Research and Development – I/UCRC

January 2009 was the start of a NSF-created Industry-University Cooperative Research Center (I/UCRC) for BioEnergy Research and Development. The CBERD I/UCRC will provide the foundation of a nation-wide cooperation

between 5 universities and over 30 companies in the area of Bioprocessing.

Other founding member universities include Kansas State University, the State University of New York at Stony Brook, North Carolina State University, and the University of Hawaii. Industry dues from the I/UCRC fund over \$2 million of research activities each year.

The School of Mines is the lead institution and the administrative headquarters for the multi-university NSF CBERD I/UCRC. Industrial members pay annual membership dues which entitle them to conduct research through the I/UCRC. Service by the I/UCRC to the industrial community is in the form of efforts to commercialize the technologies developed through formal patent license agreements. Work in the I/UCRC provides multidisciplinary research experiences for undergraduates, graduate students and faculty.

NSF Center for Friction Stir Processing I/UCRC

The Center for Friction Stir Processing (CFSP) is a multi-university Industry/University Cooperative Research Center (IUCRC) established in 2004 with a collaborative research partnership between the South Dakota School of Mines and Technology (SDSM&T), University of South Carolina (USC), and, the Brigham Young University (BYU). The Missouri University of Science and Technology (MST) was added as a university site in 2005 and Wichita State University (WSU) was added in 2007. 28 industry and government sponsorships from six countries represent the current active membership and provide funding for the research programs. Collaborative NSF funded programs have been developed with the Center for NDE at the Iowa State University and the Center for E-Design at Virginia Tech. The School of Mines CFSP University Site has been designated as the Headquarters Institution for this global NSF IUCRC Research Center

The CFSP is one of the world's leading focal points for research and development in the emerging Friction Stir Welding and Processing

technologies. We are collaborating with major government laboratories, universities, and industrial companies and are training our students for positions of responsibility within these organizations. The CFSP has an extensive government base of support for our R&D programs with current research collaborations with the Army Research Laboratory, Air Force Research Laboratory, NASA Langley Research Center, DOE Pacific Northwest and Oak Ridge National Laboratories. Industrial partnerships exist with aerospace, automotive, defense, energy, and primary materials production sectors. These partnerships include direct funding, materials and equipment contributions, and engineering consultation and support.

The overall objective of the Center is to develop and deliver relevant scientific knowledge that will help its industrial members with future challenges. Center programs are designed to complement the members' in-house research and development in the area of friction stir processing by bringing together theoretical, experimental and application experts from industry and academia. The specific objectives focus on the following: (1) *Friction Stir Welding (FSW) and Friction Stir Spot Welding (FSSW)*: Process optimization (parameters, pin tool materials, pin tool designs); process modeling (thermal, forces, metal flow, residual stress, distortion, microstructure evolution); microstructural characterizations; property characterizations (tensile, fatigue, fracture, creep, corrosion); nondestructive evaluations; new alloy development; (2) *Friction Stir Processing (FSP)*: Induced super plasticity and local ductility; grain refinement; sub-micron and nano particle injection; defect removal; (3) *Friction Stir Post-Processing*: Heat treatment; forming (stretch, spin, age, and creep); machining; finishing; (4) *Friction Stir Structural Designs and Applications*: replacement of fusion welds and rivets; static and dynamic response of structures; efficient design and analysis methodologies; (5) *Friction Stir Intelligent Controllers and Efficient Tooling*: Process sensors; logic-based controllers; reconfigurable tooling; (6) *Friction Stir Cost Benefits Analysis*: Business case development and environmental impact assessments. For more

information, see the NSF CFSP website located at: < <http://cfsp.sdsmt.edu/> >.

Office of Sponsored Programs (OSP)

The Office of Sponsored Programs works with faculty members to promote efficient and effective submission and administration of sponsored research and grants.

The OSP is the only agent authorized to submit proposals and to receive awards from external funding sources on behalf of researchers at the School of Mines. Services offered can be broken down into three broad categories – Pre-Award Support, Post-Award Support, and Project Support.

Pre-Award Support

OSP aids in the initial development of proposals through supporting the budget process and untangling the complex rules and regulations that are associated with each funding source. Specific services associated with pre-award support are as follows:

- Review of proposal submission instructions or guidelines
- Budget preparation services including development & review
- Proposal package assembly
- Provide assurances that all requirements and documentation are in place
- Proposal submission

Post-Award Support

Once a proposal has been approved OSP will assist in the administration of the resulting Fund(s). Specific services associated with post-award support are as follows:

- Fund Creation in Banner
- Assistance in Drafting Subawards and other Contracts
- Assistance in Documenting Cost Share Match
- Review of specific purchases for allow ability upon request
- Monthly Invoicing upon receipt of fully executed awards/contracts
- Fund close-out

Project Support

This is the newest area of customer service provided by the OSP. As the research endeavor at the School of Mines grows, the OSP is committed to helping to support Projects and Centers. Realizing that the appropriate place for that support is within the Projects, a “field placement” position model has been created and integrated into the administrative processes and regulations associated with supporting grants. To accommodate growth, newly funded areas may receive support directly from Research Affairs by adding a “field placement” staff member.

In addition to the services listed above, the OSP also keeps all information on policies and rates from the Board of Regents up to date as possible through online links. OSP also produces a monthly newsletter, “Miners’ Paydirt,” and archives the weekly lists of funding opportunities online. In addition, OSP also generates several quarterly and annual reports for the Board of Regents and other external funders upon request. Information and reports can be found at <<http://research.sdsmt.edu/>>.

Office of Technology Transfer (OTT)

The Office of Technology Transfer is a division of Research Affairs charged with assisting professors, students and staff in the commercialization of products and concepts that they may develop while at the School of Mines. A consultation with the Office of Technology Transfer would provide resources such as Non-Disclosure Agreements, assistance in the development of patent applications and personalized review of the commercialization process as it pertains to the scientist’s specific invention.

Requests for additional information should be directed to Mr. Dale Skillman, director, via phone at (605) 394-4006 or via email at Dale.Skillman@sdsmt.edu.

Center for Accelerated Applications at the Nanoscale (CAAN) / Printed Electronics Applied Research Laboratory (PEARL)

Significant advances in the development of new functional electronic materials coupled with innovations in deposition technologies are enabling the establishment of new manufacturing platforms for microelectronics and large area electronics such as flexible / roll-able displays and photovoltaics. CAAN / PEARL is the only organization in the U.S. dedicated to the applied research, development, and testing facets of the printed electronics supply-chain for digital print manufacturing platforms. As such, the Lab is engaged in R&D spanning a number of academic disciplines such as chemistry, materials engineering, nanotechnology, mechanical and process engineering, and electrical engineering.

Requests for additional information should be directed to Shawn Decker, director, via phone at (605) 394-5210 or via e-mail at Shawn.Decker@sdsmt.edu.

Repair, Refurbish, and Return to Service Applied Research Center (R3S) - 2010 Center

The South Dakota Governor's 2010 Initiative *Repair, Refurbish, and Return to Service (R3S) Applied Research Center (ARC)* was established at the South Dakota School of Mines and Technology in 2009. The R3S-ARC is an integrated research consortium of the School of Mines, South Dakota State University (SDSU), Western Dakota Technical Institute (WDTI), University of North Dakota (UND), Iowa State University (ISU), and, regional and national industrial partners engaged in applied research, development, test, and evaluation (RDT&E) programs of weapons systems repair and life extension technologies of interest to the Department of Defense (DoD) and DoD prime contractors. Collaborative and companion activities are also in development with Department of Energy (DOE), NASA, and civilian infrastructure sustainment programs. The overall objective of the R3S-ARC is to reduce life-cycle maintenance costs and extend the structural life of legacy and future weapon and infrastructure systems and create educational and economic development opportunities within the

Black Hills Area and the upper Great Plains region

Unique high reliability materials and processing R3S technologies are available at each of the partner university sites and are ready to transition into qualified repair processes. These include friction stir welding and supersonic cold spray technologies at the Advanced Materials Processing and Joining Laboratory (AMP) and Center for Friction Stir Processing (CFSP), laser additive manufacturing at the Additive Manufacturing Laboratory (AML), non-metallic materials technologies at the Composites and Polymer Engineering Laboratory (CAPE), and the advanced modeling capabilities of the Computational Mechanics Laboratory (CML).

The R3S-ARC interdisciplinary and multi-center RDT&E programs involve faculty and students from the undergraduate (BS) and graduate (MS and PhD) programs at the SDSMT. The RDT&E programs are coordinated with DoD repair depots and logistics centers through collaborations with industrial partners and government research centers (Army Research Laboratory and Army Research and Development Engineering Center) to maximize the low cost sustainment solutions to the end user. For more information, see the Advanced Materials Processing Center website located at: <http://ampcenter.sdsmt.edu/>.

Supersonic Wind Tunnel

(See Mechanical Engineering B.S.)



Student Services

Vice President for Student Affairs and Dean of Students

The Vice President for Student Affairs and Dean of Students office develops, manages, and directs student services programs at the School of Mines. Members of the School of Mines Division of Student Affairs engage students through the Students Emerging as Professionals (STEPS) development of personal qualities and skills to enhance professional and personnel success.



These programs are designed to assist students in fulfilling their academic, educational, and career objectives by developing their optimum potential intellectually, socially, and emotionally. Through STEPS our goal is that School of Mines graduates will effectively: act with integrity; value diversity; respect self and others; communicate; lead and serve on teams; value a global perspective; serve the community; apply technical understanding; and engage in lifelong learning.

The Vice President of Student Affairs and Dean of Students serves as a student advocate; advises the School of Mines community on student matters; supervises all units within student affairs; conducts student-centered research; advises student organizations; develops student-related policies; and produces the campus safety and student code of conduct brochure.

Campus Ministry

Various campus ministries are available for students seeking to grow in their faith, as well as for those looking to explore faith for the first time. Activities include worship, Bible study, fellowship meals, and volunteering activities. These ministries also help maintain a food pantry

for students in need, PRAXIS opportunities for community service, and pastoral help to students in crisis. Contact information for the campus ministries student organizations is available on the SCHOOL OF MINES student organization web site.

Career Center

The Career Center assists students with their career development and their searches for full-time, summer internship, and co-op opportunities. For additional information, call (605) 394-2667 or visit: <<http://sdmines.sdsmt.edu/career>>. Services offered by the Career Center include the following:

Career and Professional Development

The office assists students with their resumes, cover letters, interviewing skills, and job searches through a series of workshops offered throughout the academic year. In addition, the Career Center sponsors several professional development workshops to help students develop their social networking, business etiquette, cultural awareness, and other skills important to career success after graduation. Career resources available to students include employer materials, placement and salary data, interest inventory programs, Career Guides, publications, and other information that can help students make career decisions, search for jobs, and prepare for interviews.

On-Campus Interviews

Each year many employers visit the campus to recruit School of Mines students for full-time, summer, and co-op positions. The Career Center coordinates the scheduling of campus interviews through an e-recruiting system, which can be accessed at: <www.sdsmtcareers.com>. This system also allows electronic posting of resumes by students and job openings by employers. In addition to electronic postings, the Career Center also posts jobs from employers not interviewing on campus on its office bulletin boards.

Career Fairs

The Career Center organizes career fairs that are held on campus each fall and spring. A wide range of employers — including Fortune 500, regional companies and government agencies — participate in these events. Several hundred students from freshman to graduate levels attend each of these career fairs.

Summer Internships

A wide range of employers from the private and public sectors hire School of Mines students for summer internships that can help students obtain valuable work experience in their career field and confirm their career choice. Students should start their search in the fall semester for internships the following summer. Summer job opportunities are posted in the Career Center's online e-recruiting system, as well as on office bulletin boards.

Placement and Salary Data

The Career Center maintains placement records of School of Mines graduates and also computes average starting salary offers received by the School of Mines graduates from employers.

Career Counseling

Individuals interested in information on career choices, deciding a major, or changing majors are encouraged to contact the director of Career Center at (605) 394-2667. Resources available to School of Mines students include interest inventory and personality assessments.

Alumni Placement Assistance

The Career Center offers School of Mines alumni free access to its online résumé and job posting system. Visit <www.sdsmtcareers.com> for more details.

Cooperative Education Program

A partnership with business, industry, and government agencies, the Cooperative Education Program provides students with opportunities to apply their classroom learning to “real world”

work experiences in industry. Co-op students are hired by employers to work in positions related to their major. Minimum GPA and other co-op eligibility requirements vary among employers. Interested students should contact the Career Center or their department's Cooperative Education Coordinator. Students are responsible for securing their own co-op positions and are encouraged to register with the Career Center for assistance with identifying and applying for co-op opportunities. After accepting a co-op offer, students are to inform the Career Center of their co-op employer, salary, and dates of employment.

During their co-op work experience, students are expected to apply knowledge learned in the classroom and to grow professionally through development of their interpersonal, communication, teamwork, and workplace etiquette skills.

1. Academic Credit: 1 to 3 credits. Prerequisite: Permission of instructor. Credit is available for each semester or summer work experience upon approval by the departmental Cooperative Education Coordinator. Students must satisfy departmental requirements in order to earn credit for their co-op. Requirements include a written report of the work experience and an employer's evaluation of work performance. Because the work performed by a student working full-time while on co-op is equivalent to the workload of a full-time student, a student on co-op who is registered for CP credit shall be considered to have full-time status.

2. Administration: The Cooperative Education Steering Committee is comprised of the departmental Cooperative Education Coordinators, the Provost and Vice President for Academic Affairs, and the director of Career Center. The committee is responsible for developing cooperative education industrial or business experiences; assisting students with identifying co-op opportunities; maintaining contact with cooperative education employers; and conducting an on-going evaluation of the

program. For additional information, contact the director of Career Center (605) 394-2667 or visit: <<http://sdmines.sdsmt.edu/career>>.

Child-Care Services

The Kids Kastle Little Miner's Clubhouse provides campus-based, quality licensed child care for School of Mines students, faculty, staff, and community parents. Part-time and full-time programs are available. The Clubhouse is open year-round; contact the Kids Kastle Little Miner's Clubhouse at (605) 394-2586.

A limited number of stipends for child care are available for School of Mines students. For more information contact the Dean of Students or visit: <<http://sdmines.sdsmt.edu/sdsmt/lmc>>.

Counseling and Student Americans with Disabilities Act (ADA) Services

Professional counseling and student ADA services are offered free of charge to all School of Mines students. The office is located in Surbeck Center. Individual, group, and couples counseling, as well as wellness programming, is available. Students may receive counseling on stress, family problems, depression, substance abuse, or other personal concerns and on school-related problems. A "gatekeeper" program is taught to students and staff regarding identification of various factors related to depression, stress, and suicidal thoughts as well as the intervention, referral and services available to students experiencing these issues. Students with medical, psychiatric, and learning disabilities who are seeking accommodations should contact the university counselor. The Assistive Technologies Lab, funded through a Department of Education Title III Strengthening Institutions grant, is equipped with state-of-the-art computers, scanners, and software to facilitate learning for students with ADA certified disabilities such as visual or auditory impairments, dyslexia, ambulatory impairments, etc. Students wishing to use the Assistive Technologies Lab must be ADA certified through the campus counselor and ADA coordinator. Walk-ins are welcome. Call (605)

394-2416 for information or an appointment.

Alcohol, Tobacco and Other Drug Prevention Program (ATOD)

The Campuses Community Prevention Coalition (CCPC) was established in 2005 and the Tobacco Prevention Program in 2006. Both programs offer a wide range of educational services including Alcohol, tobacco and other drug (ATOD) surveys, social norms information, bystander training, wellness activities, counseling and referral, alcohol and drug prevention classes such as Choices and Prime For Life. These initiatives are funded through the South Dakota Offices of Highway Safety and the Department of health tobacco grant. (605) 394-2416.

Dining Services

Students and faculty and staff members may dine on campus in the Hardrocker Dining Hall or the Miner's Shack Snack Bar. They are both located in the lower level of the Surbeck Student Center.

Students can choose from the all-you-care-to-eat meal plans, Declining Balance Dollars, or pay by cash options in the Hardrocker Dining Hall. Daily features include traditional home-style meals, vegetarian soups, a salad bar, and items from the made-to-order grill.

The Miner's Shack Snack Bar offers convenience items to made to order pizzas, deli sandwiches, soups, burgers, beverages, and other snacks. Declining Balance Dollars may be used.

Health Services

The Student Health Service is a two-part program that provides undergraduate and graduate students the best medical care possible at reasonable cost.

Part I — Clinical Service

An on-campus nurse and physician assistant are available during posted hours. Student Health staff provide routine medical treatment on campus. When deemed necessary, the campus

health provider will refer the patient or will provide additional services. Recommended or required vaccinations are provided at minimum cost. Procedures for emergency care are listed in the campus safety brochure. Student health fees are included in the mandatory general activities fee that all students pay at registration.

Part II — Optional student injury and sickness limited benefit insurance plan

Optional student health insurance is available through student injury and sickness limited benefit plan. This coverage is mandatory for all international students in order to provide protection from serious financial hardship. Since this is a group policy for students enrolled in South Dakota Board of Regents institutions, the cost has been held to a minimum to cover most of the normal hospitalization and surgical charges. Additional coverage may be purchased for student's spouse and dependents. For complete information regarding this student health insurance plan, contact the School of Mines Business Office, Student Health Services, or the Vice President for Student Affairs and Dean of Students, or the university website.

Ivanhoe International Center

The Ivanhoe International Center (IIC) was established through the generosity of alumnus Lytton F. "Buster" Ivanhoe, in the fall semester, 1994. The Center is located in the lower level of Surbeck Center and is the center of international activities on campus, including services for international students and for students who may be planning to study abroad. The Ivanhoe International Center is a department in the division of Student Affairs.

A broad program of services is provided to international students, including assistance with US Citizenship and Immigration Service (USCIS) student matters; advocacy with all campus offices, organizations, and the surrounding community; housing inquiry referrals; and federal income tax requirements. The IIC coordinates orientation sessions, the English as a Second Language (ESL) program, social activities, community and campus

outreach, and provide newspapers and literature from native countries.

The IIC also serves as a resource for various community groups and individuals, and collaborates with area universities and organizations on a number of activities. The physical facility of the IIC offers a relaxed setting for students to work on computers, collaborate on projects, read a native publication, or just "hang out" with friends.

The IIC welcomes everyone who wishes to become involved in any of its programs, particularly the Friendship Family Program and the Conversation Partners Program. For more information, email the Ivanhoe Center at Ivanhoe@sdsmt.edu or go to <http://international.sdsmt.edu>.

Study Abroad

Students are strongly encouraged to participate in a study abroad experience and the Ivanhoe International Center assists students with the logistics of learning abroad. Engineering and science have become global enterprises, and education in these fields must prepare graduates to function professionally on multi-national and multicultural teams and/or to work overseas at some point in their career. The School of Mines encourages departments and programs to develop innovative ways of incorporating experiences into the curriculum that provide this preparation.

Reasons to pursue study abroad opportunities include the following:

- Employer preference for employees with a global perspective and the ability to function in global and multicultural environments;
- Learning about other cultures and the self-awareness that can arise from such life-changing experiences;
- Personal development in the areas of independence and adaptability; and
- Expansion of your career opportunities to include multinational businesses that give preference to candidates who show initiative, adaptability, flexibility, and respect for other cultures.

The School of Mines offers a variety of options for students to participate in a learning abroad experience. These include such things as field camps, research projects, and humanitarian projects as well as the more traditional semester or year abroad studying at another university. Students may also choose to participate in a program offered by another institution. For more information, email the Ivanhoe Center at Ivanhoe@sdsmt.edu or go to <http://international.sdsmt.edu>.

Multicultural Affairs

The Office of the Multicultural Affairs/Study Center is located in the lower level of the Surbeck Center. Staff is committed to helping students from underrepresented populations thrive at the School of Mines while preserving their cultural distinctiveness. The office provides the following services:

- Welcome and orientation for minority students & families
- Guidance, advocacy and problem-solving help
- Friday Lunches for networking and social support
- Assistance in forming study groups
- Connections to tutors through Tech Learning Center, AISES and other sources
- Help in identifying and applying for scholarships
- Help with locating internships and co-ops through Career Services and other resources
- The promotion of appreciation for diverse cultures
- Exposure to diversity efforts of the corporate world
- Opportunities for professional development
- Feathering ceremony for American Indian graduates
- Coordination of service projects and outreach opportunities to sustain cultural identity in the larger Rapid City community

- Collaboration with Office of Admissions to successfully recruit students from underrepresented populations

OMA works in cooperation with the Ivanhoe International Center and the Student Activities and Leadership Center to provide opportunities for the student body at large to experience an appreciation for diversity.

The Office of Multicultural Affairs has a dynamic definition of multiculturalism: the interweaving of culture, race/ethnicity, social class, religion, geographic location, age, and gender. Through this definition they embrace similarities, respect the differences among groups, and discourage assumptions based on stereotypical notions about someone's culture.

The director of Multicultural Affairs is a co-advisor to the School of Mines American Indian Science and Engineering Society (AISES) chapter. This campus chapter of the national organization nurtures the building of community by bridging science and technology with traditional Native values. AISES also provides activities/programs that offer students internship, co-ops, community service, and scholarship opportunities.

Residence Life

Living Accommodations at the School of Mines

Living on campus in one of the three School of Mines residence halls or in one of our three apartment complexes is a unique and valuable part of the educational experience. Residence Life contributes in a positive manner to the academic achievement of students and to the educational atmosphere of the university while assisting underclassmen in adjusting to the overall university experience. All students are encouraged to take advantage of the opportunity to live, learn and lead in the residence halls and apartments at School of Mines.

Most first- and second-year students are required to live on-campus in the residence halls. The South Dakota Board of Regents policy 3:6 on housing states the following: "during the first two (2) years from the time they were or would have

been graduated from high school, all unmarried students who enroll in courses delivered on a main campus for six credit hours or more are required to enter into a housing agreement with the institution unless special permission to room elsewhere is received from the institution. Permission ordinarily shall be granted to students with dependent children or to students who reside full time during the academic year with parents or legal guardians. Students who have enrolled for twelve (12) or more credits for four semesters may be exempted from this agreement at the discretion of the institution.”
<www.sdbor.edu/policy/3-Student_Affairs/documents/3-6.pdf>.

Residence Hall & Apartment Applications and Agreements

The Housing Application and Exemption Request forms are available at: <<http://reslife.sdsmt.edu>>. During the spring semester, currently enrolled students have the opportunity to reserve specific rooms online between February 1 and March 31 as coordinated by the Residence Life Office. Applicants for a residence hall or apartment assignment must have a \$100.00 deposit on account for the application to be complete (current residents’ deposits carry over from year to year). The deposit will be refunded according to published procedures which are online within the housing application/agreement.

Upon check-in, each student becomes responsible for upholding the Housing Agreement, which is included with his or her application. Housing Agreements ensure apartment/room assignment for these periods and obligate the resident to comply with policies, regulations, and guidelines as stated in the Residence Life Handbook. If the student is released from this agreement (agreement release is at the discretion of the university), charges may be assessed based upon the date of the student’s request. Complete procedures are contained within the Housing Agreement (available online).

Per university policy, all dorm residents are required to purchase a meal plan each semester.

Apartment residents are not required to purchase a meal plan.

On-Campus Living

Connolly Hall, completed in 1948, Palmerton Hall, completed in 1969, and Howard Peterson Hall, completed in 2004, provide comfortable living accommodations for approximately 570 students on campus in dorms. Apartment style living is an option for upperclassmen and graduate students. Three apartment complexes — Kelley, LaCroix, and Park Vista — offer a variety of units for approximately 60 students.

All students who live on campus are required to abide by the policies, regulations, and guidelines of the residence halls. The Residence Life Handbook, available on-line, covers all such policies, regulations, and guidelines. Resident Assistants, Hall Directors and Apartment Managers live and work with students to ensure the residence hall communities are environments conducive to academic success.

Local telephone service, high speed internet connections and expanded basic cable TV service are available and included in rent. Dorm rooms are furnished with a bed (frame with mattress), a desk, and a study chair for each resident. Additionally, closet space, wastebasket, and dressers are also provided. Telephones, TVs, and computers are not provided. The apartments are not furnished, but do feature all utilities paid, including high speed internet and basic cable.

Housing Policy Exemptions

In practice, School of Mines supports the South Dakota Board of Regents housing policy previously stated and, at its discretion, will approve exemptions to a student

- if two or more years have passed since high school graduation, as of registration day.
- is living full time with an immediate family member in the Rapid City area.
 - Full time is defined as staying more than five nights in any seven day period throughout the academic year.

- Rapid City area is defined as within a 45 mile radius of the School of Mines campus.
- has dependent children.
- is an active member of a college-recognized student organization and will reside in their house.
- has completed four semesters of institutional enrollment with 12 or more credits.
- is 21 years of age before registration day.
- is married. NOTE: If under 21, student will need to submit a copy of the marriage certificate.
- is a military veteran with one or more years active service.
- is classified as a non-degree seeking students.
- is taking less than six credit hours.

Exemptions are initiated by completing the Housing Exemption form (available online). When a student submits the Housing Exemption form, he or she is certifying that the conditions of an approved exemption as described in (a) through (j) above exist. Any exceptions to the above policy must be supported by full written documentation of the individual circumstance(s) and are subject to the approval of the director of Residence Life.

Graduate Housing

Anticipated renovation during the 2009-2010 academic year will limit the accommodations ResLife is able to provide for graduate students. Three apartment complexes located adjacent to campus and within several blocks of campus offer more options for graduate students. The apartments provide housing for single students in 9- or 12- month agreement lengths. Married or family student housing is not available. Apply on-line by visiting our website at: <http://reslife.sdsmt.edu>

Off-Campus Housing

New students who require off-campus housing are encouraged to arrive in Rapid City at least one month prior to registration in order to get settled. Temporary summer housing is available at the end

of the spring term through August 15. The Residence Life Office posts notices about private rooms, apartments, motels, houses, etc., available in the Rapid City area online at <http://reslife.sdsmt.edu>. Some information is also posted in Surbeck Center. Information on accommodations in the Rapid City area may also be obtained from area realtors, local newspapers, current students, or the Ivanhoe International Center.



Mines Matters: Co-ops and internships provide excellent opportunities for students to integrate their classroom learning with “real world” work experiences in industry. Seventy-five percent of School of Mines graduates in 2009 had relevant work experience.

Student Activities

Student Activities and Leadership Center

The mission of the Student Activities and Leadership Center (SALC) is to enhance student involvement through educational and social activities while promoting leadership development through empowering students. The SALC motto: "Connecting you to the campus, preparing you for the world." The center provides support for organizations in a diverse range of programming areas, new member recruitment, and teambuilding activities. Organizations can also use several office resources as needed. The center creates and implements new student orientation sessions, leadership development programs, student organizations and programs, and advises the homecoming committee. The SALC also provides advisors for a variety of student organizations, including student government, student programming board, and the campus Greek council.

Student Organizations

Involvement in student organizations is strongly encouraged at South Dakota School of Mines and Technology. Through co-curricular involvement, students develop their leadership skills; and gain real-life experiences in collaboration, critical thinking, and time management. There are more than 70 organizations at the School of Mines, with new ones being created throughout the year. To find out how to get involved in any of these organizations, or to get information about starting an organization, contact the SALC.

Academic Organizations

Aero Design Team
AIChE ChemE Car
American Chemical Society
American Institute of Chemical Engineers
American Society of Civil Engineers
Concrete Canoe
Steel Bridge
American Society of Mechanical Engineers
Human Powered Vehicle

Association for Computing Machinery/Linux User Group
Drill and Crucible Club
Institute of Electrical and Electronic Engineers
Institute of Industrial Engineers
Materials Advantage
Paleontology Club
Robotics Team
Society of Automotive Engineers International
Alternative Fuel Vehicle
Baja SAE
Formula SAE
Society of Economic Geologists
Society of Explosive Engineers
Unmanned Aerial Vehicle

Athletic Organizations

Cycling Club
Hardrock Climbing Club
Hot Rockers Dance Team
Ski and Snowboard Club
Tech Soccer Club

Community Service Organizations

Circle K
Engineers and Scientists Abroad

Greek Organizations

Alpha Chi Sigma
Alpha Delta Pi
Alpha Omega Epsilon
Delta Sigma Phi
Interfraternity Council
Theta Tau
Triangle

Honor Societies

Alpha Pi Mu
Eta Kappa Nu
Order of Omega
Phi Eta Sigma
Tau Beta Pi

Multicultural Organizations

American Indian Science and Engineering Society
Chinese Student and Scholar Association
Cultural Expo Committee
India Club
Mongolian Student Association

Religious Organizations

International Christian Fellowship
InterVarsity Christian Fellowship
Latter-day Saint Student Association
Lutheran Campus Ministry
Muslim Student Association
Newman Club
United Campus Ministry

Special Interest Organizations

Ambassadors for Life
College Republicans
Drama Club
Hardrocker College Bowl Club
Hardrocker Flying Club
Leadership Development Team
M-Week
Non-Trad Student Forum
Ranger Challenge
Student-Alumni Connection
Tech Association of Gamers
Veterans Club

Student Government Organizations

Residence Hall Association
Student Association

Student Media

Amateur Radio Club
Raver

Student Association

All regularly enrolled students at the School of Mines are eligible for active membership in the student association upon registration and payment of the required activity fees. The purpose of the student association is to administer and coordinate student activities; to provide a means for representing student ideas and opinions to faculty, administration, and the community; and to improve and clarify academic, cultural, recreational, and social aspects of the academic community. The student senate conducts the affairs of the student association.

Elections for class representatives and senators occur in spring semester, with the exception of the Freshman class, which occurs in the fall semester. The president of the student senate appoints additional representatives.

Visual and Performing Arts

Apex Gallery

The Apex Gallery was established in 1989 and is housed in the Classroom Building. It offers challenging educational art and science exhibitions for enjoyment and enrichment of people of all ages. Contemporary works of artists and scientists, many of who are nationally and internationally recognized, are exhibited. These exhibitions are designed to reflect a cross section of cultural expressions and perspectives. In addition to providing students and staff with opportunities to view the exhibits, the Apex Gallery has an active community outreach component.

Music Program

The Music Program, a division of the Department of Humanities, is housed in the King Center. Included are an ensemble rehearsal area of 1,600 square feet with adjoining music offices, music library, and storage, and two smaller rehearsal areas of 1,000 square feet; one designated as an applied music teaching studio and jazz band rehearsal area and the other which provides space for an electronic music laboratory and individual practice. Cultural and educational enrichment opportunities provided by Music Activities include the following:

- Academic offerings — see courses listed under MUS, MUEN, or MUAP in this catalog, on Web Advisor, or on the Music Activities website.
- Ensembles — Symphonic Band, Concert Choir, Jazz Band, Master Chorale, Pep Band, Alumni & Friends Choir, and other instrumental and vocal ensembles. School of Mines music ensembles range from academic course offerings to recreational student-led groups.
- Performance Opportunities

School of Mines concerts are presented by the major ensembles every semester at venues around Rapid City and the Black Hills.

School of Mines recitals are presented by faculty and students throughout the academic year in the Rapid City area.

Appearances are made throughout South Dakota and neighboring states at various venues such as the Grand Teton Choral Festival in Jackson Hole (WY), music association conventions, and alumni gatherings.

Appearances are made at national events such as the Music Educators National Conference in California and the Washington (DC) National Cathedral dedication.

International tours result in critical acclaim and international awards. Venues have included New Years Eve Mass in Vienna's Karlskirche (1990), Lindenhofhaus Harmonie-Festival (1993), Florence's Palazzo Vecchio (1996), Circolo Musica in Venice (2001), the Konstanz (Germany) Münster (2003), and the Association of Irish Musical Societies Choral Festival (2006).

For current concert listings and more information, visit < <http://music.sdsmt.edu> >.

Drama Club

Opportunities are available to students to be a part of the entertainment world through participation in the Drama Club, a division of Student Activities and Leadership. Two full dramatic productions are presented each year with student involvement in all aspects: acting, producing, stage, set design and set construction, costume, makeup, and technical design. Recent productions have run the gamut from Oscar Wilde to Woody Allen.

In addition, student-directed one-act play productions are presented each spring semester. Other opportunities lend themselves to performing students. During spring semester 2007, several Drama Club students were cast as extras in a local production of *Star Wars: Heart of The Rebellion*. Other students auditioned for, and were cast in, *National Treasure: Book of Secrets*, the sequel to the blockbuster hit *National Treasure*.

Intercollegiate Athletics

The athletic program has always been considered a major extracurricular activity on the campus of School of Mines. It is believed that a student's participation in athletics fosters well-rounded development. The intercollegiate sports scheduled throughout the year include basketball,

cross country, football, golf, track, and volleyball.

The university is a member of the DAC Conference and is NAIA affiliated. The DAC awards championships in all conference sports each season. A double round robin in basketball plus post-season conference tournament and a single round robin in football are scheduled each year and determine the conference championship. The championships in cross country, golf, and track are awarded on the basis of a conference championship meet. The conference volleyball champions are determined by a double round robin schedule and a tournament. There is a high degree of success even at the national level by our conference representatives.

Eligibility for Intercollegiate Athletics

To be eligible for intercollegiate competition at the South Dakota School of Mines and Technology, a student must:

1. Be making normal progress toward a recognized degree and maintain the GPA required to remain in good standing as set forth by this catalog.
2. Be enrolled in a minimum of 12 semester credit hours at the time of participation, or if the participation takes place between terms, the student must have been enrolled in the term immediately preceding the date of participation. Students become ineligible upon dropping below 12 credit hours of enrollment.
3. Pass 24 credit hours (or equivalent) in the two terms of attendance immediately preceding the term of participation. A second-term freshman must pass 9 credit hours (or equivalent) in the first term.
4. Be eligible in the appropriate conference.
5. Transfer students from a four-year institution must have eligibility remaining at the institution they are transferring from to be eligible for further intercollegiate competition. Junior college transfers or graduates need to check with the athletic director about their status.

Intramural Sports

All students are encouraged to participate in the intramural program, which provides organized athletic contests and wholesome recreation. In the past several years, approximately 70 percent of

the student body has participated in the intramural program. It provides for individual and team competition and fosters a spirit of fair play and sportsmanship. Among the activities are co-ed water polo, kickball, indoor soccer, 3 on 3 basketball, 5 on 5 basketball, dodge ball, volleyball, and flag football. A director of Intramural Activities is responsible for directing the Intramural Program.



Mines Matters: School of Mines students can get involved in more than 74 student-run clubs and organizations.



Atmospheric Sciences Minor



Contact Information

Dr. Mark R. Hjelmfelt

Department of Atmospheric Sciences
Mineral Industries 201
(605) 394-2291
E-mail: Mark.Hjelmfelt@sdsmt.edu

Faculty

Professors Detwiler, Hjelmfelt, and Helsdon;
Associate Professor Capehart; Associate Professor
Sundareshwar; Instructor Kliche; Adjunct
Professor Zimmerman.

The purpose of the atmospheric sciences curriculum is to educate students to the level of scientists and engineers who are capable of developing and applying knowledge concerning physical, dynamical, and chemical processes in the atmosphere.

Undergraduate minor in Atmospheric Sciences

A minor in atmospheric sciences is offered to any student enrolled in any undergraduate degree program that allows minors at the School of Mines. For some majors this would require an additional semester or more of study beyond the normal four years. A minimum of 18 credits in atmospheric science course work must be earned. Two courses, Introduction to Atmospheric Sciences (ATM 301) and Global Environmental Change (ATM 406) are required for the minor.

Specialization in Atmospheric Sciences within the Bachelor of Science in Interdisciplinary Sciences degree program

Students in the Bachelor of Science in Interdisciplinary Sciences (IS) degree program may choose a specialization in atmospheric sciences. The successful student is expected to be capable of independent and critical thinking in the areas of physical, synoptic, and dynamic meteorology; remote sensing; and global atmospheric change. As such, the student should be qualified for employment where expertise in atmospheric sciences is a primary requirement, though need not necessarily qualify as a meteorologist by the federal government's criteria. The curriculum also is suitable for preparation toward graduate study at the M.S. and Ph.D. level.

The IS Bachelor of Science degree program offers a specialization in atmospheric sciences. General requirements for a B.S. in Interdisciplinary Sciences are described on p.147. Required course work for the atmospheric sciences specialization includes

Degree: meteorology, atmospheric science, or other natural science major that includes

- 1) All courses and other curriculum requirements for the general IS degree requirement.
- 2) The atmospheric sciences undergraduate core: ATM 301, ATM 404, ATM 406, ATM 450, ATM 450L
- 3) The following mathematics and science courses

(which may require additional prerequisites):
CHEM 114, CHEM 114L, CSC 150, PHYS 213,
PHYS 213L, MATH 225, BIOL 311

4) Twelve hours of additional ATM or ATM-directed cooperative education (CP) credits

5) Twelve Hours of additional professional development credits from ATM, BIOL, CHEM, CEE, CSC, CP, ENVE, GEOE, GEOL, MATH, or PHYS, within the requirements of the IS program. (Engineering course credits cannot be counted toward IS degree requirements but can be counted as general electives.)

Federal Certifications as a Meteorologist

Students in the undergraduate minor or IS programs desiring to be qualified for federal employment as meteorologists (with the National Weather Service or other federal government agencies employing meteorologists) should contact a Department of Atmospheric Sciences advisor to ensure that their plan of study meets the strictly enforced civil service requirements. The basic requirements for federal civil service qualification as a meteorologist (as dictated by the United States Office of Personnel Management):

Degree: meteorology, atmospheric science, or other natural science major that includes

A. At least 24 semester hours (36 quarters) of credit in atmospheric science/meteorology including a minimum:

1. Six semester hours of atmospheric dynamics and thermodynamics
2. Six semester hours of analysis and prediction of weather systems (synoptic/mesoscale)
3. Three semester hours of physical meteorology and
4. Two semester hours of remote sensing of atmosphere and/or instrumentation

B. Six semester hours of physics, with at least one course that includes laboratory sessions

C. Three semester hours of ordinary differential equations

D. At least 9 semester hours of course work appropriate for a physical science major in any combination of three or more of the following: physical hydrology, statistics, chemistry, physical oceanography, physical climatology, radiative transfer, aeronomy, advanced thermodynamics, advanced electricity and magnetism, light and optics, and computer science.

OR: Combination of education and experience-course work as shown in A above, plus appropriate experience or additional education.

Note: There is a prerequisite or corequisite of calculus, physics, and differential equations for course work in atmospheric dynamics and thermodynamics. Calculus courses must be appropriate for a physical science major.

Atmospheric sciences undergraduate curriculum scheduling

It is the student's responsibility to check with his or her advisor in the atmospheric sciences department for any course offering or other program modifications that may occur after the publication of this catalog. Most courses are offered only every other year. Attention must be paid to this two-year cycle in planning a program of study.

Master of Science Graduate Degree Program

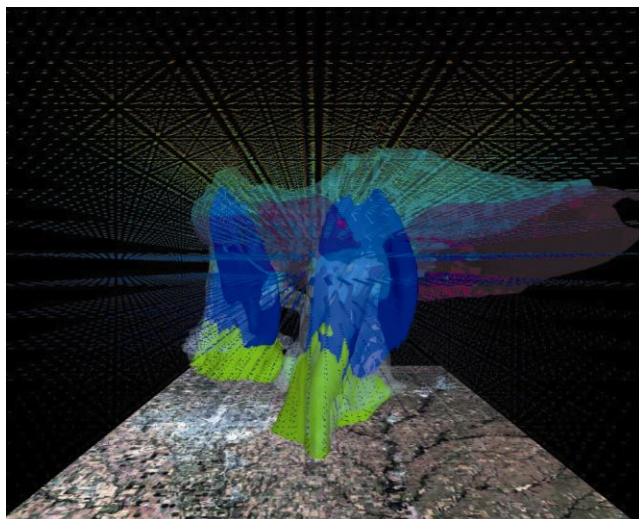
A master of science graduate program in the atmospheric sciences is offered to students with undergraduate degrees in atmospheric sciences or meteorology, physics, mathematical sciences, biology, chemistry, or engineering. A resident undergraduate student in any of these fields may take upper-division courses in meteorology as electives, either as part of the minor or otherwise, and proceed directly to graduate work in meteorology upon receipt of the bachelor's degree. In addition to meeting the goals listed above for undergraduate minor and IS atmospheric science graduates, the master of science graduate will be able to review the literature; devise strategies for attacking a

problem in atmospheric sciences; acquire, organize, and interpret data; and prepare results for both oral and written presentation. He or she is expected to be able to carry out such original investigations both individually and as a member of a team.

A master of science degree requires 24 credit hours of course work, with an additional 6 semester hours of research credit for completing a thesis. There are two specializations in the program, meteorology and earth systems, with a common core of three courses shared by both specializations. See pages 198-200 for more details. A properly-prepared undergraduate science or engineering graduate with minimal meteorological background may use the M.S. program to complete sufficient course work to satisfy the federal civil service requirements for employment as a meteorologist. The M.S. program can be a stepping-stone to Ph.D. work in the atmospheric and environmental sciences, as well as a terminal degree leading to employment in private industry or government.

Atmospheric and Environmental Sciences Interdisciplinary Ph.D. Graduate Program

In addition to the M.S. program in atmospheric sciences, the atmospheric sciences department participates in the Atmospheric and Environmental Sciences (AES) Ph.D. program. Faculty in several departments are involved in delivering the program, including chemistry and chemical engineering, civil and environmental engineering, mining and engineering management, geology and geological engineering, and atmospheric sciences. Degree candidates are expected to complete courses in a broad range of topics selected from these disciplines. For complete information on the AES program, please refer to the AES section of this catalog beginning on page 194.



Biology



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Faculty

Professor Bang, Assistant Professor Sani.

Biology

Many students need knowledge of biology as part of their background. The biology courses are offered for students in science, engineering, and general studies. Students are advised to take laboratory courses whenever possible.

Minimum enrollments, as established by administration policy, are necessary to teach a course. A minor in biology is not available. However, for students considering medical, dental, veterinary, or graduate school in a biology field, the department recommends students and advisors consider one of three biology sequences for study rather than selecting courses at random. Record of successful completion of an approved sequence can be made a part of a student's permanent record. A minimum of 18 credits is recommended with 8 of those credits being BIOL 151/151L; BIOL 153/153L; or equivalent. At least 6 credits should be at the 300 level or above.

Recommended Options

A. General Biology Sequence

8 core credits:

BIOL 151, 151L, 153, 153L

Ten (10) additional credits from:

| | | |
|-----------|---|-----|
| BIOL 231 | General Microbiology | 3 |
| BIOL 231L | General Microbiology Lab | 1 |
| BIOL 341 | Microbial Processes in Engr and Natural Sciences | 3 |
| BIOL 371 | Genetics | 3 |
| BIOL 491 | Independent Study | 1/4 |

B. Health Science Sequence

8 core credits:

BIOL 151, 151L, 153, 153L

10 additional credits from:

| | | |
|-----------|--------------------------|-----|
| BIOL 121 | Basic Anatomy | 3 |
| BIOL 121L | Basic Anatomy Lab | 1 |
| BIOL 123 | Basic Physiology | 3 |
| BIOL 123L | Basic Physiology Lab | 1 |
| BIOL 231 | General Microbiology | 3 |
| BIOL 231L | General Microbiology Lab | 1 |
| BIOL 371 | Genetics | 3 |
| BIOL 423 | Pathogenesis | 3 |
| BIOL 423L | Pathogenesis Lab | 1 |
| BIOL 492 | Topics | 1/5 |

C. Environmental Science Sequence

8 core credits:

BIOL 151, 151L, 153, 153L

10 additional credits from:

| | | |
|-----------|---|-----|
| BIOL 311 | Principles of Ecology | 3 |
| BIOL 341 | Microbial Processes in Engr and Natural Sciences | 3 |
| BIOL 371 | Genetics | 3 |
| BIOL 431 | Industrial Microbiology | 3 |
| BIOL 431L | Industrial Microbiology Lab | 1 |
| BIOL 403 | Global Environmental Change | 3 |
| BIOL 492 | Topics | 1/5 |

Biological Laboratories

These laboratories, located on the ground floor of the McLaury Building, are equipped for the preparation and study of biological materials, both macroscopic and microscopic. For some courses field trips add significant experience.

Chemical Engineering B.S.



Contact Information

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Faculty

Professors Bang, Dixon, Puszynski, and Winter; Associate Professor Gilcrease; Assistant Professors Benjamin, Hower, Menkhaus, Sani, and Shende; Instructor Coble.

Emeritus and Other Faculty

Emeritus professors Bauer, Munro, and Sandvig; Professor and 2010 Center Director Christopher.

Staff

Chemical and Biological Engineering Secretary, Linda Embrock. Chemical and Instrumentation Specialist, Ivan Filipov.

Chemical and Biological Engineering (CBE)

Chemical engineers with a B.S. degree from the School of Mines acquire a solid foundation in the sciences of biology, chemistry, and physics in mathematics; and in applied engineering and technology. This broad foundation allows graduating chemical engineers to discover new ideas required to solve the problems challenging the people of the world, while constantly pursuing the efficient and safe use of the world's resources. These needs or problems might be related to the environment, electronics, energy, food, fibers, biotechnology, petroleum, pharmaceuticals, and new engineering materials (nano-materials, ceramics, and polymer composites). To learn more about a career in chemical engineering, visit our webpage: <<http://cbe.sdsmt.edu>> and the student web page of the American Institute of Chemical Engineers, AIChE <<http://www.aiche.org/Students/Careers/index.aspx>>

The 21st century brings with it many exciting opportunities and careers for chemical engineers. Chemical engineers are involved in all aspects of many projects, serving as the connection between engineering, science, and business disciplines. Their broad knowledge base allows them to be found throughout the entire structure of industry and commerce, and they are often considered the “universal” engineer. As such, the profession offers many interesting and challenging opportunities in areas such as research and development, manufacturing, production, plant or process design, technical sales or service, and management. Combining the scientific, math and problem-solving skills acquired as part of the core chemical engineering degree with an emphasis in biology, advanced materials, or environmental

issues offered at the School of Mines provides students additional opportunities to explore. The chemical engineering degree prepares students to pursue graduate study in medicine, materials science, patent or environmental law, or even business administration, in addition to chemical, biochemical, materials, or nanoengineering.

Chemical engineers, in their effort to solve real world problems for the betterment of society, use their knowledge and skills to control chemical and physical changes of raw materials to create high-value products, while minimizing pollution to the environment. Some specific examples:

Chemical and food process industry:

Design processes using catalytic and multi-phase reactions to convert petroleum and agricultural feed stocks into much needed chemicals, fuels, and foods, and to subsequently purify the products. Reactor design and development of separations such as distillation, extraction, crystallization, evaporation, filtration, gas absorption, industrial waste reduction, and absorption are commonly used to make products such as plastics, paints, cosmetics, candies, cereals, chocolate, beverages, gasoline, paper, and countless other products.

Biotechnology industry: Design and operate bioreactors where conditions must be optimized for the growth of specialized microbes to produce desired metabolites, such as penicillin, human insulin, pharmaceutical proteins, fuel ethanol, food additives/sweeteners, and biopolymers. Develop special separation techniques to isolate these high-value biological materials. Use genetic engineering and recombinant DNA techniques to create new and improved agricultural products and microbes over-expressing biopharmaceuticals. Discover and produce new polymers for delivery of drugs or development of artificial organs.

Advanced materials and electronics:

Develop new hurricane resistant windows made from recycled glass and polymers; produce intermetallic nano-powders created to store hydrogen more safely for fuel cell applications, or novel ion-conducting polymers for improved fuel cell efficiency; design and produce the next generation of protective combat gear, solar cells, or aeronautics equipment. Manufacture

microchips and intricate circuitry for a variety of electronics applications. Synthesis and processing of nanopowders and nanostructures.

Environmental applications: Protection of human health and the environment is of vital concern to the process industries. Additionally, many sites have been previously contaminated and must be remediated. Design and development of in-situ and ex-situ technologies for the remediation or biological destruction of hazardous wastes such as polycyclic aromatic hydrocarbons, halogenated solvents, chlorinated aliphatic compounds, and toxic metals, such as uranium, arsenic, chromium and lead.

The chemical engineering program is challenging, but rewarding. It is designed to prepare students to become practicing chemical engineers, ready to enter the workforce and make immediate contributions or ready to enter graduate education to pursue additional career opportunities. Critical analysis of chemical processes, both as an entire process and individual components, is the core of the program. In addition to becoming proficient in using computers and process simulation software to solve chemical engineering problems, students will also learn to become effective communicators that can work and learn independently as well as within a successful team. As a part of the program, students will be expected to conduct themselves with the highest ethical standards and learn to appreciate the societal responsibilities of being a professional chemical engineer.

Safety and Chemical Education (SACHE) Certificate Program

The AIChE Chemical Engineering professional is a founder in the Safety and Chemical Education (SACHE) Safety Certificate Program, which School of Mines chemical engineering students may earn. This online program was developed by chemical safety experts to provide safety education. It also gives ChE students and graduates an edge over other job candidates, by allowing companies to hire School of Mines graduates who are prepared to improve safety in industrial facilities and laboratories. SACHE and AIChE present a Certificate of Completion to every student who

successfully completes the program and demonstrates proficiency in process safety.

Professional Development and Scholarship Opportunities

Students in the School of Mines Chemical Engineering Program have many chances to enrich their formal engineering education. The department has an active student professional organization, the American Institute of Chemical Engineers Student Chapter, which is associated with the national AIChE professional organization <www.aiche.org>. In this chapter, students learn more about their chosen profession, conduct community service, and participate in regional and national meetings.

At the regional and national AIChE meetings, chemical engineering students from the School of Mines compete against chemical engineering students from other universities in contests such as research paper presentations, process designs, and a Chem-E Car Competition. School of Mines students compete in and win several of these competitions. For example, in 2003, the fuel cell powered “ChemE-Car” car they designed won first place in the AIChE Rocky Mountain Regional competition, beating teams from Colorado, Utah, New Mexico, and Arizona. At the 2008 Annual AIChE meeting in Philadelphia, School of Mines ChE students were recognized for many honors. For example, one student received one of 15 national AIChE scholarships, and the SDSM&T Student Chapter was recognized as one of 15 Outstanding Student Chapters. In 2007, a School of Mines AIChE student was one of 11 engineering students from throughout the United States who participated as a Washington Internships for Students of Engineering intern in Washington, DC. <www.wise-intern.org> Highlights of the AIChE student chapter activities may be found at <<http://aiche.sdsmt.edu>>.

Numerous scholarship opportunities are available to students through the university and the Department of Chemical and Biological Engineering. Funding sources come from foundations, industry, and individual sponsors. The dollar amount and number of scholarships

available fluctuate from year to year. In 2008-09, approximately 75 percent of the sophomore, junior, and senior ChE students received a scholarship. The total amount of scholarships given to all ChE students in 2008-09 exceeded \$153,000.

Laboratories and New Initiatives

The chemical engineering program has laboratory facilities that are used extensively to enhance the theory and skills presented in the classroom and provide students hands-on experience in operating chemical process equipment. These facilities include the main laboratory that houses mini-plant equipment such as a distillation column, evaporators, heat exchangers, and gas absorbers. Other laboratories include a process dynamics laboratory, which is used to study the dynamics and control of process variables such as temperature, pressure, flow rate, and liquid level; a bioChE laboratory for students to use for addressing the solution and study of bioprocessing; and several research laboratories.

During the 2009-2010 calendar year, construction and renovation will begin on a new two-story wing and the mini-plant laboratory in the in the Chemistry/Chemical Engineering Building. While this will take a few years to complete, the new wing will provide integrated education and research opportunities for future generations of chemical/biological engineering and chemistry undergraduate and graduate students. As an essential teaching and learning environment, it will enrich the education of all School of Mines students in science and engineering. It will enhance recruitment and retention of the best students and faculty, promote multidisciplinary and global collaboration, foster new generations of innovators and leaders, and advance the resources of the State of South Dakota.

The Ph.D. program in Chemical and Biological Engineering has been growing over the past two years. This Ph.D. program complements nicely the B.S. undergraduate program. Three new faculty members have joined the department, thus providing enhanced opportunities for undergraduate students to experience the diverse perspectives that different faculty members bring

to the classroom, as well as increased undergraduate research experiences.

The department has been awarded substantial grants from industrial foundations and companies to enhance the laboratory facilities as well as the biochemical engineering area. The **Dow Corning Foundation Enhanced Materials, Automation, Processing, and Simulation (M.A.P.S.) Laboratory** is the foundation for an applied open-ended laboratory experience. Students are exposed to the challenge of effectively applying process design skills in a pilot plant environment. This is coupled to advanced process simulation using AspenPlus and state-of-the-art Opto-22 process controllers. The chemical engineering program is continuing to expand in the growth area of biochemical engineering and biology. Generous donations by the **Cargill Corporation and Foundation** have made the development of this program very successful. Students may develop an emphasis in biochemical engineering through elective courses in biochemistry, microbiology, and biochemical engineering. Additional biochemical engineering topics are integrated into the core chemical engineering courses. Students can gain practical experiences in our modern **Cargill Biochemical Engineering Laboratory**, which is substantially funded by **Cargill**. Check out the latest developments at <<http://cbe.sdsmt.edu/bioche.html>>.

Co-op and Research Opportunities

The chemical engineering curriculum is designed to allow students to prepare themselves to enter the workforce within the traditional four-year period. Opportunities also exist for students to participate in on-the-job training in the form of cooperative education (co-ops), summer internships and research. These employment opportunities may be included as an integral part of the student's studies. Students who participate in these opportunities demonstrate the high level of their educational knowledge and learn more about the profession of chemical engineering.

A number of industrial partners offer cooperative education opportunities for students majoring in chemical engineering. Students are encouraged to apply for these opportunities as

they provide valuable exposure to the practice of chemical engineering. For each semester or summer term spent in a co-op position, students register for 2 credits of a Cooperative Education (CP) course. These credits can be used to fulfill the chemical engineering curriculum requirements. Students wishing to register for a co-op course should visit with their advisor prior to accepting a co-op position to ensure that departmental procedures are followed and to optimize the sequencing of co-op courses with other required courses.

The chemical and biological engineering faculty is actively engaged in research and development and welcomes the participation of undergraduates in these efforts. Additionally, students are encouraged to apply to Research Experience for Undergraduates (REU) sites at other institutions. For example, during the past few summers, School of Mines students have conducted summer research on fuel cells at the University of Houston, bioprocessing at Colorado State University, biomedical engineering at the University of Minnesota, synthesis of pharmaceutical building blocks at Aachen University of Technology in Aachen, Germany, and cellulosic biomass conversion at Iowa State University. Individual School of Mines CBE faculty member research projects and areas of interest may be found from their web pages that are linked from <<http://cbe.sdsmt.edu/personel.html>>.

Chemical Engineering Curriculum/Checklist

The courses listed in the curriculum have been chosen to develop a well-rounded education, beginning with the foundations of mathematics, physics, biology, and chemistry, and culminating with a capstone process design course at the senior level. Along the way, students develop competencies in fluid dynamics, heat transfer, mass transfer, computer solutions to complex engineering problems, process control, kinetics, and reactor design, all while developing their critical thinking and general problem solving skills.

Although a minor in chemical engineering is not available, one can obtain a special emphasis in

emerging areas such as biochemical engineering, environmental engineering, or advanced materials by tailoring their elective courses.

Students in the School of Mines B.S. environmental engineering program may elect chemical engineering as their specialty emphasis. With the increased national emphasis on the environment, the opportunity exists at School of Mines for one to earn dual degrees in chemical engineering and environmental engineering, thus coupling a focus on the environment with complementary chemical processing and design skills.

The chemical engineering faculty at the School of Mines strives to keep the curriculum current and dynamic. As a part of this evolution, the faculty continues to develop innovative approaches to teaching chemical engineering lectures and laboratories. An example of this is the integration of process design and simulation throughout the chemical engineering laboratory experiences. Sophisticated process design simulators (such as the commercial software, AspenPlus and COMSOL), are being co-integrated with process design projects. Major funding for the development came from the National Science Foundation and from industrial sponsors. The chemical engineering faculty is also involved in the university's tablet PC program, which has been used to explore new ways to deliver courses and integrate sophisticated process software. In addition, the School of Mines offers the opportunity for students and professors to interact in small groups and individual sessions.

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

Freshman Year

First Semester

| | | |
|---|-------------------------|-----------|
| MATH 123 | Calculus I | 4 |
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| GE 130 | Introduction to Engr. | 2 |
| ENGL 101 | Composition I | 3 |
| Humanities or Social Sciences Elective(s) | | 5 |
| TOTAL | | 18 |

Second Semester

| | | |
|---|-----------------------------|-----------|
| MATH 125 | Calculus II | 4 |
| CHEM 114 | General Chemistry II | 3 |
| CHEM 114L | General Chemistry II Lab | 1 |
| PHYS 211 | University Physics I | 3 |
| CBE 111 | Intro. Engr. Modeling | 1 |
| CBE 117 | Prof. Pract. in Chem. Engr. | 2 |
| Humanities or Social Sciences Elective(s) | | 4 |
| TOTAL | | 18 |

Sophomore Year

First Semester

| | | |
|--------------|------------------------|-----------|
| CBE 217 | Chemical Engineering I | 3 |
| MATH 225 | Calculus III | 4 |
| ENGL 279 | Technical Comm. I | 3 |
| CHEM 326 | Organic Chemistry I | 3 |
| CHEM 220L | Exp. Organic Chem. IA | 1 |
| PHYS 213 | University Physics II | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|---|---------------------------|-----------|
| CBE 218 | Chemical Engineering II | 3 |
| CBE 222 | Chem. Engr. Thermo. I | 3 |
| CBE 250 | Comp. App. in Chem. Engr. | 2 |
| CHEM 328 | Organic Chemistry II | 3 |
| MATH 321 | Differential Equations | 4 |
| Humanities or Social Sciences Elective(s) | | 3 |
| TOTAL | | 18 |

Junior Year

First Semester

| | | |
|--------------|-----------------------------|-----------|
| CBE 317 | Chemical Engr. III | 3 |
| CBE 321 | Chemical Engr. Thermo. II | 3 |
| CBE 333 | Process Measure and Control | 1 |
| CBE 361 | Chemical Engr. Lab II | 2 |
| CHEM 230 | Analytical Chem. for Engr. | 2 |
| CHEM 332L | Analytical Chem. Lab | 1 |
| CHEM 341 | Physical Chem. for Engr. I | 2 |
| ENGL 289 | Technical Comm. II | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|------------------------------|-----------------------------|---|
| CBE 318 | Chemical Engineering IV | 3 |
| CBE 362 | Chemical Engr Lab III | 1 |
| CBE 343 | Chem Kinetics/Reactor Des | 3 |
| CHEM 343 | Physical Chem. for Engr II | 2 |
| CHEM 345L | Physical Chem. I and II Lab | 1 |
| Engineering Elective | | 3 |
| Department Approved Elective | | 3 |

TOTAL 16

484, 484L, 488, 491, 492, 498 or others approved by advisor.

Senior Year

First Semester

| | | |
|--------------|--|-----------|
| CBE 417 | Chemical Engineering V | 2 |
| CBE 461 | Chemical Engineering Lab IV | 1 |
| CBE 464 | Chemical Engr. Design I | 4 |
| | Chemical Engineering Elective | 3 |
| | Biology Elective | 3 |
| | Hum/SS 300 Level or Higher Elective(s) | 3 |
| TOTAL | | 16 |

CHE Lab Elective (1 cr hr): Select 1 credit from CBE 434L, 474L, 484L, 498 or other approved by advisor.

Engineering Elective (3): Select 3 credits from engineering courses other than CBE prefix; requires advisor approval. These courses are typically at a 200 level or higher.

Department Approved Elective (7): Select from the following: CBE, Chem, or other approved courses to fulfill emphasis electives. These courses are typically at a 150 level or higher. May include up to 3 credits of advanced military science and up to 6 credits of cooperative education (CP 297, CP 397, or CP 497).

Second Semester

| | | |
|--------------|--|-----------|
| CBE 433 | Process Control | 3 |
| CBE 465 | Chemical Engr Design II | 3 |
| CBE 487 | Global and Contemporary Issues in Chemical Engineering | 1 |
| | Chemical Engineering Elective | 2 |
| | Chemical Engineering Lab Elective | 1 |
| | Department Approved Elective | 4 |
| PE | Physical Education/MUEN | 2 |
| TOTAL | | 16 |

136 credits required for graduation

Curriculum Notes

Board of Regents General Education

Requirements: Students working in conjunction with their advisor need to ensure General Education Requirements are completed in the required timeframe. Hum/SS electives require 6 cr hr each from Humanities and Social Sciences. Additionally, 3 cr hr of advanced (300 level or higher) of either Hum or SS is required.

Optional emphases in ChE: The academic advisor recommends and approves courses to take if students are interested in an emphasis in one of these areas: biochemical engineering, environmental engineering, or advanced materials (nano materials, polymers, ceramics, materials processing, corrosion, or solid state/semi-conductors).

BIOL Elective (3 cr hr): Select from BIOL 341, 231, or other approved by advisor.

CHE Elective (5 cr hr): Select 5 credits from CBE 434/434L, 444, 450, 455, 474, 474L, 476,

Chemistry B.S.



Contact Information

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Faculty

Professor Boyles; Associate Professor Fong, Heglund; Assistant Professors Meyer, and Zhu; Instructor Christofferson.

Staff

Department of Chemistry Secretary, Vickie Magnuson; Chemical and Instrumentation Specialist, Margaret Smallbrock.

Chemistry

The Department of Chemistry offers undergraduate chemistry courses that meet the requirements for the bachelor of science degree and for other programs on campus. The chemistry program offers the American Chemical Society (ACS) certified degree, which meets the national requirements of the ACS. This degree requires 128 semester credits.

Upon graduation with a bachelor's degree in chemistry, students have knowledge of chemical and physical phenomena at the molecular level. They are expected to possess the skills of critical thinking in chemical problem-solving, such as instrumental data interpretation for molecular structure characterization. Students are expected

to have a command of the four major sub-disciplines of chemistry, namely, analytical, inorganic, organic, and physical chemistry, as well as to be familiar with the chemical literature.

Chemistry graduates of the department distinguish themselves in that the chemistry curriculum gives them ample opportunity to supplement their chemical knowledge with a breadth of other courses, which may be elected from diverse offerings on campus including the humanities, social sciences, biological and physical sciences, mathematics, engineering, and more. This distinctive latitude inherent within the chemistry curriculum allows students to develop as well-rounded individuals who are able to face and meet the challenges they may anticipate in their chosen careers.

Chemistry, by its very nature, is the central science in the world, and many graduates use their degrees as a solid foundation for advanced study in chemistry as well as for study in medicine, pharmacy, veterinary medicine, forensic science, materials science, environmental science, medical technology, physical therapy, patent or environmental law, education. These are all possibilities for students with a chemistry education. Likewise, students who opt not to further their education beyond their B.S. degrees in chemistry are also prepared for a wide variety of employment opportunities. Among former chemistry graduates, these have included research and quality assurance positions in academic, industrial, governmental, and private sectors of the economy.

The department also participates in both the M.S. and Ph.D. programs in Materials and Engineering Science (MES), the Ph.D. program in Biomedical Engineering and the Ph.D. program in Nanoscience and Nanoengineering. Students seeking these degrees may choose to emphasize any of the representative sub-disciplines of chemistry in addition to interdisciplinary research specialties as an integral part of their graduate program of study.

The department prides itself in having modern instrumentation available not only for research but as an integral part of undergraduate education. The instrumentation within the department currently includes FT-IR spectrometers, a 300

MHz superconducting heteronuclear nuclear magnetic resonance spectrometer, a spectrofluorometer, diode-array spectrophotometer, voltammograph, atomic absorption spectrometer, gas chromatograph-mass spectrometer and other instruments.

advisors work closely with their assigned students in order to ensure that they will complete all degree requirements in a timely manner, will meet prerequisites for further education such as medical school, and will be knowledgeable about post-graduation options and employment opportunities.

Bachelor of Science in Chemistry, ACS Certified

The ACS-certified curriculum provides an excellent foundation in science and mathematics for professional preparation in chemistry and

Freshman Year

First Semester

| | | |
|----------------------|-------------------------|-------------|
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| ENGL 101 | Composition I | 3 |
| MATH 123 | Calculus I | 4 |
| Gen. Ed. Goal 3 or 4 | Elective | 3 |
| IS 110 | Explorations | 2 |
| CHEM 290 | Seminar | 0.5 |
| TOTAL | | 16.5 |

Second Semester

| | | |
|-----------------|--------------------------|-------------|
| CHEM 114 | General Chemistry II | 3 |
| CHEM 114L | General Chemistry II Lab | 1 |
| MATH 125 | Calculus II | 4 |
| PHYS 211 | University Physics I | 3 |
| Gen. Ed. Goal 3 | Elective | 3 |
| Gen. Ed. Goal 4 | Elective | 3 |
| CHEM 290 | Seminar | 0.5 |
| TOTAL | | 17.5 |

Sophomore Year

First Semester

| | | |
|-----------|--------------------------|---|
| CHEM 332 | Analytical Chemistry | 3 |
| CHEM 332L | Analytical Chemistry Lab | 1 |
| CHEM 326 | Organic Chemistry I | 3 |
| CHEM 326L | Organic Chem I Lab | 2 |
| MATH 321 | Differential Equations | 4 |

meets the nationally-recognized high standards established by the American Chemical Society. This curriculum opens the way for a variety of careers in research and development in private industry or government, and gives the student an excellent foundation for graduate study in chemistry.

Students desiring to meet the minimum requirements for certification by the American Chemical Society should follow the curriculum outlined below.

Chemistry Curriculum, ACS Certified

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

| | | |
|--------------|--------------------------------|-------------|
| CHEM 252 | Systematic Inorganic Chemistry | 3 |
| PE | Physical Education | 1 |
| CHEM 290 | Seminar | 0.5 |
| TOTAL | | 17.5 |

Second Semester

| | | |
|-------------------------------|---------------------------|-------------|
| PHYS 213 | University Physics II | 3 |
| PHYS 213L | University Physics II Lab | 1 |
| CHEM 328 | Organic Chemistry II | 3 |
| CHEM 328L | Organic Chem II Lab | 2 |
| ENGL 279 | Technical Comm I | 3 |
| Humanities or Social Sciences | Elective(s) ¹ | 5 |
| CHEM 290 | Seminar | 0.5 |
| TOTAL | | 17.5 |

Junior Year

First Semester

| | | |
|--------------|----------------------|-------------|
| ENGL 289 | Technical Comm II | 3 |
| CHEM 342 | Physical Chemistry I | 3 |
| CHEM 342L | Physical Chem I Lab | 1 |
| Elective(s) | | 9 |
| PE | Physical Education | 1 |
| CHEM 490 | Seminar | 0.5 |
| TOTAL | | 17.5 |

Second Semester

| | | |
|-----------|-----------------------|---|
| CHEM 344L | Physical Chem II Lab | 1 |
| CHEM 344 | Physical Chemistry II | 3 |

| | |
|---|-------------|
| CHEM 370 Chemical Literature | 1 |
| Advanced Chemistry Requirement ² | 6 |
| CHEM 490 Seminar | 0.5 |
| Advanced Chemistry Elective(s) ³ | 3 |
| TOTAL | 15.5 |

Senior Year

First Semester

| | |
|---|-------------|
| Elective(s) | 8 |
| CHEM 490 Seminar | 0.5 |
| Advanced Chemistry Requirement ² | 3 |
| Advanced Chemistry Elective ³ | 3 |
| TOTAL | 14.5 |

Second Semester

| | |
|--|---|
| Electives | 6 |
| Adv Chemistry Requirement ² | 6 |

| | |
|------------------|-------------|
| CHEM 490 Seminar | 0.5 |
| TOTAL | 12.5 |

128 credits required for graduation

Curriculum Notes

¹A minimum of 16 credit hours of university-approved humanities and social sciences are required, with a minimum of 6 hours in humanities and 6 hours in social sciences.

²Fifteen credits of advanced chemistry courses are required: Chem. 434, 434L 452, 452L, 460 and 482.

³Three credits of advanced chemistry electives are required. Take any one of the following courses: 420, 421, 426.



Civil Engineering B.S.



Contact Information

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Faculty

Professors Bang, Fontaine, Hansen, Kenner, and Mott; Associate Professors Fazio, Stone, and Surovek; Assistant Professors Arneson-Meyer, Fick, Roberts and Robinson; Professor Emeritus Ramakrishnan; Associate Professor Emeritus Klasi.

Civil Engineering Program Mission

The mission of the civil engineering program supports the mission of the institution and was developed in parallel with it. The civil engineering program's mission is:

1. To prepare men and women for an enhanced quality of life by providing an educational experience that leads to baccalaureate and post-baccalaureate degrees in civil engineering.
2. To contribute to the expansion of knowledge of civil engineering through programs of basic and applied research, scholarship, and other creative endeavors.

3. To use the special capabilities and expertise of the program's faculty to address regional, national, and international needs in civil engineering, including the areas of environmental, geotechnical, structural and water resources.

4. To serve the State of South Dakota and the nation by providing training and education that will benefit the planning, design, construction and maintenance of facilities essential to civilization.

The principal goals in support of the civil engineering program's mission are:

1. To enhance our state and national recognition as an outstanding civil engineering program that provides well-prepared employees to the civil engineering profession.
2. To develop centers of excellence in research and graduate education, using faculty expertise to further develop interdisciplinary research.
3. To create and maintain an environment that ensures growth of the intellect, character, and spirit of students as well as faculty and staff members.
4. To build mutually beneficial partnerships with the broader community.
5. To increase the resources available to the department and the civil engineering program.

Civil Engineering Program Objectives

The goal of the civil and environmental engineering program with regard to undergraduate education is to produce graduates with capabilities to

1. engage in the professional practice of civil engineering within the region working in the public or private sector,
2. actively participate in professional organizations that promote civil engineering and provide continuing self-development, and
3. pursue advanced studies in civil engineering or a related professional discipline.

These program objectives can also be found on the CEE website <<http://cee.sdsmt.edu>> and are stated in departmental informational materials.

Graduates of the civil engineering program are expected to be competent for entry-level professional practice in four major areas of civil engineering 1) environmental, 2) geotechnical, 3) structural, and 4) water resources. In the senior year, students have two civil engineering focus electives and three department-approved electives. Students have the option of emphasizing in one of the focus areas. Students can also choose a general civil engineering option, selecting a mix of approved elective courses. Focus electives can be in one or two of the four major areas. Department approved electives can be in one or more of the four major civil engineering focus areas or can be courses from outside the department that support the 'students focus area. This provides the student the option of keeping breadth in their study program or emphasizing in one focus area. Studies in these areas culminate in major engineering design experiences to help bridge the gap between education and professional practice.

Civil Engineering Program Outcomes

Program outcomes as stated here define what students are expected to know or be able to do by graduation. The civil engineering program has adopted the program outcomes established by ABET, through its Criterion 3. Achieving these outcomes establishes the foundation for achieving program objectives. Students completing the civil engineering program will be able to demonstrate:

- a. An ability to apply knowledge of mathematics, science, and engineering;
- b. An ability to design and conduct experiments, as well as to analyze and interpret data;
- c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
- d. An ability to function on multi-disciplinary teams;
- e. An ability to identify, formulate, and solve engineering problems;
- f. An understanding of professional and ethical responsibility;
- g. An ability to communicate effectively;
- h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
- i. A recognition of the need for, and an ability to engage in life-long learning;
- j. A knowledge of contemporary issues; and
- k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Civil Engineering Education

An undergraduate education in civil engineering is founded upon a broad knowledge of engineering sciences and selected courses in mathematics, physical sciences, social sciences, technical communication, and national computer methods. Required civil engineering courses address the emphasis areas of environmental, geotechnical, structural, and water resource engineering. Each student is asked to choose one or more of these areas as an emphasis from which elective courses are selected at the senior level. Alternatively, they may complete courses in several of the areas for a broad-based civil engineering emphasis. The graduate program affords an opportunity for qualified students to pursue their academic training to a more specialized and advanced level for higher professional attainment.

Integration of Design into the Civil Engineering Curriculum

The curriculum in the civil engineering program begins by giving the student a thorough knowledge in mathematics and basic sciences. Courses in the engineering sciences begin the transition from theory to creative application. During their junior year, students complete required courses in four major areas of the civil engineering program: environmental, geotechnical, structural, and water resources

engineering. In each of these courses, students learn to apply mathematics, science, and engineering science to the solution of civil engineering problems, to employ learning the fundamental elements of engineering design. During their senior year, students complete five elective courses. The low enrollments in these courses allows for more individualized interaction between students and faculty. As seniors, students get an even more intense design experience, learning about alternative solutions, feasibility, economics, and detailed design via a two-semester capstone design course. Working either in groups or alone, with the guidance of a faculty member, students complete a meaningful major engineering design project that draws upon previous course work. The capstone design experience culminates with a formal final report and a presentation to the faculty and the students' peers.

Laboratories

The Department of Civil and Environmental Engineering maintains separate laboratories equipped for materials testing, study of fluid flow and hydraulic systems, geotechnical engineering, environmental engineering, structural engineering design, and computer-aided design. The comparatively rugged terrain on and near the campus offers excellent opportunity for a variety of practice in surveying methods and techniques.

Professionalism

For promotion of professional and cultural ethics and specialties in the profession, students in civil engineering are encouraged to participate in the technical and professional activities of the Student Chapter of the American Society of Civil Engineers. Students are required to complete the fundamentals of engineering examination as the first step in becoming a registered professional engineer. Because there is a human side to engineering, students are required to complete courses in the humanities and social sciences. Students also complete required sophomore and senior courses that directly address professionalism and engineering ethics. They are

also exposed to these ideas throughout the engineering curriculum.

A minor in civil engineering is not available.

Civil Engineering Curriculum/Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

Freshman Year

First Semester

| | | |
|--------------|--|-----------|
| ENGL 101 | Composition I | 3 |
| CHEM 112 | General Chemistry I | 3 |
| MATH 123 | Calculus I | 4 |
| GE 130 | Introduction to Engineering | 2 |
| PE | Physical Education | 1 |
| | Humanities or Social Sciences Elective(s) ⁴ | 3 |
| TOTAL | | 16 |

Second Semester

| | | |
|--------------|--|-----------|
| CHEM 112L | General Chem I Lab | 1 |
| CHEM 114 | General Chem II | 3 |
| PHYS 211 | University Physics I | 3 |
| MATH 125 | Calculus II | 4 |
| CEE 117 | Computer Aided Design and Interpretation in CEE | 2 |
| PE | Physical Education | 1 |
| | Humanities or Social Sciences Elective(s) ⁴ | 3 |
| TOTAL | | 17 |

Sophomore Year

First Semester

| | | |
|---------------------|--|-----------|
| MATH 321 | Differential Equations | 4 |
| EM 214 ¹ | Statics | 3 |
| CEE 284 | Digital Computation in CEE | 4 |
| CEE 206 | CEE Pract & Engr. Surveys I | 4 |
| | Humanities or Social Sciences Elective(s) ⁴ | 3 |
| TOTAL | | 18 |

Second Semester

| | | |
|---------------------|--|-----------|
| ENGL 279 | Technical Comm I | 3 |
| MATH 225 | Calculus III | 4 |
| EM 331 ¹ | Fluid Mechanics | 3 |
| EM 321 ¹ | Mechanics of Materials | 3 |
| | Humanities or Social Sciences Elective(s) ⁴ | 3 |
| TOTAL | | 16 |

Junior Year¹

First Semester

| | | |
|----------------------|-------------------------------|-----------|
| ENGL 289 | Technical Comm. II | 3 |
| CEE 316 ¹ | Engr. and Construct Materials | 3 |
| CEE 326 ¹ | Intro. Env. Engr. Design | 3 |
| CEE 336 ¹ | Hydraulic Systems Design | 3 |
| CEE 346 ¹ | Geotechnical Engineering I | 3 |
| CEE 353 ¹ | Structural Theory | 3 |
| TOTAL | | 18 |

Second Semester

| | | |
|--------------------------------------|------------------------------------|-----------|
| PHYS 213 | University Physics II ⁵ | 3 |
| Science Elective | | 3 |
| CEE 368 | Intro. to Transportation Engr. | 3 |
| Three of the following four courses: | | 9 |
| CEE 327 | Env. Engr. Proc. Analysis | (3) |
| CEE 337 | Engineering Hydrology | (3) |
| CEE 347 | Geotechnical Engr. II | (3) |
| CEE 358 | Applied Struct. Design | (3) |
| TOTAL | | 18 |

Senior Year

First Semester

| | | |
|--------------|-------------------------------------|-----------|
| IENG 301 | Basic Engineering Econ. | 2 |
| CEE 474 | Engr. Project Management | 3 |
| CEE | Track Elective ² | 3 |
| CEE | Approved Elective ³ | 3 |
| EM 215 | Dynamics ⁵ | 3 |
| OR | | |
| ME 221 | Dynamics of Mechanisms ⁵ | 3 |
| CEE 464 | CE Capstone Design I | 1 |
| TOTAL | | 18 |

Second Semester

| | | |
|---|--------------------------------------|-----------|
| CEE 463 | CEE Profession | 1 |
| ME 211 | Intro to Thermodynamics ⁵ | 3 |
| CEE 465 | CE Capstone Design II | 2 |
| CEE | Track Elective ² | 3 |
| CEE | Approved Elective ³ | 3 |
| Humanities or Social Sciences Elective(s) | | 3 |
| TOTAL | | 15 |

136 credits required for graduation

Minor in Geospatial Technology

Geospatial technology is a rapidly expanding field that covers the management and analysis of spatial data from many sources, such as satellites,

airborne remote sensing, geographic information systems (GIS), global positioning systems (GPS), surveying, and more. Students in civil engineering may find this minor a useful complement to their studies. Complete information on the requirements is given in the Geology B.S. section.

Curriculum Notes

¹ In order to enroll in the CEE junior courses, the student must earn at least a C in EM 214, EM 321, and EM 331.

² Students have the option of emphasizing in one area selected from among the environmental, geotechnical, structural, or water resources engineering offerings where 2 or more approved courses can be selected. The student can also chose a general engineering option thus selecting a mix of approved elective courses. Track electives for the four focus areas are environmental - CEE 426 and CEE 427, geotechnical - CEE 447 and CEE 448, structural - CEE 456 and CEE 457, and water resources - CEE 433 and CEE 437, respectively.

³ See your advisor for a listing of BSCE approved elective courses. Only one approved elective can be completed at the graduate level.

⁴ Consult the section of the catalog addressing graduation requirements for a description of the combinations of lower level (1xx/2xx) social sciences and humanities courses meeting the SDBOR General Education Goals #3 and #4.

⁵ Phys 213, EM 215 or ME 221, and ME 211 all address natural or engineering science topics of import to the general education of civil engineers. The student is free to schedule completion of these courses in any order or in any semester he/she might deem most appropriate to his/her progression through the civil engineering curriculum.

Computer Engineering B.S.



Contact Information

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Faculty

Professors Batchelder, Corwin, Logar, Penaloza, and Weiss; Professor Emeritus Opp; Associate Professors McGough, Tolle; Assistant Professors Hoover, Zhang, Zong; Instructor Linde.

Computer Engineering

The computer engineering curriculum prepares students for life-long careers by providing them with the engineering and technical education appropriate to meet modern technological challenges. The basic curriculum includes required course work in mathematics, basic sciences, humanities, social sciences, and fundamental engineering topics in circuit analysis, electronics, electrical systems, digital systems, assembly language, data structures, operating systems, and software engineering. Computer engineering students are required to select three (3) senior elective courses from a wide variety of subject areas to fit their particular interests. Elective subject areas include digital signal processing, microprocessor-based system design, computer networks, computer architecture, and

VLSI design.

Mission

The mission of the computer engineering program, in support of the mission of School of Mines, is to provide computer engineering students with education that is broadly based in the fundamentals of the profession so that graduates will be able to maintain a high degree of adaptability throughout their professional careers. It is also intended that the students will develop a dedication to the profession and an ability to maintain professional competency through a program of life-long learning.

Objectives

1. Graduates will be able to successfully practice computer engineering and related fields regionally, nationally, and globally.
2. Graduates will be well-educated in the fundamental concepts of computer engineering and be able to continue their professional development throughout their careers.
3. Graduates will be skilled in clear communications and teamwork and capable of functioning responsibly in diverse environments.

Program Strengths

A two-semester capstone design experience requires computer engineering students to conduct their own design project in a simulated industrial environment. They are encouraged to work on team projects, which are often multidisciplinary. This foundation provides students with a broad base of understanding that allows them to apply their knowledge of scientific and engineering principles to the practical and innovative solutions of existing and future problems.

Students are required to develop a high level of written and oral communication skills and to work well as a member of a team. They must develop a social and ethical awareness so they understand their responsibility to protect both the occupational and public health and safety and to

implement these factors in their professional activities. Students are encouraged to participate in the activities of professional societies, such as the Institute of Electrical and Electronics Engineers and Eta Kappa Nu, to enhance their educational and social life while on campus and to gain professional contacts for their careers. Students have opportunities to participate in cooperative education and summer intern programs whereby they elect to seek employment to experience engineering work before they complete their degree requirements. Students gain insight into future opportunities and are often hired by their intern companies after graduation.

Integration of Design Concepts

One of the key elements of the undergraduate computer engineering education experience is to integrate design throughout the curriculum. Students experience various design concepts in a variety of settings:

- Hands-on laboratory projects (including team projects);
- Effective integration of computer applications;
- Senior elective courses;
- Senior capstone experience; and
- Participation in competitive team projects such as the Robotics team, the Alternative Fuel Vehicle Team, the Unmanned Aerial Vehicle Team, and the Formula SAE Mini-Indy Team.

Graduate School Opportunities

The undergraduate curriculum is broad based to give graduates flexibility in their career paths. Qualified students may study areas of interest in more depth and specialize further by pursuing a graduate program at the School of Mines.

Laboratories

The Electrical and Computer Engineering Department houses well-equipped laboratories designed to give students easy access to experimental support for their theoretical studies. Junior and senior laboratory projects are conducted on an open laboratory basis that allows

students to schedule experimental work at their own convenience. Laboratory facilities are open to students and are supervised until 10 p.m. on most weeknights.

Four general-purpose laboratories are fully equipped to provide facilities for experiments in such diverse areas as communication systems, control systems, electromechanics, energy conversion, digital circuits, and electronics. These laboratories can also be used to provide practical experience under the direct supervision of electrical and computer engineering faculty. In addition, there are special-purpose laboratories serving the fields of power systems, antennas, microwave engineering, analog and digital systems, mechatronics, real-time embedded systems, computer instrumentation, microprocessor development, reconfigurable logic, and parallel processing and cluster computing (in conjunction with the Mathematics and Computer Science Department).

Seniors and graduate students have access to facilities to work on senior design and graduate thesis projects. The work area allows students a convenient place in which to work for the duration of their project.

Notes on Computer Engineering Courses

Classes that are typically offered every semester include CENG 244, CENG 464, and CENG 465.

Computer Engineering Curriculum/Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

| <u>Freshman Year</u> | | |
|-----------------------------|---|-----------|
| First Semester | | |
| MATH 123 | Calculus I | 4 |
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| CENG 244 | Intro to Digital Systems | 4 |
| PE | Physical Education ¹ | 1 |
| | Humanities or Social Sciences Elective(s) | 3 |
| TOTAL | | 16 |

| | | |
|------------------------|---|-----------|
| Second Semester | | |
| ENGL 101 | Composition I | 3 |
| MATH 125 | Calculus II | 4 |
| PHYS 211 | University Physics I | 3 |
| PE | Physical Education | 1 |
| | Humanities or Social Sciences Elective(s) | 3 |
| CSC 150 | Computer Science I | 3 |
| TOTAL | | 17 |

Sophomore Year

| | | |
|-----------------------|---------------------------|-----------|
| First Semester | | |
| EE 220 | Circuits I | 4 |
| MATH 321 | Differential Equations | 4 |
| PHYS 213 | University Physics II | 3 |
| PHYS 213L | University Physics II Lab | 1 |
| | Free Elective | 2 |
| CSC 250 | Computer Science II | 4 |
| TOTAL | | 18 |

| | | |
|------------------------|---|-----------|
| Second Semester | | |
| CSC 251 | Finite Structures | 4 |
| ENGL 279 | Tech Comm. I | 3 |
| EE 221 | Circuits II | 4 |
| | Humanities or Social Sciences Elective(s) | 3 |
| EE 351 | Mechatronics and Measurement Systems | 4 |
| TOTAL | | 18 |

Junior Year

| | | |
|-----------------------|-------------------|-----------|
| First Semester | | |
| CENG 314 | Assembly Language | 3 |
| ENGL 289 | Tech Comm II | 3 |
| EE 320 | Electronics I | 4 |
| CSC 300 | Data Structures | 4 |
| MATH 225 | Calculus III | 4 |
| TOTAL | | 18 |

| | | |
|------------------------|-------------------------------------|-------------|
| Second Semester | | |
| EE 312 | Signals | 3.5 |
| CSC 470 | Software Engineering | 3 |
| CENG 342 | Digital Systems | 4 |
| | Approved Math Elective ² | 3 |
| EM 216 | Statics and Dynamics | 4 |
| TOTAL | | 17.5 |

Senior Year

| | | |
|-----------------------|-----------------|-----|
| First Semester | | |
| EE 311 | Systems | 3.5 |
| CENG 464 | Senior Design I | 2 |

| | | |
|--------------|---|-------------|
| CENG | Elective(s) ³ | 4 |
| IENG 301 | Basic Engr. Economics | 2 |
| | Free Elective | 1 |
| | Humanities or Social Sciences Elective(s) | 3 |
| TOTAL | | 15.5 |

| | | |
|------------------------|---|-----------|
| Second Semester | | |
| CENG 465 | Senior Design II | 2 |
| CSC 456 | Operating Systems | 4 |
| CENG | Elective(s) ³ | 3 |
| CENG | Elective(s) ³ | 4 |
| | Humanities or Social Sciences Elective(s) | 3 |
| TOTAL | | 16 |

136 credits required for graduation

Curriculum Notes

¹ Music ensemble courses, (MUEN 101, 121 or 122) may be substituted for physical education courses for qualified students. Any other substitution must be approved in advance by the physical education department head.

² MATH 381 and 441 are approved electives

³ Eleven CENG elective credits are required.

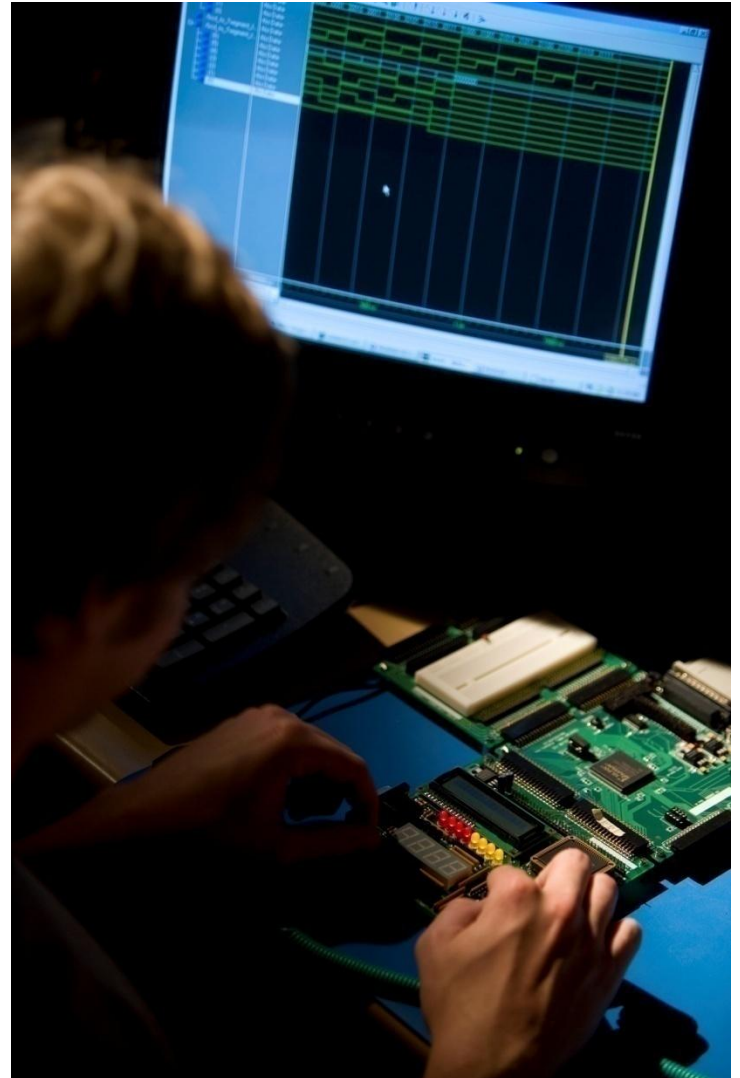
CENG Electives

| | | |
|----------|--|---|
| EE 322 | Electronics II | 4 |
| EE 421 | Communications Systems | 4 |
| EE 451 | Control Systems | 4 |
| EE 452 | Robotic Control System | 3 |
| CENG 420 | Design of Digital Signal Processing Systems | 4 |
| CENG 440 | VLSI Design | 4 |
| CENG 442 | Microprocessor Design | 4 |
| CENG 444 | Computer Networks | 4 |
| | (credit for only one of CENG 444 or CSC 463 may be used) | |
| CENG 446 | Advanced Computer Architectures | |
| | (credit for only one of CENG 446 or CSC 440 may be used) | |
| CENG 447 | Embedded and Real-Time Computer Systems | 4 |
| CSC 410 | Parallel Computing | 3 |
| CSC 415 | Robotics | 3 |
| CSC 416 | Introduction to Autonomous Systems | 3 |
| CSC 433 | Computer Graphics | 3 |
| CSC 440 | Adv Digital Systems | 4 |

| | | |
|---------|---|---|
| CSC 447 | Artificial Intelligence | 3 |
| CSC 464 | Intro to Digital Image Processing and Computer Vision | 3 |
| CSC 476 | Theory of Compilers | 3 |

A maximum of 4 co-op credits may be used toward the CENG electives requirement if a written request presented by the student is approved by the ECE faculty. The student request must justify that the CENG design requirement is met.

Computer engineering students are required to take the Fundamentals of Engineering (FE) exam prior to graduation.



Computer Science B.S. and Minor



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Associate Professor McGough; Assistant
Professors Hoover and Zong; Instructor Schrader;
Emeritus Professors Carda, Opp and Weger.

General Information

The Department of Mathematics and
Computer Science offers a bachelor of science
degree in computer science and a master of
science degree in Robotics and Intelligent

Autonomous Systems (RIAS). The bachelor of
science degree in computer science is accredited
by the Accreditation Board for Engineering and
Technology (ABET).

Students who desire to major in this program
should announce their intention to the Department
of Mathematics and Computer Science as early as
possible and should consult advisors in the
department at each registration period.

Any student who is pursuing a double major
and whose designated advisor is in another
department should consult an advisor in the
mathematics and computer science department at
each registration.

Laboratories

The School of Mines has a variety of
computing platforms available. Resources
include an extensive PC network, a Linux lab, a
Tablet PC lab, and robotics lab. The Linux lab is
fully equipped with quad-core desktops. Other
computing resources may be accessed via the
Internet. The institution encourages its students to
use the computer facilities in the creative and
efficient solution of scientific and engineering
problems.

Computer Science Major

The primary goal of the computer science
program is to prepare graduates to enter a
dynamic and rapidly changing field as competent
computer scientists. Graduates are expected to be
capable in all phases of software development
including design, development, and testing.
Graduates should also have a firm understanding
of hardware technologies. These capabilities
require the graduate to possess good
communication skills, both oral and written, and
the ability to work effectively as a team member.
Graduates must be able to read and comprehend
the literature of the discipline and be sufficiently
well-versed in general theory to allow growth
within the discipline as it advances. Most of the
graduates will pursue careers as software
engineers within the computer industry. Some
may choose careers as entrepreneurs and others
will pursue advanced degrees and careers in

research.

The sample Computer Science Checklist in this section lists all required courses for the bachelor's degree in their proper prerequisite sequence. Students should consult course listings for prerequisites and should consult their advisors at each registration.

A computer science major must complete 30 total hours in humanities, social science, or other nontechnical disciplines that serve to broaden the background of the student. Within that requirement, the student must complete a minimum of 16 credits in humanities and social science, with at least 6 credit hours in humanities and at least 6 credit hours in social science. Refer to the humanities and social sciences section of this catalog for a list of courses satisfying these requirements. It is also important to refer to the general education core requirements under bachelor of science graduation requirements for further information. Students must complete the general education core requirements within the first 64 credits.

Any computer science major desiring a minor in another field should consult his or her advisor in the Department of Mathematics and Computer Science as early in his or her program of study as possible. The Office of the Registrar and Academic Services has a form that must be signed by the student and the department heads of both departments involved.

Minor in Computer Science

A minor in the Department of Mathematics and Computer Science must be approved by the student's major department. The Office of the Registrar and Academic Services has forms that should be completed and signed by the department heads from both departments involved in this minor. The minor in computer science requires the completion of 21 credit hours.

The core course work includes CSC 150, CSC 250, CSC 251, CSC 300, and at least 6 credit hours from an approved list.

The approved list of courses for the minor: CSC 314, CSC 317, CSC 372, CSC 410, CSC 412, CSC 421, CSC 433, CSC 440, CSC 445, CSC 447, CSC 448, CSC 456, CSC 461, CSC

463, CSC 464, CSC 476, and CSC 484.

Computer Science and Mathematics Double Major

Due to the large number of courses common to the computer science major and the mathematics major, many students find it attractive to pursue a double major in these two areas. Students seeking the double major should consult their advisors for details about this option.

Computer Science Curriculum/Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

Freshman Year

| First Semester | | |
|--|--------------------|-----------|
| ENGL 101 | Composition I | 3 |
| Science Elective ¹ | | 3 |
| Science Elective Lab ¹ | | 1 |
| MATH 123 | Calculus I | 4 |
| CSC 150 | Computer Science I | 3 |
| Humanities or Social Sciences Elective(s) ¹ | | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|--|---------------------|-----------|
| MATH 125 | Calculus II | 4 |
| Humanities or Social Sciences Elective(s) ¹ | | 3 |
| CSC 250 | Computer Science II | 4 |
| CSC 251 | Finite Structures | 4 |
| PE | Physical Education | 1 |
| TOTAL | | 16 |

Sophomore Year

| First Semester | | |
|--|--------------------------|-----------|
| CSC 300 | Data Structures | 4 |
| MATH 225 | Calculus III | 4 |
| CENG 244 | Intro to Digital Systems | 4 |
| PE | Physical Education | 1 |
| Humanities or Social Sciences Elective(s) ¹ | | 3 |
| TOTAL | | 16 |

Second Semester

| | | |
|--|-------------------|---|
| ENGL 279 | Technical Comm | 3 |
| CSC 314 | Assembly Language | 4 |
| Humanities or Social Sciences Elective(s) ¹ | | 3 |

| | |
|-----------------------------------|-----------|
| Science Elective ¹ | 3 |
| Science Elective Lab ¹ | 1 |
| Free Elective | 2 |
| TOTAL | 16 |

Junior Year

First Semester

| | | |
|---------------------------------------|------------------------|-----------|
| ENGL 289 | Technical Comm II | 3 |
| MATH 321 | Differential Equations | 4 |
| PHYS 211 | University Physics I | 3 |
| CSC 372 | Analysis of Algorithms | 3 |
| Elective or CSC Elective ¹ | | 3 |
| TOTAL | | 16 |

Second Semester

| | | |
|---------------------------|--|-----------|
| CSC 317 | Computer Organization and Architecture | 4 |
| MATH 315 | Linear Algebra | 3 |
| CSC 461 | Programming Languages | 4 |
| CSC 470 | Software Engineering | 3 |
| CSC Elective ¹ | | 3 |
| TOTAL | | 17 |

Senior Year

First Semester

| | | |
|--|---------------------------|-----------|
| CSC 465 | Senior Design I | 2 |
| CSC 484 | Database Mgmt Systems | 3 |
| CSC 421 | Graphical User Interfaces | 3 |
| Humanities or Social Sciences Elective(s) ¹ | | 4 |
| Free Elective | | 3 |
| TOTAL | | 15 |

Second Semester

| | | |
|----------------------------|-------------------------------------|-----------|
| CSC 456 | Operating Systems | 4 |
| CSC 467 | Senior Design II | 2 |
| HUM 375 | Computers in Society ¹ | 3 |
| CSC Electives ¹ | | 3 |
| MATH 381 | Intro to Probability and Statistics | 3 |
| TOTAL | | 15 |

128 credits required for graduation

Curriculum Notes

- CSC 465/467 is a two-course sequence in senior design. It is expected that the course sequence will be taken in successive semesters.

- An exit exam, such as the Major Field Achievement Test in Computer Science, will be given as part of CSC 467. The overall results of this exam will be used to assess the computer science program.
- CSC 105 may not be counted toward any mathematics, computer science, or engineering degree. Other majors should consult their departments on policy regarding this course.
- MUEN 101, 121, 122 can be used to substitute for one or two of the required two physical education credits.

¹Elective courses must be chosen to satisfy all of the following requirements.

- Sixteen semester hours in humanities or social science. At least 6 hours must be in humanities and at least 6 hours must be in social sciences.
- Six credit hours of humanities and 6 credit hours of social science must be completed within the first 64 hours. It is important to refer to the general education requirements under bachelor of science graduation requirements for further information.
- Thirty total hours in humanities, social science, or other nontechnical disciplines that serve to broaden the background of the student. This may include all English classes, 2 credits of physical education, and those courses used to meet requirement (1) above.
- A minimum of 3 computer science elective courses numbered 400 or above must be taken. A 3-credit Co-op may be substituted for one computer science elective. Special topics and independent study courses may not be used to satisfy the computer science elective requirement.
- Eleven credits of science. Students must take three science courses that count toward the major in that discipline, with two accompanying labs. These courses must be selected from at least two different disciplines, and one science course must be PHYS 211.

Course Offering Schedule

In an attempt to help students plan their future semesters, the following information is presented. This reflects the best available knowledge at the time of the preparation of this document. This is not meant as a guarantee of when classes will be offered. Students concerned about when classes will be offered should contact the department head for any changes to the following. Courses not listed below have no defined rotation and will be offered contingent on demand and staff. Most computer science courses are not suitable to offering in an eight-week Summer session. Students should not expect computer science offerings in the summer.

Classes that are typically offered every semester include CSC 105, CSC 150, CSC 250, CSC 251, CSC 314, and CSC 300.

Classes that are typically offered every fall semester include CSC 372, CSC 415/515, CSC 421/521, CSC 465, and CSC 484.

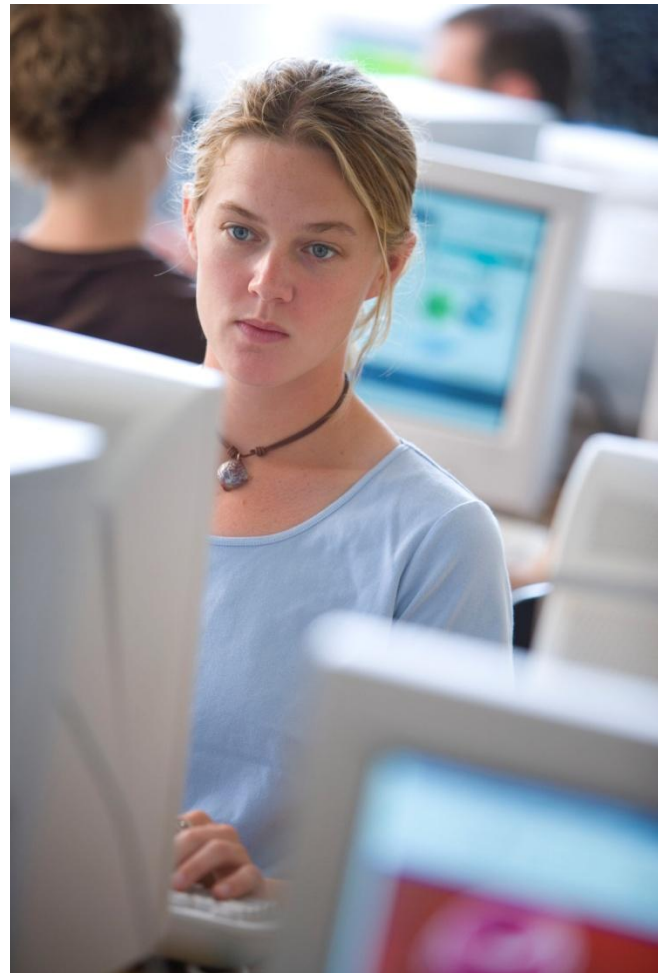
Classes that are typically offered every spring semester include CSC 317, CSC 416/516, CSC 447/547, CSC 461, CSC 456, CSC 467, CSC 470, and MATH 315.

Classes that are typically offered in the fall semester of even numbered years, for example fall 2010, include CSC 433/533 and CSC 449/549.

Classes that are typically offered in the spring semester of odd numbered years, for example spring 2011, include MATH 463.

Classes that are typically offered in the fall semester of odd numbered years, for example fall 2009, include CSC 445/545, and CSC 464/564.

Classes that are typically offered in the spring semester of even numbered years, for example spring 2010, include CSC 410/510.



Electrical Engineering B.S.



Contact Information

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Faculty

Steven P. Miller Endowed Chair and Professor Whites; Professor Batchelder; Associate Professor Tolle; Assistant Professors Montoya, Zhang, Fathelbab, and Anagnostou; Instructor Linde.

Electrical Engineering

The electrical engineering curriculum prepares students for life-long careers by providing them with the engineering and technical education appropriate to meet modern technological challenges. The basic curriculum includes required course work in mathematics, basic sciences, humanities, social sciences, and fundamental engineering topics in circuit analysis, electronics, electrical systems, electromagnetics, energy systems, and properties of materials. Electrical engineering students are required to select 3 senior elective courses from a wide variety of subject areas to fit their particular interests. Elective subject areas include communication systems, power systems, control systems, microwave engineering, antenna engineering, and computer systems.

Mission

The mission of the electrical engineering program, in support of the mission of School of Mines, is to provide electrical engineering students with education that is broadly based in the fundamentals of the profession so that graduates will be able to maintain a high degree of adaptability throughout their professional careers. It is also intended that the students will develop a dedication to the profession and an ability to maintain professional competency through a program of lifelong learning.

Objectives

1. Graduates will be able to successfully practice electrical engineering and related fields regionally, nationally, and globally.
2. Graduates will be well-educated in the fundamental concepts of electrical engineering and be able to continue their professional development throughout their careers.
3. Graduates will be skilled in clear communications and teamwork and capable of functioning responsibly in diverse environments.

Program Strengths

A two-semester capstone design experience requires electrical engineering students to conduct their own design project in a simulated industrial environment. They are encouraged to work on team projects and often the team projects are multidisciplinary. This foundation provides students with a broad base of understanding that allows them to apply their knowledge of scientific and engineering principles to the practical and innovative solutions of existing and future problems.

Students are required to develop a high level of written and oral communication skills and to work well as members of a team. They must develop a social and ethical awareness so they understand their responsibility to protect both occupational and public health and safety and to

implement these factors in their professional activities. Students are encouraged to participate in the activities of professional societies, such as the Institute of Electrical and Electronics Engineers and Eta Kappa Nu, to enhance their educational and social life while on campus and to gain professional contacts for their careers. Students have opportunities to participate in cooperative education and summer intern programs whereby they elect to seek employment to experience engineering work before they complete their degree requirements. Students gain insight into future opportunities and are often hired by their intern companies after graduation.

Integration of Design Concepts

One of the key elements of the undergraduate electrical engineering education experience is to integrate design throughout the curriculum. Students experience various design concepts in a variety of settings:

- Laboratory projects (including team projects);
- Effective integration of computer applications;
- Senior elective courses;
- Senior capstone experience; and
- Participation in competitive team projects such as the Robotics Team, the Alternative Fuel Vehicle Team, the Unmanned Aerial Vehicle Team, and the Formula SAE Mini-Indy Team.

Graduate School Opportunities

The undergraduate curriculum is broadly based to give graduates flexibility in their career paths. Qualified students may study areas of interest in more depth and specialize further by pursuing a graduate program at the School of Mines.

Laboratories

The electrical and computer engineering department houses well-equipped laboratories designed to give students easy access to experimental support for their theoretical studies. Junior and senior laboratory projects are

conducted on an open laboratory basis that allows students to schedule experimental work at their own convenience. Laboratory facilities are open to students and are supervised until 10 p.m. on most weeknights.

Four general-purpose laboratories are fully equipped to provide facilities for experiments in such diverse areas as communication systems, control systems, electromechanics, energy conversion, digital circuits, and electronics. These laboratories can also be used to provide practical experience under the direct supervision of electrical and computer engineering faculty. In addition, there are special-purpose laboratories serving the fields of power systems, antennas, microwave engineering, analog and digital systems, mechatronics, real-time embedded systems, computer instrumentation, microprocessor development, reconfigurable logic, and parallel processing and cluster computing (in conjunction with the Mathematics and Computer Science Department).

Seniors and graduate students have access to facilities to work on senior design and graduate thesis projects. The work area allows them a convenient place in which to work for the duration of their project.

Notes on Electrical Engineering Courses

Classes that are typically offered every semester include EE 220, EE 221, EE 301, EE 351, EE 464, and EE 465.

Electrical Engineering Curriculum/Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

Freshman Year

First Semester

| | | |
|---|---------------------------------|-----------|
| MATH 123 | Calculus I | 4 |
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| CENG 244 | Intro to Digital Systems | 4 |
| Humanities or Social Sciences Elective(s) | | 3 |
| PE | Physical Education ¹ | 1 |
| TOTAL | | 16 |

| | | |
|------------------------|---|-----------|
| Second Semester | | |
| ENGL 101 | Composition I | 3 |
| MATH 125 | Calculus II | 4 |
| PHYS 211 | University Physics I | 3 |
| PE | Physical Education I | 1 |
| | Humanities or Social Sciences Elective(s) | 3 |
| | Free Elective ⁴ | 2 |
| TOTAL | | 16 |

Sophomore Year

| | | |
|-----------------------|---|-----------|
| First Semester | | |
| EE 220 | Circuits I | 4 |
| MATH 321 | Differential Equations | 4 |
| CSC 150 | Computer Science I | 3 |
| PHYS 213 | University Physics II | 3 |
| PHYS 213L | University Physics II Lab | 1 |
| | Humanities or Social Sciences Elective(s) | 3 |
| TOTAL | | 18 |

| | | |
|------------------------|---|-----------|
| Second Semester | | |
| ENGL 279 | Technical Comm I | 3 |
| EE 221 | Circuits | 4 |
| MATH 225 | Calculus III | 4 |
| EE 351 | Mechatronics and Measurement Systems | 4 |
| | Humanities or Social Sciences Elective(s) | 3 |
| TOTAL | | 18 |

Junior Year

| | | |
|-----------------------|------------------------------|-------------|
| First Semester | | |
| ENGL 289 | Tech Comm. II | 3 |
| EE 311 | Systems | 3.5 |
| EE 320 | Electronics I | 4 |
| EE 381 | Electric and Magnetic Fields | 3 |
| EM 216 | Statics and Dynamics | 4 |
| TOTAL | | 17.5 |

| | | |
|------------------------|-------------------------------------|-------------|
| Second Semester | | |
| EE 312 | Signals | 3.5 |
| EE 322 | Electronics II | 4 |
| EE 330 | Energy Systems | 4 |
| EE 382 | Applied Electromagnetics | 3 |
| | Approved Math Elective ² | 3 |
| TOTAL | | 17.5 |

Senior Year

| | | |
|-----------------------|--|---|
| First Semester | | |
| EE 362 | Electric and Magnetic Properties of Materials | 3 |

| | | |
|--------------|---------------------------------------|-----------|
| IENG 301 | Basic Engr. Economics | 2 |
| ME 211 | Thermodynamics | 3 |
| EE 464 | Senior Design I | 2 |
| EE | Electrical Engr Elective ³ | 4 |
| | Free Elective ⁴ | 3 |
| TOTAL | | 17 |

| | | |
|------------------------|---|-----------|
| Second Semester | | |
| EE 465 | Electrical Engr. Design II | 2 |
| EE | Electrical Engr. Elective ³ | 4 |
| EE | Electrical Engr. Elective ³ | 3 |
| | Technical Elective ⁵ | 3 |
| | Humanities or Social Sciences Elective(s) | 3 |
| | Free Elective ⁴ | 1 |
| TOTAL | | 16 |

136 credits required for graduation

Curriculum Notes

¹ Music ensemble courses, (MUEN 101, 121 or 122) may be substituted for physical education courses. Any other substitutions must be approved in advance by the physical education department head.

² MATH 381 and 441 are approved electives.

³ Eleven electrical engineering elective credits required.

| | | |
|---------------------|---|---|
| EE Electives | | |
| EE 421 | Communications Systems | 4 |
| EE 431 | Power Systems | 4 |
| EE 432 | Power Electronics | 4 |
| EE 451 | Control Systems | 4 |
| EE 481 | Microwave Engineering | 4 |
| EE 483 | Antennas for Wireless Communications | 4 |
| EE 552 | Robotic Control Systems | 3 |
| CENG 342 | Digital Systems | 4 |
| CENG 420 | Design of Digital Signal Processing Systems | 4 |
| CENG 440 | VLSI Design | 4 |
| CENG 442 | Microprocessor Design | 4 |
| CENG 444 | Computer Networks | 4 |
| | (credit for only one of CENG 444 or CSC 463 may be used) | |
| CENG 446 | Advanced Computer Architectures | 4 |
| | (credit for only one of CENG 446 or CSC 440 may be used) | |

CENG 447 Embedded and Real-Time
Computer Systems 4

⁴ A free elective is any college level course 100 level or above that is acceptable toward an engineering or science degree. Military science courses, 100 level and above, apply as free electives only; substitution for departmental, technical, humanities, or social science electives

is not permitted.

⁵ A technical elective is any science or engineering course 200 level or above that does not duplicate the content of any other course required for graduation. Co-op credits may be used for technical elective credit. A maximum of 6 co-op credits may be used for the EE degree.

Electrical engineering students are required to take the Fundamentals of Engineering exam prior to graduation.



Environmental Engineering B.S.



Contact Information

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Management Committee

Professors Davis (GEOE), and Mott(CEE);
Associate Professors Menkhaus (CBE), Stone
(CEE); and Assistant Professors Cross (MET)

Environmental Engineering

Environmental engineers serve our society at the most fundamental level in caring for the air we breathe, the water we drink, and the soil in which we grow our food. Environmental engineers solve existing and prevent future environmental problems. Students in the B.S. Environmental Engineering program will be educated in higher mathematics, basic sciences, engineering sciences, and engineering design. The experience will be augmented by applied laboratory courses at the freshman through senior levels. Students will use computers in virtually all engineering course work. Fundamental environmental engineering course work will involve heat and mass transfer, classical and chemical thermodynamics, ground-water and surface-water hydrology, and environmental systems analysis. Each student will participate in a two-semester capstone design experience that will involve work with a

multidisciplinary team on the solution to a significant environmental problem.

In order to develop a technical link with one of five disciplines closely related to environmental engineering, each student will opt for an emphasis consisting of 4 to 5 required and elective courses, delivered by the respective discipline. This course work prepares the student to cooperatively work alongside engineers of the emphasis discipline in solution of environmental problems.

Emphasis areas include

1. Chemical Engineering — The application of chemical, chemical engineering, and environmental engineering principles to the environmentally safe production of a wide range of products including pharmaceuticals for human consumption, materials for electronic applications, and energy to power our society.
2. Civil Engineering — Engineering our society's infrastructure through treatment of water for potable use, renovation of waste waters generated by domestic and industrial users, safe handling (both disposal and recycling) of solid and hazardous wastes generated by society, clean-up of existing environmental pollution, and general stewardship of the Earth's land and water resources.
3. Geological Engineering — Engineering for the environmentally sound use and conservation of the Earth's natural resources including development of ground-water supplies, cleanup of contaminated aquifers, isolation of hazardous wastes, and exploration for and development of mineral or petroleum resources.
4. Materials and Metallurgical Engineering — development and implementation of environmentally sound processes for producing the metals, ceramics, and composite materials used by our society, and leadership in the area of recycling of materials for re-use by society.
5. Mining Engineering — The development of mining and reclamation plans that ensure environmentally sound mining operations and that

the Earth and oceans are returned to environmentally acceptable conditions upon the completion of mining activities.

The objective of the environmental engineering program is to provide graduates with an educational foundation that will enable them to engage in the professional practice of environmental engineering within the public or private sector, or complete advanced studies in either environmental engineering or a related professional discipline.

Graduates of this program are expected to:

1. Ethically apply, as appropriate in applicable global and contemporary societal contexts, principles from mathematics, the natural sciences, engineering, humanities, and social sciences, to the definition, formulation, and solution of both existing and potential environmental problems.
 2. Develop, interpret, and utilize appropriate laboratory process data; think critically; and use modern engineering skills, techniques, and tools in the iterative decision-making process associated with environmental engineering design.
 3. Work and learn, on a lifelong basis, both independently and cooperatively with peers.
 4. Communicate the results of their work and their ideas effectively, both orally and in written form, to peers and to non-technical audiences.
- A minor is not available in environmental engineering.

Cooperative Education Program

Students may participate in the Cooperative Education Internship Program. Within the limits specified by each emphasis, these credits may be applied toward elective requirements.

Laboratories

Laboratories maintained by the chemical and biological, civil and environmental, geological, materials and metallurgical, and mining engineering and management programs are equipped with modern analytical instrumentation. Descriptions of these laboratories are given

elsewhere in respective sections of this catalog. These laboratories are utilized both in graduate and undergraduate research and in association with undergraduate courses to enhance student understanding of critical phenomena. Computational laboratories maintained by all 5 programs are equipped with modern personal and workstation computing equipment. These computers are networked with the university's file server.

Environmental Engineering Environmental Engineering Curriculum/Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

Freshman Year

| First Semester | | |
|-----------------------|---|-----------|
| ENGL 101 | Composition I | 3 |
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| MATH 123 | Calculus I | 4 |
| GE 130/130L | Intro. to Engineering | 2 |
| | General Education goal 3 or 4 elective ⁷ | 3 |
| PE | Physical Education ⁶ | 1 |
| TOTAL | | 17 |

Second Semester

| | | |
|--------------|---|-----------|
| CBE 111 | Intro. Engr. Modeling | 1 |
| CHEM 114 | General Chemistry II | 3 |
| CHEM 114L | General Chemistry II Lab | 1 |
| CBE 117 | Prof. Pract. in ChE ⁵ | 2 |
| MATH 125 | Calculus II | 4 |
| PHYS 211 | University Physics I | 3 |
| | General Education goal 3 or 4 elective ⁷ | 3 |
| PE | Physical Education ⁶ | 1 |
| TOTAL | | 18 |

Sophomore Year

| First Semester | | |
|-----------------------|---|---|
| ENVE 217 | Chem Engr. I | 3 |
| MATH 225 | Calculus III | 4 |
| CHEM 230 | Anal. Chem. for Engr | 2 |
| ENGL 279 | Tech. Comm. I | 3 |
| BIOL 341 | Microbial Processes in Engr. and Nat. Science | 3 |
| | General Education goal 3 or 4 elective ⁷ | 3 |

TOTAL 18

Second Semester

| | | |
|---|-----------------------------------|-----------|
| PHYS 213 | University Physics II | 3 |
| GEOE 221 | Geology for Engineers | 3 |
| EM 216 | Statics and Dynamics ¹ | 4 |
| MATH 321 | Differential Equations | 4 |
| General Education goal 3 or 4 elective ⁷ | | 3 |
| ENVE 390 | Seminar | 0 |
| TOTAL | | 17 |

Junior Year

First Semester

| | | |
|--------------|-----------------------------|-----------|
| ENGL 289 | Tech. Comm II | 3 |
| IENG 301 | Basic Engr. Economics | 2 |
| ENVE 307 | Environmental Geostatistics | 2 |
| ENVE 315 | Fund. of Heat Transfer | 2 |
| ENVE 320 | Thermodynamics ² | 4 |
| ENVE 326 | Introd. Env. Engr. Design | 3 |
| CHEM 332L | Anal. Chemistry Lab | 1 |
| TOTAL | | 17 |

Second Semester

| | | |
|-----------------------------------|--------------------------------------|-----------|
| CBE 250 | Computer Apps in ChE ⁵ | 2 |
| CHEM 316 | Fund. of Org. Chem. | 3 |
| ENVE 318 | Chemical Engr. IV | 3 |
| ENVE 327 | Env. Engr. Proc Analysis | 3 |
| EM 328 | Applied Fluid Mechanics ³ | 3 |
| ENVE 390 | Seminar | 0 |
| Emphasis elective(s) ⁴ | | 3 |
| TOTAL | | 17 |

Senior Year

First Semester

| | | |
|-----------------------------------|--------------------------|-----------|
| ENVE 421 | Environ Systems Analysis | 3 |
| ENVE 464 | Environ Engr. Design I | 2 |
| ENVE 475 | Ground Water | 3 |
| Emphasis elective(s) ⁴ | | 8 |
| TOTAL | | 16 |

Second Semester

| | | |
|---|-----------------------|-----------|
| ENVE 337 | Engineering Hydrology | 3 |
| ENVE 390 | Seminar | 1 |
| ATM 405 | Air Quality | 3 |
| ENVE 465 | Envr. Engr. Design II | 2 |
| Emphasis elective(s) ⁴ | | 3 |
| Humanities or Social Sciences Electives | | 4 |
| TOTAL | | 16 |

136 credits are required for graduation

Minor in Geospatial Technology

Geospatial technology is a rapidly expanding field that covers the management and analysis of spatial data from many sources, such as satellites, airborne remote sensing, geographic information systems (GIS), global positioning systems (GPS), surveying, and more. Students in environmental engineering may find this minor a useful complement to their studies. Complete information on the requirements is given in the Geology B.S. section.

Curriculum Notes

¹A combination of EM 214/321, EM 214/215, or EM 214/ME 221 may replace EM 216.

²CBE 222 and CBE 321 will satisfy the thermodynamics requirement.

³CBE 218, EM 331, or ME 331 will also satisfy fluid mechanics requirements.

⁴Each student must select a set of emphasis area course work totaling 14 credits. (See emphasis areas below).

⁵CEE 284 (4 cr.) meets the combined requirement for CBE 117-CBE 250, 4 credits total. Math 373, 3 credits, may be substituted for CBE 250, 2 credits.

⁶Music Ensemble courses may be substituted for physical education courses for qualified students. Any other substitutions must be approved in advance by the physical education department head.

⁷Consult the section of the catalog addressing graduation requirements for a description of the combinations of lower level (1xx/2xx) social sciences and humanities courses meeting the SDBOR General Education goals #3 and #4.

Environmental Engineering Emphasis Areas

Chemical Engineering

Required course work:

| | |
|--------------------------------------|---|
| Sub CBE 222 and CBE 321 for ENVE 320 | 2 |
| BIOL 231L General Microbiology Lab | 1 |
| CBE 343 Chem Kin./Reactor Design | 3 |
| <u>CBE Lab Electives</u> | 2 |
| (2 cr. from the following) | |

| | | |
|----------|--------------------|-----|
| CBE 362 | Chem Engr. Lab III | (1) |
| CBE 434L | Sep process Lab | (1) |
| CBE 461 | Chem Engr. Lab IV | (1) |
| CBE 484L | BioChem Engr. Lab | (1) |

| | | |
|---|----------------------------|-----|
| Engineering Topics Elective(s) ⁽³⁾ : | | 3 |
| 3 credits from the following: | | |
| CBE 417 | Chemical Engr. V | (2) |
| CBE 434 | Des. of Sep. Processes | (1) |
| CBE 444 | Reactor Design | (3) |
| CBE 455 | Poll Phen and Proc Control | (3) |
| CBE 484 | Fund. of BioChem. Engr. | (3) |
| Technical Elective(s) ⁽¹⁾ : | | 3 |

Civil Engineering

Required course work:

| | | |
|----------|----------------------------|---|
| ENVE 426 | EnvE Phys/Chem. Proc. Des. | 3 |
| ENVE 427 | EnvE Bio. Proc. Des. | 3 |

| | | |
|-------------------------------|--------------------|-----|
| One of the following options: | | 2 |
| ENVE 428 | EnvE Ops/Proc. Lab | (2) |

OR

| | | |
|-----------|--------------------|-----|
| ENVE 426L | EnvE Phys/Chem Lab | (1) |
|-----------|--------------------|-----|

AND

| | | |
|-----------|---------------------|-----|
| ENVE 427L | EnvE Bio. Proc. Lab | (1) |
|-----------|---------------------|-----|

| | | |
|--|--|---|
| <u>Engineering Topics elective(s)⁽³⁾:</u> | | 3 |
|--|--|---|

| | | |
|--|---------------------------|-----|
| 3 credits from the following | | |
| MET 220 | Min. Proc./Res Rec | (3) |
| MET 310 | Aq. Extrac/Conc/Recy | (3) |
| CEE 425 | Sust. Engr. Design | (3) |
| CEE 433 | Open Channel Flow | (3) |
| CEE 437 | Wtshd/Floodplain Mod | (3) |
| ENVE 491 | Independent Study | (3) |
| CEE 492 | Topics | (3) |
| ENVE 498 | Undergraduate Research | (3) |
| CEE 621 | Env. Cont. Fate & Transp. | (3) |
| CEE 622 | Adv. Trt. Plant Design | (3) |
| CEE 627 | Trt/Disp/Mgmt Haz waste | (3) |
| CEE 628 | Env. Engr. Measurements | (3) |
| Technical Elective(s) ⁽¹⁾ : | | 3 |

Geological Engineering

Required course work:

| | | |
|----------|------------------------|---|
| GEOE 324 | Engineering Geophysics | 3 |
|----------|------------------------|---|

| | | |
|-----------------------------|--|---|
| <u>One of the following</u> | | 3 |
|-----------------------------|--|---|

| | | |
|----------|-----------------------|-----|
| GEOE 466 | Engr. and Env Geology | (3) |
| GEOE 482 | Applied Geomorphology | (3) |

| | | |
|---|------------------------|-----|
| GEOE 682 | Fluvial Processes | (3) |
| Engineering Topics Elective(s) ⁽³⁾ : | | 5 |
| 5 credits from the following | | |
| GEOE 425 | Engr. Geophysics II | (3) |
| CEE 437 | Watshd/Floodplain Mod | (3) |
| GEOE 461 | Petroleum Engr. | (3) |
| GeoE 462 | Drilling Engineering | (3) |
| GEOE 482 | Applied Geomorphology | (3) |
| ENVE 498 | Undergraduate Research | (2) |
| GEOE 498 | Undergraduate Research | (2) |
| GEOE 615 | Adv. Field Meth in GW | (3) |
| GEOE 626 | Env .Geophysics | (3) |
| GEOE 641 | Geochemistry | (3) |
| GEOE 662 | Anal. Methods in GW | (3) |
| GEOE 663 | Ground Water Geochem. | (3) |
| GEOE 664 | Adv. Ground Water | (3) |
| GEOE 682 | Fluvial Processes | (3) |
| Technical Elective(s) ⁽¹⁾ : | | 3 |

Materials and Metallurgical Engineering

Required course work:

| | | |
|--|--------------------------|---|
| MET 220 | Min. Proc./Res Rec | 3 |
| MET 220L | Min. Proc./Res Rec Lab | 1 |
| MET 310 | Aq Extrac/Conc/Recy | 3 |
| MET 310L | Aq Extrac/Conc/Recy Lab | 1 |
| MET 321 | High Temp Extr/Conc/Recy | 4 |
| Technical Elective(s) ⁽¹⁾ : | | 3 |

Mining Engineering

Required course work

| | | |
|---|-------------------------------------|-----|
| MEM 120 | Int. Mining/Sust Dev. | 2 |
| MEM 203 | Intro. to Mine Health/Safety | 1 |
| MEM 301 | Computer Apps in Mining | 2 |
| MEM 405 | Mine Permitting/Recl. | 3 |
| Engineering Topics elective(s) ⁽³⁾ : | | 3 |
| 3 credits from the following | | |
| MEM 204 | Surf Mining Meth | (3) |
| MET 220 | Min. Proc./Res Rec | (3) |
| MEM 307 | Mineral Expl./Geostats ² | (1) |
| MEM 466 | Mine Management | (2) |
| Technical Electives ⁽¹⁾ : | | 3 |

¹A 3xx or higher level course, approved by the student's advisor, addressing natural science, applied science or, engineering topics, which are related to environmental engineering and to the student's program of study.

²EnvE 307, which is the first 2/3 of MEM 307 is a required core course. Completion of MEM 307 nets one emphasis credit.

³Students wishing to include more than 3 credits of 6xx course work in their programs of study must petition to and receive permission

from the BS EnvE Program Management Committee.



General Studies, Associate of Arts Degree A.A.



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The Associate of Arts Degree in General Studies is a two-year degree program that provides a student the opportunity to complete a curriculum in traditional fields of study. The curriculum offers a broad and varied background in general education as well as opportunities to explore a number of disciplines as a basis for entrance into a four-year degree program. Completion of the A.A. degree will fulfill the general education requirements for a baccalaureate degree at the state universities of South Dakota. Approved general education courses from other state universities may be used to satisfy the School of Mines general education requirements. The program of studies is:

Associate of Arts Degree General Education Requirements

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

Written and Oral Communication

A minimum of 9 semester hours is required. This requirement can be met by taking one of two sequences of courses. Either:

| | | |
|----------|-------------------|---|
| ENGL 101 | Composition I | 3 |
| ENGL 279 | Technical Comm. I | 3 |

| | | |
|------------|------------------------|---|
| ENGL 289 | Technical Comm. II | 3 |
| OR: | | |
| ENGL 101 | Composition I | 3 |
| ENGL 201 | Composition II | 3 |
| SPCM 101 | Fundamentals of Speech | 3 |

Humanities

Courses in history, literature, philosophy, religion, non-English languages, art, music, and theatre may be used. A minimum of 6 semester hours in two disciplines, i.e. two different course prefixes or a two-semester sequence in a foreign language, is required.

| | | |
|---------------|---|-----|
| ART 111/112 | Drawing and Perception I and II | 3/3 |
| ARTH 211* | History of World Art II | 3 |
| ENGL 221/222* | British Lit. I ¹ and II ¹ | 3/3 |
| ENGL 241/242* | American Lit I ¹ and II ¹ | 3/3 |
| ENGL 250 | Science Fiction | 3 |
| FREN 101/102* | Intro French I ¹ and II ¹ | 4/4 |
| GER 101/102* | Intro German I ¹ and II ¹ | 4/4 |
| HIST 121/122* | Western Civilization I ¹ and II ¹ | 3/3 |
| HUM 100* | Intro. to Humanities ¹ | 3 |
| HUM 200* | Connections: Humanities and Technology ¹ | 3 |
| MUS 100* | Music Appreciation ¹ | 3 |
| MUS 110* | Basic Music Theory II | 3 |
| PHIL 100 | Intro. to Philosophy | 3 |
| PHIL 200 | Intro. to Logic | 3 |
| PHIL 220* | Intro. to Ethics ¹ | 3 |
| PHIL 233 | Philosophy and Literature | 3 |
| REL 230 | Introduction to the Bible | 2 |
| REL 250* | World Religions ¹ | 2 |
| SPAN 101/102* | Intro. Spanish I ¹ and II ¹ | 4/4 |

Social Sciences

Courses in anthropology, economics, geography, history, political science, psychology, and sociology may be used. A minimum of 6 semester hours in two disciplines, i.e. two different course prefixes, is required.

| | | |
|---------------|---|-----|
| ANTH 210* | Cultural Anthropology ¹ | 3 |
| ECON 201* | Prin of Microeconomics ¹ | 3 |
| ECON 202* | Prin of Macroeconomics ¹ | 3 |
| GEOG 101* | Introduction to Geography ¹ | 3 |
| GEOG 212 | Geography of North America | 3 |
| HIST 151/152* | US History I ¹ and II ¹ | 3/3 |

| | | |
|----------|--|---|
| POLS 100 | American Government | 3 |
| PSYC 101 | General Psychology | 3 |
| SOC 100 | Introduction to Sociology ¹ | 3 |
| SOC 150* | Social Problems ¹ | 3 |
| SOC 250 | Courtship and Marriage | 3 |

Mathematics

A minimum of 3 semester hours of college algebra or a math course with college algebra as a prerequisite is required.

| | | |
|----------|-----------------|---|
| MATH 102 | College Algebra | 3 |
|----------|-----------------|---|

Natural Sciences

A minimum of 6 semester hours in the natural sciences is required including one semester hour of laboratory. Courses in biology, chemistry, earth science, geology, and physics may be used.

| | | |
|---------------|---|-----|
| BIOL 151/151L | General Biology I and Laboratory | 3/1 |
| BIOL 153/153L | General Biology II and Laboratory | 3/1 |
| CHEM 106/106L | Chemistry/Laboratory | 3/1 |
| CHEM 108/108L | Organic and Bio. Chemistry/Laboratory | 4/1 |
| CHEM 112/112L | General Chemistry I and Laboratory | 3/1 |
| CHEM 114/114L | General Chemistry II and Laboratory | 3/1 |
| GEOL 201/201L | Physical Geology/Laboratory | 3/1 |
| PHYS 111/111L | Introduction to Physics I and Laboratory | 3/1 |
| PHYS 113/113L | Introduction to Physics II and Laboratory | 3/1 |
| PHYS 211 | University Physics I | 3 |
| PHYS 213/213L | University Physics II and Laboratory | 3/1 |

* Cultural Diversity

A minimum of 6 semester hours is required. Courses must be selected from those marked with an asterisk * in the Humanities and Social Sciences sections above. If non-asterisked courses are selected to fulfill the Humanities and Social Science requirements, additional asterisked

courses must be selected to fulfill this requirement.

Information Technology

A minimum of 2 semester hours is required and may be satisfied via:

| | |
|---------------|--|
| CEE 284/284L | Digital Computation Applications in CE |
| CHEM 182 | Chemical Computations |
| CSC 105 | Introduction to Computers |
| CSC 150/150L | Computer Science I |
| GE 112/112L | Personal Computer Programming |
| GE 130/130L | Introduction to Engineering |
| GEOE 211/211L | Earth Systems Engineering Analysis |

Electives

Total semester hours required to graduate is 64. The number of elective credits will vary from a minimum of 24-30 semester hours, depending on the courses selected in humanities, social sciences, cultural diversity, and natural sciences. All elective courses must be approved by the student's academic advisor.

Other Degree Requirements

Students are required to pass the CAAP proficiency examination and the Information Literacy Examination. For additional information on these examinations, contact the Office of the Registrar and Academic Services at (605) 394-2400.

Students must have achieved a minimum cumulative grade point average of 2.00 in order to graduate with this degree.

After completion of 48 credit hours, students may register for up to nine hours of 300 level courses.

Students must meet the Institutional Credit Requirements, which include completion from School of Mines of 8 of the last 16 credits counted toward the degree.

This information and an A.A. worksheet may be found at: <<http://sdmines.sdsmt.edu/is>>.

Geology B.S. and Minor



Contact Information

Dr. Maribeth H. Price

Department of Geology and Geological Engineering
Mineral Industries 307
(605) 394-2461
E-mail: Maribeth.Price@sdsmt.edu

Faculty

Professors Duke and Paterson; Associate Professors Price and Uzunlar; Assistant Professor Terry; Professors Emeritus Fox, Lisenbee, and Redden, Haslem Post-doctoral Fellow Pagnac.

Supporting Faculty

Professors Roggenthen and Davis. Associate Professor Stetler. Assistant Professors Katzenstein and Sawyer. Professor Emeritus Rahn.

Geology

The program in geology fully utilizes the magnificent geologic setting of the Black Hills and Badlands, and the extensive fossil and mineral specimens in the Museum of Geology, to train students for careers in geology including environmental applications, mineral and petroleum exploration, governmental agencies, museums, academic fields, teaching, and entrepreneurship. Both undergraduate and graduate programs are available. The

undergraduate program develops a strong background in basic sciences and students may choose from three different specializations.

The Applied Geology specialization prepares students for careers in the traditional geologic industries such as petroleum or mineral exploration, water resources, or environmental science. The Earth System Science specialization emphasizes interactions among the lithosphere, atmosphere, and biosphere and prepares students for careers in environmental science. The Paleontology specialization studies ancient creatures and environments and prepares students for opportunities in research, teaching, or museum conservation and curation.

For careers in science education, students should consult teaching programs at other colleges for auxiliary education courses that would be needed for teacher certification. With some adaptation, the specializations can provide a foundation for professional graduate degrees such as medicine or law. All specializations prepare the individual for graduate study in geology or related areas.

The graduate programs, both master's and doctoral, involve additional specialization in geology and paleontology and commonly include research on regional or local problems. Analytical and computational facilities in the department and related departments include the electron microprobe, heating-cooling fluid inclusion stage, AA-ICP, XRD, SEM, TEM, and the Geographic Information Systems/ Remote Sensing Laboratory. The Museum of Geology holds over 300,000 fossil and mineral specimens that are available for educational and research use. Completion of graduate degrees leads to higher-level professional employment including college-level instruction.

Professional Development

The senior year culminates in an individual research project in which the student practices the professional accomplishments of project planning, organization, time management, and oral/written communication. Students are strongly encouraged to participate in professional societies active on campus, including the Tech Geological

Association, the Society of Economic Geologists and the Paleontology Club. Paleontology students will have opportunities to volunteer or work on archival and research projects at the Museum of Geology. Internships in industry and government are commonly available and highly recommended.

Minor In Geology

Other science and engineering majors may pursue a minor in geology by completing 18 credit hours of geology courses including: GEOL 201, 201L, 212, 321, 341, and GEOE 322. GEOL 331 may be substituted for GEOL 321 with the permission of the head of the Department of Geology and Geological Engineering. Students pursuing a degree in Mining Engineering may take GEOL 214L and GEOE 451 in place of GEOL 212.

Minor in Geospatial Technology

Geospatial technology is a rapidly expanding field that covers the management and analysis of spatial data from many sources, such as satellites, airborne remote sensing, geographic information systems (GIS), global positioning systems (GPS), surveying, and more. It has many applications in the sciences, engineering, business, planning, and transportation. Other science and engineering majors may pursue a minor in geospatial technology by completing 18 credit hours of courses, including GEOL 316, GEOL 417, GEOL 419, and GEOL 420. Six additional credits taken from any of the groups below complete the minor.

ONE of these surveying courses may be applied to the minor:

- CEE 206 Civil Engineering Practice and Engineering Surveys (4 cr)
- MEM 201 Surveying for Mining Engineers (2 cr)

ONE of these statistics courses may be applied to the minor:

- ENVE 307 Environmental Geostatistics (2 cr)
- MEM 307 Mineral Exploration and Geostatistics (3 cr)

- MATH 281 Intro to Statistics (3 cr)
- MATH 381 Probability and Statistics (3 cr)
- MATH 441 Engineering Statistics (4 cr)

ONE of these programming courses may be applied to the minor:

- CHE 117 Professional Practices in Chemical Engineering (2 cr)
- GEOE 211 Earth Systems Engineering Analysis (2 cr)
- CEE 284 Digital Computation Applications in Civil Engineering (4 cr)
- CSC 150 Computer Science I (3 cr)

ANY of these courses may be applied to the minor:

- GEOE 475 Ground Water Modeling (3 cr)
- CEE 437 Watershed and Flood Plain Modeling (3 cr)
- CSC 250 Computer Science II (3 cr)
- CSC 284 Database Processing (3 cr)
- GEOL 376 Geospatial Field Methods (3 cr)

Geology Curriculum/Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog. When planning course work, students in all three specializations are advised that the courses GEOL 212, GEOL 341, GEOE 322 and GEOL 410 form a critical sequence that must be taken in the order listed.

Applied Geology Specialization

Freshman Year

First Semester

| | | |
|--------------|-------------------------|-----------|
| MATH 123 | Calculus I | 4 |
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| ENGL 101 | Composition I | 3 |
| GEOL 201 | Physical Geology | 3 |
| GEOL 201L | Physical Geology Lab | 1 |
| IS 110 | Explorations | 2 |
| TOTAL | | 17 |

Second Semester

| | | |
|----------|----------------------|---|
| CHEM 114 | General Chemistry II | 3 |
|----------|----------------------|---|

| | | |
|---|--------------------------|-----------|
| CHEM 114L | General Chemistry II Lab | 1 |
| MATH 125 | Calculus II | 4 |
| PHYS 211 | University Physics I | 3 |
| Gen. Ed. Goal 3 and Goal 4 Electives ¹ | | 6 |
| TOTAL | | 17 |

| | | |
|---------------------------------------|----------------------|-----------|
| GEOE 475 | Ground Water | 3 |
| GEOE 461 | Petroleum Production | 3 |
| Free Elective(s) ³ | | 4 |
| Humanities/Social Science elective(s) | | 3 |
| TOTAL | | 14 |

Sophomore Year

First Semester

| | | |
|--------------|------------------------------------|-----------|
| GEOL 331 | Stratig and Sedimentation | 3 |
| MATH 225 | Calculus III | 4 |
| PHYS 213 | University Physics II | 3 |
| MEM 201 | Surveying for Mineral Engineers | 2 |
| GEOL 321 | Search For Our Past | 3 |
| TOTAL | | 15 |

Second Semester

| | | |
|---|-----------------------------------|-----------|
| ENGL 279 | Technical Comm. I | 3 |
| GEOL 212 | Mineralogy and Crystallography | 3 |
| GEOE 211 | Earth Systems Engr. Analysis2 | 2 |
| PE | Physical Education | 1 |
| Gen. Ed. Goal 3 and Goal 4 Electives ¹ | | 6 |
| TOTAL | | 15 |

Junior Year

First Semester

| | | |
|---------------------------------------|---------------------------------|-----------|
| ENGL 289 | Technical Comm II ¹ | 3 |
| GEOL 316 | Intro to GIS | 3 |
| GEOL 341 | Elementary Petrology | 3 |
| GEOL 461 | Invertebrate Paleo ² | 3 |
| Humanities/Social Science Elective(s) | | 1 |
| PE | Physical Education | 1 |
| TOTAL | | 14 |

Second Semester

| | | |
|----------------------------------|--------------------------------|-----------|
| GEOE 322 | Structural Geology | 3 |
| GEOL 403 | Regional Field Geology | 1 |
| GEOE 324 | Engr. Geophysics I | 3 |
| GEOL 442 | Optical Petrology ² | 3 |
| Geology Elective(s) ³ | | 3 |
| TOTAL | | 13 |

Summer

| | | |
|----------|---------------|---|
| GEOL 410 | Field Geology | 6 |
|----------|---------------|---|

Senior Year

First Semester

| | | |
|----------|--------------------------------|---|
| GEOL 464 | Senior Research I ⁴ | 1 |
|----------|--------------------------------|---|

Second Semester

| | | |
|----------------------------------|------------------------------------|-----------|
| GEOL 465 | Senior Research II ⁴ | 3 |
| GEOE 482 | Applied Geomorphology ² | 3 |
| GEOE 451 | Economic Geology | 3 |
| Geology Elective(s) ³ | | 3 |
| Free electives | | 3 |
| TOTAL | | 15 |

128 credits required for graduation

Earth System Science Specialization

Freshman Year

First Semester

| | | |
|--------------|-------------------------|-----------|
| BIOL 151 | General Biology I | 3 |
| MATH 123 | Calculus I | 4 |
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| GEOL 201 | Physical Geology | 3 |
| GEOL 201L | Physical Geology Lab | 1 |
| IS 110 | Explorations | 2 |
| TOTAL | | 17 |

Second Semester

| | | |
|--|--------------------------|-----------|
| CHEM 114 | General Chemistry II | 3 |
| CHEM 114L | General Chemistry II Lab | 1 |
| MATH 125 | Calculus II | 4 |
| ENGL 101 | Composition I | 3 |
| PHYS 211 | Univ. Physics I | 3 |
| Gen. Ed. Goal 3 Electives ¹ | | 3 |
| TOTAL | | 17 |

Sophomore Year

First Semester

| | | |
|--|---------------------------|-----------|
| ATM 301 | Intro to Atmospheric Sci | 3 |
| GEOL 331 | Stratig and Sedimentation | 3 |
| MATH 225 | Calculus III | 4 |
| PHYS 213 | Univ. Physics II | 3 |
| Gen. Ed. Goal 4 Electives ¹ | | 3 |
| TOTAL | | 16 |

Second Semester

| | | |
|----------|--------------------------------|---|
| ENGL 279 | Technical Comm. I ¹ | 3 |
|----------|--------------------------------|---|

| | | |
|---|--------------------------------|-----------|
| GEOL 212 | Mineralogy and Crystallography | 3 |
| GEOE 211 | Earth Systems Engr. Analysis2 | |
| PE | Physical Education | 1 |
| Gen. Ed. Goal 3 and Goal 4 Electives ¹ | | 6 |
| TOTAL | | 15 |

Junior Year

| | | |
|---------------------------------------|---------------------------------|-----------|
| First Semester | | |
| ENGL 289 | Technical Comm. II ¹ | 3 |
| GEOL 341 | Elementary Petrology | 3 |
| GEOL 416 | Intro to GIS | 3 |
| BIOL 311 | Principles of Ecology | 3 |
| GEOL 321 | Search For Our Past | 3 |
| Humanities/Social Science Elective(s) | | 1 |
| TOTAL | | 16 |

Second Semester

| | | |
|----------------------------------|------------------------|-----------|
| GEOE 322 | Structural Geology | 3 |
| ATM 406 | Global Environ. Change | 3 |
| PE | Physical Education | 1 |
| Program Elective(s) ⁵ | | 3 |
| Free Elective(s) | | 4 |
| TOTAL | | 14 |

Summer

| | | |
|----------|---------------|---|
| GEOL 410 | Field Geology | 6 |
|----------|---------------|---|

Senior Year

| | | |
|--|--------------------------------|-----------|
| First Semester | | |
| GEOL 464 | Senior Research I ⁴ | 1 |
| GEOL 351 | Earth Resources and Environ | 3 |
| GEOL 420 | Intro to Remote Sensing | 3 |
| Program Elective(s) ⁵ | | 2 |
| Free elective(s) | | 3 |
| Humanities/Social Sciences elective(s) | | 3 |
| TOTAL | | 15 |

Second Semester

| | | |
|----------------------------------|------------------------------------|-----------|
| GEOL 465 | Senior Research II ⁴ | 3 |
| GEOL 417 | Geospatial Databases | 3 |
| GEOE 482 | Applied Geomorphology ² | 3 |
| Program Elective(s) ⁵ | | 3 |
| TOTAL | | 12 |

128 credits required for graduation

Paleontology Specialization

Freshman Year

| | | |
|-----------------------|-------------------------|-----------|
| First Semester | | |
| BIOL 151 | General Biology I | 3 |
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| ENGL 101 | Composition I | 3 |
| GEOL 201 | Physical Geology | 3 |
| GEOL 201L | Physical Geology Lab | 1 |
| IS 110 | Explorations | 2 |
| TOTAL | | 16 |

Second Semester

| | | |
|---|--------------------------|-----------|
| CHEM 114 | General Chemistry II | 3 |
| CHEM 114L | General Chemistry II Lab | 1 |
| BIOL 153 | General Biology II | 3 |
| MATH 123 | Calculus I | 4 |
| Gen. Ed. Goal 3 and Goal 4 Electives ¹ | | 6 |
| TOTAL | | 17 |

Sophomore Year

| | | |
|--|---------------------------|-----------|
| First Semester | | |
| GEOL 331 | Stratig and Sedimentation | 3 |
| BIOL 121 | Basic Anatomy | 3 |
| BIOL 121L | Basic Anatomy Lab | 1 |
| MATH 125 | Calculus II | 4 |
| PHYS 211 | University Physics I | 3 |
| Gen. Ed. Goal 3 Electives ¹ | | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|---------------------------|-----------------------------------|-----------|
| ENGL 279 | Technical Comm. I ¹ | 3 |
| GEOL 212 | Mineralogy and Crystallography | 3 |
| GEOL 276 | Dinosaurs and Extinct Vertebrates | 3 |
| GEOE 211 | Earth Systems Engr. Analysis2 | |
| PE | Physical Education | 1 |
| Gen. Ed. Goal 4 Electives | | 3 |
| TOTAL | | 15 |

Junior Year

| | | |
|-----------------------|---------------------------------|---|
| First Semester | | |
| ENGL 289 | Technical Comm. II ¹ | 3 |
| MATH 281 | Intro. to Statistics | 3 |
| GEOL 321 | Search for our Past | 3 |
| GEOL 341 | Elementary Petrology | 3 |
| GEOL 461 | Invertebrate Paleo ² | 3 |

| | |
|---------------------------------------|-----------|
| Humanities/Social Science Elective(s) | 1 |
| TOTAL | 16 |

Second Semester

| | | |
|----------------------------------|--------------------------------------|-----------|
| GEOE 322 | Structural Geology | 3 |
| GEOL 403 | Regional Field Geology | 1 |
| GEOL 316 | Intro to GIS | 3 |
| GEOL 472 | Museum Conserv Curation ² | 3 |
| PE | Physical Education | 1 |
| Geology Elective(s) ³ | | 3 |
| TOTAL | | 14 |

Summer

| | | |
|--------------|--------------------|----------|
| GEOL 410 | Field Geology | 6 |
| GEOL 371 | Field Paleontology | 2 |
| TOTAL | | 8 |

Senior Year

First Semester

| | | |
|---------------------------------------|-------------------------------------|-----------|
| GEOL 464 | Senior Research I ⁴ | 1 |
| GEOL 473 | Museum Prep and Exhibit Design | 3 |
| GEOL 351 | Earth Resources and the Environment | 3 |
| BIOL 311 | Principles of Ecology | 3 |
| Humanities/Social Science Elective(s) | | 3 |
| TOTAL | | 13 |

Second Semester

| | | |
|----------------------------------|---------------------------------|-----------|
| GEOL 465 | Senior Research II ⁴ | 3 |
| Geology Elective(s) ³ | | 3 |
| Free Elective(s) | | 6 |
| TOTAL | | 12 |

128 credits required for graduation

Curriculum Notes

¹Students must complete 27 credits of the general education core in their first 64 credit hours, including 6 credits of science, 3 credits math, 6 credits English/technical communication, 6 credits humanities, and 6 credits social science. ENGL 289 yields an addition 3 general education credits, for a total of 30.

²Courses offered alternate years.

³A geology elective is any course with a GEOL or GEOE prefix.

⁴Under exceptional circumstances, a student may petition the department head to substitute

geology electives for senior research.

⁵A program elective is any 300-400 level course with a prefix of GEOL, GEOE, ATM, BIOL, CHEM, or MATH.

Additional course work in mathematics and statistics is strongly recommended, especially for students planning to go to graduate school. MATH 381 and MATH 382 are recommended statistics courses; MATH 432 is recommended for students interested in numerical modeling of partial differential equations

The Black Hills Natural Sciences Field Station

The Black Hills Natural Sciences Field Station functions in cooperation with universities from South Dakota, North Dakota, Mississippi, and Wisconsin with the purpose of providing summer field courses in the Black Hills and nearby areas, as well as overseas. Field courses in geology, geological engineering and environmental science and engineering are offered. For descriptions of all courses offered, see the listings of the Department of Geology and Geological Engineering in this catalog.

The Field Station operates from five sites: School of Mines campus, Ranch A in the northern Black Hills of Wyoming, Taskesti in the country of Turkey, the city of Chennai, and the Andaman Islands in India.

Geology and Geological Engineering Field Camps:

GEOL 410 Field Geology — five weeks (6 semester hours) — Ranch A, Wyoming

GEOL 410 Field Geology — five weeks (6 semester hours) --- Taskesti, Turkey

GEOE 410 Engineering Field Geology five weeks (6 semester hours) — Rapid City, SD

Black Hills Natural Sciences Field Station (BHNSFS)

GEOE 410 Engineering Field Geology five weeks (6 semester hours) – Taskesti, Turkey

GEOL/GEOE 412/512 Science and Engineering Applications (3 to 6 semester hours), Rapid City - SD, Taskesti – Turkey and Chennai - Andaman Islands, India

BHNSFS also offers youth and freshman geology field camps and field trips.

Further information may be obtained by calling (605) 394-2494, or by visiting the website: <<http://geologyfieldcamp.sdsmt.edu>> . Online registration or applications (available from the web page) should be received by March 1st. All deposit fees are non-refundable upon acceptance into the course.

Geographic Information Systems (GIS) and Remote Sensing Lab

The Geographic Information Systems (GIS) and Remote Sensing laboratory is a facility for generating and analyzing spatially-referenced digital information, including maps and remotely-sensed data. Undergraduate and graduate courses in GIS are offered through the Department of Geology and Geological Engineering. (See section on Research Centers and Related Activities for a full description.)



Geological Engineering B.S.



Contact Information

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Mineral Industries 307

(605) 394-2461

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Faculty

Professors Davis and Roggenthen; Associate Professors Price and Stetler; Assistant Professors Katzenstein and Sawyer, Professor Emeritus Rahn.

Supporting Faculty

Professors Duke, Hladysz, and Paterson; Associate Professor Uzunlar, Assistant Professor

Terry; Adjunct Professors Anderson and Long.

Black Hills Natural Sciences Field Station (BHNSFS)

The BHNSFS serves as the residential base camp for geology and geological engineering summer programs. (See section under Geology B.S. and Minor for a full description.)

Information Systems (GIS) and Remote Sensing Lab

The Geographic Information Systems (GIS) and Remote Sensing Laboratory is a facility for generating and analyzing spatially-referenced digital information, including maps and remotely-sensed data. Undergraduate and graduate courses in GIS are offered through the Department of Geology and Geological Engineering. (See section on Research Centers and Related Activities for a full description.)

Geological Engineering

Geological engineering is the development and conservation of natural resources in ways useful to mankind. It encompasses diverse fields such as ground-water resources, subsurface contamination, slope stability, environmental site investigations, petroleum exploration and production, and mineral resources. The instruction in geological engineering provides training at both the undergraduate and graduate.

Geological Engineering Program Objectives

The objectives of the program in geological engineering are to provide students with: 1) an understanding of the fundamental principles of geological engineering, basic engineering, and geology, and 2) academic training and design experiences to prepare them for practice in the geological engineering profession. This education also prepares them to continue with graduate studies, if they desire.

Graduates of the geological engineering program are expected to be competent for entry-

level professional practice in the areas of 1) ground water, 2) environmental site planning and natural hazards, 3) geomechanics and geotechnics, and 4) exploration for and development of fuels or minerals. In the senior year, students select two of these four main areas of emphasis, depending on their interests and career objectives. Studies in these areas culminate in major engineering design experiences to help bridge the gap between education and professional practice. Graduates of the program who obtain employment in their area of expertise are expected to advance more rapidly than their peers who do not have similar specialized training.

Geological Engineering Education

An integral part of the educational experience is development of the ability to design solutions for meeting desired needs in geological engineering work. The design component of the curriculum is developed within geological engineering courses that integrate basic science (including geology, chemistry, and physics) and engineering science (including statics, mechanics of materials, fluid mechanics, soil mechanics, and thermodynamics). This engineering design experience includes a two-semester capstone design sequence. The capstone engineering design courses build upon and integrate previous course work to prepare graduates for the professional practice of geological engineering.

The nature of geological engineering is continually evolving as the needs of employers change in response to advances in technology and economic forces. To prepare adequately for careers in geological engineering, students must be willing to engage in lifelong learning in order to embrace new technologies and to stay current within the engineering profession. Graduates with a broad range of skills, flexibility in learning new technologies, and sound training in fundamental principles can expect a competitive advantage in the job market and workplace.

The bachelor of science program in geological engineering is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone (410) 347-7700.

A minor in geological engineering is not available.

Professional Development

Students in geological engineering are encouraged to participate in the Student Chapter of the Association of Engineering Geologists as well as to become student members of the National Ground Water Association, the Society for Mining, Metallurgy, and Exploration (SME), and the Society of Petroleum Engineers (SPE). Students are strongly encouraged to take the Fundamentals of Engineering examination, as the first step in becoming a registered professional engineer.

Geological Engineering Laboratories

The Department of Geology and Geological Engineering has laboratory facilities that include a digital and analytical modeling laboratory, a Geographic Information Systems (GIS) laboratory, a ground-water laboratory, a wind engineering laboratory, a geotechnics laboratory, a drilling fluids laboratory, and an operational well field with data loggers and transducers. Available instrumentation includes ground-probing radar, a hydrologic analysis system, a portable wind tunnel, a mobile drilling rig, and petroleum engineering equipment. The computer laboratory is continually updated and contains high-speed computers with GIS and other analytical capabilities. Programs are available for digital modeling of ground-water flow and contaminant migration, petroleum engineering, slope stability, geophysical applications, geochemical modeling, and spreadsheet applications.

Geological Engineering Curriculum/Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

Freshman Year

First Semester

CHEM 112 General Chemistry I 3

| | | |
|--------------------------------------|----------------------|-----------|
| MATH 123 | Calculus I | 4 |
| ENGL 101 | Composition I | 3 |
| GE 130 | Intro to Engineering | 2 |
| Gen. Ed. Goal 3 and Goal 4 Electives | | 6 |
| TOTAL | | 18 |

Second Semester

| | | |
|--------------|---|-----------|
| CHEM 112L | General Chem I Lab | 1 |
| CHEM 114 | General Chemistry II | 3 |
| MATH 125 | Calculus II | 4 |
| PHYS 211 | University Physics I | 3 |
| GEOE 221 | Geology for Engineers | 3 |
| CEE 117 | Computer Aided Design and Interpretation in Civil Engr. | 2 |
| TOTAL | | 16 |

Sophomore Year

First Semester

| | | |
|---------------------------|---------------------------------|-----------|
| EM 214 | Statics | 3 |
| MATH 225 | Calculus III | 4 |
| MEM 201L | Surveying for Mineral Engineers | 2 |
| PE | Physical Education | 1 |
| PHYS 213 | University Physics II | 3 |
| Gen. Ed. Goal 3 Electives | | 3 |
| TOTAL | | 16 |

Second Semester

| | | |
|---------------------------|----------------------------|-----------|
| ENGL 279 | Technical Communications I | 3 |
| EM 321 | Mechanics of Materials | 3 |
| GEOL 212 | Mineralogy/Crystallography | 3 |
| MATH 321 | Differential Equations | 4 |
| PE | Physical Education | 1 |
| Gen. Ed. Goal 4 Electives | | 3 |
| TOTAL | | 17 |

Junior Year

First Semester

| | | |
|--------------|------------------------------|-----------|
| ENGL 289 | Technical Communications II | 3 |
| GEOL 331 | Stratigraphy & Sedimentation | 3 |
| GEOL 341 | Elementary Petrology | 3 |
| CEE 346 | Geotechnical Engineering | 3 |
| MET 320 | Met Thermodynamics | 4 |
| TOTAL | | 16 |

Second Semester

| | | |
|----------|--------------------------|---|
| GEOE 322 | Structural Geology | 3 |
| GEOE 324 | Engineering Geophysics I | 3 |

| | | |
|---|--------------------------|-----------|
| EM 328 | Applied Fluid Mechanics | 3 |
| Approved Elective ¹ | | 3 |
| MEM 302 | Mineral Econ and Finance | 3 |
| Humanities or Social Sciences Elective(s) | | 1 |
| TOTAL | | 16 |

Summer

| | | |
|--------------|---------------------------|----------|
| GEOE 410 | Engineering Field Geology | 6 |
| TOTAL | | 6 |

Senior Year

First Semester

| | | |
|--------------|-----------------------------------|-----------|
| GEOE 466 | Engr. and Envr. Geology | 3 |
| GEOE 475 | Ground Water | 3 |
| GEOE 461 | Petroleum Production ² | 3 |
| GEOE 464 | Geol Engr. Design Project I | 3 |
| GEOL 316 | Intro to GIS | 3 |
| TOTAL | | 15 |

Second Semester

| | | |
|---|------------------------------|-----------|
| MEM 304 | Rock Mechanics I | 4 |
| Professional Electives ³ | | 6 |
| GEOE 465 | Geol Engr. Design Project II | 3 |
| Humanities or Social Sciences Elective(s) | | 3 |
| TOTAL | | 16 |

136 credits required for graduation

Minor in Geospatial Technology

Geospatial technology is a rapidly expanding field that covers the management and analysis of spatial data from many sources, such as satellites, airborne remote sensing, geographic information systems (GIS), global positioning systems (GPS), surveying, and more. Students in geological engineering may find this minor a useful complement to their studies. Complete information on the requirements is given in the Geology B.S. section.

Curriculum Notes

¹ Approved elective. Must be a course approved by the Department of Geology and Geological Engineering.

² Students interested in mineral exploration may substitute GEOE 451 for GEOE 461.

³ Professional electives. Students may choose two of the following courses.

| | |
|----------|--|
| GEOE 451 | Economic Geology |
| GEOE 425 | Engineering Geophysics II |
| GEOE 462 | Drilling Engineering |
| GEOE 482 | Applied Geomorphology |
| ENVE 327 | Environmental Engineering Process Analysis |
| ENVE 421 | Environmental Systems Analysis |
| CEE 337 | Engineering Hydrology |
| CEE 347 | Geotechnical Engineering II |
| CEE 437 | Watershed and Floodplain Modeling |
| CEE 447 | Foundation Engineering |
| CEE 474 | Engineering Project Management |
| ME 351 | Mechatronics and Measurement Systems (cross-listed with EE 351) |
| MEM 433 | Computer Applications in Geoscience Modeling |
| MEM 405 | Mine Permitting and Reclamation |
| MEM 450 | Rock Slope Engineering |
| MEM 305 | Introduction to Explosives Engineering |

Additional course work in mathematics and statistics is encouraged. MATH 381 and MATH 382 are recommended statistics courses; MATH 432 is recommended for students interested in numerical modeling of partial differential equations.



Humanities



Contact Information

Dr. Sue Shirley

Department of Humanities

Classroom Building 317

(605) 394-2482

E-mail: Sue.Shirley@sdsmt.edu

Faculty

Professors Antonen, Boysen, Feiszli, Rice, Shirley, and Sneller; Associate Professors Hudgens, Lee, Mitchell, and Palmer; Assistant Professor Bruni.

Humanities

The Department of Humanities provides study in the fields of communication, fine arts, literature, religion, western civilization, and philosophy. The curriculum provides a broad-based approach, which develops linkages between the humanities areas and the technological fields that are the mission of School of Mines. Interdisciplinary sciences degree candidates are required to complete 24 semester hours of humanities and social science courses. Other science and engineering degree candidates are required to complete 16 semester hours of humanities and social sciences courses — at least 6 credits in each area. Engineering majors are required to enroll in at least one upper-level humanities or social science course (of at least 3

credit hours).

All IS degree candidates must complete ENGL 101, ENGL 279, ENGL 289, IS 110, IS 201, IS 401, and IS 498, which cannot be used to meet the humanities and social sciences requirements.

Humanities

(Upper level courses are in bold print.)

Art:

ART 111, 112, ARTH 211, **321, 491, 492**

English:

ENGL 031¹, 032¹, 033¹, 101², 201², 221, 222, 241, 242, 250, 279², 289², **300, 330, 343, 350, 360, 374, 383, 391³, 392³, 468**

Foreign Language:

FREN 101, 102, GER 101, 102, SPAN 101, 102

History:

HIST 121, 122

Humanities:

HUM 100, 200, 291, 292, **300, 350, 375, 491, 492**

Music:

MUAP 200, 201, MUEN 101⁴, 121⁴, 122⁴, 260³
MUS 100, 110, 217/217L¹, 250, **317/317L, 326**

Philosophy:

PHIL 100, 200, 220, 233

Speech Communications:

SPCM 101³

¹ Does not meet general requirements for graduation.

² Meets general requirements for graduation, but not for humanities credits.

³ May not be used as humanities credit, but may be used for free elective credit. Consult advisor for further details.

⁴ May not be used as humanities credit, but may be used for PE or free elective credit. Consult advisor for further details.

Industrial Engineering and Engineering Management B.S.



Contact Information

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Industrial Engineering

Civil Mechanical 126

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Faculty

Ervin Pietz Professor Kellogg; Professor Kerk;
Associate Professors Matejcek and Karlin;
Assistant Professor Jensen; Instructor Kelly
Combs.

Industrial engineering and engineering management is concerned with the design, improvement, installation, and management of integrated systems of people, material, and equipment. Graduates of the program employ a set of skills that includes mathematical modeling, probability and statistics, computer science, human factors, interpersonal skills, project management, and an ability to manage and administer large technical engineering and research projects. Thus, industrial engineering and engineering management may be thought of as applied problem solving, from inception to implementation and management.

Program Objectives

The objectives of the industrial engineering and engineering management program are to produce graduates who:

- Contribute to the success of companies through effective problem solving.
- Design, develop, implement, and improve integrated systems that include people, materials, information, equipment, and environments.
- Effectively manage business operations and project management teams.
- Continue to develop the personal and professional skills necessary to adapt to our changing societal, technological, and global environments.

Graduates of the industrial engineering and engineering management program are expected to be competent for entry-level professional practice and possess basic scientific and mathematical competence, be able to solve engineering problems, have the appropriate skills for contemporary engineering practice, and develop holistically as a learner.

Education

The curriculum is designed to give students a thorough knowledge in the fundamental principles within the four primary stems of industrial engineering: operations research and optimization, manufacturing, statistical processes, and human engineering. In addition, through a variety of course work and experiential learning activities, students develop an understanding of the engineering relationships with the management tasks of planning, leading, organizing, and controlling as well as the integrative nature of management systems.

Throughout the program of studies, special emphasis is placed upon application of systems

principles in engineering design to assure proper integration of the individual (or individuals), procedures, materials, and equipment. Service learning components, laboratories, case work, simulations, and the capstone design sequence reinforce the managerial aspects of systems integration, systems design, and the global, societal, and business context for product and process improvement.

Students may participate in the Cooperative Education Internship Program. The co-op credits may count as approved engineering elective courses.

Laboratories

The Human Engineering Laboratory supports the minor in occupational safety and courses in work methods and measurement, ergonomics/human factors engineering, safety engineering, and industrial hygiene. Laboratories typically include an enterprise team or service learning component that provide real world work experience. The Computer Integrated Manufacturing Laboratory supports the computer controlled manufacturing course. Using modern equipment, students will utilize robots, material handling equipment, and computer numerically controlled machinery to design and fabricate a finished product. The Operational Strategies Laboratory complements computer-aided manufacturing but allows students to simulate large production systems to explore flexible manufacturing systems and strategies for lean manufacturing.

Minor in Occupational Safety

The minor in occupational safety is offered to students pursuing any B.S. degree program. The minimum math and science course requirements are CHEM 112/112L, MATH 123, PHYS 111 or 211, and MATH 281 or 381 or 441. Required courses are IENG 321/331/341, PSYC 331 or POLS 407, Senior Design or Senior Project in home department, and a minimum of 6 credit hours: BIOL 121/121L/123/123L, ENVE 7326, CHEM 114/114L, CHEM 480, CP 297/397/4971,

IENG 4911, ME 380, MEM 203, PE 105, and PHYS 363. (Note 1: Pre-approved, significant safety content.) Thus, a total of at least 21 credit hours is needed for an occupational safety minor. A minor in occupational safety must be approved by the student's major department and the minor coordinator on a form available at the Office of the Registrar and Academic Services.

Additional information may be found at the department website: <<http://ie.sdsmt.edu>>.

Certificate Programs

Students may elect to add value to their transcript via certificate program offerings in Six Sigma Greenbelt, Engineering Management and Leadership, and Technology Innovation. The Six Sigma Greenbelt program provides the necessary components and training for greenbelt certification desired by industry. Students will gain an exposure to the six sigma quality management philosophy culminating in a project application of quality by design. The Engineering Management and Leadership program provides students an opportunity to complement their technical skills with modern management techniques, organizational theory, and change management practices required to effectively manage technical industries. The Technology Innovation certificate provides students with a value-added curriculum in creativity and innovation, product development, and business and entrepreneurial functions. Additional information may be found at the department web site: <<http://ie.sdsmt.edu>>.

Industrial Engineering Curriculum/Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

Freshman Year

First Semester

| | | |
|---------------|---------------------------------|---|
| MATH 123 | Calculus I | 4 |
| CHEM 112 | General Chemistry I | 3 |
| Humanities or | Social Sciences Elective(s) | 3 |
| PE | Physical Education ¹ | 1 |
| ENGL 101 | Composition I | 3 |

| | | |
|--------------|---------------------------|-----------|
| CHEM 112L | General Chemistry I Lab | 1 |
| ME 110 | Intro. to Mechanical Engr | 2 |
| OR | | |
| CEE 117 | Computer Aided Design | 2 |
| TOTAL | | 17 |

Second Semester

| | | |
|--------------|---|-----------|
| MATH 125 | Calculus II | 4 |
| PHYS 211 | University Physics I | 3 |
| PE | Physical Education I | 1 |
| PSYC 101 | General Psychology | 3 |
| | Engineering Fundamentals Elective | 3 |
| | Humanities or Social Sciences Elective(s) | 3 |
| TOTAL | | 17 |

Sophomore Year

First Semester

| | | |
|--------------|-----------------------------------|-----------|
| | Engineering Fundamentals Elective | 3 |
| ENGL 279 | Technical Communications I | 3 |
| MATH 225 | Calculus III | 4 |
| IENG 381 | Intro to Probability and Stats | 3 |
| PHYS 213 | University Physics II | 3 |
| PHYS 213L | University Physics II Lab | 1 |
| TOTAL | | 17 |

Second Semester

| | | |
|------------------|---|-----------|
| IENG 382 | Probability Theory and Stats II | 3 |
| MATH 321 | Differential Equations | 4 |
| IENG 215/216/217 | Cost Estimating for Engineers | 3 |
| IENG 241 | Production Tools for Quality Improvement | 2 |
| IENG 302 | Engineering Economics | 3 |
| | Humanities or Social Sciences Elective(s) | 3 |
| TOTAL | | 18 |

Junior Year

First Semester

| | | |
|----------|---|---|
| ENGL 289 | Technical Communications II | 3 |
| IENG 311 | Work Methods and Measurement | 3 |
| IENG 486 | Statistical Quality and Process Control | 3 |
| IENG 352 | Creativity and Innovation | 1 |
| IENG 354 | Marketing Technology Innovations | 1 |

| | | |
|--------------|---|-----------|
| IENG 362 | Stochastic Models | 3 |
| | Humanities or Social Sciences Elective(s) | 1 |
| | Professional Breadth Elective | 3 |
| TOTAL | | 18 |

Second Semester

| | | |
|--------------|--------------------------------------|-----------|
| IENG 355 | Financing Technology Innovations | 1 |
| IENG 441 | Simulation | 3 |
| MATH 353 | Linear Optimization | 3 |
| IENG 321 | Ergonomics/Human Factors Engineering | 3 |
| | Engineering Fundamentals Elective | 3 |
| | Professional Breadth Elective | 3 |
| TOTAL | | 16 |

Senior Year

First Semester

| | | |
|--------------|--|-----------|
| IENG 425 | Production and Operation | 3 |
| IENG 331 | Safety Engineering ² | 3 |
| IENG 471 | Facilities Planning | 3 |
| IENG 464 | Senior Design Project I | 2 |
| IENG 462 | Industrial and Engineering Management Profession | 1 |
| | Professional Breadth Elective | 6 |
| TOTAL | | 18 |

Second Semester

| | | |
|--------------|---|-----------|
| IENG 366 | Engineering Management | 3 |
| IENG 465 | Senior Design Project II | 3 |
| IENG 475 | Computer Controlled Manuf. | 3 |
| | Humanities or Social Sciences Elective(s) | 3 |
| | Department Elective | 3 |
| TOTAL | | 15 |

136 credits required for graduation

Curriculum Notes

¹ Music ensemble courses may be substituted for physical education courses for qualified students. Any other substitutions must be approved in advance by the physical education department head.

²IENG 341 (Industrial Hygiene) may be substituted during a second semester.

Elective courses must be chosen to satisfy all of the following requirements.

1. Sixteen semester hours in humanities or social science. At least 6 hours must be in humanities and at least 6 hours must be in social sciences. This may include PSYC 101, which is required.

2. Six hours of humanities or social science must be included in the list of approved cultural diversity courses.

3. At least 3 hours of humanities or social science must be at the 300 or 400 level.

A. Department Electives (3 credits)

- Human Engineering (3 credits) IENG 331 or 431
- Department Breadth IENG 451, 452, 466, 491, or 492

B. Engineering Fundamentals (11 credits)

- Graphics (2 credits) ME 110 or CEE 117
- Fundamentals (9 credits from at least two different areas)
- Materials MET 231, MET 232, or MET 233
- Circuits EE 301 or EE 220
- Statics/Dynamics EM 214, EM 215, EM 216, or ME 221
- Thermodynamics ME 211, ME 331, MeT 320 or ChE 222
- Fluid Mechanics EM 327, EM 328, or EM 331
- Mechanics ME 216 or EM 321

C. Professional Breadth (12 credits)

- Courses in A beyond 3-credit requirement
- Courses in B beyond 11 credit requirement
- Engineering Breadth
- ME 262
- CENG 244
- GEOE 211
- CSC 150, CSC 251
- Transport phenomena ChE/EnvE 218, EnvE 315, ChE 317, ChE/EnvE 318,
- MET 422
- Mathematics Breadth
- Math 315 Linear Algebra

- Math 373 Numerical Analysis
- Math 423 Advanced Calculus
- Math 431 Dynamical Systems
- Math 451 Mathematical Modeling
- Math 447 Design of Experiments
- Science Breadth
- GEOL 201
- GEOE 221
- BIOL 121, 121L
- BIOL 123, 123L
- BIOL 151, 151L
- BIOL 153, 153L
- CHEM 114, 114L
- CHEM 326, 326L
- CHEM 328, 328L
- Organizational Management Breadth
- PSYC 331
- TM xxx
- ACCT 210, 211
- BADM 350
- BADM 370
- BADM 407
- ECON 201, 202
- Petitioned Courses

Interdisciplinary Sciences B.S.



Contact Information

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The bachelor of science degree in interdisciplinary sciences (IS) is a science degree program that seeks to serve the needs of students whose goals cannot be met within the other science departments. IS students choose from three areas of specialization: atmospheric sciences; pre-professional health sciences; and science, technology, and society. The IS degree program allows students to enroll in a wide variety of math and science courses, as well as carefully chosen electives in the humanities, fine arts, and social sciences.

The Interdisciplinary Sciences degree is especially appropriate for the following individuals.

- Students pursuing pre-professional and health services careers, including, but not limited to law, business, medicine, physical therapy, and radiography.
- Students whose educational and career goals necessitate courses in several departments;
- Students whose professional experiences require that they integrate knowledge from diverse fields.

The benefits of the interdisciplinary sciences degree include.

- Flexibility in a wide range of study;
- Individual design allowing the student to help select the content of the degree; and
- The opportunity to study natural sciences, social sciences, humanities, and liberal arts from a broad perspective, thus providing a well-rounded program.

Areas of Specialization

Interdisciplinary sciences majors choose from three areas of specialization that will prepare them for a career or for graduate and professional programs.

- Atmospheric Sciences
- Pre-Professional Health Sciences
- Science, Technology, and Society

1. Atmospheric Sciences:

The atmospheric sciences specialization is designed for students whose career goal is meteorology or atmospheric research. Working with faculty from the Department of Atmospheric Sciences, students can take course work to satisfy federal guidelines (e.g., for National Weather Service, US Bureau of Reclamation and US Geological Survey) for the title of meteorologist. This specialization also serves as excellent preparation for graduate study in meteorology, atmospheric sciences, and adjacent fields. Courses range from those in traditional operational meteorology to those in earth system sciences.

2. Pre-Professional Health Sciences:

A strong background in science will prepare students in the pre-professional health sciences specialization for entry into a variety of graduate and professional programs, including medical and dental schools, physical and occupational therapy programs, physicians assistant and chiropractic programs, optometry and ophthalmology specialties, and radiography or medical technology programs. Internships in the community and complementary course work in the humanities and social sciences are included to help students meet the admissions requirement of

the professional schools.

Students planning to enter these professions should consult the programs of study of the schools they plan to attend. Working closely with their advisor, they will select the courses needed to fulfill the graduation requirements for the IS degree and to meet the entrance requirements for the professional schools in health science.

Medical Technology (MT)/Radiologic Technology (RT):

The School of Mines has an articulation agreement with Rapid City Regional Hospital, which has fully certified MT and RT programs. Students take prerequisite course work for MT or RT at the School of Mines before applying to either program. Upon completion of the MT or RT program, students may elect to complete the requirements for the IS degree, thus graduating with both a bachelor's degree in IS and the MT or RT certification. A number of the courses needed to complete the MT or RT program count toward the IS degree. Note: Faculty and staff from the School of Mines and the IS degree program are not involved in the selection of candidates for the RT/MT programs. School of Mines students are not guaranteed admission to the RT/MT programs.

3. Science, Technology, and Society:

The science, technology, and society specialization combines a strong science background with a firm grounding in environmental, social and science policy issues. Students pursue a science concentration, such as environmental science, or a minor in a science field, which is complemented by studies in areas such as political science, history, humanities, English, and philosophy. Course work will prepare students for additional study in law school or in science policy or public policy programs. Careers can include positions in community and government agencies, in science and technology companies, in the military, or as science lobbyists.

Interdisciplinary Sciences Program Admission Policy

After successful completion of at least 64 credit hours and at least one year prior to the

intended graduation date, the student must apply for admission to the degree program by filing a plan of study with the IS Steering Committee. The plan of study must be approved by the steering committee before a student will be formally admitted to the program. This plan of study consists of (1) a Letter of Intent stating the career goals to which the IS degree course work is to be applied and (2) an IS worksheet showing the courses already taken and the courses to be completed prior to graduation. The Letter of Intent and worksheet must be reviewed and approved by the student's IS advisor before submission to the Steering Committee. The Letter of Intent form and worksheet are available from the IS office or may be accessed on the IS website.

The deadlines for submitting the Letter of Intent and worksheet to the IS office: For May graduates — April 30 of the preceding year; for August graduates — July 30 of preceding year; for December graduates — November 30 of preceding year. Students must have an approved Letter of Intent and IS worksheet on file in the IS office before registering for IS 498, the senior capstone project.

General Requirements for Graduation

For all interdisciplinary sciences specializations, students are responsible to check with their advisors for any program modifications that may occur after the publication of this catalog.

| | |
|---|-----------|
| I. IS Core Courses (IS 110, IS 201, IS 401, IS 498) | 11 |
| II. English sequence (ENGL 101, 279, 289) | 9 |
| III. Math, Computer Science, Sciences | |
| Math and Computer Sciences ¹ | min. 12 |
| Biology ² | min. 3 |
| Chemistry ² | min. 3 |
| Additional Natural Sciences ³ | min. 24 |
| Other Math, CSC, Science | min. 18 |
| SUBTOTAL | 60 |

IV. Humanities and Social Sciences

| | |
|-----------------------------------|-----------|
| Humanities general education | 6 |
| Humanities upper division | 6 |
| Social Sciences general education | 6 |
| Social Science upper division | 6 |
| SUBTOTAL | 24 |
| V. Physical Education | 2 |
| VI. Program Approved Electives | 22 |

128 credits required for graduation

¹All IS specializations require MATH 123 Calculus I and a minimum of 3 credit hours in computer science.

²Some specializations require additional course work in chemistry and biology.

³All IS specializations require a minimum of 30 credit hours in the natural sciences, including 6 hours in sequence and 12 hours at the upper division.

Thirty-six of the required 128 credits must be at the junior or senior level (courses numbered 300 and above.)

Interdisciplinary Sciences Core Courses

All IS students take a sequence of four core courses, spread out over the course of four years:

- IS 110: Explorations in the freshman year;
- IS 201: Introduction to Science, Technology, and Society in the sophomore year;
- IS 401: Writing and Research in the Interdisciplinary Sciences in the first semester of the senior year; and
- IS 498: Undergraduate Research/Scholarship (senior project) in the second semester of the senior year.

Science Minors available to IS Students

When possible, students pursuing the IS specializations are strongly encouraged to complete a minor in another science field at School of Mines as part of their 128 total credits. Minors are available in computer science, geology, mathematics, physics, or occupational

safety. Students should consult the policy on minors and the specific courses required for each minor, provided elsewhere in the catalog. The IS degree is not available as a minor.

Transfer Studies

Students who reside in local communities can achieve considerable savings in their education costs by completing a significant portion of their studies close to home before transferring to another institution to complete their desired major. Students who do not intend to pursue a degree offered at the School of Mines are encouraged to take courses appropriate for the two-year associate of arts (A.A.) degree in general studies. Through this program of access and transfer, students still experience the excellent educational environment found on the School of Mines campus. Students should consult the programs of study for the school from which they plan to graduate and then work closely with their A.A. advisor to select courses with the highest likelihood of transferability. Completion of the A.A. degree will fulfill the general education requirements for a baccalaureate degree at the other state universities of South Dakota (BHSU, DSU, NSU, SDSU, and USD).

Pre-law/Pre-medicine Study at School of Mines

While the IS specializations in pre-professional health sciences and science, technology, and society (STS) are especially designed to help students meet the entrance requirements for medical or law school, a particular baccalaureate degree is not required for admission into most law and medical programs. Graduates from the School of Mines with degrees in several of the science and engineering programs have successfully completed these professional programs. Students are encouraged to consult the admissions requirements and policies for those law and medical schools to which they intend to apply.

Teaching Opportunities and Certification

Students who are interested in teaching science at the secondary education level should contact education programs at the other state universities for information on the auxiliary

courses required for certification. Project SELECT, an intensive one-year certification program offered through the Black Hills State University College of Education, may be of interest to students completing the IS and other science degrees at the School of Mines. Information on this BHSU program can be obtained from the Humanities/Social Sciences office.

Minor in Entrepreneurial Studies

A 25-credit minor in entrepreneurial studies is available to all School of Mines students through collaboration with the Black Hills State University College of Business and Technology. The requirements for the minor are BADM 406 or ACCT 210/ACCT 211, BADM 336, BADM 438, BADM 334, BADM 360, BADM 370, BADM 474, and BADM 492. The minor must be approved by the student's major department. Contact the Humanities/Social Sciences office for more information.

Interdisciplinary Sciences

(Upper level courses are in bold print)
 IS 110¹, 191, 192, 201¹, 291, 292, **370, 380, 391, 392, 401¹, 491, 498¹, 492, 691, 692**
¹IS degree core courses.

Specialization in Atmospheric Sciences: Curriculum/Course Checklist

Course sequences vary by student entry year, math/science placements, availability of ATM courses, and career objectives. Students should consult with an atmospheric sciences / interdisciplinary sciences advisor for a more personalized course of study based on career goals within the atmospheric sciences.

Freshman Year

First Semester

| | | |
|---|-------------------------|-----------|
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| ENGL 101 | Composition I | 3 |
| IS 110 | Explorations | 2 |
| MATH 123 | Calculus I | 4 |
| Gen Ed Humanities/Social Science Elective | | 3 |
| TOTAL | | 16 |

Second Semester

| | | |
|---|--------------------------|-----------|
| CHEM 114 | General Chemistry II | 3 |
| CHEM 114L | General Chemistry II Lab | 1 |
| CSC 150/L | Computer Science I/Lab | 3 |
| MATH 125 | Calculus II | 4 |
| PE | Physical Education | 1 |
| Gen Ed Humanities/Social Science Elective | | 3 |
| TOTAL | | 15 |

Sophomore Year

First Semester

| | | |
|---|------------------------------|-----------|
| ATM 301 | Intro to Atmospheric Science | 3 |
| ENGL 279 | Technical Communications I | 3 |
| MATH 225 | Calculus III | 4 |
| PE | Physical Education | 1 |
| PHYS 211 | University Physics I | 3 |
| Gen Ed Humanities/Social Science Elective | | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|---|---|-----------|
| ENGL 289 | Technical Comm II | 3 |
| IS 201 | Introduction to Science, Technology, and Society | 3 |
| PHYS 213 | University Physics II | 3 |
| PHYS 213L | University Physics II Lab | 1 |
| ATM/SCI/MATH/ENG Elective | | 3 |
| Gen Ed Humanities/Social Science Elective | | 3 |
| TOTAL | | 16 |

Junior Year

First Semester

| | | |
|-------------------------------|----------------------------|-----------|
| ATM 404 | Atmos Thermodynamics | 3 |
| ATM 450/L | Synoptic Meteorology I/Lab | 3 |
| BIOL 311 | Principles of Ecology | 3 |
| ATM/SCI/MATH/ENG Elective | | 3 |
| Upper Division HU/SS Elective | | 3 |
| TOTAL | | 15 |

Second Semester

| | | |
|-------------------------------|-----------------------|-----------|
| ATM 406 | Global Environ Change | 3 |
| ATM/SCI/MATH/ENG Electives | | 10 |
| Upper Division HU/SS Elective | | 3 |
| TOTAL | | 16 |

Senior Year

First Semester

| | | |
|---|---|----|
| ATM/SCI/MATH/ENG Electives ¹ | | 11 |
| IS 401 | Writing and Research in the Interdisciplinary Sciences | 3 |

| | |
|-------------------------------|-----------|
| Upper Division HU/SS Elective | 3 |
| TOTAL | 17 |

Second Semester

| | |
|----------------------------------|-----------|
| ATM/SCI/MATH/ENG Electives | 10 |
| IS 498 Undergrad Res/Scholarship | 3 |
| Upper Division HU/SS Elective | 3 |
| TOTAL | 16 |

128 credits required for graduation

Curriculum Notes

¹All IS specializations require a minimum of 30 semester hours of natural sciences, including a minimum of 3 semester hours in chemistry, 3 semester hours in biology, 6 semester hours in a science sequence, and 12 semester hours at the upper division. The atmospheric sciences/meteorology specialization requires one year of general chemistry with labs, one year of university physics with lab, and one semester of BIOL 311: Principles of Ecology. Students should consult with their advisors to determine additional science courses appropriate for their career paths.

²All IS specializations require Math 123 or a math course requiring Math 123 as its prerequisite. Atmospheric sciences/meteorology requires CSC 150/150L and additional math course work beyond Math 123. Math 102 and Math 120 may be used toward graduation requirements.

³Students should consult with their atmospheric sciences/interdisciplinary sciences advisors on the most appropriate ATM/science/math/ engineering electives for their career paths. See also p. 153.

Specialization in Pre-Professional Health Sciences

Curriculum/Course Checklist

Students should consult with their advisors for a more personalized course of study based on career goals within the health sciences. Course requirements vary according to professional program, e.g., medical school, radiographic technology, physical therapy. Course sequence may also vary by student entry year, math/science

placements, and career objectives.

Freshman Year

First Semester

| | |
|---|-----------|
| BIOL 121/121L Human Anatomy & Lab | 4 |
| ENGL 101 Composition I | 3 |
| IS 110 Explorations | 2 |
| Math/CSC Elective ¹ | 3 |
| Gen Ed Humanities/Social Science Elective | 3 |
| TOTAL | 15 |

Second Semester

| | |
|---|-----------|
| BIOL 123/123L Basic Physiology and Lab | 4 |
| CHEM 112/112L Gen Chemistry I and Lab | 4 |
| Math/CSC Elective | 3 |
| PE Physical Education | 1 |
| Gen Ed Humanities/Social Science Elective | 3 |
| TOTAL | 15 |

Sophomore Year

First Semester

| | |
|---|-----------|
| BIOL 151/151L Gen Biology I and Lab | 4 |
| CHEM 114/114L Gen Chemistry II and Lab | 4 |
| ENGL 279 Technical Comm I | 3 |
| IS 201 Introduction to Science, Technology, and Society | 3 |
| Gen Ed Humanities/Social Science Elective | 3 |
| TOTAL | 17 |

Second Semester

| | |
|---|-----------|
| BIOL 153/153L Gen Biology II and Lab | 4 |
| ENGL 289 Technical Comm II | 3 |
| Math/CSC Elective | 3 |
| Gen Ed Humanities/Social Science Elective | 3 |
| Electives ² | 4 |
| TOTAL | 17 |

Junior Year

First Semester

| | |
|---------------------------------|-----------|
| Math/CSC Elective | 3 |
| Upper Division Science Elective | 3 |
| Upper Division HU/SS Elective | 3 |
| Electives | 7 |
| TOTAL | 16 |

Second Semester

| | |
|---------------------------------|---|
| Science Electives | 4 |
| Upper Division HU/SS elective | 3 |
| Upper Division Science Elective | 3 |

| | |
|--------------|-----------|
| Electives | 7 |
| TOTAL | 17 |

advisors for a more personalized course of study based on career plans.

Senior Year

First Semester

| | | |
|---------------------------------|--|-----------|
| IS 401 | Writing and Research in the Interdisciplinary Sciences | 3 |
| Science Elective | | 4 |
| Upper Division HU/SS Elective | | 3 |
| Upper Division Science Elective | | 3 |
| PE | Physical Education | 1 |
| Electives | | 1 |
| TOTAL | | 15 |

Second Semester

| | | |
|---------------------------------|---------------------------|-----------|
| IS 498 | Undergrad Res/Scholarship | 3 |
| Science Electives | | 4 |
| Upper Division HU/SS Elective | | 3 |
| Upper Division Science Elective | | 3 |
| Electives | | 3 |
| TOTAL | | 16 |

128 credits required for graduation

Curriculum Notes:

¹All IS specializations require Math 123 or a math course requiring Math 123 as its prerequisite. Math 102 and Math 120 may be used towards graduation requirements. Students should consult with their advisors on the most appropriate math/computer science courses for their career paths.

²Elective credits may include additional course work at the 100 level or above in math, computer science, natural and physical sciences, humanities, social sciences, business, military science, or engineering as needed to meet the required minimums or to meet admissions requirements for professional programs in health science. Students should consult with their advisors on the most appropriate courses for their career goals.

Science, Technology, and Society: Curriculum/Course Checklist

Course sequence may vary by student entry year, math/science placements, and career objectives. Students should consult with their

Freshman Year

First Semester

| | | |
|---|---------------|-----------|
| ENGL 101 | Composition I | 3 |
| IS 110 | Explorations | 2 |
| Math/CSC Elective ¹ | | 3 |
| Science Elective ² | | 4 |
| Gen Ed Humanities/Social Science Elective | | 3 |
| TOTAL | | 15 |

Second Semester

| | | |
|---|--------------------|-----------|
| Math/CSC Elective | | 3 |
| PE | Physical Education | 1 |
| Science Electives | | 7 |
| Gen Ed Humanities/Social Science Elective | | 3 |
| Elective ³ | | 3 |
| TOTAL | | 17 |

Sophomore Year

First Semester

| | | |
|---|--|-----------|
| ENGL 279 | Technical Comm I | 3 |
| IS 201 | Introduction to Science, Technology, and Society | 3 |
| PE | Physical Education | 1 |
| Science Elective | | 4 |
| Gen Ed Humanities/Social Science Elective | | 3 |
| Elective | | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|---|-------------------|-----------|
| ENGL 289 | Technical Comm II | 3 |
| Math/CSC Elective | | 3 |
| Science Elective | | 4 |
| Gen Ed Humanities/Social Science Elective | | 3 |
| Elective | | 3 |
| TOTAL | | 16 |

Junior Year

First Semester

| | | |
|-------------------------------|--|-----------|
| Math/CSC Elective | | 3 |
| Science Electives | | 7 |
| Upper Division HU/SS Elective | | 3 |
| Elective | | 3 |
| TOTAL | | 16 |

Second Semester

| | | |
|-------------------|--|---|
| Science Electives | | 7 |
|-------------------|--|---|

| | |
|-------------------------------|-----------|
| Upper Division HU/SS elective | 3 |
| Elective | 6 |
| TOTAL | 16 |

Senior Year

First Semester

| | |
|---|-----------|
| IS 401 Writing and Research in the Interdisciplinary Sciences | 3 |
| Science Electives | 8 |
| Upper Division HU/SS Elective | 3 |
| Elective | 1 |
| TOTAL | 15 |

Second Semester

| | |
|----------------------------------|-----------|
| IS 498 Undergrad Res/Scholarship | 3 |
| Science Electives | 7 |
| Upper Division HU/SS Elective | 3 |
| Elective | 3 |
| TOTAL | 16 |

128 credits required for graduation

Minor in Geospatial Technology

Geospatial technology is a rapidly expanding field that covers the management and analysis of spatial data from many sources, such as satellites, airborne remote sensing, geographic information systems (GIS), global positioning systems (GPS), surveying, and more. Students in interdisciplinary sciences may find this minor a useful complement to their studies. Complete information on the requirements is given in the Geology B.S. section.

Curriculum Notes

¹All IS specializations require Math 123 or a math course requiring Math 123 as its prerequisite. Math 102 and Math 120 may be used towards graduation requirements. Students should consult with their advisors on the most appropriate math/computer science courses for their career paths.

²All IS specializations require a minimum of 30 semester hours of natural sciences including a minimum of 3 semester hours in chemistry, 3 semester hours in biology, 6 semester hours of a science sequence, and 12 semester hours at the upper division level. Students pursuing the science, technology, and society specialization are expected to choose a science concentration. A minor in a science field (e.g., atmospheric science, computer science, geology, mathematics, physics, occupational safety) is highly encouraged. Students should consult with their advisors to determine the most appropriate science courses and sequence for their career paths.

³ Elective credits may include additional college course work at the 100 level or above in math, computer science, sciences, humanities, interdisciplinary sciences, social sciences, business, military science, or engineering as needed to meet the required minimums or to qualify for a science minor. Students should consult with their advisors to determine the most appropriate elective courses for their career goals. This information and additional information on the IS degree program can be found at: <<http://sdmines.sdsmt.edu/is>>.

Applied and Computational Mathematics B.S. and Minor



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McGough, Kowalski and Riley; Assistant
Professors Dahl, Fleming, and Geary; Instructors
Lofberg and Trimble; Emeritus Faculty, Benson,
Carda, Grimm, and Opp.

General Information

Mathematics is a broad field of study that is foundational to many areas of Science and Engineering. The Department of Mathematics and Computer Science offers a bachelor of science degree in applied and computational mathematics. This degree program emphasizes computational methods and the use of technology applied to the mathematical problems in industry and the sciences. Students who desire to major in this program should announce their intention to the Department of Mathematics and Computer

Science as early as possible and should consult advisors in the department at each registration period before selecting electives to round out the courses of study outlined in the departmental curriculum. Any student who is pursuing a double major and whose designated advisor is in another department should consult an advisor in the mathematics and computer science department at each registration to ensure that reasonable progress is being made and that conflicts are avoided.

Prerequisite and Placement Information

Before registering for any course in mathematics, a student must either have met all prerequisites and be enrolled in all co-requisites, passed the appropriate placement examinations, or have obtained permission from the head of the mathematics and computer science department. Placement examinations, however, may only be used for initial mathematics course placement (exception — students successfully completing Math 021 may skip Math 101 and proceed to Math 102 if they have obtained the written permission of the Vice President for Academic Affairs and earned a successful Algebra Placement Examination score.) Please see the course descriptions in this catalog for all information related to prerequisites and placement. Again, placement exams (with the exception noted above) may only be used for initial placement. For example, a student enrolled in (MATH 120: Trigonometry), must pass this course with at least a “C” before being allowed to enroll in MATH 125; a student receiving below a “C” in trigonometry may not use a placement examination to skip a repeat of Trigonometry before enrolling in MATH 125. Placement examinations are given prior to registration each semester.

Students transferring from other institutions or returning to the School of Mines after interrupting studies for a period of one year or more should consult the head of the Department of Mathematics and Computer Science to discuss proper placement.

Departmental Courses

MATH 021 and 101 may not be used for credit toward any bachelor's degree at School of Mines. College algebra, trigonometry, and pre-calculus courses may not be counted toward any mathematics, computer science, or engineering degree. Other majors should consult their departments on policies regarding these courses.

In an attempt to help students plan their future semesters, the following information is presented. This reflects the best available knowledge at the time of the preparation of this document. This is not meant as a guarantee of when classes will be offered. Students concerned about when classes will be offered should contact the department head for any changes to the following. Courses not listed below have no defined rotation and will be offered contingent upon demand and staff availability. Summer offerings are highly dependent on staffing. An attempt will be made to offer MATH 102, MATH 120, MATH 123, MATH 125, MATH 225, and MATH 321 during the summer session.

Classes that are typically offered every semester include MATH 101, MATH 102, MATH 120, MATH 123, MATH 125, MATH 225, MATH 321, MATH 373, and MATH 381.

Classes that are typically offered every fall semester include MATH 281, and MATH 486.

Classes that are typically offered every spring semester include MATH 315, MATH 382, MATH 441, and MATH 353.

Classes that are typically offered in the fall semester of even numbered years, for example fall 2010, include MATH 413 and MATH 431.

Classes that are typically offered in the spring semester of odd numbered years, for example spring 2011, include MATH 421, and MATH 463.

Classes that are typically offered in the fall semester of odd numbered years, for example fall 2009, include MATH 432 and MATH 423.

Classes that are typically offered in the spring semester of even numbered years, for example spring 2010, include MATH 424, MATH 451, and MATH 447.

Applied and Computational Mathematics Major

Students majoring in mathematics will use the accompanying applied and computational mathematics curriculum. The curriculum includes 56 credits of mathematics courses, 11 credits of computer science, 10 credits of sciences, and at least 9 credits of additional science and engineering courses that fall in a specific field (see emphasis area below). Any student majoring in mathematics who desires a minor in another field should consult his or her advisor in the Department of Mathematics and Computer Science as early in the program of study as possible. In addition, the student must contact the Office of the Registrar and Academic Services in order to declare a minor. Departmental majors contemplating a career in actuarial science should prepare for the examinations given by the Society of Actuaries. It is recommended that this preparation be attained, in part, by electing courses from: MATH 353, MATH 381, MATH 382, MATH 463, MATH 447, IENG 362, and IENG 301 or IENG 302. Information concerning these examinations can be obtained from the Department of Mathematics and Computer Science.

The primary goal of the applied and computational mathematics program is to give graduates a firm understanding of mathematics and its applications to science and engineering. Graduates are expected to develop a strong foundation of knowledge and skill in the core areas of analysis, differential equations, numerical methods, and modeling. They are also expected to attain a basic understanding of probability, statistics, and algebra. Because applied mathematicians are problem solvers, graduates must develop the ability to formulate and solve problems arising from scientific and engineering applications. This entails acquiring fundamental knowledge in the basic sciences, which School of Mines students accomplish by taking courses in an emphasis area. The student will take three courses in an external discipline that will provide exposure and depth in an application area of mathematics. Information on emphasis areas and

the associated courses is available from the department or advisor.

Graduates must be prepared to continue learning throughout their careers. In the two-course sequence of MATH 498 and MATH 402, students will have the opportunity to work with individual faculty members on research and develop their communication skills. This work will result in a technical paper and an oral presentation.

Upon graduation, some graduates pursue careers in fields such as computer software development, actuarial science, applied statistics, data analysis, and operations research. Others go on to pursue advanced degrees in mathematics or seek certification to teach mathematics at the elementary or secondary levels.

An applied and computational mathematics major must complete a minimum of 16 credit hours in humanities and social sciences with at least 6 credit hours in humanities and at least 6 credit hours in social sciences. Refer to the humanities and social sciences section of this catalog for a list of courses satisfying these requirements. It is also important to refer to the general education core requirements under bachelor of science graduation requirements for further information. Students must complete the general education core requirements within the first 64 credits.

The accompanying sample schedule lists all required classes for the degree in their proper prerequisite sequence. Students should consult course listings for prerequisites and should consult their advisors at each registration.

Minor in Mathematics

The core requirements for a minor in mathematics are MATH 123, MATH 125, MATH 225, and the completion of CSC 251 or MATH 221. In addition, students must also successfully complete MATH 423 or MATH 413 plus the completion of at least 6 credit hours from: MATH 315, MATH 381, MATH 382, or any MATH course 400-level and above, excluding Special Topics and Independent Studies courses. Thus, a total of at least 23 semester credit hours is needed

for a Math minor. MATH 423 and MATH 413 are offered in alternate years so plans for a minor should be made early.

A minor in the Department of Mathematics and Computer Science must be approved by the student's major department. A form for declaring a minor is available at the Office of the Registrar and Academic Services. The form must be completed and signed by the department heads from both departments involved in this minor.

Double Major with Mathematics

Due to the large number of courses that many majors have in common with the mathematics major, many students find it attractive to pursue a double major. Students are encouraged to pursue the double major and should contact their advisor for details.

Applied and Computational Mathematics Curriculum

For the bachelor of science in mathematics, a student must:

1. Take all of the courses listed in the applied and computational mathematics curriculum checklist;
2. Take 3 emphasis area courses (information about emphasis areas and supporting courses is available from the department); and
3. Have a departmental grade point average of at least 2.00 in all mathematics courses 300 level or higher. (Courses taken more than once will have only the higher grade counted for computing the departmental grade point average.)

Applied and Computational Mathematics Curriculum/Checklist

It is the student's responsibility to check with his or her advisor for any program modifications that may occur after the publication of this catalog. Additional information about the program may be found at: www.mcs.sdsmt.edu/.

Freshman Year

First Semester

| | | |
|-----------------------|--------------------|-----------|
| ENGL 101 | Composition I | 3 |
| IS 110 | Explorations | 2 |
| MATH 123 | Calculus I | 4 |
| CSC 150 | Computer Science I | 3 |
| Elective ² | | 3 |
| PE ⁴ | Physical Education | 1 |
| TOTAL | | 16 |

Second Semester

| | | |
|---|---------------------|-----------|
| MATH 125 | Calculus II | 4 |
| Science Elective/Science Lab ¹ | | 4 |
| CSC 250 | Computer Science II | 4 |
| Elective ² | | 3 |
| PE ⁴ | Physical Education | 1 |
| TOTAL | | 16 |

Sophomore Year

First Semester

| | | |
|-----------------------|------------------------|-----------|
| ENGL 279 | Technical Comm I | 3 |
| MATH 225 | Calculus III | 4 |
| MATH 321 | Differential Equations | 4 |
| PHYS 211 | University Physics I | 3 |
| Elective ² | | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|-----------------------|-----------------------|-----------|
| MATH 315 | Linear Algebra | 3 |
| CSC 251 | Finite Structures | 4 |
| ENGL 289 | Technical Comm II | 3 |
| PHYS 213 | University Physics II | 3 |
| Elective ² | | 3 |
| TOTAL | | 16 |

Junior Year

First Semester

| | | |
|--------------------------------|-----------------------------|-----------|
| MATH 413 | Abstract Algebra | 3 |
| MATH 381 | Probability and Statistics | 3 |
| MATH 431 | Dynamical Systems | 3 |
| MATH 373 | Intro to Numerical Analysis | 3 |
| Elective/Emphasis ³ | | 3 |
| TOTAL | | 15 |

Second Semester

| | | |
|----------|-------------------------------|---|
| MATH 382 | Probability and Statistics II | 3 |
| MATH 463 | Scientific Computing | 3 |

| | | |
|--------------------------------|------------------|-----------|
| MATH 421 | Complex Analysis | 3 |
| Elective/Emphasis ³ | | 7 |
| TOTAL | | 16 |

Senior Year

First Semester

| | | |
|--------------------------------|--------------------------------|-----------|
| MATH 423 | Advanced Calculus I | 4 |
| MATH 432 | Partial Differential Equations | 3 |
| MATH 498 | Undergraduate Research I | 1 |
| Elective/Emphasis ³ | | 8 |
| TOTAL | | 16 |

Second Semester

| | | |
|--------------------------------|-----------------------------|-----------|
| MATH 424 | Advanced Calculus II | 4 |
| MATH 451 | Math Modeling | 3 |
| MATH 402 | Communicating Mathematics I | 1 |
| Elective/Emphasis ³ | | 8 |
| TOTAL | | 16 |

128 credits required for graduation

Curriculum Notes

¹The science requirement for this major consists of PHYS 211, PHYS 213, one course from among BIOL 151, CHEM 112, GEOL 201, plus a lab associated with one of the science courses taken – either BIOL 151L, CHEM 112L, GEOL 201L, or PHYS 213L.

²Students should consult the “General Education Requirements” section of this catalog for a complete listing of all general education requirements. It is important to note that all general education requirements must be completed within the first 64 credits taken. Math majors are additionally required to take a total of at least 16 semester hours of electives in humanities and social sciences.

³Math majors must complete 3 courses in a science or engineering emphasis area. Any double major automatically satisfies this emphasis area requirement with their other major. Further information about possible emphasis areas is available from the department.

⁴MUEN 101, 121, 122 can be used to substitute for one or two of the required two physical education credits.

Mechanical Engineering B.S.



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Faculty

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Mechanical Engineering

Mechanical engineering (ME) is a very broad field that provides opportunities for interesting and challenging work in every phase of modern technology. The curriculum in the mechanical engineering department is designed to give students a thorough knowledge of the fundamental principles of engineering and science within the major areas of mechanical engineering: manufacturing, mechanical systems, and thermal science and energy. Beyond this basic foundation, the curriculum also develops:

1. The various aspects of engineering design including design theory and teamwork;

2. An effective integration of computer technology;
3. Communication skills and effective presentations; and
4. Improved understanding of engineering theory through practical laboratory experience.

In the senior year, students select from course electives that best reflect their interests and career objectives. Students may select courses from one or more of the following general areas:

1. Manufacturing, e.g., control, design, development, and manufacture of diverse equipment and processes;
2. Thermal Science/Energy, e.g., design of power systems and heating/air conditioning systems.
3. Mechanical Systems/Design, e.g., design of machines, structures, and systems.

Mission

The mission of the mechanical engineering program is to prepare our graduates for leadership roles in the mechanical engineering profession by

- Offering a quality education to foster a distinctive curriculum accentuating design and project-based learning,
- Committing to individual development while emphasizing the values of teamwork in a culturally diverse, multidisciplinary environment,
- Encouraging undergraduate and graduate research to nurture creative solutions to complex engineering problems.

Objectives

Building upon the department's tradition of excellence requires continual development of active partnerships among the faculty, the

students, and our constituents. In keeping with this tradition, the mechanical engineering program produces graduates who are able to perform at a level that meets or exceeds industry expectations. ME students will be able to achieve the objectives listed below within a few years of graduation through attainment of the outcomes listed below at the time of graduation.

OBJECTIVE 1: Lead and/or manage effective engineering design analyses

Outcomes

- Apply skills in engineering, science, and mathematics
- Practice effective analysis
- Conduct data analyses and analyses verification

OBJECTIVE 2: Lead and/or manage effective engineering design teams

Outcomes

- Apply effective engineering design skills
- Demonstrate teaming proficiency
- Participate in research and professional development

Students may participate in the Cooperative Education Internship Program. In some instances, credits earned during the co-op may be applied toward department elective requirements.

The mechanical engineering department does not offer a minor.

Mechanical Engineering Laboratories

There are several undergraduate laboratories in the department, including mechanical systems and instrumentation, thermal and fluid systems, manufacturing, robotic systems, and vibrations. Laboratories are updated with personal computers, peripherals, and data acquisition equipment.

Graduate research laboratories and resources

include advanced workstation computer facilities, equipment for modern digital controls, machine vision systems, image analysis equipment, structural testing and analysis equipment, compliant structures and computational solid mechanics, fluid mechanics, and heat transfer codes on the workstation facilities.

Mechanical Engineering Curriculum/Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog. To graduate, students must attain a grade of C or better in all ME core courses (noted below with an *)

Freshman Year¹

First Semester

| | | |
|---|---------------------------------|-----------|
| MATH 123 | Calculus I | 4 |
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| ME 110 | Intro to Mechanical Engr. | 2 |
| ENGL 101 | Composition I | 3 |
| PE | Physical Education ² | 1 |
| Humanities or Social Sciences Elective(s) | | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|---|---------------------------------|-----------|
| MATH 125 | Calculus II | 4 |
| PHYS 211 | University Physics I | 3 |
| CSC 150 | Computer Science I | 3 |
| PE | Physical Education ² | 1 |
| Humanities or Social Sciences Elective(s) | | 6 |
| TOTAL | | 17 |

Sophomore Year

First Semester

| | | |
|---|----------------------------|-----------|
| EM 214 | Statics | 3 |
| ENGL 279 | Technical Communications I | 3 |
| ME 262 | Product Development | 2 |
| ME 264/264L | Sophomore Design | 2 |
| MATH 321 | Differential Equations | 4 |
| Humanities or Social Sciences Elective(s) | | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|---------|-------------------------|---|
| ME 221* | Dynamics of Mechanisms | 3 |
| ME 211* | Intro to Thermodynamics | 3 |

| | | |
|--------------|-----------------------------|-----------|
| PHYS 213 | University Physics II | 3 |
| PHYS 213L | University Physics II Lab | 1 |
| MET 231 | Properties of Materials Lab | 1 |
| MET 232 | Properties of Materials | 3 |
| ME 216* | Intro to Solid Mechanics | 3 |
| TOTAL | | 17 |

Junior Year

First Semester

| | | |
|--------------|---|-----------|
| MATH 225 | Calculus III | 4 |
| ENGL 289 | Technical Comm II | 3 |
| ME 316* | Solid Mechanics | 3 |
| EE 301 | Introductory Circuits, Machines, and Systems | 4 |
| ME 331* | Thermo Fluid Dynamics | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|--------------|------------------------------|-----------|
| ME 313* | Heat Transfer | 3 |
| ME 352* | Intro to Dynamic Systems | 3 |
| MATH 373 | Intro to Numerical Methods | 3 |
| ME 322* | Machine Design I | 3 |
| ME 351* | Mechatronics and Meas. Syst. | 4 |
| ME 312* | Thermodynamics II | 3 |
| TOTAL | | 19 |

Senior Year

First Semester

| | | |
|--------------|------------------------------|-----------|
| ME 477 | Mechanical Engr. Design I | 2 |
| IENG 302 | Engineering Economics | 3 |
| MATH 381 | Probability/Statistics | 3 |
| ME 4XX | Mechanical Engr Elective #1 | 4 |
| ME 481 | Advanced Prod. Dev. Lab I | 1 |
| ME 4XX | Mechanical Engr. Elective #2 | 3 |
| TOTAL | | 16 |

Second Semester

| | | |
|---|------------------------------|-----------|
| ME 479 | Mechanical Syst Design II | 2 |
| ME 482 | Advanced Prod. Dev. Lab II | 2 |
| ME 4XX | Mechanical Engr. Elective #3 | 3 |
| ME 4XX | Mechanical Engr. Elective #4 | 3 |
| Humanities or Social Sciences Elective(s) | | 4 |
| Free Elective | | 2 |
| TOTAL | | 16 |

136 credits required for graduation

* A grade of C or better required for graduation

Curriculum Notes

¹ Many courses are prerequisites for other courses, and their sequencing is important. A faculty advisor should be consulted for any deviation from the above schedule.

² Music ensemble courses may be substituted for physical education courses for qualified students. Any other substitutions must be approved in advance by the physical education department head.

Supersonic Wind Tunnel

The Advanced Fluid Mechanics Laboratory at the South Dakota School of Mines and Technology has designed and constructed a supersonic wind tunnel of the indraft type, with an extremely low level of free stream turbulence ($Tu < 0.01$ percent). The test section area is 16 in² (4 inch x 4 inch) with full view schlieren quality glass windows and removable access plugs for ease of model and sensor installation. Novel implementation of a solid desiccant drying system permits a measured test section Mach number of 2.8, with no evidence of condensation, for the current nozzle geometry. A two-stage vacuum system allows for pump down times less than 30 minutes between runs, with an ultimate low pressure capability of several tenths of a psi absolute, which should allow start-up at Mach numbers up to 5 with an appropriately designed nozzle geometry. For pedagogical purposes, the current Mach 2.8 nozzle was also designed to permit schlieren viewing of the flow acceleration from stagnation conditions to the test section supersonic condition along with static pressure measurements at various locations along the length of the nozzle, for comparison with classroom theory. Because of the low free-stream noise level attendant to the indraft design, the facility is ideally suited for basic research studies of supersonic flow stability and transition mechanisms.

Metallurgical Engineering B.S. and Minor (Materials Science – Metals)



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Materials and Metallurgical Engineering

Materials and metallurgical engineering is the branch of engineering that develops and supplies the materials for virtually every other engineering field. Three-fourths of all elements are metals, so metals play a vital role in nearly every aspect of modern life. Metallurgical engineers transform the Earth's mineral resources into finished products by extracting metals from ores, producing ceramics from metal compounds, and fabricating composite structures.

Modern materials are exotic and so are the methods of producing them. Metallurgy is based upon the principles of chemistry, physics, and

mathematics. These sciences provide an understanding of the methods of metal production processes and the behavior of materials. In addition to familiar materials such as steel, aluminum, copper, glass, gold, and silver, metallurgical engineers produce many exotic materials such as metals with shape memories, ultrahigh-purity materials for integrated circuits, materials for surgical implants, ceramics for space vehicles, nano-scale metal particles and superconductors. There are 3 areas of specialization in metallurgical engineering: mineral processing, extractive metallurgy, and materials engineering. Mineral processors concentrate ores and recycled materials so that extractive metallurgists can produce pure, high-quality metals and non-metallics for use by materials engineers who transform these materials into the marvels of our advanced civilization, ranging from space craft to thin diamond films. Metallurgical engineers are actively involved in nanotechnology and the production and utilization of nano-scale materials.

Advances made by metallurgical and material engineers make advances possible in other engineering fields. This happens because virtually every engineering field is in constant search of higher-performing materials. Metallurgical engineers are responsible for the production of materials and also for the evaluation of metals, ceramics, and polymer-based composites. The evaluation of materials includes tests to determine strength, hardness, toughness, corrosion behavior, and many other properties. It is the role of metallurgical engineers to develop processing methods to create materials with specific and exacting properties for every conceivable application.

The primary source for materials continues to be extracted as ores and petroleum from the Earth. However, recycled materials are an increasingly important material source for metallurgical engineers.

Materials and metallurgical engineers are employed throughout the nation and the world.

The Objectives of the B.S. Metallurgical Engineering Degree Program

The program graduates will:

- Successfully apply metallurgical engineering principles in their employment
- Meet societal needs through science and technology
- Grow professionally and personally
- Serve their profession and community

Materials and Metallurgical Engineering Laboratories

Laboratory facilities in metallurgical engineering are equipped for instruction in mineral processing, chemical metallurgy, physical metallurgy, and mechanical metallurgy. Sample preparation facilities, laser light scattering particle size analyzers, gravitational separation equipment, laser Doppler particle size and zeta potential measurement equipment are available for mineral and materials processing. Induction melting and vacuum furnaces, fluidized-bed reactors, corrosion potentiostat, contact angle goniometer, and high pressure autoclaves are available for chemical metallurgy. X-ray diffraction spectrometer, Fourier transform infrared spectrometer, Raman spectrometer, Langmuir-Blodgett trough, metallographs, atomic force microscope, controlled atmosphere furnaces, quantitative image analyzer, scanning and transmission electron microscopes, universal testing machine (MTS), Charpy impact testing machine, and micro hardness, Rockwell and Vickers hardness testers are available for measuring material performance.

Modern laboratory facilities for welding and joining are available within the metallurgical engineering laboratories. These facilities include traditional joining (fusion welding) as well as advanced joining (friction stir joining) equipment.

Co-Curricular Opportunities

Co-curricular opportunities in blacksmithing and the artistic aspects of metallurgy are also available. Where appropriate, these co-curricular activities are integrated into the metallurgical engineering curriculum.

The program hosts the summer Research Experiences for Undergraduates (REU) Site: *Back*

to the Future! The REU Site is sponsored by the National Science Foundation.

Minor in Materials Science — Metals

The requirements for a minor in materials science — Metals are MET 232, 330, 332, 443, and two classes from MET 430, 440 and 445, for a total of 18 credits. MET 330, MET 332, MET 440, MET 443 and MET 445 are offered in alternate years, so plans for a materials science-metals minor should be made early. This minor is designed for students in engineering and science disciplines that desire focused training in the field of materials science with special emphasis on metals. Students completing the minor in materials science-metals will demonstrate the following outcomes:

1. A proficiency in materials science concepts covering metals and alloys;
2. The ability to develop and improve new metals/alloys;
3. The ability to predict and evaluate the performance of metals and alloys.

Given the redundancy in the B.S. metallurgical engineering core curriculum, the minor in materials science-metals is not available to those students who receive a B.S. degree in metallurgical engineering. A minor in materials science-metals must be approved by the student's major department. The Office of the Registrar and Academic Services has forms that should be completed and signed by the department heads from both departments involved in this minor.

Metallurgical Engineering Curriculum/Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

| <u>Freshman Year</u> | | |
|-----------------------------|----------------------------------|---|
| First Semester | | |
| MATH 123 | Calculus I ⁵ | 4 |
| CHEM 112 | General Chemistry I ⁶ | 3 |

| | | |
|--------------|--|-----------|
| ENGL 101 | Composition I ¹ | 3 |
| GE 130 | Intro to Engineering | 2 |
| PE | Physical Education | 1 |
| | Humanities or Social Sciences Elective(s) ^{3,4} | 3 |
| TOTAL | | 16 |

Second Semester

| | | |
|--------------|--|-----------|
| MATH 125 | Calculus II | 4 |
| CHEM 114 | General Chemistry II ⁶ OR | 3 |
| BIOL 151 | General Biology I ⁶ OR | 3 |
| BIOL 153 | General Biology II ⁶ | 3 |
| PHYS 211 | University Physics I | 3 |
| CHEM 112L | General Chem Lab | 1 |
| PE | Physical Education | 1 |
| | Humanities or Social Sciences Elective(s) ^{3,4} | 3 |
| | Humanities or Social Sciences Elective(s) ^{3,4} | 3 |
| TOTAL | | 18 |

Sophomore Year

First Semester

| | | |
|--------------|---|-----------|
| MET 232 | Properties of Materials | 3 |
| MET 231 | Structures and Properties of Materials Lab | 1 |
| MATH 321 | Differential Equations | 4 |
| PHYS 213 | University Physics II | 3 |
| CHEM 114L | General Chem II Lab OR | 1 |
| BIOL 151L | General Biology I Lab OR | 1 |
| BIOL 153L | General Biology II Lab | 1 |
| ENGL 279 | Technical Comm ¹¹ | 3 |
| EM 214 | Statics | 3 |
| TOTAL | | 18 |

Second Semester

| | | |
|--------------|--|-----------|
| MATH 225 | Calculus III | 4 |
| EM 321 | Mechanics of Materials OR | 3 |
| ME 216 | Intro to Solid Mechanics | 3 |
| PHYS 213L | University Physics II Lab | 1 |
| MET 220 | Min Proc and Res Recov | 3 |
| MET 220L | Min Proc and Res Recov Lab | 1 |
| | Humanities or Social Sciences Elective(s) ^{3,4} | 4 |
| TOTAL | | 16 |

Junior Year

First Semester

| | | |
|--------------|--------------------------------|-----------|
| ENGL 289 | Technical Comm II ² | 3 |
| MET 320 | Metallurg Thermodynamics | 4 |
| MET 351 | Engineering Design I | 2 |
| | Set A or C | 7 |
| TOTAL | | 16 |

Second Semester

| | | |
|--------------|-----------------------------|-----------|
| MET 352 | Engineering Design II | 1 |
| MATH 373 | Intro to Numerical Analysis | 3 |
| | Free Elective | 2 |
| | Set B or D | 11 |
| TOTAL | | 17 |

Senior Year

First Semester

| | | |
|--------------|---|-----------|
| MET 464 | Engineering Design III | 2 |
| IENG 301 | Basic Engineering Econ Science Elective ⁷ | 2 3 |
| | Humanities or Social Sciences Elective(s) | 3 |
| | Set A or C | 7 |
| TOTAL | | 17 |

Second Semester

| | | |
|--------------|-------------------------------|-----------|
| MET 433 | Process Control | 3 |
| MET 465 | Engineering Design IV | 1 |
| | Science Elective ⁷ | 3 |
| | Set B or D | 11 |
| TOTAL | | 18 |

136 credits required for graduation

Curriculum Notes

- ¹ Satisfies General Education Goal #1
- ² Satisfies General Education Goal #2
- ³ Satisfies General Education Goal #3
- ⁴ Satisfies General Education Goal #4
- ⁵ Satisfies General Education Goal #5
- ⁶ Satisfies General Education Goal #6
- ⁷ See Advisor for approved Science Electives

Set A-Fall Even Years

| | | |
|---------|---------------------|---|
| MET 422 | Transport Phenomena | 4 |
| | Free Elective | 3 |

Set B-Spring Odd Years

| | | |
|---------|--------------------------------|---|
| MET 321 | High Temp Extract/Conc/Rec | 4 |
| | Directed Met Elective | 3 |
| EE 301 | Intro Circuits, Machines, Syst | 4 |

Set C-Fall Odd Years

| | | |
|----------|----------------------------|---|
| MET 330 | Physics of Metals | 3 |
| MET 330L | Physics of Metals Lab | 1 |
| MET 332 | Thermomechanical Treatment | 3 |

Set D-Spring Even Years

| | | |
|-----------------------|---------------------------|---|
| MET 440 | Mechanical Metallurgy | 3 |
| MET 440L | Mechanical Metallurgy Lab | 1 |
| Directed Met Elective | | 3 |
| MET 310 | Aqueous Extract/Conc/Rec | 3 |
| MET 310L | Aq Extract/Conc/Rec Lab | 1 |



Military Science



Contact Information

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Faculty

Professor Hansen; Assistant Professors Bryan, Ruedebusch, and Dringman.

General Information

The School of Mines maintains a unit of the senior division of the Army Reserve Officers Training Corps (ROTC). The unit was established in 1950 and is administered by commissioned and noncommissioned officers of the United States Army nominated by the Department of the Army and approved by the president of the university. The ROTC program is open to both men and women. MSL courses complement any course of study providing leadership training unavailable anywhere else on campus. Participation in the ROTC Basic Course incurs no military obligation.

Laudable achievements by the ROTC corps of cadets includes three-time consecutive first-place finishes in varsity Ranger Challenge team competition, first-time occurrence of two competing teams in 2003, individual cadet accomplishment of #23 / 4099 on national order

of merit listing and team / individual competition at Bataan Memorial Death March.

Curriculum

ROTC provides leadership training and experience demanded by both corporate America and the U.S. Army. ROTC consists of Basic and Advanced Courses of instruction. The Basic Course consists of the first four semesters of MSL. It is designed to provide all college students with leadership and management skills that complement any course of study. There is no obligation or commitment to continue in ROTC or serve in the Armed Forces. The Advanced Course consists of the last four semesters of the ROTC program. The Advanced Course is offered to students possessing the potential to become Army officers and who desire to serve as commissioned officers in the Active Army, U.S. Army Reserve, or the Army National Guard. The objective of the Advanced Course is to select, train, and prepare students for military service. The ROTC program is designed to provide an understanding of the fundamental concepts and principles of military art and science; to develop leadership and managerial potential and a basic understanding of associated professional knowledge; to develop a strong sense of personal integrity, honor, and individual responsibility; and to develop an appreciation of the requirements for national security. Attainment of these objectives will prepare students for commissioning and will establish a sound basis for future professional development and effective performance in the Army or any chosen career field.

In the traditional four-year program, students enroll in eight consecutive semesters of MSL courses, 2 credit hours each semester the first two years, and 4 credit hours each semester the last two years. Leadership laboratories are offered concurrently with each of the classroom courses. Non-traditional two-year programs include eligible veterans with prior military service, current members of the US Army Reserve or Army National Guard, and students who have had high school junior ROTC or Civilian Air Patrol experience. A two-year program is available for any student having four academic semesters

remaining or enrollment into a School of Mines master's degree program after attending a summer ROTC Leadership Training Course at Ft. Knox, Kentucky. Participation at the basic course does not carry any commitment to participate in ROTC but it does satisfy the prerequisites necessary to enter the final four semesters of ROTC.

Students must additionally complete a course in the following areas to satisfy commissioning requirements: 1) American Military History, 2) Communications, and 3) Computer Literacy.

Tuition, Credit, and Equipment

Military science and leadership courses are tuition free. Books and equipment are provided by the department. Associated fees assessed for all courses do apply. MSL credit may be applied as free electives towards graduation. MSL 101L or MSL 102L may be used to meet physical education requirements. Tuition is charged for courses when used to meet physical education requirements.

Financial Information

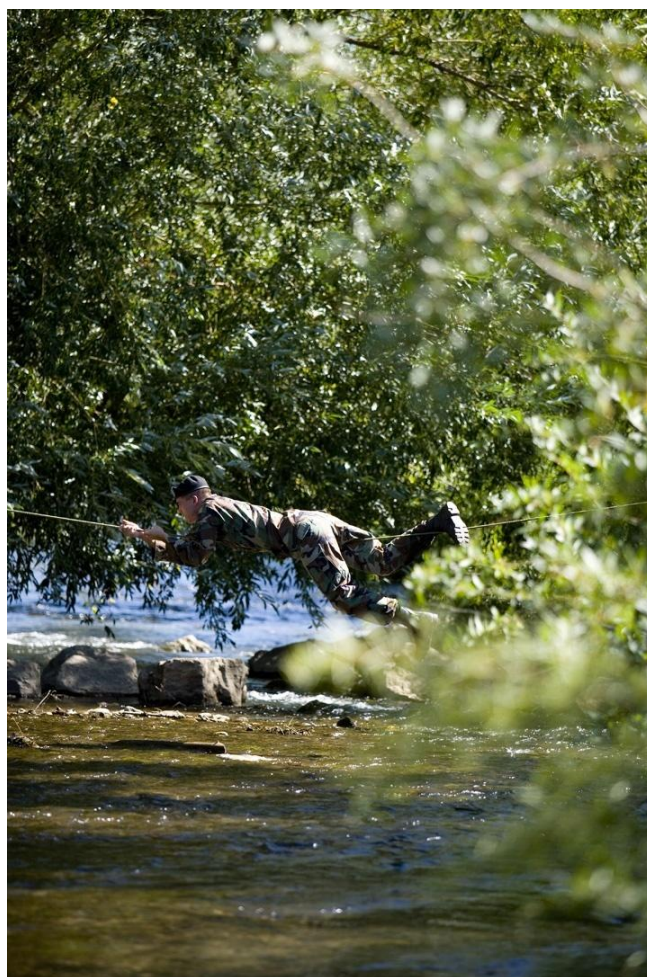
Financial support of \$300 freshman, \$350 sophomore, \$450 junior, and \$500 senior subsistence per month for up to ten months of the academic school year is paid to contracted students enrolled in the ROTC Advanced and Basic Courses. Students attending the four-week ROTC Leadership Training Course or the 32-day Leaders Development and Assessment Course (LDAC) receive approximately \$800 plus room, board, and travel expenses.

Additional financial aid is available to eligible freshman, sophomore, and junior students in the form of four-year, three-year, and two-year Army ROTC scholarships. The scholarship provides tuition, fees, and a textbook allowance, in addition to the monthly subsistence allowance paid during the school year. In addition, all non-scholarship, South Dakota resident advanced-course cadets receive a 50 percent reduction in tuition costs.

Extracurricular Activities

Military-related extracurricular activities and

organizations available to the ROTC student include Scabbard and Blade, Pershing Rifles, Bataan Memorial Death March, and the School of Mines Ranger Challenge Team. Students may also take part in voluntary hands-on training to include physical fitness, self-defense, survival, weapons, orienteering, rappelling, mountaineering, and first aid. These exercises are designed to provide the student with an opportunity to practice and improve skills learned in the classroom.



Mining Engineering B.S.



Contact Information

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Faculty

Professors Kliche, and Hladysz; Instructor Kanth.

Supporting Faculty

Professor Hansen; Associate Professor Klasi.

Mining Engineering

The mining engineering and management program, introduced as a new program in 2003, is designed to better meet the needs of the mining industry. It combines traditional mining engineering education with selected management-related concepts in order to better prepare the graduates for the modern mining industry.

Mining engineering is the application of engineering and scientific principles to the discovery, appraisal, and extraction of minerals from the Earth and sea. Mining engineering and management takes traditional mining engineering education one step farther by including management-related education in the curriculum.

The curriculum provides students with fundamental training in the basic sciences,

engineering sciences, engineering design, geology, the humanities, and mining engineering. Principles of mine operations, mine planning, mining technology, advanced 3-D design and modeling, rock mechanics, explosives technology and computer applications receive special emphasis. Key management-related concepts are introduced at all levels of the curriculum.

Significant design experience is built into the curriculum and is enhanced by the use of sophisticated 3-D design software in many of the mining courses. Teamwork is stressed in the program. As students work together in small, specialized teams during many of the laboratory exercises and to complete the final capstone design project. The students present their final design project both orally and in written form.

The mining engineering program is scheduled for accreditation review by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET) during their next general review in 2009.

A minor in mining engineering is not available.

Mining Engineering Program Objectives

The program in mining engineering is designed to meet the changing needs of the mining industry all over the nation and the world by providing graduates who are technically sound in mining engineering and can progress quickly through supervision and into management.

The curriculum has been designed to meet accreditation requirements in mining engineering. The core mining engineering curriculum provides technical training in areas such as rock mechanics, mine ventilation, ore reserve evaluation, mine design, explosive application, mining equipment selection, mining method selection, and mine land reclamation. The curriculum also includes a strong emphasis on management-related topics: health and safety, economics and finance, labor relations, project management, environmental management, international business, and communication skills.

The educational objectives of the program are:

- Graduates from the mining engineering program will have the analytical, technical

and mine design abilities necessary to work effectively in the field of mining engineering and will be informed of recent technical advances in the field.

- Graduates from the mining engineering program will be cognizant of societal issues and their role as future professional engineers working for the general benefit of society.

Professional Development

Students in the program are encouraged to become student members of their primary professional organization-the Society for Mining, Metallurgy, and Exploration (SME). Upon graduation, they are further encouraged to continue professional membership in SME. Additionally, the students can become student members of the International Society of Explosives Engineers (ISEE). Both SME and ISEE have local chapter meetings, which students are encouraged to attend.

During their senior year, students in the mining engineering program are encouraged to take the Fundamentals of Engineering (FE) examination. Passing the FE examination is the first step toward registration as a Professional Engineer (PE). The second and final step in the registration process is the successful completion of the Professional Engineering examination, which is normally taken at least four years after graduation.

The mining engineering program participates in a cooperative education program that provides an opportunity for students to combine course work with meaningful work experience in industry. Participating companies in the program provide jobs for students during semesters scheduled for work. A student in the cooperative program should plan on four and one half to five years to graduate.

Mining Engineering Laboratories

Laboratory facilities exist in the department for rock mechanics, ventilation, GPS surveying and computer-aided mine design. Laboratory equipment available for student use includes

equipment for rock specimen preparation, uniaxial and triaxial rock strength testing machine, direct shear machine, computerized data acquisition system, ventilation network model, and modern GPS-based surveying equipment.

The computer laboratory consists of a new (2007) lab sponsored by industry leader in mine design software (MAPTEK) with personal computers. Available software packages are routinely used by undergraduate and graduate students for the solution of problems in rock mechanics, geostatistics, management, mineral economics, ventilation, blasting, mapping, and mine design. Contemporary geoscience modeling and mine planning software is used by students for surface and underground mine design.

Mining Engineering Curriculum/Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

Freshman Year

First Semester

| | | |
|---|-------------------------|-----------|
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| MATH 123 | Calculus I | 4 |
| Humanities or Social Sciences Elective(s) | | 3 |
| GE 130 | Intro to Engineering | 2 |
| ENGL 101 | Composition I | 3 |
| PE | Physical Education | 1 |
| TOTAL | | 17 |

Second Semester

| | | |
|---|--|-----------|
| CHEM 114 | General Chemistry II | 3 |
| MATH 125 | Calculus II | 4 |
| PHYS 211 | University Physics I | 3 |
| MEM 120 | Introduction to Mining and Sustainable Development | 2 |
| PE | Physical Education | 1 |
| Humanities or Social Sciences Elective(s) | | 3 |
| TOTAL | | 16 |

Sophomore Year

First Semester

| | | |
|----------|---|---|
| MATH 205 | Mining and Management Math I (Calc III) | 2 |
|----------|---|---|

| | | |
|--------------|---|-----------|
| PHYS 213 | University Physics II | 3 |
| EM 216 | Engineering Mechanics (Statics and Dynamics) | 4 |
| MEM 201 | Surveying for Mineral Engineers | 2 |
| MEM 203 | Introduction to Mine Health and Safety | 1 |
| ENGL 279 | Technical Comm. I | 3 |
| ECON 201 | Microeconomics | 3 |
| TOTAL | | 18 |

Second Semester

| | | |
|---------------|---|-----------|
| MATH 211 | Mining and Management Math II (Diff Eq) | 3 |
| GEOE 221/221L | Geology for Engineers | 3 |
| ENGL 289 | Technical Comm. II | 3 |
| | Humanities/Social Science Elective(s) | 3 |
| MEM 202 | Materials Handling and Transportation | 2 |
| MEM 204 | Surface Mining Methods and Unit Operations | 2 |
| TOTAL | | 16 |

Junior Year

First Semester

| | | |
|--------------|---|-----------|
| MEM 301 | Computer Applications in Mining | 2 |
| MEM 303 | Underground Mining Methods and Equipment | 2 |
| MEM 305 | Introduction to Explosives Engineering | 3 |
| EE 303 | Circuits (for Mining) | 3 |
| IENG 366 | Engineering Management | 3 |
| MEM 307 | Mineral Exploration and Geostatistics | 3 |
| ATM 404 | Atmospheric Thermo (for Mining) | 2 |
| TOTAL | | 18 |

Second Semester

| | | |
|-----------|---|---|
| GEOL 214L | Mineralogy for Mining Engineers | 1 |
| MEM 302 | Mineral Economics and Finance | 3 |
| MEM 304 | Theoretical and Applied Rock Mechanics | 4 |
| EM 328 | Applied Fluid Mechanics | 3 |
| MEM 4XX | Mining Technical Elective ¹ | 1 |
| MET 220 | Mineral Processing | |

| | | |
|--------------|-----------------------|-----------|
| | and Resource Recovery | 3 |
| TOTAL | | 15 |

Senior Year

First Semester

| | | |
|---------------|---|-----------|
| GEOL 341/341L | Elementary Petrology | 3 |
| BADM 407 | International Business | 3 |
| MEM 401 | Theoretical and Applied Ventilation Engineering | 4 |
| MEM 466 | Mine Management | 2 |
| | Free Elective | 2 |
| | Hum/Soc. Sci. (Language) | 4 |
| TOTAL | | 18 |

Second Semester

| | | |
|---------------|--------------------------------------|-----------|
| MEM 464 | Mine Design and Feasibility Study | 4 |
| ECON 304 | Managerial Economics | 3 |
| GEOE 322/322L | Structural Geology | 3 |
| MEM 405 | Mine Permitting and Reclamation | 3 |
| HRM 417 | Human Resource Management | 3 |
| TOTAL | | 16 |

136 credits required for graduation

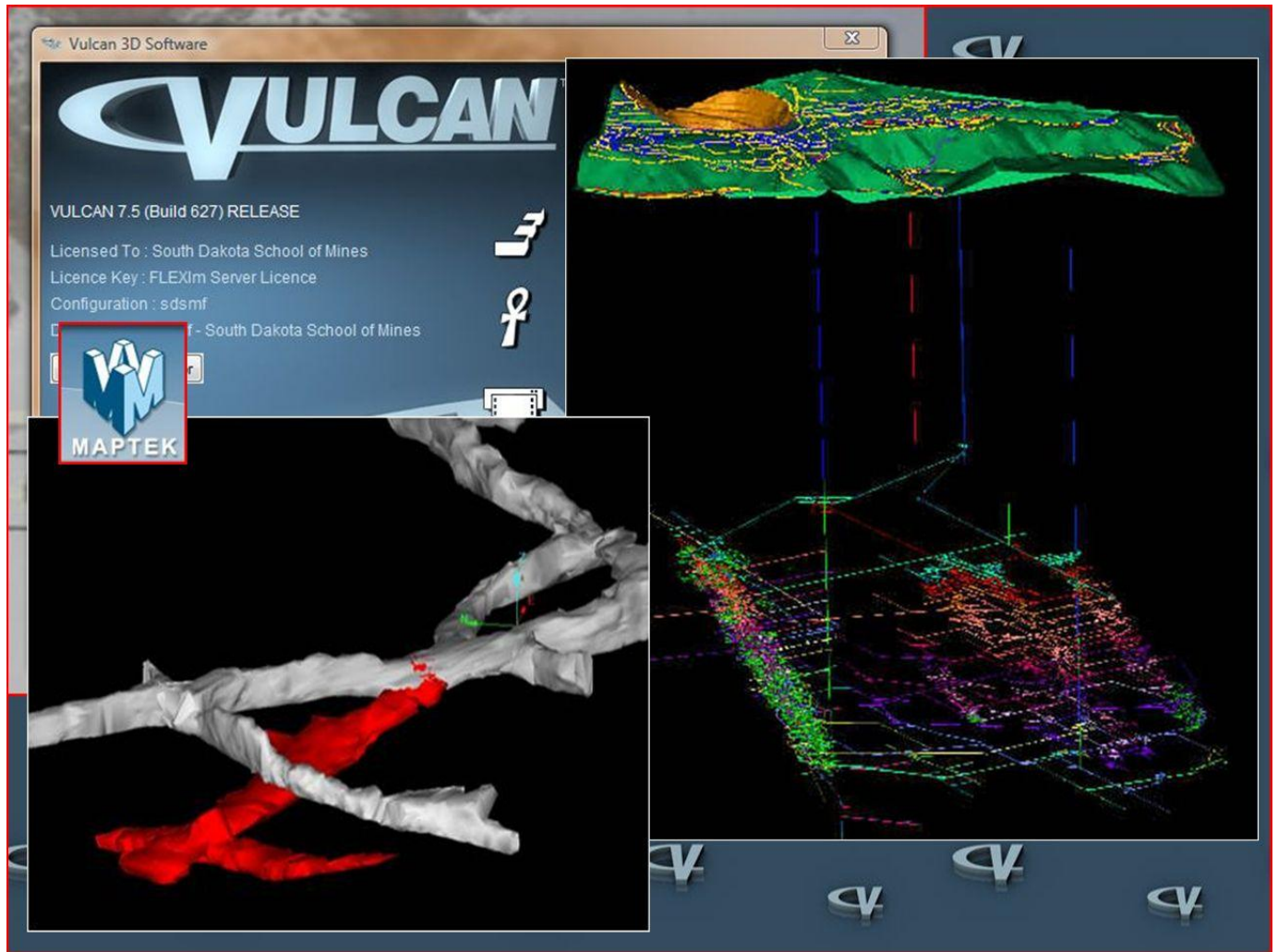
Curriculum Notes

¹Elective chosen from a list of approved mining or business courses.

MAPTEK Lab

The MAPTEK Advanced Mine Design and Global Communications Center is a modern computer design lab that is fully equipped with the world's most popular Mine Design Software – VULCAN from MAPTEK. This program is the leading design software used by the majority of mining operations worldwide. It enables students to design, review, analyze and perform extremely complex mine design tasks that are commonly performed daily at mining operations. Additionally, the lab is equipped with all of the requisite audio-video equipment to conduct video conference sessions with any organization across the globe. The set-up also allows for easy

integration to distance learning modules and participation from industry executives worldwide.



Mines Matters: 3-D modeling Vulcan software donated by Maptek helps students learn advanced technical design aspects of the mining industry. The Maptek Advanced Mine Design Center enhances the faculty's ability to promote and teach advanced technical aspects of the mining industry, with emphasis on 3D-modeling and design.

Physical Education

Contact Information



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Department of Physical Education

King Center 152

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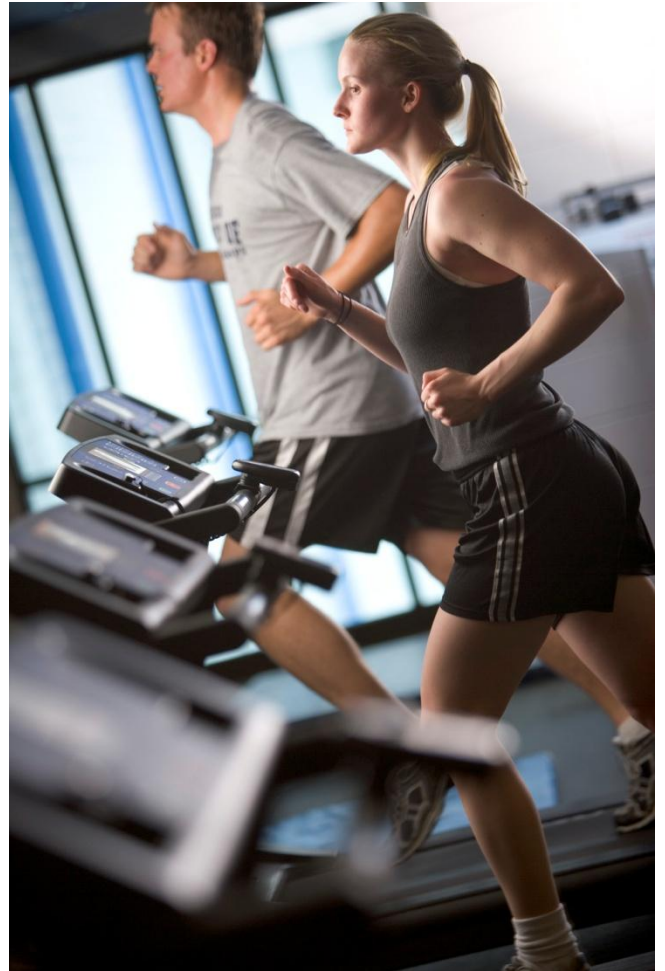
Faculty

Professor Felderman; Associate Professor Schafer; Assistant Professor Kratzer; Instructor Henry.

Physical Education

The physical education program is administered as a phase of a student's general education with the primary mission of the department being to provide physical activity for each student. The main objective is to assist in developing a healthy and active lifestyle for each student.

The specific objectives are to create an interest in physical fitness and physical skills and to develop those skills as much as time and facilities permit, while fulfilling the physical education requirement for graduation.



Mines Matters: The School of Mines offers a number of free on-campus recreation activities, including a pool, racquetball courts, gymnasium, and Wellness Center, which offers weights and cardio equipment.

Physics B.S. and Minor



Contact Information

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Faculty

Professors M. Foygel, A. Petukhov, and V. Sobolev; Associate Professor R. Corey; Assistant Professor X. Bai.

Physics

The goal of a program of study in physics is to provide students with an understanding of the basic laws of physics and to develop skills that will enable students to further explore physical phenomena and to solve related problems.

Students should have a sense of curiosity about their surroundings and a strong desire, not only to find solutions to problems that are encountered, but also to develop a deeper understanding of the basic principles involved. Students will be expected to develop a high level of mathematical skills and to become proficient in oral and written communications. Laboratory skills are also emphasized.

At the bachelor of science level, students will not be expected to specialize in any branch of physics. However, the curriculum does have room for electives, providing an opportunity to develop a minor in other fields of science or in an

engineering discipline. It provides a background in applications of physics for students seeking employment in industry and also provides a solid foundation for graduate study in physics or in other fields such as geophysics, meteorology, metallurgy, computer science, mathematics, materials science, and many branches of engineering.

Because physics is the basis of most engineering disciplines, understanding basic principles of physics can help one become a better engineer. An increasing number of students are choosing a double major, consisting of physics plus some field of engineering. Students going this route often end up in industrial research and development. In a rapidly changing economy where one field of engineering may be in a slump while others are not, understanding physics can assist students in moving across disciplines. For these reasons, students are encouraged to consider double majors.

Graduate studies leading to the degree of Master of Science in Physics and Materials Science and Ph.D. in Materials Science and Nanoscience are offered. Research is primarily in condensed matter and particle physics. At this level of study, students are expected to assume much of the responsibility for carrying out a research project. For details of graduate programs in physics, see the graduate section.

Minor in Physics

A minor in physics requires a minimum of 18 hours of courses in physics, which must include PHYS 213, and at least 15 hours of physics courses numbered higher than PHYS 213. All minors in physics must be approved by the department and must conform to the institutional policies and guidelines for minors.

Physics Laboratories

The facilities in the EE-Physics building are ample for all aspects of the department's experimental work from the introductory laboratories through graduate research. They are equipped to enable students to observe physical phenomena, demonstrate physical principles, and

learn techniques for making quantitative measurements in the fields of mechanics, heat, optics, electricity and magnetism, atomic, particle, and solid state physics. The equipment is the type that students will likely to encounter after graduation, with emphasis on computer-based data acquisition and control of experiments.

Physics Curriculum Checklist

Students are responsible for checking with their advisors for any program modifications that may occur after the publication of this catalog.

Freshman Year

First Semester

| | | |
|---|-------------------------|-----------|
| MATH 123 | Calculus I | 4 |
| CHEM 112 | General Chemistry I | 3 |
| CHEM 112L | General Chemistry I Lab | 1 |
| ENGL 101 | Composition I | 3 |
| PE | Physical Education | 1 |
| IS 110 | Explorations | 2 |
| Humanities or Social Sciences Elective(s) | | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|--------------|----------------------|-----------|
| MATH 125 | Calculus II | 4 |
| PHYS 211 | University Physics I | 3 |
| PE | Physical Education | 1 |
| CHEM 114 | General Chemistry II | 3 |
| CHEM 114L | Gen Chemistry II Lab | 1 |
| CSC 150 | Computer Science I | 3 |
| TOTAL | | 15 |

Sophomore Year

First Semester

| | | |
|---|---------------------------|-----------|
| MATH 225 | Calculus III | 4 |
| PHYS 213 | University Physics II | 3 |
| PHYS 213L | University Physics II Lab | 1 |
| PHYS 275 | Relativity | 3 |
| ENGL 279 | Technical Comm I | 3 |
| Humanities or Social Sciences Elective(s) | | 3 |
| TOTAL | | 17 |

Second Semester

| | | |
|---|------------------------|-----------|
| MATH 321 | Differential Equations | 4 |
| EE 220 | Circuits I | 4 |
| ENGL 289 | Technical Comm II | 3 |
| Humanities or Social Sciences Elective(s) | | 6 |
| TOTAL | | 17 |

Junior Year

First Semester

| | | |
|--------------|--------------------------------|-----------|
| MATH 432 | Partial Differential Equations | 3 |
| PHYS 341 | Thermodynamics | 2 |
| PHYS 343 | Statistical Physics | 2 |
| PHYS 312 | Exper. Physics Design I | 2 |
| CENG 244 | Intro to Digital Systems | 4 |
| PHYS 451 | Classical Mechanics | 4 |
| TOTAL | | 17 |

Second Semester

| | | |
|---|--------------------------|-----------|
| MATH 315 | Linear Algebra | 3 |
| PHYS 471 | Quantum Mechanics | 4 |
| PHYS 314 | Exper. Physics Design II | 2 |
| Math/Computer Science Electives | | 3 |
| Humanities or Social Sciences Electives | | 3 |
| TOTAL | | 15 |

Senior Year

First Semester

| | | |
|---|-----------------------------------|-----------|
| PHYS 421 | Electromagnetism | 4 |
| PHYS 361 | Optics ¹ | 3 |
| PHYS 412 | Advanced Design Projects I | 2 |
| PHYS 481 | Mathematical Physics ¹ | 4 |
| Humanities or Social Sciences Elective(s) | | 2 |
| TOTAL | | 15 |

Second Semester

| | | |
|---|---|-----------|
| PHYS 433 | Nuclear and Particle Physics ¹ | 3 |
| PHYS 439 | Solid State Physics ¹ | 4 |
| PHYS 414 | Advanced Design Projects II | 2 |
| Math/Physics Electives | | 3 |
| Humanities or Social Sciences Elective(s) | | 3 |
| TOTAL | | 15 |

128 credits required for graduation

Curriculum Notes

At the end of the sophomore year 12 hours of electives must include 6 hours in humanities (in two disciplines or in a sequence of foreign language courses) and 6 hours in social sciences (in two disciplines).

The electives must contain a minimum of 16 hours in social sciences and humanities and 3 hours of mathematics or computer science at the 200 level or above. 10 credit hours of military science may also be used as electives.

¹ Courses offered alternate years.

Social Sciences



Contact Information

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Faculty

Professor Goss; Assistant Professor Keohane, Associate Professors Dendinger, McReynolds and Van Nuys; Devereaux Library Director Andersen; Associate Librarian Collection Development Davies.

Social Sciences

The Department of Social Sciences provides study and understanding of the branch of science that focuses on the institutions and functioning of people in society. By utilizing empirical and quantitative methods in the study of human beings, the curriculum reflects the technical and scientific nature and mission of the university.

Interdisciplinary science degree candidates are required to complete 24 semester hours of humanities and social sciences courses. Other

science and engineering degree candidates are required to complete 16 semester hours of humanities and social sciences courses — at least 6 credits in each area. Engineering majors are required to enroll in at least one upper-level humanities or social science course of at least 3 credit hours.

Social Sciences

(Upper-level courses are in bold print.)

Anthropology:

ANTH 210

Business Administration:

ACCT 210¹, ACCT 211¹, BADM 101¹, **310¹**, **334¹**, **336¹**, **350**, **360**, **370¹**, **406¹**, **438¹**, **474¹**, **492¹**.

Economics:

ECON 201, 202

Geography:

GEOG 101, 212, 400

History:

HIST 151, 152, 492

Management Information System:

MIS 205

Political Science:

POLS 100, 350, 407

Psychology:

PSYC 101, 323, 331, 391, 392, 451, 461

Sociology:

SOC 100, 150, 250, 391, 392

Curriculum Notes

¹ May not be used as social sciences credits, but may be used for free elective credit. (Consult advisor for further details.)

Graduate Student General Information

South Dakota School of Mines and Technology offers graduate degree programs at the master's and doctoral levels. The graduate program provides opportunities for advanced study and research in the fields of engineering and science. Each individual degree program of study is designed to broaden and extend the student's knowledge within the chosen field, to develop the power of independent critical thinking, and to promote the skill of individual and cooperative research skills.

A master's degree program was authorized at the South Dakota School of Mines and Technology in October 1935, and the first degree was granted in 1937. Permission to start a Ph.D. program during the 1967-68 academic year was granted in January 1967 to the Department of Geology and Geological Engineering. In June, 1983, the Board of Regents authorized the doctorate in materials engineering and science. The Board authorized the atmospheric, environmental, and water resources Ph.D. program (cooperative with South Dakota State University) in October of 1993. In March 2005 this program was changed to atmospheric and environmental sciences. Also in March 2005, The Board of Regents authorized a Ph.D. program in nanoscience and nanoengineering and in March 2006 authorized an M.S./Ph.D. program in biomedical engineering, which is a joint program with the University of South Dakota. In April 2007, a Ph.D. program in chemical and biological engineering was authorized by the Board.

The graduate office was organized formally in 1950-51. The policies of the graduate office are formulated with the assistance of the Council on Graduate Education, which is advisory to the Dean of Graduate Education. The policies are approved by the Faculty Senate and the Board of Regents and are administered by the Graduate Dean.

The Council on Graduate Education

The Council on Graduate Education consists of three faculty representatives elected by each college, two graduate student representatives and the Dean of Graduate Education or his/her designee. (The Vice President for Academic

Affairs serves in an ex-officio capacity.)

Graduate Programs

Master of Science degrees are offered in:

- Atmospheric Sciences
- Biomedical Engineering
- Chemical Engineering
- Civil Engineering
- Construction Management
- Electrical Engineering
- Geology/Geological Engineering
- Materials Engineering and Science
- Mechanical Engineering
- Paleontology
- Physics
- Robotics and Intelligent Autonomous Systems
- Technology Management

Doctor of Philosophy degrees are offered in:

- Atmospheric and Environmental Sciences
- Biomedical Engineering
- Chemical and Biological Engineering
- Materials Engineering and Science
(multi-disciplinary)
- Geology/Geological Engineering
- Nanoscience and Nanoengineering

Admission to the Graduate School

The Graduate Office encourages applications from qualified students holding bachelor's degrees in engineering or science from accredited four-year colleges and universities. Bachelor's degrees or "diplomas" in technical engineering fields generally do not qualify as accredited four-year degrees for purposes of admission. A student desiring admission should obtain an application form from the Graduate Office or via the website at: <<http://graded.sdsmt.edu>>. The completed form, accompanied by a transcript of all undergraduate work and a non-refundable application fee of \$35 for all applicants should be submitted to the Graduate Office. Application materials from domestic applicants should be received at least three months before the beginning of the semester for which the student desires admission (June 1 for fall semester and October 1 for spring semester). International applicants must submit all of their materials at least five (5) months

Graduate Student General Information

before the beginning of the semester (April 1 for fall semester and August 1 for spring semester). Applicant files will not be reviewed until the \$35 application fee has been paid.

Three letters of recommendation are required. These should be submitted, upon request of the applicant, by three persons familiar with the scholastic ability and interests of the applicant. However, applications from students at or graduated from the South Dakota School of Mines and Technology need only include the signatures of two faculty members familiar with the applicant's academic performance unless otherwise specified on the application form.

If the applicant has not completed an undergraduate program, a list of the remaining requirements should accompany the application. Evidence of graduation must be submitted prior to enrollment.

The Graduate Record Examinations (GRE) is required by all graduate programs. The GRE should be taken in advance so that the scores are available for review at the time the student's application is reviewed. Please use school code 6652 for the results to be sent to the School of Mines. This examination is prepared by the Educational Testing Service, Princeton, New Jersey. School of Mines graduates applying for any master's program or for a Ph.D. in either geology or atmospheric and environmental science are exempt from the GRE requirement.

The descriptions that follow provide information on requirements for specific graduate programs. When an application for admission to a graduate program is received, the faculty of the department or multi-disciplinary program in which the applicant expects to major will evaluate the applicant's academic qualifications. The head/coordinator, on behalf of the faculty, will recommend whether or not the applicant should be accepted into the graduate program, and whether the admission should be as an unconditional, provisional, probationary, or special student. The Dean of Graduate Education will review this recommendation and provide a letter of decision to the applicant. For further information, refer to the section on "Probation Policy."

Admission to the graduate school for study toward a master's degree does not imply that the

student will be allowed to work toward a doctorate. A separate application and evaluation of the student's qualifications are necessary before acceptance into a doctoral program. It should be noted further that admission to the graduate school for study toward a Ph.D. degree does not constitute admission to candidacy for the Ph.D. degree. Refer to a later section for information on admission to candidacy.

International Student Admissions

An international applicant for graduate school must provide evidence of English proficiency. English proficiency for graduate applicants from countries in which English is not the native language must be verified by the TOEFL (Test of English as a Foreign Language). In addition, TWE (Test of Written English) scores are recommended, but are not required. TOEFL results must be sent to the Graduate Office, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701-3995. Please use school code 6652 for the results to be sent to the School of Mines. A minimum score of 560/220/83 is required for unconditional satisfaction of the requirement. Students having scores greater than 520/190/68 but below 560/220/83 will be required to undergo an evaluation and will be required to complete a program of study in English as a second language. Admittance will not be granted to students with TOEFL scores below 520/190/68. Information on worldwide test centers and on registration for the TOEFL can be obtained by contacting any U.S. Embassy or Consulate or by writing to Test of English as a Foreign Language, Educational Testing Service, Princeton, New Jersey 08540, U.S.A. International students from countries where English is either the native or common language may be exempted by the Dean of Graduate Education from the TOEFL requirement. Likewise, applicants who have a prior degree from a college or university in the United States are generally exempted.

Conditional acceptance can be granted to international applicants after they first pass English as Second Language classes. An international applicant will not be issued the U.S. Department of Justice Form I-20, Certificate of Eligibility for Non-

Graduate Student General Information

immigrant (F-1) Student status, until admission to graduate school for study toward a specific advanced degree has been granted and the applicant has provided documentary evidence of financial ability to cover the projected annual costs of education at this university. Form I-20 is usually necessary for admission to the United States for college attendance. This institution will issue a DS-2019 Form only when appropriate. All international applicants are required to submit the \$35 application fee. (At the time of first registration on campus, a \$116.65 international student enrollment fee must be paid.) Both charges are non-refundable.

International students are advised that full-time status at this university is necessary in order to satisfy F-1 status requirements (see “Tuition and Fees” section of the catalog).

Each international student (and any dependents accompanying him/her to the United States) is **REQUIRED** to enroll in the Major Medical Hospitalization/Surgical Insurance Plan provided through South Dakota School of Mines and Technology. No outside policies will be accepted as substitutes. The only exception to this rule is if the student is covered by his/her home country (documentation of this policy is necessary). Additionally, each international student is required to carry at least \$10,000 of life insurance while enrolled at South Dakota School of Mines and Technology.

As a result of the regulations that became effective on January 1, 2003, the Family Educational Rights and Privacy Act (FERPA) is waived for F and J students with respect to these specific reporting requirements. The regulations will be strictly enforced by the appropriate bureau(s) within the US Department of Homeland Security (DHS) and information will be reported electronically to DHS via Student and Exchange Visitor Information System (SEVIS). The consequences to students for non-compliance with the new regulations are severe. For more information, email the Ivanhoe International Center at Ivanhoe@sdsmt.edu or go to <http://international.sdsmt.edu>.

Funding for Graduate Students

Graduate Assistantships

South Dakota School of Mines and Technology has funds available from various sources for graduate assistantships and fellowships. Such awards are usually made on the basis of scholastic merit and the availability of funds. Assistantships are not available to students on probation unless an exception is granted by the Dean of Graduate Education.

Financial assistance is available for graduate teaching assistants (GTA) and for graduate research assistants (GRA). A GTA handles laboratory sections, grades papers, or performs other assigned instructional duties. A GRA is compensated to conduct supervised research, which generally relates to the student’s thesis or dissertation research.

The Dean of Graduate Education grants the award, acting upon the recommendation of the department head, program coordinator, or major professor after evaluation of the student’s academic record, overall qualifications, and programmatic progress. Graduate assistants are required to attend GTA/GRA training each semester prior to any release of funds.

The following rules apply to all graduate assistants:

1. An assistant receiving a full time stipend (50 percent academic study, 50 percent research or teaching) must be registered for a minimum of 9 credit hours during the academic semester which the assistantship is in effect, and 2 credits during the summer.
2. An assistant receiving a three-quarter time stipend (62.5 percent academic study, 37.5 percent research or teaching) must be registered for a minimum of 7 credit hours during the academic semester which the assistantship is in effect, and 1 credit during the summer. (does not qualify for reduced tuition unless registered for 9 credits)
3. An assistant receiving a half time stipend (75 percent academic study, 25 percent research or teaching) must be registered

for a minimum of 5 credit hours during the academic semester which the assistantship is in effect, and 1 credit during the summer. (does not qualify for reduced tuition unless registered for 9 credits)

4. All assistants receiving reduced tuition must be registered for a minimum of 9 credits hours during the academic semester which the assistantship is in effect, and a minimum of 2 credits during the summer. They must also be awarded at least the minimum compensation established annually by the Board of Regents (currently \$2,779).

Graduate students receiving a qualifying summer assistantship or who have received a qualifying graduate assistantship for the preceding fall and spring are automatically eligible for reduced tuition for the following summer. Graduate assistants and fellows who are eligible for reduced tuition at one institution are eligible at other Regental institutions.

Graduate students who are U.S. citizens or eligible non-citizens may be eligible for other forms of financial aid such as Federal Stafford Student Loans, Federal Perkins Student Loans, or Federal Work-Study. Application and requests for additional information on these programs should be made to the Office of the Registrar and Academic Services — Financial Aid.

Graduate assistants under state contract are subject to institutional policies set forth in the Faculty/Staff Handbook.

A conventional, full-time GRA/GTA for an M.S. degree pays \$11,116 per academic year and \$2,779 per month in the summer for a total of approximately \$22,232 per calendar year. A conventional full-time GRA/GTA for a Ph.D. degree pays \$12,450 per academic year and \$3,112 per month in the summer for a total of approximately \$24,900 per calendar year. If funds are available, extra support can also be provided for work effort during the winter holiday break. Part-time service is compensated in accordance with expected hourly effort and the above hourly rates.

The student with a research assistantship (GRA) should recognize that the prescribed hours of research work are minimum expectations

mandated by employment practices and may not represent the effort that will be actually necessary to produce a satisfactory thesis or dissertation within a reasonable period of time.

The graduate student must be considered a full-time student during the academic period in order to receive an assistantship. Students not registered for full time credits will be required to complete a certificate of enrollment form certifying that their work is considered full time by their advisor. Up to eight semester hours of research credit may be awarded for one summer of work. Continuing students must register before assistantships and fellowships are processed for the semester for which they are authorized. Pre-registration is required to prevent payment delays.

Graduate Fellowships

A growing number of fellowships from industrial and governmental agency sources are currently available. Eligibility requirements and restrictions are parallel to those for research assistantships. A fellowship award may not always include reduced tuition as a benefit. Pre-registration by continuing students is required to prevent payment delays.

Graduate College Registration

A graduate student will report to the advisor specified in the admission letter and thereafter will follow the registration procedure for all South Dakota School of Mines and Technology students. The advisor is responsible for counseling the graduate student in the formulation of a program of study until the student has selected a major professor.

Full-Time/Half-Time Defined

A full-time graduate student is defined as a student registered for nine or more credit hours per semester at any of the six universities in the South Dakota Regental system during the academic year, or 2 or more credit hours during the summer session.

A half-time graduate student is defined as a student registered for 4.75 to 8 credit hours per semester during the academic year, or 1 credit

hours during the summer session.

Audited or remedial English credits do not apply to the above definitions.

During the regular academic year, registration in evening courses counts toward the determination of full-time status if the student is registered also in regular daytime courses. During the summer session, full-time student status may be earned completely with evening courses.

Graduate students are assessed the same campus fees as undergraduates (see “Tuition and Fees”). State law does not permit reduction or remission of fees under any circumstances.

Continuing Registration

Note: Graduate-level special students (as defined in another section) are exempt from the following continuing registration rule. The only other exception to the continuing registration policy is when a student has been granted a formal leave of absence (see “Leave of Absence” section below).

Degree-seeking graduate students must be registered on a continuing basis during each fall and spring semester of the regular academic year (see section on “Minimum Registration”). This applies regardless of whether the graduate student is in residence, is off-campus, or is pursuing a degree on a part-time basis. Failure to maintain continuing registration will result in deactivation of the graduate student’s program. Therefore, graduate students who fail to comply and subsequently wish to return to their same program of study will be required to obtain written permission from the Dean of Graduate Education and may be charged a minimum reinstatement fee of \$50.

All graduate students must register within the designated period each semester. Beyond that point, the reinstatement fee may be imposed along with any other late registration fees.

Minimum Registration

The minimum registration for graduate students, including graduate-level special students, is 2 credits. Minimum registration is required during any semester or summer when

using departmental or institutional resources, including scheduling and taking exams. The number of credit hours taken in excess of the minimum should accurately reflect the extent of the graduate student’s course work and research activities.

Graduate students must also meet this minimum registration requirement during the specific semester or summer in which they complete all requirements for their degree and become eligible for graduation. There will be no grace period; hence, students who fail to complete all degree requirements prior to the official closure date for a given semester or summer will be required to register for a minimum of 2 credits during a subsequent semester or summer in order to graduate.

Academic Loads

Thirteen credit hours per semester are considered to be the normal maximum graduate load. Higher loads must be approved by the Dean of Graduate Education and may be permitted if the student is taking a combination of courses at the graduate and undergraduate level. A reduced load may be recommended at the discretion of the student’s advisor and major professor for students working as GTAs or GRAs.

Please refer to a previous section for additional information on assistantships and financial aid.

Leave of Absence

A student who is unable to continue his/her program of graduate study due to unanticipated major circumstances may request a leave of absence from his/her program of study by completing and submitting a “Request for Leave of Absence” form, available in the Graduate Office. The form must be completed and signed by the student, the student’s advisor, department head or program coordinator, and then submitted to the Graduate Office. The Dean of Graduate Education will evaluate the request, and either approve or deny it. If the request is approved, the student will not be subject to continuing registration and the leave of absence will not

count toward the time limits to complete his/her program of study. A leave of absence is determined on a semester-by-semester basis and is usually limited to a maximum of one calendar year.

Change of Major

A student admitted to the graduate school in a specified department/program must complete at least one semester in the original department/program before being allowed to change to another department/program. A student who wishes to change majors should obtain an "Intent to Transfer" form and return it to the Graduate Education Office with the appropriate signatures from his/her current department/program. Upon favorable recommendation from the department/program, the Dean of Graduate Education will issue a letter of transfer and notify the appropriate offices and the student of the change.

Dual Enrollment in Ph.D./M.S. Programs

Concurrent enrollment in a Ph.D. program and an M.S. program in a different department is normally not allowed. Students who are pursuing a Ph.D. may not take more than 15 graduate credits in a second department. If the student leaves the Ph.D. program and is admitted to the second department, no more than fifteen (15) credits may be counted toward the M.S.

Exception Policy

A student who seeks an exception to the above policy must follow the procedure set forth below. Students must be aware that exceptions to this policy will only be granted under extraordinary circumstances.

1. The Ph.D. student must obtain prior written approval for this dual-degree plan from his/her major professor and the head/coordinator of the relevant Ph.D. program.
2. If approval is granted in Step 1, then the Ph.D. student must obtain written approval for the M.S. degree plan from the head of the corresponding M.S. program.

3. If approval is granted for Step 2, then the student will need to establish a second graduate committee and file a separate program of study for the M.S. degree with the Graduate Office.
4. The Dean of Graduate Education will have the normal authority to either approve or disapprove this second program of study. If the M.S. program of study is approved by the Dean of Graduate Education, then the major professor of the student's Ph.D. program will be appointed as the representative of the graduate school of the student's M.S. graduate committee.
5. The first two semesters of the dual program will be considered probationary. The second program of study can be terminated based on recommendations of the Ph.D. major professor and/or M.S. major professor to the Dean of Graduate Education.

Dual Majors

South Dakota School of Mines and Technology does not permit, in general, credit hours that have been used to satisfy requirements for one master of science degree to be applied toward another master's degree from this institution. Under exceptional circumstances however, a student may petition the Committee on Graduate Education through his/her advisory committee for a variance from this policy.

Special Students

An individual who holds a baccalaureate degree and wishes to pursue further study without a commitment to advanced degree candidacy may apply to the Graduate Office for admission as a special student at the graduate level. The applicant must provide evidence of the baccalaureate degree. Upon admission as a special student, he/she will be subject to Graduate Office policies including the probation policy. A maximum of 12 credit hours may be accumulated, after which the student must either apply for admission as a degree-seeking student or must petition for a variance from this policy. Graduate

students classified as special students are not eligible for assistantships.

Graduate Grading System:

The graduate grades will be assigned to the graduate academic level and to all courses and sections with course numbers of 500 or greater. Plus and minus grades are not used.

The following grades are recommended to be associated with the Graduate Grade System:

1. Standard Grades:

A Exceptional

4.00 grade points per semester hour.

B Good

3.00 grade points per semester hour.

C Average

2.00 grade points per semester hour.

D Unsatisfactory

1.00 grade points per semester hour.

F Failure

0.00 grade points per semester hour.

S Satisfactory

Does not calculate into any GPA.

U Unsatisfactory

Does not calculate into any GPA.

W Withdrawal

Does not calculate into any GPA, no credit granted.

AU Audit

Does not calculate into any GPA. An audit (AU) grade may be granted only when the student has elected the AU option on or prior to the census date of the term.

I Incomplete

Does not calculate into any GPA. An incomplete (I) grade may be granted only when all of the following conditions apply:

- a. A student has encountered extenuating circumstances that do not permit him/her to complete the course.
- b. The student must be earning a passing grade at the time the Incomplete is necessitated. Anticipated course failure is not a justification for an incomplete.
- c. The student does not have to repeat the course to meet the requirements.
- d. The instructor must agree to grant an incomplete grade.
- e. The instructor and student must agree on a plan to complete the course work.
- f. The course work must be completed within one calendar year; extensions may be granted by the Dean of Graduate Education.
- g. If the student completes the course within the specified time, the grades that may be assigned are A, B, C, D, F, S, or U.
- h. If the student does not complete the course within the specified time, the Incomplete grade remains on the transcript.

IP In Progress

Does not calculate into any GPA. An in progress (IP) grade may be granted only when all of the following conditions apply:

- a. The requirements for the course (for every student enrolled in the course) extend beyond the current term.
- b. The extension beyond the current term must be defined before the class begins.
- c. The instructor must request permission to award IP grades for a course from their department head and from the Dean of Graduate Education. Then approval must be obtained from the Vice President for Academic Affairs.
- d. A definite date for completion of the course must be established in the course syllabus.

NP Normal Progress

Does not calculate into any GPA. A normal progress (NP) grade calculates into attempted credits but does not calculate into completed credits or grade point averages.

A normal progress (NP) grade may be granted by an instructor when the instructor determines that a graduate student is making normal progress in a graduate Thesis/Dissertation course. If a graduate

student does not enroll for a period of one calendar year, the NP grade may change to I (Incomplete) upon approval by the Dean of Graduate Education.

A Satisfactory/Unsatisfactory (S/U) grade may be granted only when the entire course requires the S/U grade or the student has elected the S/U option on or prior to the census date of the term.

NRGrade not reported by the Instructor

Does not calculate into any GPA.

EX Credit by Exam

Does not calculate into any GPA. An examination for credit (EX) grade may be granted only for non course credit validation obtained through a validation process. This grade is not used for any Regental university course.

CRCredit

Does not calculate into any GPA. A credit (CR) grade may be granted only for non-course credit that is not related to an examination or to equating transfer grades to the BOR grading system. This grade is not used for any Regental university course.

TRTranscripted

Does not calculate into any GPA and no credit is granted.

LRLab grade linked to Recitation Grade

0 credit course.

Advanced-Degree Grade Requirements

To qualify for any advanced degree, the faculty has stipulated that the following requirements must be satisfied:

1. The student must earn a minimum 3.00 average of grades in all 300- through 800-numbered courses taken (a) in all departments AND (b) in his/her major department after admission to the graduate program, or taken for graduate credit at the School of Mines as an undergraduate or Special student. Note that thesis and dissertation research credit hours and

grades will not be counted in the determination of these grade-point averages.

2. The student must earn a "C" grade or better in any graduate course (500 through 800 level), which is to be credited toward advanced degree requirements.
3. The student must earn a "B" grade or better in any 300 or 400 level course, which is to be credited toward advanced degree requirements.
4. The student's thesis or dissertation research must be of a quality to earn a final grade of "S."
5. Students who fail any course must repeat the course with a passing grade. The student may petition, through their advisor or major professor, and the Dean of Graduate Education for a potential waiver of this rule.
6. The student cannot apply any credit hours or grades for 100 and 200 level courses (which are usually taken to overcome academic deficiencies) toward advanced degree requirements. If, in the opinion of the student's advisor, major professor and advisory committee, progress in these courses is unsatisfactory, additional work may be required to demonstrate proficiency.
7. Of credits counted for an advanced degree, not more than 50 percent of the credit hours in any graduate program can be at the 500 level.

If a course is repeated for a passing or improved grade, only the grade for the last attempt will be included in the computation of the cumulative grade-point average shown on the graduate student's transcript.

A limitation of a total of nine credit hours exists for advanced-degree credit for courses identified as "Special Topics in," "Advanced Topics in," or "Seminar in." Refer to the specific course description for any other restrictions.

All graduate research credit hours are graded according to regular grading standards. However, for thesis research (courses numbered 700) and dissertation research (courses numbered 800) the final grades for a completed program will be

issued as either “U” for Unsatisfactory or “S” for Satisfactory. These S and U grades will not be used in the computation of grade-grade point averages.

Research credit may be applied toward the fulfillment of credit-hour requirements. The number of credit hours so applied is identified in the relevant sections under master of science and doctor of philosophy degree programs.

Undergraduates Taking Graduate Courses/Graduates Taking Undergraduate Courses

1. Graduate-level credits (500 level or above) taken as an undergraduate student are automatically placed on a graduate transcript, and may not be used toward an undergraduate degree unless appropriate approvals and credit transfers are obtained through Academic and Enrollment Services. Graduate-level credits taken as an undergraduate and used to fulfill requirements for the undergraduate degree may not be used also toward a graduate degree.
2. Up to 12 semester hours of graduate-level credits taken as an undergraduate and not used to fulfill requirements for the undergraduate degree may be used toward a graduate degree only after the courses in question are included on the student’s program of study with all necessary approvals listed thereon. Upon written justification by the head/coordinator of the graduate student’s major department / program, the Dean of Graduate Education may approve a minor variance from this rule.
3. Undergraduate-level credits (300 or 400 level) taken as a graduate student are automatically placed on an undergraduate transcript, and may not be used toward a graduate degree except under the following circumstances:
 - a. The courses in question are outside the student’s major department, but are included on the student’s program of study with all necessary approvals listed thereon. (See also individual department restrictions on 300-400 level courses.)
 - b. The courses in question are within the student’s major department, appear on the waiver list pre-approved by the Council on Graduate Education, and are included on the student’s program of study with all necessary approvals listed thereon. (See also individual department restrictions on 300-400 level courses.)
 - c. The courses in question are at the 400 level, are within the student’s major department, do not appear on the waiver list pre-approved by the Council on Graduate Education, but are included on the student’s program of study along with a petition of support from the student’s major professor, with all necessary approvals listed thereon.
 - d. The student must have earned a “B” grade or better in any 300 or 400 level course which is to be credited toward advanced degree requirements.
 - e. The student cannot apply any credit hours or grades for 100 and 200 level courses (which are usually taken to overcome academic deficiencies) toward advanced degree requirements. If, in the opinion of the student’s advisor, major professor and advisory committee, progress in these courses is unsatisfactory, additional work may be required to demonstrate proficiency.

The number of undergraduate credits not used to fulfill requirements for the undergraduate degree that may be applied toward a master’s degree is limited to nine hours.

Forms mentioned above are available at the Graduate Office in MI-235 or on the graduate education website.

Work Taken at Another Institution

The minimum percentage of credit hours in the graduate degree program that must be completed from the institution granting the degree is 60 percent. Credit for up to 12 semester hours of graduate-caliber course work taken at another institution may be transferred toward the requirements for the master’s degree at the South Dakota School of Mines and Technology.

Domestic graduate transfer courses and transfer grades are recorded and evaluated by the School of Mines, calculated into grade point averages according to the South Dakota Regental grade scheme, and recorded on the student's academic transcript ONLY if these transfer courses are equivalent to a specific graduate course at South Dakota School of Mines and Technology. International transfer courses will appear on the transcript along with the number of credits earned, but no grade will appear and will not be calculated into grade point average.

Such credit from institutions external to the South Dakota Regental system must be reviewed and approved by the student's committee and by the Dean of Graduate Education. The Dean of Graduate Education shall notify the Registrar and Director of Academic Services in writing of the credits to be accepted and placed on the student's transcript. An official transcript received directly from the issuing institution to support the request is required. The transferred course number, title, and semester hours will be entered on the student's transcript. Credits transferred from an institution outside the South Dakota Regental system may be used to reduce graduation requirements, but will not affect the cumulative GPA earned at the South Dakota School of Mines and Technology.

Course Retake Policy

A student will be allowed a total of two registrations for any particular graduate course (course numbers of 500 and above) for which credit is to be counted toward graduation. The student must petition the Dean of Graduate Education and obtain the Dean's approval to be permitted to take a graduate course more than two (2) times. Only the LAST attempt of the course will count in the grade point average calculations.

A student will be allowed multiple registrations for certain graduate courses for which credit toward graduation may be received more than once (e.g., Independent Study, Thesis, Research, etc.). Grades for all such courses will be used for grade point average calculations. Please note that individual departments/programs

may limit the number of credits allowed toward graduation in these types of courses.

Pass-Fail Option for Graduate Students

The following policy pertains to the pass/fail option at the graduate level:

1. 100 and 200 level courses, either within or without the department, which cannot be applied for credit toward a graduate degree may (with the consent of the student's major professor and advisory committee) be taken on a pass-fail basis under the same rules that apply to undergraduate students.
2. 300 through 800 level courses outside of the student's department/program may (with the consent of the student's major professor and advisory committee) be taken on a pass-fail basis except that a "C" grade shall be considered the lowest passing grade. The maximum number of hours of pass-fail work for which a master's degree candidate may receive credit will be six for the thesis option and nine for the non-thesis option.
3. No 300 through 800 level courses offered by the student's major department/program may be taken for credit under the pass-fail option. Beyond the master's level, the pass-fail option may be exercised at the discretion of the candidate's graduate advisory committee, but must still be approved by the Dean of Graduate Education.

Probation and Reinstatement Policy

An applicant who has a large number of deficiencies, or whose undergraduate record is relatively weak, may be admitted to the graduate program on probationary status. For a student admitted on probation, a deficiency in grade requirements during the first semester of enrollment may be considered sufficient grounds for terminating the student's enrollment in the graduate program. Such a termination decision will be made by the Dean of Graduate Education after consulting with the student's major professor and the department head or relevant program coordinator.

A current graduate student who does not meet

the following requirements (items 1-7 below) during any semester will be placed on probation and will be so informed by the Dean of Graduate Education. A failure to remove the deficiencies during the following semester may be considered sufficient grounds for terminating the student's enrollment in the graduate program. For further information regarding restrictions on financial assistance to graduate students on probation, refer to the section entitled "Assistantships and Fellowships for Graduate Students." Probation imposed because of grade deficiencies in specific courses (items 2-3 below) will continue each semester until the course(s) has been retaken and an acceptable grade(s) has been received.) Probation imposed because of overall GPA deficiencies (item 1 below) will continue each semester until the GPA reaches the acceptable level.

A student will be placed on probation for a "U" grade received for research credit(s). Since a "U" is a final grade, probation will be maintained until at least one subsequent "S" credit is awarded. A student may graduate with "U" grades, but must also accumulate "S" grades for the required minimum number of research credits in a given advanced degree program. A student who has transferred from a thesis to a non-thesis program and who has received "U" grades as the last research grades in the thesis program will be admitted to the new program on a probationary status. Such probation may be removed by satisfactory progress (according to the usual performance criteria) during the first semester in the new program.

A student may be placed on probation for failing to meet either general or specific program requirements, e.g., failure to meet the required deadline for filing the required program of study with the graduate office and/or failure to meet the deadlines for taking and passing applicable qualifying, comprehensive, and final exams, etc. Probation for such deficiencies will be removed after the requirement(s) has been satisfied. A student's probationary status will be reviewed at the close of each semester for appropriate action-removal from probation, continuation of probation, or termination. A student may petition the Dean of Graduate Education for

reconsideration of a termination decision. (Refer to section on "Appeal Procedure.")

1. A student must maintain a "B" (3.00) or better grade point average in all 300 through 800 level courses taken for graduate credit at the School of Mines. Thesis and dissertation research credit hours and grades will not be counted in the determination of this GPA.
2. A student must earn no less than a "C" (2.00) grade in any graduate course (500 through 800 level) taken for graduate credit, and which is to be credited toward advanced degree requirements.
3. A student must earn no less than a "B" (3.00) in any 300 or 400 level course taken for graduate credit, and which is to be credited toward advanced degree requirements.
4. A student's thesis or dissertation research must be of a quality to warrant the issuance of a semester grade of "S" or an interim grade of "NP."
5. A student must earn no less than a "B" (3.00) in any 100 and 200 level courses taken for grade credit even though they cannot be applied toward a graduate degree.
6. A student must pass all courses taken on the pass-fail basis. (Refer to section on "Pass-Fail Option for Graduate Students.")
7. A student must remove all other program deficiencies, such as meeting state deadlines for applicable qualifying, comprehensive, and final examinations; selection of a graduate advisory committee; and filing of a satisfactory program of study in the graduate office.

Appeal Procedure

Procedures for appealing or petitioning for a variance from certain policies are set forth in the relevant sections of this document when such variances are permitted in unusual or exceptional circumstances. Appeals or petitions involving such matters as grade changes from "F" or "I" to "W" and refund of late registration fees should be lodged with the Academic Appeals Committee through the Vice President for Academic Affairs, after

review by the Dean of Graduate Education.

Appeals concerning probation, suspension, or potential variances in academic graduate policy should first be lodged with the student's major department/program. Before rendering a decision on the appeal, the department head or program coordinator will seek a recommendation from the student's graduate advisory committee. If the student is not satisfied with the decision on the appeal, the student may petition the Committee for Graduate Education for reconsideration. Such petition must be filed with the Dean of Graduate Education.

In those cases where this document does not provide appropriate information concerning the resolution of a conflict or problem encountered by the graduate student, or if the student is dissatisfied with a prior appeal decision, he/she should seek the advice of the Dean of Graduate Education or the Dean of Students to determine what recourse is available to assist in seeking a solution to such problems.

Supervision of Advanced degree programs

The supervision of the general study program of each student, including compliance with all the various Board of Regents, institutional, and Graduate Division policies, is primarily the responsibility of the advisor. The graduate advisory committee assists in this role. The advisory committee consists of a major professor, a graduate division representative, and at least one additional member for master's students and 3 additional members for doctoral students. The major professor is primarily responsible for supervision of the graduate student's research and thesis/dissertation preparation, as well as ensuring that academic standards and requirements are met and satisfied. The advisor and the major professor may or may not be the same person, depending on restrictions or requirements within the student's program and/or department.

The major professor serves as chairperson of the graduate advisory committee, assists the student in selection of other members of the committee, and is responsible for obtaining

approval from each prospective member for that person's service on the committee. The graduate division representative must be chosen from outside the major department/program.

A change in advisor may be accomplished at the student's request, only by submitting a Request to Change Advisor form, with all appropriate approval signatures, to the Dean of Graduate Education. If staff changes or other valid reasons dictate a change in major professor, such a transition can be made at the request of the student and with the consent of the student's committee as evidenced by filing a revised program of study with the graduate office. A written appeal by a student for a change in major professor may be filed with the Committee on Graduate Education through the Dean of Graduate Education in contested cases. The decision by the Committee on Graduate Education is final. When such changes occur, a new program of study must be submitted to the graduate office.

If a master's candidate has expressed a desire to continue for a doctorate, then at some time during the semester in which he/she expects to attain 36 credit hours beyond the baccalaureate degree, the student's department/program shall determine by qualifying examination or by review of his/her record to date whether the student shall be permitted to continue toward the doctoral degree.

Concurrently, the department head or program coordinator, after consultation with the student and the existing advisory committee, shall expand the student's committee to a total of five members by the addition of one or two members of the faculty who may eventually be called upon to assist with the student's doctoral program. If there is an anticipated change in major professor for the doctoral program, one of the new members shall be the prospective major professor. If only one additional member from outside the major department/program is selected for the doctoral advisory committee, that person shall represent the field identified as the candidate's minor.

Program of Study

The student's advisory committee will assist the student in formulating a program of study

leading to the advanced degree. A copy of the program of study and advisory committee assignments must be filed with the student, the student's department/program, and the graduate office no later than the mid-term of the second semester of the student's registration as a degree-seeking candidate. The student must seek the advisory committee's approval for any subsequent modification of the original plan of study. A copy of any amended program must be filed in a timely manner by the student and with the same offices as the original schedule. Each program of study or amendment thereof must have the signature approval of the student and all members of the student's committee before it will be reviewed for final approval by the Dean of Graduate Education.

Language Requirements

There is no standard language requirement within the Graduate Division. However, departments/programs may establish their own language requirement.

Certification for the Degree

Before a diploma can be released, the Dean of Graduate Education must certify that the candidate has fulfilled all degree requirements. For certification of the degree for a given semester, ALL requirements must be complete on or before the day grades are due for that semester or end of the summer session. Note that ALL KEYS MUST BE RETURNED to the Physical Plant before the degree is granted.

Candidates are cautioned not to make travel plans or other arrangements that will be difficult or costly to change until they are certain that all degree requirements can and will be satisfied. It is the responsibility of the candidate to know and comply with these degree requirements

MASTER OF SCIENCE PROGRAMS

Thesis and Non-Thesis Options

With the thesis option, the minimum graduation requirement is thirty (30) credit hours including six (6) to nine (9) hours of thesis

research credit.

At the discretion of the student's major department/program, thesis research and the submission of a thesis may be waived and additional course work substituted. Such course work may include a limited number of credits for non-thesis or project research. The graduation credit minimum in this non-thesis option is thirty-two (32) credit hours. Candidates for the non-thesis option may not normally use thesis research credits for the fulfillment of credit-hour requirements for the master's degree. However, when a student is transferring from a M.S. thesis degree program to a M.S. non-thesis program, the student may petition the Dean of Graduate Education to transfer up to 3 credit hours of previous thesis research with the documented support and approval of the student's major professor. Additional thesis credits above the 3 credit hours can be transferred on a case by case basis with the approval of the student's committee and the Graduate Dean.

M.S. Degree Requirements

The M.S. degree minimum requirements for the thesis option are:

1. A program of at least 30 credit hours of course work and research.
2. At least 15 credit hours of graduate course work (500 level courses and above).
3. At least 6 credit hours of thesis research. (No more than nine credit hours of thesis research will count toward degree requirements.)
4. A satisfactory thesis based upon individual research.
5. Meeting or exceeding academic standards prescribed elsewhere in this bulletin.
6. Passing an examination on general knowledge and successfully defending the thesis.

The non-thesis option requires:

1. A program of at least 32 credit hours of course work (refer to specific program requirements for exact number of minimum course work credit hours).
2. At least 20 credit hours of graduate course work (500 level and above).

3. Meeting or exceeding prescribed academic standards.
4. Passing an examination on general knowledge in the field.

A candidate for the master's degree is expected to make up undergraduate deficiencies as determined by the department/program. Credit for such makeup work is generally not allowed toward the degree. However, the policy established by the faculty does allow for a certain number of upper-level undergraduate credits to be used for the fulfillment of master's degree requirements according to the following limitations and conditions:

1. For the thesis and non-thesis options, the number of undergraduate credits that may be used for the degree is limited to 9 hours.
2. For the non-thesis option, the number of non-thesis research credits that may be used for the degree is limited to 6 hours.
3. Out-of-program courses at the 300 level may be accepted toward the fulfillment of degree requirements in exceptional circumstances but only with the approval of the Dean of Graduate Education. This written justification should be submitted by the head/coordinator of the student's major department/program to the Graduate Dean.
4. Major department (or program) courses at the 300 level are not acceptable for graduate degree credit under any circumstances.
5. Out-of-program courses at the 400 level may be used to fulfill degree requirements at the discretion of the head/coordinator of the student's major department/program in accordance with the credit hour limitations prescribed above. Also, see individual departmental restrictions.
6. Major program courses at the 400 level may be accepted toward the fulfillment of degree requirements in exceptional circumstances. Such courses will only be considered after a written justification is

submitted by the head/coordinator of the student's major department/program to the Dean of Graduate Education for his or her review and potential approval.

¹ In the above sections (1-6) the term "program" refers to a division in a department such as environmental engineering program within the department of civil and environmental engineering, or a non-departmental unit such as technology management, materials engineering and science, or atmospheric and environmental sciences.

The maximum number of thesis credit hours required for the thesis option is determined by the department and the thesis committee. At least 6 credit hours and no more than nine 9 credit hours of thesis research will be permitted to count toward the degree credit requirements for the thesis option. However, the student may register for additional research credits for continuing registration purposes.

Thesis

The thesis should represent an effort of such quality and construction that it can be displayed in the school library with similar scholarly works, as well as providing material for publication(s) in an appropriate professional journal(s).

The thesis is written under the direction of the major professor, but the student should feel free to seek guidance from all members of his/her advisory committee. Before starting to write the thesis, the student is urged to consult "Instructions for the Preparation of Theses and Dissertations" on the graduate education website, and to consult style manuals in the Devereaux Library. In general, the thesis may follow the style of captions, footnotes, and bibliographical references used by the leading technical journal in the student's field. Students are urged to review carefully copyright ownership provisions in the "Instructions" document.

A final draft of the thesis should be submitted by the student to each member of his/her advisory committee a minimum of two full weeks before the time and date of the student's scheduled examination. Earlier submission deadlines may

be required by the advisory committee.

The final draft of the thesis, after all revisions recommended by the committee have been made, must be signed by the author and approved and signed by the major professor, the head/coordinator of the student's major department/program, and the Dean of Graduate Education before final reproduction. The dean requires that the final draft of the thesis be submitted to the graduate office 21 calendar days before graduation to allow adequate time for review, corrections and revisions, and potential approval.

The institution requires four copies of the thesis in final form: the original (unbound) manuscript and one bound copy for the Devereaux Library, and two bound copies for the student's department/program, one of which will be forwarded to the major professor. Two electronic versions of the thesis will also be required in digital format, one for the department and one for the graduate office. Contact the graduate office for instructions and requirements for this digital version. In case of a proprietary thesis, the original hard copy and digital version will be retained without reproduction in secured graduate office files throughout the specified proprietary period.

Final Examination

All master of science degree candidates will be given a final examination covering course material. The examination may be written, oral, or both at the discretion of the major department or program.

Students pursuing the thesis option must also defend their thesis in an oral examination. Final examinations covering both course work and thesis research may be combined. Oral examinations are open to all interested faculty members. Departmental or program policy shall determine whether non-faculty persons may attend the examination.

The student shall obtain and complete the relevant graduate office form to schedule the final examination. The major professor shall seek the approval of all committee members and shall file the form with the graduate office no less than five

working days before the exam. The graduate office will announce this exam information as appropriate.

The thesis defense oral examination will normally be held during the last six weeks of the student's last term, but it may be given at any time after the thesis has received committee approval. No final examination may be scheduled during the period of course work final examinations.

The student's committee constitutes the examining board for a final oral examination. The major professor will head the session. The major professor is responsible for ensuring that a majority of the committee, as well as the graduate office representative, is present. The examination will not be held if these conditions cannot be met. A negative vote by any two or more members of the student's committee or a negative vote by the graduate office representative will signify failure of the examination. All committee members must be given the opportunity for input to, and evaluation of, a written non-thesis final examination. Refer to the graduate office policies for information on committees and exam procedures for proprietary thesis programs.

Results of all written or oral examinations will be attested to by all committee members on a form furnished to the graduate office representative by the graduate office. The original form with signatures and dates will be filed with the graduate office and a copy with the department/program.

If the candidate fails to satisfy the examiners on either course work or thesis, written or oral examinations, the committee may schedule a re-examination over general background, thesis, or both. The re-examination will be scheduled at the discretion of the candidate's advisory committee, normally eight to 12 weeks after the date of the first examination.

The student may petition his/her committee for re-examination prior to the eight week limit.

Time Limitation

A master of science degree program must be completed within five calendar years dating from the student's formal entrance into a degree-seeking program. Courses taken by the student at

any institution that are requested to be part of the degree program and that were taken more than five years prior to the date of anticipated graduation must be reviewed by the student's major department/program and the Dean of Graduate Education for possible acceptance. Following this review, the student's major department/program and the Dean of Graduate Education will determine whether a reduction in credits applicable toward the degree, a re-examination, or both is required for the student to complete his or her degree program.

DOCTOR OF PHILOSOPHY PROGRAMS

Nature and Purpose of the Doctoral Programs

The doctoral program is designed to prepare a student for a lifetime of intellectual inquiry that manifests itself in creative scholarship and research, often leading to professional careers in social, governmental, business, industrial organizations, and academia. The program emphasizes freedom of inquiry and expression and development of the student's capacity to make significant contributions to knowledge. An essential element is the development of the ability to understand and evaluate critically the literature of the field and to apply appropriate principles and procedures to the recognition, evaluation, interpretation, and understanding of issues and problems at the frontiers of knowledge. These goals are most effectively accomplished in close association with those experienced in research and teaching.

A central purpose of doctoral programs is the extension of knowledge, but this cannot be accomplished on all fronts simultaneously. Students must choose an area in which to specialize, a faculty member with whom to work, and a research topic of mutual interest to the student and the faculty advisor. Individualized programs of study are then developed, and committee members are selected cooperatively as course work and research are undertaken. When all course work has been completed, the research finished, the dissertation written, and all examinations passed, the student will have acquired the knowledge and skills expected of a

scholar and will have extended knowledge and research capability in the field.

Ph.D. Degree Requirements

The requirements for the Doctor of Philosophy degree are:

1. Satisfactory completion of a Comprehensive Examination.
2. A minimum of a total of 80 semester credits beyond the bachelor's degree.
3. A minimum of 50 semester credit hours of course work beyond the bachelor's degree. A maximum of 24 semester credits are allowed from appropriate M.S. course work to apply to the Ph.D. credit requirement.
4. A minimum of 20 semester credit hours of appropriate research credits. A maximum of 6 semester credits of acceptable M.S. research credits can be applied to the Ph.D. research credits upon approval of a corresponding petition by the candidate's department/program and the Dean of Graduate Education.
5. Satisfaction of academic standards as prescribed elsewhere in this catalog.
6. At least two consecutive semesters of residence as a full-time student.
7. Satisfaction of any departmental language or other specific requirements.
8. A dissertation written in grammatical English that represents results from at least the equivalent of one academic year of full-time research.

Between three and four academic years of full-time graduate study beyond the baccalaureate degree normally are required to earn a doctorate.

A candidate who has entered a Ph.D. program directly from a baccalaureate program may be allowed to use up to 12 credits of upper-division undergraduate 400 level courses toward the 50 credit-hour course requirement for the degree with the same restrictions and procedures as those specified for master's degrees. Ph.D. candidates already holding an M.S. degree may use up to 6 credits of 400 level course work toward the 26 credit course work requirement. The head of the student's major department must petition the Committee on Graduate Education through the

Dean of Graduate Education for use of 300 level credits for Ph.D. programs.

The graduate advisory committee approves the total number of research credits that the candidate may carry, consistent with departmental, continuing registration, and other requirements. The student's advisory committee can recommend to the Dean of Graduate Education a program requiring more credits than the minimum indicated above if it believes that this is in the best interests of the student.

Furthermore, the committee may approve a plan for the student to undertake work at some other institution of recognized standing, but may not reduce the two-semester residence requirement.

Residence Requirements

At least two consecutive semesters of residence as a full-time student are required at South Dakota School of Mines and Technology. The comprehensive examination may not be taken before the last half of the second semester of residence. The final defense of the dissertation will not be permitted within the first five months following the successful completion of the comprehensive examination.

Supporting Fields

In order to foster the principles upon which a Doctor of Philosophy degree is based, as set forth in the introductory paragraphs to this section on doctoral programs, a Ph.D. candidate and his/her advisory committee are strongly encouraged to formulate a program of study that comprises, minimally, one-quarter of the required course work in minor or supporting fields. These courses may be completed in one or more departments in areas of study consistent with the student's major program. Typically, therefore, 12 of the 45 credit hours of required course work would be taken in non-major courses by a student entering a doctoral program with a baccalaureate degree. A Ph.D. candidate who has already earned a master's degree would be expected to satisfactorily complete 6 of the 26 credit hours of required course work in courses outside of the major field.

Because individual program requirements may exceed these minimum institutional guidelines, the student is urged to review carefully the curriculum for his or her field of study.

The Qualifying Examination

Doctoral students admitted into all Ph.D. disciplines must pass a qualifying examination, normally to be taken no later than the second semester of residence. A master's candidate who proposes to continue into a doctoral program should so advise his/her major professor. Thereupon, the student will be given an examination by the advisory committee to determine whether to permit the student to proceed to the doctoral level of graduate study. This qualifying examination may be scheduled in the semester during which it is expected that 36 hours of credit beyond the B.S. degree, (which are deemed acceptable toward the student's doctoral program) will be accumulated. The examination for the master's degree may be used as the forum for the qualifying examination, at the discretion of the department/program.

The Comprehensive Examination

When the student's program of course work has been substantially completed, he/she will undertake the comprehensive examination for admission to candidacy. This examination will consist of written and oral examinations covering his/her field of study and related subjects. It will be prepared by the student's advisory committee, with potential suggestions from any faculty member from whom the student has taken a graduate course.

The student's advisory committee schedules and arranges the written and oral examinations. Review of the examinations will be accomplished as soon as possible by all members of the committee, and the results will be reported to the Dean of Graduate Education on the appropriate form supplied by the graduate office.

Satisfactory completion of the comprehensive examination requires that no more than one member of the advisory committee votes against passing. If the student passes with conditions,

such as failure to pass a part of the examination, the committee shall inform him/her promptly as to how and when the conditions may be removed. If, in the opinion of two or more members of the advisory committee, the student has failed the comprehensive examination, another such examination may not be attempted during the same semester. After failure to pass a second time, work toward the doctorate can be continued only with the consent of the advisory committee, the committee for graduate education, and the Dean of Graduate Education.

The comprehensive examination should normally be passed at least five months before the dissertation is defended.

Admission to Candidacy

Four months before the dissertation defense, the doctoral student should apply to his/her major professor for admission to candidacy on a form available from the graduate office. If the advisory committee and department head/program coordinator approve the application by certifying that the candidate has passed the comprehensive examination, the signed form must be returned to the Dean of Graduate Education who, in turn, will admit the student to candidacy.

The Dissertation

It is expected that the dissertation will represent the culmination of at least the equivalent of one academic year of full-time research.

The dissertation need be of no specific length, but it must be written in grammatically proper English. It must also advance or modify knowledge and demonstrate the candidate's technical mastery of the field. The dissertation can consist of a compilation of three published and/or submitted journal manuscripts that are derived from the candidate's doctoral research and are either authored or co-authored by the candidate. Dissertations submitted in this form must have an introduction and conclusion to tie the journals into a cohesive research paper. The more conventional dissertation format is also acceptable if recommended by the candidate's major department and the major professor. The

final dissertation must be accompanied by an abstract of 250 to 600 words and vitae of the candidate.

The dissertation and abstract shall be approved by all members of the student's advisory committee, and a preliminary acceptance page of the dissertation shall bear the signed initials of each member of the committee.

The final draft of the dissertation, after all revisions recommended by the committee have been made, must be signed by the student and approved and signed by the major professor, the head/coordinator of the student's major department/program, and the Dean of Graduate Education before final reproduction. The Dean of Graduate Education requires that the final draft of the dissertation must be delivered to the graduate office for a minimum of 21 days prior to graduation to allow adequate time for review and potential approval.

The institution requires four copies of the dissertation in final form: the original, unbound manuscript and one bound copy for the Devereaux Library; and two bound copies for the student's major department/program, one of which will be forwarded to the major professor. Two digital versions should also be submitted in electronic format, one for the graduate office and one for the department. Contact the graduate office for guidance in regard to the required digital format.

A final draft of the dissertation must be submitted by the candidate to each member of his/her advisory committee a minimum of two full weeks before the scheduled dissertation defense. Earlier submission deadlines may be required by the advisory committee.

Defense of the Dissertation

The defense of the dissertation is an oral examination open to the public except in proprietary programs. It will be scheduled at the convenience of the candidate's advisory committee at any time after the student has completed course work and after the major professor is satisfied that the dissertation is in an acceptable manuscript, both in terms of technical quality and proper expression. The student shall obtain and complete the graduate office form to

schedule the defense. The major professor shall seek the approval of all committee members, and shall return the form to the graduate office no less than five working days before the defense date. The graduate office will announce this exam information as appropriate.

While the student's committee determines the character and length of the examination, sufficient time should be devoted to a consideration of matters relating to the dissertation to test thoroughly the ability of the candidate to defend his/her work. Questions will, in general, be confined to the dissertation and to background material related to it.

Satisfactory completion of the final examination requires a "pass" vote from the graduate office representative and no more than one "fail" vote from the other members of the advisory committee. If the student fails, another examination can be scheduled only with the approval of the student's advisory committee and the Dean of Graduate Education.

Time Limitation

If the requirements for the Doctor of Philosophy degree are not completed within a maximum period of eight calendar years from the date of original enrollment in the doctoral program, the student's program is subject to review by the staff of the student's major department/program and the Dean of Graduate Education to determine whether a reduction in credits applicable toward the degree is justified before the student is permitted to proceed with the degree program. The procedures described under "Time Limitation" for M.S. degree candidates also apply here.



Atmospheric and Environmental Sciences Ph.D.



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Program Description

The Atmospheric and Environmental Sciences program aims to unravel the complex interactions between all the earth's components, such as the biosphere, the atmosphere and oceans, as well as the influence of human activity on the global environment. These interactions occur across many spatio-temporal scales and can profoundly affect the living organisms, the atmosphere around them and the ecosystem. The atmosphere and biosphere are fundamentally coupled on a variety of time-scales and support a complex set of bi-directional interactions. Managing wildfire potential, for example, includes components of atmospheric dynamics, precipitation patterns, vegetation distribution and condition, topographic factors, and more. Similarly, in terrestrial ecosystems, rapid exchange of CO₂, water and energy between the atmosphere and the land surface may dominate bi-directional interactions on short time-scales, whereas, on long time-scales, the interactions involve changes in

ecosystem structure and composition in response to changes in climate. The key to success lies in training scientists to form interdisciplinary teams that can simultaneously tackle the broad range of processes needed to achieve understanding and prediction of such complex phenomena.

Measuring, monitoring, and modeling earth and atmospheric systems increasingly demands an interdisciplinary approach, because problems in earth processes impacting society often cannot be solved by studying the atmosphere, hydrosphere, lithosphere, and/or biosphere in isolation.

The Atmospheric and Environmental Sciences program links expertise in atmospheric science, biogeochemistry, geology, hydrology, water quality and water resources to address regional and local issues that may also be nationally or globally significant. The fundamental objective lies in developing the predictive capability to address linkages between earth system components and land management practices in a way that benefits decision-making at regional and national levels. We use the Black Hills of South Dakota and the surrounding Great Plains as a natural laboratory for the development of methodologies to link fundamental observations of the environment across a range of temporal and spatial scales, and integrate them with state-of-the-art modeling, visualization, and analysis.

Key interrelated research themes drive the research and teaching program, building on ongoing research and disciplinary strengths already present at the School of Mines, including meteorology, biogeochemistry, ecology, geology, climatology, hydrology, remote sensing, and geographic information systems.

Specific examples include:

- Physical meteorology and storm processes, including impacts on hydrology and fire issues.
- *In situ* atmospheric measurements of storms, aerosols, trace gas concentrations, and more using specially adapted storm-penetrating aircraft.

- Wildfire dynamics and associated issues related to fire prevention, suppression, and post-fire mitigation.
- Carbon cycling and the potential effects of local and regional climate change, including the frequency and severity of storms, drought cycles, and wildfire potential.
- Nutrient transformations in aquatic and terrestrial ecosystems, including Black Hills Forests and coastal salt marshes.
- Water quality and quantity as it impacts regional growth and environmental systems.
- A Geographic Information System (GIS) laboratory as well as IBM-compatible computers with modeling and remote sensing analysis software.
- The Museum of Geology, located on campus and housing over 300,000 specimens, serves as a resource for paleontological instruction.

Many School of Mines faculty members who are actively involved in the AES program have externally funded research projects. These projects provide research assistantship opportunities for AES students. In addition to graduate research assistantships, support is also possible through graduate teaching assistantships and various fellowships and scholarships. AES students are strongly encouraged to work with their advisors and faculty colleagues to apply for research funding or fellowships to support their studies.

Program Requirements

Degree candidates in AES are expected to complete an approved multidisciplinary program of course work and also perform original research in a focused area. A minimum total of 80 credit hours beyond the bachelor's degree is required. Students entering the AES program with a previous M.S. degree in a relevant discipline are allowed to apply a maximum of 24 course credit hours in an appropriate field toward the course credit requirement and 6 thesis research credits

toward the research-credit requirement. There is no language requirement in the AES program. However, all AES students are expected to be proficient in speaking, understanding, and writing the English language. Graduate students who are enrolled full time in the AES program should be able to complete their degree requirements and graduate within three to four years starting with a master's degree, and four to five years starting from a bachelor's degree. The time required to complete the degree will vary depending on the transfer of previously earned credits, course work recommendations specified by the student's committee, and individual research requirements.

The following key learning outcomes will be developed in all students:

- a. A core of basic and specialized scientific and technical knowledge;
- b. An understanding of the basic scientific tools of measuring, monitoring, and modeling;
- c. The ability to apply these tools to understand atmospheric and land-surface interactions;
- d. The professional skills crucial to research, including obtaining and reviewing research literature, proposing research problems, critically evaluating their own work and the work of others, and communicating in writing and orally with their colleagues;
- e. The understanding and application of professional methods and ethics in their work; and
- f. The ability to form interdisciplinary teams to solve complex problems.

Students entering the program will normally already possess a foundational degree (typically the M.S. degree) in atmospheric sciences, meteorology, geology, hydrology, or environmental sciences/engineering. Students will build on this foundation by pursuing elective courses that prepare them for advanced work in their chosen specialty. The student and his/her committee are charged to prepare a course of study that will help the student become proficient in a specific research area. Great emphasis is placed on the independent origination of a research problem that will yield a new, original scientific insight.

Ph.D. in Atmospheric and Environmental Studies **Credit Hours**

| | |
|--|----|
| M.S. academic core (24 cr) and research (6 cr) | 30 |
| Required academic courses | 10 |
| Elective academic courses | 13 |
| Research credits | 27 |
| Total required for the degree | 80 |

The required academic courses include:

AES 790 Seminar

This course builds professional communication skills, including writing and oral presentation, while exposing students to examples of disciplinary and interdisciplinary research. (1credit)

AES 792 Topics (Interdisciplinary Problems)

This innovative course brings together faculty and students to create a working group that selects a research problem, studies the literature, and develops a research plan that integrates the multiple disciplines of all the participants. Students participate in this course for 1 credit in their first year, and repeat the course in the second year for two credits, taking a correspondingly greater role in the work of the group. This course is modeled after traditional disciplinary research working groups, but is intended to facilitate the emergence of cohesive interdisciplinary teams, and to provide an incubator for new research plans and funding proposals. (3credits)

AES 808 Fundamental Problems in Engineering and Science

This course trains students to identify and tackle fundamental research problems; it combines literature review, proposal development, critical thinking, and professional ethics, and leads to an actual proposal in the student’s specialty for submission to a funding agency. (3 credits)

Department Elective in Measuring/Modeling of Earth Systems

Students must complete at least one course in measuring and/or modeling techniques, to be selected by the student’s committee. An array

of courses are offered at the School of Mines to fulfill this 3 credit elective course requirement. These courses are offered by the Departments of Civil and Environmental Engineering, Geology and Geological Engineering, Atmospheric Sciences, Chemistry, and Chemical and Biological Engineering, and Mathematics and Computer Sciences, and by other departments on campus as well. Listed below are examples of courses that might be included as electives in an AES program of study. These lists are intended as examples and are not intended to limit a student and committee as they construct an individual program.

Potential elective courses for AES:

- ATM 501 Atmospheric Physics
- ATM 502 The Global Environmental Change
- ATM 503 Biogeochemistry
- ATM 505 Air Quality
- ATM 510 Introduction to Environmental Remote Sensing
- ATM 515 Earth Systems Modeling
- ATM 520 Remote Sensing for Research I
- ATM 530 Radar Meteorology
- ATM 603 Biosphere-Atmosphere Interactions
- ATM 540 Atmospheric Electricity
- ATM 560 Atmospheric Dynamics
- ATM 612 Atmospheric Chemistry
- ATM 625 Scaling in Geosciences
- CEE 634 Surface Water Hydrology
- ATM 642 Physics and Dynamics of Clouds
- ATM 643 Precipitation Physics and Cloud Modification
- ATM 644 Numerical Dynamics and Prediction
- ATM 660 Atmospheric Dynamics II
- ATM 670 Boundary Layer Processes
- ATM 673 Mesometeorology
- CEE 521 Environmental Systems Analysis
- CEE 526/526L Environmental Engineering Physical/Chemical Process Design
- CEE 527/527L Environmental Engineering Biological Process Design
- CEE 528 Advanced Treatment Plant Design
- CEE 533 Open Channel Flow
- ATM 620 Remote Sensing for Research II
- CEE 628 Environmental Engineering Measurements
- CEE/GEOE 692 Environmental Remediation

Processes
 CEE 723 Environmental Contaminant Fate and Transport
 CEE 721 Principles of Environmental Engineering
 CEE 733 Techniques of Surface Water Resource and Water Quality Investigations I
 CEE 784 Modeling and Computation in Civil Engineering
 CEE 785 Applications of Finite Element Methods in Civil Engineering
 GEOL 516/517/519 GIS I/II/III
 GEOL 633 Sedimentation
 GEOE 663 Ground-water Geochemistry
 GEOE 682 Fluvial Processes

provides oversight of student affairs, including meeting with new and existing students, tracking student progress, and conducting orientations for new students.

The preceding committee is distinct from the graduate student advisory committees that provide guidance to individual AES students during the course of their academic studies. The graduate student's major professor serves as the head of this advisory committee.

Student progress and mastery will be measured using the usual instruments in a doctoral program. A written or oral qualifying exam is used to assess the student's mastery of the M.S. course work. A comprehensive examination is given to evaluate the student's ability to formulate a research problem based on substantive literature review, and to test the student's knowledge in the area of specialty. It is given in two parts: 1) a written examination consisting of a review paper in the student's field of study and a research proposal, and 2) an oral examination to evaluate the research proposal and verify the student's understanding of the basic sciences and specialized field of study. The dissertation forms the final test of the student's ability to perform and communicate research. The student must prepare a doctoral dissertation and successfully complete a public defense covering the scientific validity of the work, as well as the student's basic and specialized knowledge in the field of study.

Management of the AES Program

The AES program is managed by the Graduate Office. A program committee composed of 3-5 faculty representing different disciplines oversees the program, including setting policies and reviewing the curriculum. The program committee will also take measures to facilitate interaction by all faculty and students participating in the program. A program coordinator heads the program committee, and

Atmospheric Sciences M.S.



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Associate Professors Capehart and Sundareshwar;
Instructor Kliche; Adjunct Professor Zimmerman.

Atmospheric Sciences

The Department of Atmospheric Sciences offers advanced undergraduate and graduate courses leading to the master of science degree in atmospheric sciences with specializations in meteorology or earth systems science, and doctor of philosophy degree in atmospheric and environmental sciences (AES). For more information on the AES program, see pages 193 - 196 in this catalog. Faculty in the Department of Atmospheric Sciences are members of the Institute of Atmospheric Sciences (IAS), an active research group that conducts research with sponsorship from the State of South Dakota and various federal agencies.

The primary objective of the atmospheric sciences graduate program is to give students a basic understanding of the factors influencing

atmospheric phenomena, including solar and terrestrial radiation, the laws of fluid motion and thermodynamics, microphysical and electrical processes in clouds, ecology, atmospheric chemistry, and biogeochemistry. Instruction is offered in the interpretation of conventional weather data, satellite data, and radar data; observations collected by specially instrumented aircraft, trace-gas flux towers, and laboratory gas analysis instrumentation; and output from numerical models of atmospheric processes. The graduate student is expected to carry out original research in the atmospheric sciences using some of these tools and resources. In addition, the student must successfully complete the course work and program requirements enumerated below.

A student applying for admission to the master's degree program in the Department of Atmospheric Sciences should have a baccalaureate degree in meteorology or atmospheric sciences, one of the biological or physical sciences, earth system sciences, mathematics, or engineering. It is desirable for applicants to have received undergraduate credit for mathematics through Calculus 2 (for the earth systems science specialization — see below) or ordinary differential equations (for the meteorology specialization). For the meteorology specialization, undergraduate physics is required, and for the earth systems specialization, undergraduate physics and chemistry are desirable. Experience with computer programming is recommended. Graduate Record Examination (GRE) scores from the General Test are required for all students except School of Mines graduates. TOEFL scores are required of all applicants from colleges outside the U.S.

Course requirements for the M.S. degree

1. Fifteen credit hours of course work in atmospheric sciences at the 500-level or above.
2. Nine additional credit hours of non-atmospheric sciences electives at the 400-level or above (300-level non-atmospheric sciences courses can be accepted if approved by the

Graduate Education and Research Council), or atmospheric sciences electives at the 500-level.

3. Thesis research — 6 credit hours.
(Please note undergraduate credit limitations given under “M.S. Degree Requirements” (p. 186) for Master of science degrees.)

Other program requirements

The following program requirements apply to all students in atmospheric sciences:

- At least one course at the 500/600-levels must be taken in each of the following core areas: meteorology, earth system science, and techniques. Course descriptions in the catalog describe the area to which each ATM course belongs.
- Satisfactory performance on a general course work exam covering each of the core courses as well as selected elective course work.
- Registration in ATM 700 Graduate Research (thesis) each semester the student is receiving an assistantship, and in ATM 690 Graduate Seminar each spring semester.
- Completion of a master’s thesis. The thesis must adhere to the format and content guidelines as set forth by the graduate school, and be approved by the student’s graduate advisory committee and the Dean of Graduate Education.

In addition, there are requirements specific to the two ATM M.S. specializations. Each student will choose one of these specializations. The requirements are:

Meteorology Specialization

Students entering the program with a bachelor’s degree in physics, mathematics, computer science, chemistry, or engineering must take the following courses: ATM 450 - Synoptic Meteorology I (not for graduate credit), ATM 550 - Synoptic Meteorology II, ATM 501 - Atmospheric Physics, and ATM 560 - Atmospheric Dynamics I.

Students entering the program with a bachelor’s degree in atmospheric sciences or meteorology from another institution are required only to take ATM 501 (Atmospheric Physics), presuming that they have completed undergraduate work in the other areas listed in the preceding paragraph.

Earth System Science Specialization

All students will be required to take the following course: ATM 603 - Atmosphere-Biosphere Interactions. They also must complete at least one remote sensing course.

A specific plan of study will be determined on an individual basis with concurrence from the student’s advisor and graduate advisory committee members. In either specialization, exceptions to these departmental requirements may be granted by the student’s committee for good cause.

Elective courses offered by other departments are encouraged as long as the 15 hours of course work in atmospheric sciences at the 500-level or above are completed as outlined in course requirements for M.S. degree. Graduate students may take electives in the fields of physics, mathematics, computer science, chemistry, engineering, technology management, social sciences, or the humanities to further integrate their course work in the atmospheric sciences with knowledge in other technical fields and with the general concerns of society.

A student may choose the meteorology specialization with the intent to qualify for employment in the federal civil service as a meteorologist. Specific course distribution requirements to do so are listed on page 149 earlier in this catalog within the general description of the Department of Atmospheric Sciences. Students in either specialization may pursue an M.S. degree in atmospheric sciences without satisfying these requirements and be qualified for careers in many non-federal and/or non-meteorological careers. Examples of such career options include research in and applications of remote sensing techniques; work in air quality either for non-federal government agencies, or for industry or the consulting firms industries often employ; research and applications in the

environmental sciences with an emphasis on atmospheric issues, and further graduate work in atmospheric or environmental sciences.

Undergraduate students at School of Mines may decrease the time required to obtain a master of science degree in atmospheric sciences by taking as electives the preparatory undergraduate and entry-level graduate courses available to them or by completing the bachelor of science in interdisciplinary sciences program with an emphasis on atmospheric sciences. They may then enter the graduate program with the necessary background for graduate study in atmospheric sciences as above.

Facilities and Resources

Students typically work directly with faculty on externally-funded research projects. Graduate research assistantships associated with these projects are available that provide part-time employment for students during the academic months and possible full-time employment during the summer. Facilities and resources of the IAS are utilized in these research efforts. These facilities comprise various meteorological instrument platforms and packages including several automated surface weather stations, an instrumented flux measurement tower in the Black Hills National Forest, portable equipment for land surface and plant canopy ecosystem studies, and atmospheric analytical chemistry field and laboratory instrumentation. Sophisticated computer facilities are available on campus, including a state-of-the-art 3-D computer visualization facility and a high-speed multiple-node computer cluster, with additional access to the larger computer complexes elsewhere.

Faculty Research

Current research projects include field investigations of thunderstorms; applications of weather radar data to rainfall measurements and remote inference of cloud microphysical characteristics; numerical modeling of clouds ranging in size from small cumulus to severe storms including storm electrification, lightning, and lightning-influenced atmospheric chemistry;

analysis of field observations and numerical simulations of lake effect snow storms; satellite remote sensing; land-surface/atmosphere exchange processes; fire weather prediction and modeling; biogeochemical cycling; trace-gas flux measurements; and carbon sequestration and ecological modeling. In addition, IAS scientists are currently involved in activities to disseminate scientific knowledge to wider audiences and improve and enhance scientific literacy and educational opportunities for the people of South Dakota.



Biomedical Engineering M.S. and Ph.D.

Contact Information

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Advisory Council

Professors Bang, Buck, Kalanovic, Kerk, Kjerengtroen, Korde, Langerman, Thubrikar and Weiss, Associate Professors Medlin, Muci; Assistant Professors Fong, Yoon, AML lab-Sears.

Biomedical Engineering

Offered jointly with University of South Dakota (USD).

Biomedical engineering (BME) is concerned with the application of engineering and science methodologies to the analysis of biological and physiological problems and to the delivery of health care.

The biomedical engineer serves as an interface between traditional engineering disciplines and living systems and may work in either direction, applying the patterns of living organisms to engineering design or engineering new approaches to human health.

Both the master of science and doctor of philosophy degrees are cross-disciplinary degrees. The objective of the M.S. program is to prepare a student for research and development careers in

biomedical industry and further research at the doctoral level. The Ph.D. program will prepare a student for a career as a researcher who advances the frontiers of biomedical science and engineering with attention to generating new ideas for commercialization.

Current focus areas of faculty activity within the program are (1) cardiovascular mechanics, pathology, and devices (heart valves, stents, etc.), (2) biomaterials (nanomaterials, bioadhesives, tissue engineering, etc.), (3) computational biomedical engineering (biomechanics, imaging, advanced modeling/simulations, etc.), and (4) assistive technology/rehabilitation engineering (advanced prosthetics, control, biomimetics, etc.). Students in the programs will be associated with one or more of several existing and newly formed research centers and laboratories, e.g., the Cardiovascular Research Institute, the Center for Accelerated Applications at the Nanoscale, the Center for Development of Light Activated Materials, the Computational Mechanics Laboratory, or the Direct Write Technology Laboratory.

The program is administered by the Dean of Graduate Education with input from the program coordinator, who is advised by the program advisory council. The program advisory council is comprised of faculty from the mechanical, materials science and metallurgical engineering, electrical and computer engineering, chemistry, and mathematics and computer science departments.

Admission to the programs will be based on the established graduate admission standards at the South Dakota School of Mines and Technology. The Graduate Record Examination (GRE), three letters of recommendation, and a GPA of 3.00 or better are expected of all applicants for the Ph.D. program. The TOEFL exam is required for students whose native language is not English. Students seeking exceptions warranted by special circumstances are requested to contact the biomedical engineering graduate program coordinator.

Students completing their M.S. degrees will graduate with a high level of competence in

- understanding of cardiovascular systems and devices;

- the application and characterization of various forms of biomaterials;
- the acquisition and processing of medical signals and images;
- the computation and simulation of phenomena in biomechanical systems; and
- transferring their understanding of biomaterials, biomechanics, and signal processing to the creation of new applications.

Students completing their Ph.D. degrees will graduate with a higher level of expertise in transferring their understanding of one of the program focus areas—cardiovascular mechanics/pathology/devices, biomaterials, computational biomedical engineering, or rehabilitation engineering/assistive technology to the creation of new knowledge and applications.

Additionally, doctoral students will possess a high level of expertise in their specialized area of research. This competency will be developed through focused research objectives which culminate in the doctoral dissertation. Graduates of the programs will also demonstrate

- the ability to communicate effectively in written and oral presentations,
- intellectual honesty when working with data and ideas, and
- the ability to make an original contribution to their fields.

Courses are offered at both School of Mines and USD campuses, and students may elect either campus as their campus of residence. Courses offered at School of Mines are relayed to students resident at USD by video, and vice versa.

Students entering with baccalaureate degrees in biomedical engineering are required to take the courses listed in the table (Group A) below.

Group A (Required Courses for students entering with a B.S. in BME)

| Course # | Course Title | Credits |
|----------------------|---------------------------------|---------|
| BME 603 | Molecular Biology for Engineers | 3 |
| BME 673 ¹ | Engineering Analysis I | 3 |
| BME 773 ² | Engineering Analysis II | 3 |
| BME 790 | Graduate Seminar | 1 |
| BME 798 | Master's Thesis | |

| | | |
|---------|-------------------------------------|----|
| | (M.S. students) | 6 |
| BME 896 | Field Experience (Ph.D. students) | 1 |
| BME 898 | Ph.D. Dissertation (Ph.D. students) | 30 |

Students entering with baccalaureate degrees in engineering disciplines other than biomedical engineering are required to take the courses listed in the table below (Group B). Depending on the student's background, the student's advisory committee may recommend that one or more of the required courses below be substituted by course(s) listed in the elective courses category.

Group B (Required courses for students entering with a B.S. in a non-BME engineering discipline)

| Course # | Course Title | Credits |
|----------------------------------|--------------------------------------|---------|
| BME 601 | Biomaterials | 3 |
| BME 602 | Anatomy and Physiology for Engineers | 3 |
| BME 603 | Molecular Biology for Engineers | 3 |
| BME 604 | Sensing and Signal Processing | 3 |
| One of the following two: | | |
| BME 606 | Occupational Biomechanics | 3 |
| BME 607 | Biomechanics 3 | |
| BME 673 ¹ | Engineering Analysis I | 3 |
| BME 773 ² | Engineering Analysis II | 3 |
| BME 790 | Graduate Seminar | 1 |
| BME 798 | Master's Thesis (M.S. students) | 6 |
| BME 896 | Field Experience (Ph.D. students) | 1 |
| BME 898 | Ph.D. Dissertation (Ph.D. students) | 30 |

Elective courses in the area of the student's intended research are to be selected in consultation with the student's advisory committee. These courses are listed in the Group C table below. The number of Group C elective courses required will depend on the student's background and educational goals, as summarized below.

Elective Course Requirements

M.S.: Five Group C courses for those entering with a B.S. in biomedical engineering; one Group C course for those entering with a B.S. in a non-biomedical engineering program.

Ph.D.: Six Group C courses including one Special Topics course, and seven additional engineering or Group C courses; for those entering with a B.S. in biomedical engineering. Nine Group C courses including one Special Topics course for those entering with a B.S. in a non-biomedical engineering program.

Minimum of six Group C courses along with additional Group B and C courses for those entering with an M.S. degree. An additional 21 credits of prior graduate level course work may be applied toward the Ph.D. program at the discretion of the student's advisory committee.

Group C (Elective Courses)

| Course # | Course Title | Credits |
|---|--|---------|
| Biomaterials Area | | |
| BME 721 ³ | Tissue Engineering | 3 |
| BME 722 ⁴ | Regeneration | 3 |
| BME 724 | Biopolymers | 3 |
| BME 725 | Biocomposites | 3 |
| BME 726 | Bio/MEMS and Nano Systems | 3 |
| BME 730 | Vascular Mechanics/Pathology | 3 |
| BME 751 | Drug Delivery | 3 |
| BME 761 | Bioadhesives | 3 |
| BME 792 | Topics: Special Topics in Biomaterials | 4 |
| BME 792 | Topics: Special Topics in Tissue Engineering | 3 |
| Computational Biomedical Engineering | | |
| BME 730 | Vascular Mechanics/Pathology | 3 |
| BME 731 | Advanced Biomechanics | 3 |
| BME 732 | Medical Imaging | 3 |
| BME 733 | Cardiovascular Fluid Dynamics | 3 |
| BME 734 | Transport Phenomena in Biomedical Engr. | 3 |
| BME 735 | CAD/CAM in Medicine and Surgery | 3 |
| BME 737 | Advanced Signal | |

| | | |
|---------|--|---|
| | Processing and Imaging | 3 |
| BME 761 | Bioadhesives | 3 |
| BME 738 | Information Technology in Medicine | 3 |
| BME 792 | Topics: Special Topics in computational Biomedical Engineering | 4 |

Rehabilitation Engineering /Assistive Technology Area

| Course # | Course Title | Credits |
|----------|--|---------|
| BME 743 | Bio/MEMS and Nano Systems | 3 |
| BME 732 | Medical Imaging | 3 |
| BME 745 | Molecular Machines | 3 |
| BME 737 | Advanced Signal Processing and Imaging | 3 |
| BME 738 | Information Technology in Medicine | 3 |
| BME 735 | CAD/CAM in Medicine and Surgery | 3 |
| BME 761 | Bioadhesives | 3 |
| BME 792 | Topics: Special Topics in Assistive Technology | 4 |

Graduate courses from another university or from a related engineering discipline 21 credits (max)

Curriculum Notes

¹May substitute: ME 673.

² May substitute: ME 773.

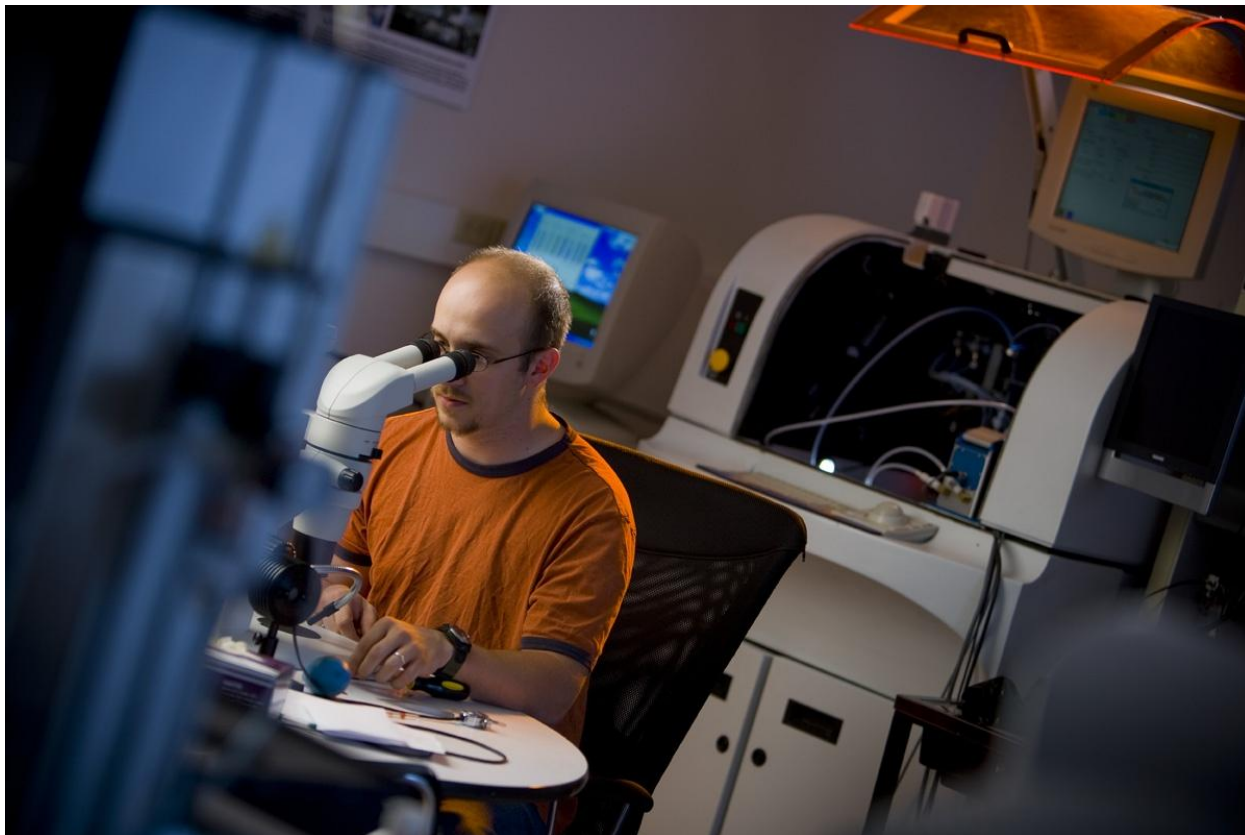
^{3,4} Offered by USD.

The details of individual tracks can be discussed with the program director. An assessment of the student's qualifications will be undertaken early in his or her program. The assessment comprises preliminary and qualifying examinations. Additional information is available in the Handbook of Biomedical Engineering.

Each student is also required to pass a comprehensive examination. There is no language requirement for the BME Ph.D. program.

For program supervision purposes, the BME graduate program coordinator is the graduate advisor until the major professor is appointed. The major professor is the person responsible for the student's dissertation research. The graduate

office representative on the student's dissertation committee must be selected from outside of the department with which the major professor is affiliated, and also is to be a member of the BME advisory council. Each program of study must be approved by the BME advisory council. It is not necessary that the student be associated with the department of his or her major professor. Detailed information on examination policy, admission to candidacy, and defense of dissertation is included in the South Dakota School of Mines Biomedical Engineering M.S./Ph.D. Handbook.



Chemical and Biological Engineering Ph.D.



Contact Information

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Faculty

Professors Bang, Dixon, Puszynski, and Winter;
Associate Professor Gilcrease; Assistant
Professors Benjamin, Hower, Menkhaus, Sani,
and Shende.

Program Advisory Council

Professors Bang; Dixon, and Puszynski, Program
Coordinator; Associate Professor Gilcrease.

Chemical and Biological Engineering

The Department of Chemical and Biological Engineering (CBE) offers, in addition to B.S. and M.S. degrees in chemical engineering, a Ph.D. degree in chemical and biological engineering. The Ph.D. program provides the chemical and biological engineering Ph.D. graduate a core educational experience in transport phenomena, chemical kinetics, biochemical engineering, chemical thermodynamics, and biotechnology.

This knowledge base, along with key electives, provides graduate students the training to participate in biochemical and petrochemical processing, bio-based energy technologies, including biomass and biofuels; bio-based and bio-compatible materials; bioremediation; emerging energy technologies; synthesis and functionalization of nanomaterials, and processing of polymers and composite materials. These areas are aligned with the expertise of our faculty members.

The State of South Dakota is recognized as a leader and major producer of ethanol from starch in the United States. Hence the State of South Dakota is well positioned to play an important role in development of new bio-based technologies and value-added agricultural products. This Ph.D. program is integral with the recently established **National Science Foundation Industry/University Cooperative Research Center (NSF I/UCRC) for BioEnergy Research & Development (CBERD)**. This unique national center focused on bio-based energy and chemical feedstocks, is comprised of five universities, including the School of Mines, North Carolina State University, Kansas State University, State University of New York - Stony Brook, University of Hawaii, and more than 30 industries and state and federal laboratories. Students participating in I/UCRC Center research will be working on projects of current and immediate interest to the industrial sponsors. Students also have the opportunity to participate in more fundamental research being pursued through the 2010 Center for Bioprocessing Research and Development (CBRD) at the South Dakota School of Mines and Technology and the South Dakota State University. The CBRD center focus is to develop the fundamental understanding and technologies to convert lignocellulose to fuels and key building block chemicals. The research foci of the of these two research centers — pretreatment, conversion, extremophiles, separations, and process simulation and economic analysis — relies on the fundamental underpinnings taught in the chemical and biological engineering Ph.D. program.

The Ph.D. program is also a strong supporter of State-focused areas in advanced materials,

polymers, composites, and nanotechnology. Opportunities exist for CBE Ph.D. students to participate in cutting-edge research funded by the National Science Foundation, the Department of Energy, the Department of Defense, and industrial collaborators. The current research interest of the faculty can be found on the departmental website <<http://cbe.sdsmt.edu>>.

The Ph.D. Program in chemical and biological engineering is administered by a graduate program coordinator and Program Advisory Council consisting of appointed faculty members actively involved in the program. The Program Advisory Council is responsible for the curriculum and program policies.

Curriculum

The current curriculum is designed to provide the CBE Ph.D. graduate with the depth and breadth of engineering knowledge to become a leader in their chosen focus area. To facilitate this, each student is asked to complete a program of study plan that will provide the framework for the student's course work and research. This should be filed with the Program Coordinator before the midterm of the second semester in residence. The CBE Ph.D. Advisory Council must approve all programs of study. Detailed information on examination policy, admission to candidacy, and defense of dissertation are included in the Chemical and Biological Engineering Ph.D. Program Handbook. Below is the summary of the basic required courses:

| Category | Credits |
|---|-----------|
| Required courses ¹ (minimum 6 credits from Chemical Engineering and 6 credits from Biological Engineering focus areas) | 24 |
| Required seminar | 2 |
| Minimum required research credits | 30 |
| Minimum electives ^{1,2} | 12 |
| TOTAL | 80 |

¹Students entering with a M.S. degree in Chemical Engineering or a closely related discipline may apply a maximum of twenty-four (24) course credit hours toward the required and elective course requirements subject to approval of the

Chemical and Biological Engineering Ph.D. Program Advisory Council.

²Elective courses can be selected from other School of Mines courses as a part of a student's program of study, subject to approval of his/her major professor and graduate committee.

Students entering the program with B.S. or M.S. degrees from disciplines other than Chemical or Biochemical Engineering will be required to take several selected courses in Chemical Engineering at the undergraduate level, to provide a firm understanding of engineering principles. The Graduate Record Examination (GRE), three letters of recommendation, and a GPA of 3.00 or better are required of all applicants for the Ph.D. program. The TOEFL exam is required for students whose native language is not English. All CBE Ph.D. candidates are required to successfully complete the required minimum credits and earn a grade of "C" or better, except for a final grade of "S" in CBE 898.

Required courses (focus area — Chemical Engineering)

| | | |
|-----------|---|---|
| CBE 544 | Reactor Design | 3 |
| OR | | |
| CBE 728 | Heterogeneous Kinetics | 3 |
| CBE 550 | System Analysis Applied to Chemical Engineering | 3 |
| CBE 612 | Transport Phenomena: Momentum | 3 |
| CBE 613 | Transport Phenomena: Heat | 3 |
| CBE 621 | Advanced Chemical Engineering Thermodynamics I | 3 |
| CBE 616 | Computations in Transport Phenomena | 3 |
| CBE 714 | Transport Phenomena: Mass | 3 |

Required courses (focus area — Biological Engineering)

| | | |
|----------|---|---|
| CBE 584 | Fundamentals of Biochemical Engineering | 3 |
| CBE 584L | Biochemical Engineering Lab | 3 |
| CBE 731 | Industrial Microbiology and Biotechnology | 3 |
| CBE 733 | Metabolic Engineering | 3 |
| CBE 734 | Intro to Biocatalysis | 3 |
| CBE 735 | Bioseparations | 3 |

CBE 792 Molecular Biology for Engineers 3

Required courses (Seminar and Research)

CBE 890 Graduate Seminar 1
CBE 898 Ph.D. Dissertation 1-9

Example elective courses

CBE 744 Environmental Biotechnology 3
CBE 746 Microbial Metabolism and
Physiology 3
CBE 750 Advanced Analysis for Chemical
Engineers 3
CBE 791 Independent Study 1-3
CBE 792 Topics 1-3
CBE 890 Graduate Seminar 1
CBE 894 Adv Tech Internship 1-6
CBE 574L Experimental Polymer
Technology 1
CBE 574 Polymer Technology 3
CBE 676 Adhesion and Surface Engineering
in Polymer Composites 3
CHEM 560 Biochemistry 3
CHEM 582 Environmental Chemistry 3
MES 708/708L Advanced Instrumental
Analysis 3/1
MES 712 Interfacial Phenomena 3
NANO 701 Nano Materials 3
TM 631 Optimization Techniques 3
TM 720 Statistical Process Control 2

Chemical Engineering M.S.



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Faculty

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Chemical Engineering

The Department of Chemical and Biological Engineering offers programs of study leading to the master degree in chemical engineering. Students may consider either a thesis or non-thesis executive program option. A student who elects the thesis option will be required to present a thesis based upon an original investigation for which 6 credits must be earned toward a total requirement of 30 credits in an approved program of study. For the non-thesis executive program option, a student must earn 32 credits in an approved program of study and complete a special project. In the non-thesis executive program, which is oriented primarily toward industrial needs, students take at least one course in technology management as part of their required courses for the M.S. in chemical engineering.

Chemical engineers with a M.S. degree obtain graduate education that provides them with an in-depth understanding of the chemistry, mathematics, and physical laws describing systems at both molecular and macroscopic levels. With this knowledge, the chemical engineer can participate in interdisciplinary research, development, and implementation of new and improved technologies in areas such as: biotechnology, catalysis, nanotechnology, chemical technology, energy, environmental processes, as well as manufacturing of high-performance materials for electronic and structural applications. A student who does not have a bachelor's degree in chemical engineering will be expected to take some additional courses to provide a solid ChE foundation. The current research interest of the faculty can be found on the departmental website at: <http://cbe.sdsmt.edu>.

An oral thesis defense or oral project examination for the non-thesis degree, as well as final examination in the field of chemical engineering, are required prior to the completion of the graduate study.

A core curriculum for all M.S. candidates in chemical engineering includes the following courses or approved substitutions:

| | | |
|---------|--|---|
| CBE 550 | Systems Analysis Applied to Chemical Engineering | 3 |
| CBE 612 | Transport Phenomena: Momentum | 3 |
| CBE 613 | Transport Phenomena: Heat | 3 |
| CBE 621 | Advanced Chemical Engineering Thermodynamics I | 3 |
| | Kinetics Elective ¹ | 3 |
| | Applied Computation Elective ² | 3 |
| CBE 790 | Seminar | 1 |

¹Kinetics Elective: CBE 544 or MES 728

²Applied Computation Elective: CBE/ME 616, MATH 432, or IENG 486

In addition to the core curriculum, students pursuing the non-thesis option must complete a minimum of 2 credits of non-thesis research, CBE 788, 3 credits in technology management, and eight (8) credits of chemical engineering approved

electives. Students pursuing the thesis option are required to complete, in addition to the core curriculum, a minimum 6 credits of thesis research, CBE 798, and 5 credits of chemical engineering approved electives.



Mines Matters: The chemical engineering program has laboratory facilities that enhance the concepts learned in the classroom. These facilities include the main laboratory that houses miniplant equipment such as a distillation column, evaporators, heat exchangers, a gas absorber, and others that mimic what is found in industry.

Graduate Studies in Chemistry



Contact Information

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Faculty

Professor Boyles; Associate Professor Fong, Heglund; Assistant Professors Meyer, and Zhu; Instructor Christofferson.

Chemistry

Students interested in pursuing graduate studies in chemistry should consider the following programs in which the faculty of the Department of Chemistry participate: M.S. and Ph.D. in materials engineering and science, Ph.D. in biomedical engineering, and the Ph.D. in nanoscience and nanoengineering.

Civil Engineering M.S.



Contact Information

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Faculty

Professors Bang, Hansen, Fontaine, Kenner and Mott; Associate Professors Fazio, Stone, and Surovek; Assistant Professors Arneson-Meyer, Fick, Roberts and Robinson; Professor Emeritus Ramakrishnan; Associate Professor Emeritus Klasi.

Civil Engineering

The Department of Civil and Environmental Engineering offers graduate study programs leading to the master of science degree in civil engineering in the following specialties: advanced materials, environmental, geotechnical, water resources, and structural engineering. Any one of the above subject areas may be chosen as an area of emphasis. Additional courses can be completed from any one of the above subject areas.

Emphasis within the department is on the professional development of the student and mastery of the technical and applied aspects of his or her specialty. Both thesis and non-thesis options are available to candidates for the master of science degree in civil engineering.

Completion of a minimum of 30 credit hours are required for the thesis option of which six (6) credit hours of graduate research (CEE 798) and 24 credits of course work are required.

Independent study (CEE 691) and non-thesis research (CEE 788) are not applicable toward the thesis option. The non-thesis option requires completion of 32 credit hours of which 5 credits can be a combination of non-thesis research (CEE 788) and Independent study (CEE 691).

Modeling and computation in civil engineering (CEE 784) is required of all MSCE students.

Other specific course requirements may be applicable depending upon the student's area of specialization. Students who elect to specialize in either environmental or water resources engineering must complete CEE 521 and CEE 733. Students who specialize in Geotechnical Engineering must complete CEE 643 and CEE 647. All rules and regulations of the graduate office, included elsewhere, apply to candidates for the degree of master of science in civil engineering.

The Department of Civil and Environmental Engineering has well equipped laboratories in concrete and advanced composite materials preparation, materials testing, bench and pilot-scale bridge testing, hydraulic engineering, soil mechanics, and water and wastewater analysis. These laboratories are available for student thesis research. Students will make considerable use of various computer labs for their course work and research. A number of campus computer labs are open to all students and the CEE department supports several labs dedicated computers for use by CEE students.

Graduate Studies in Computer Engineering



Contact Information

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Computer Engineering

Students interested in pursuing graduate studies in communications and applied electromagnetics; digital computers, embedded systems and VLSI, and power and control systems, please see electrical engineering.

Students interested in pursuing graduate studies in robotics please see Robotics and Intelligent Autonomous Systems p. 238.

Graduate Studies in Computer Science



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Faculty

Professors Corwin, Logar, Penaloza, and Weiss;
Associate Professor McGough; Assistant
Professor Zong; Instructor Schrader; Emeritus
Professors Carda, Opp and Weger.

Computer Science

Students interested in pursuing graduate studies involving artificial intelligence, computer vision, pattern recognition and robotics, please see the masters of science program in Robotics and Intelligence Autonomous Systems p. 238.

Construction Management M.S.



| | |
|--|-----|
| CEE506 Constr. Surveying & site dev.* | (3) |
| CEE508 Reading/Interp. of plans/Specs* | (3) |
| CEE610 Project estimating/scheduling* | (3) |
| CEE615 Regs./Permitting for constr.* | (3) |
| CEE664 Means/Meth. of Construction* | (3) |

| | |
|--|-----|
| Professional Practice Project | 5 |
| CEE 788 MS Res/Problems/Projects | (5) |
| Technology Management Electives ⁽¹⁾ | 6 |
| Technical Electives ⁽¹⁾ | 6 |

* These courses will be taught under the special topics course numbers CEE 692 and CEE 792 for fall 2009.

⁽¹⁾Consult your advisor for a listing of applicable course work.

Contact Information

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Department of Civil and Environmental
Engineering

C/M 118

(605) 394-2439

E-mail: Scott.Amos@sdsmt.edu

Program Management Committee

Professors Amos, Bang, Hansen, Kenner, and
Mott.

Required Course work:

Construction Management Course work 15

a minimum of five of the following six (6)
courses:

CEE574 Engr Project Management (3)

Electrical Engineering M.S.



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Electrical Engineering/Physics 311

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Faculty

Steven P. Miller Endowed Chair and Professor Whites; Professor Batchelder; Associate Professor Tolle; Assistant Professors Montoya, Zhang, Fathelbab, and Anagnostou; Instructor Linde.

Electrical Engineering

The mission of the electrical and computer engineering graduate program is to provide

quality student learning at an advanced level and to disseminate new knowledge in electrical engineering, while at the same time working to increase resources in support of these objectives.

The graduate program in electrical engineering consists of research and study leading to the master of science degree in electrical engineering (M.S. EE) and multidisciplinary Ph.D. degrees in materials engineering and science, nanoscience and nanoengineering, and biomedical engineering. In special cases, with the consent of the graduate committee of the electrical and computer engineering department, students may elect to do research in association with another engineering or science department.

The prospective student should have completed a baccalaureate degree in electrical engineering or computer engineering. Applicants from universities that are not accredited by the Accreditation Board for Engineering and Technology (ABET) are generally required to submit Graduate Record Exam (GRE) scores from the General Test with their application.

Depending on the student's undergraduate background, and at the discretion of the electrical and computer engineering graduate committee, graduates of other institutions may also be required to take one or more courses of preparatory undergraduate work in addition to their graduate program of study.

The M.S. EE degree is available with thesis and non-thesis tracks. The course requirements for these tracks are as follows:

Thesis option

The thesis M.S. EE degree consists of a program of graduate course work and thesis research. Candidature for the M.S. EE degree with Thesis is contingent on an aptitude to do research. A limited number of students are accepted into the M.S. EE Thesis option, on the recommendation of a major professor. The requirements for the M.S. EE Thesis degree are as follows:

1. A program of at least 30 credit hours of course work and research.

2. At least 15 credit hours of graduate course work (500 level courses and above).
3. At least 6 credit hours of thesis research. (No more than 9 credit hours of thesis research will count toward degree requirements.)
4. A satisfactory thesis based upon individual research.
5. Meeting or exceeding prescribed academic standards.
6. Passing an examination on general knowledge and successfully defending the thesis.

Non-Thesis option

The non-thesis MSEE degree consists of a program of graduate course work. A project is not required and normally is not encouraged for the M.S. EE non-thesis option. The requirements for the M.S. EE non-thesis degree are as follows:

1. A program of at least 32 credit hours of course work.
2. At least 20 credit hours of graduate course work (500 level courses and above).
3. Meeting or exceeding prescribed academic standards.
4. Passing an examination on general knowledge in the field.

Language Requirements

1. Students whose native language is not English are generally required to take the Test of English as a Foreign Language Test (TOEFL).
2. Graduate students with a TOEFL score below 560 are required to attend a remedial course in English.
3. Meeting or exceeding prescribed academic standards.

4. Passing an examination on general knowledge in the field.

Graduate Credit Taken as an Undergraduate

Undergraduate students taking 600 level graduate courses and petitioning these courses for graduate credit should realize that application of these credits to the program of study is subject to the approval of the student's graduate committee. A student's graduate program will come under the control of the graduate committee at the time the student is accepted into the graduate program.

Graduate Committee and Program of Study

The ECE Graduate Committee is the graduate committee for all M.S. EE non-thesis degree students, with the ECE Graduate Coordinator serving as the advisor. M.S. EE thesis students form a graduate committee with a major professor who has agreed to supervise the research of the student. In both cases, the student must arrange to have a faculty member external to the Department of Electrical and Computer Engineering on his or her committee.

Each student must submit a program of study to the candidate's graduate committee by the end of the first semester of study. Approval of the program of study is necessary in order to register for the second and subsequent semesters.

The student's graduate committee has the right to disallow any course proposed in the student's program of study that they feel is not appropriate for the graduate degree in electrical engineering. A student accepted into the Ph.D. program in materials engineering and science, nanoscience and nanoengineering, or biomedical engineering must have his or her program approved by the graduate committee responsible for that respective program.

Research Areas and Resources

The M.S. EE degree offers emphases in three areas: communications and applied electromagnetics, control and power systems. In addition to the more discipline-specific equipment listed below, the ECE department has well-equipped laboratories of networked PCs and Sun workstations, general purpose test and measurement equipment such as high-speed

oscilloscopes, arbitrary function generators, logic analyzers, and printed circuit board prototyping machines and software.

Research activities in the communications and applied electromagnetics area include: compact antennas, electromagnetic propulsion of space sailcraft, engineered electromagnetic materials using active and passive circuit particles, and ultra-wideband and ground penetrating radar. Resources in support of this program include a number of vector network analyzers, impedance analyzers, Agilent Advanced Design System, and Microwave Studio. Additionally, the Steven P. Miller Endowed Chair in electrical engineering was recently established to support telecommunications in the ECE department.

Research activities in the embedded systems and signal processing area include: neural network and fuzzy logic chips, computationally intelligent systems, FPGA- and CPLD-based embedded system design, fault tolerant computer systems, residue and pseudo-floating point number architectures, pattern recognition, system identification, wavelet signal processing and adaptive signal processing. Resources in support of this program include logic analyzers, a variety of microcontroller and microprocessor development systems, FPGA and CPLD prototyping boards, VHDL and Verilog compilers, Analog Devices DSP development tools, Mentor Graphics Computer Aided Design Toolset, a variety of microchip fabrication equipment, and printed circuit board manufacturing equipment.

Research activities in the area of control systems include: robotics, machine control, fuzzy logic control, nonlinear and adaptive control, modeling of power systems, power systems stability, generator dynamics, fault analysis, and wind power. Additionally, a number of robotics projects are performed in association with the School of Mines Center of Excellence in Advanced Manufacturing and Production (CAMP).

M.S. E.E. Course Offerings

Courses that students would take for each of the focus areas would typically include, but would not be limited to, those listed below:

Communication and Applied

Electromagnetics:

| | |
|--------|-----------------------------------|
| EE 621 | Information and Coding Theory |
| EE 622 | Statistical Communication Systems |
| EE 623 | Random Signals and Noise |
| EE 692 | Topics |

Embedded Systems and Signal Processing:

| | |
|--------|------------------------------------|
| EE 612 | High-Speed Digital Design |
| EE 624 | Advanced Digital Signal Processing |
| EE 641 | Digital Systems Design |
| EE 643 | Advanced Digital Systems |
| EE 644 | Fault Tolerant Computing |
| EE 647 | HDL Design |
| EE 648 | Advanced VLSI Design |

Control and Power Systems:

| | |
|--------|---------------------------------------|
| EE 552 | Robotic Control System |
| EE 618 | Sensors and Signal Processing |
| EE 633 | Power System Analysis I |
| EE 634 | Power System Analysis II |
| EE 651 | Digital Control Systems |
| EE 652 | Nonlinear and Optimal Control Systems |

Geology and Geological Engineering M.S. and Ph.D.



Contact Information

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Geology Faculty

Professors Duke and Paterson; Associate Professors Price and Uzunlar; Assistant Professor Terry. Professors Emeritus Fox, Lisenbee and Redden.

Geological Engineering Faculty

Professor Davis; Professor Roggenthen; Associate Professor Stetler, Assistant Professors Sawyer and Katzenstein. Professor Emeritus Rahn.

Geology and Geological Engineering

The Department of geology and geological engineering offers advanced study leading to an M.S. degree in geology and geological engineering and a Ph.D. degree in geology and geological engineering. Students must elect to pursue either a geology specialization or a geological engineering specialization, each of which has different background requirements and program requirements. The available course work

and current faculty expertise support the following areas of concentration. Students take a core of required courses supplemented by electives determined by the student's committee based on the intended field of study:

1. Energy and Mineral Resources
2. Environmental/Exploration Geophysics
3. Ground Water / Environmental Studies
4. Mineral Deposits/Mineralogy/Petrology
5. Sedimentation/Stratigraphy
6. Paleontology*
7. Structural Geology/Tectonics
8. Geomechanics/Engineering Geology

* PhD only. Students concentrating in paleontology at the master's level should apply for the separate M.S. in paleontology.

Background Requirements for MS and PhD

The Graduate Record Examination (GRE) is required of all applicants except School of Mines graduates. The TOEFL exam is required for students whose native language is not English.

Geology Specialization

1. All incoming students are expected to present a full year each of college-level calculus, physics, and chemistry as part of their undergraduate record. Deficiencies in these areas must be remedied by taking the necessary course work prior to or in the first year of enrollment in the graduate program.
2. All incoming students are expected to have completed courses in, or to develop proficiency in, the following areas. Additional subjects may be required by the student's graduate committee depending on the student's area of concentration. The student and the graduate committee will arrange in writing how these requirements can best be met.

- Physical Geology
- Mineralogy
- Stratigraphy and Sedimentation
- Petrology
- Structural Geology

- Field Geology

Geological Engineering Specialization

1. All incoming students are expected to present three semesters of calculus and one semester of differential equations, as well as two semesters each of physics and chemistry, as part of their undergraduate record. Deficiencies in these areas must be remedied by taking the necessary course work prior to or in the first year of enrollment in the graduate program.

2. All incoming students are expected to have completed courses in, or to develop proficiency in, the following areas. Additional subjects may be required by the student's graduate committee depending on the student's area of concentration. The student and the graduate committee will arrange in writing how these requirements can best be met.

- Physical Geology or Geology for Engineers
- Mineralogy
- Stratigraphy and Sedimentation
- Structural Geology
- Statics
- Mechanics of Materials
- Fluid Mechanics

Master's Program

The M.S. degree program consists of research and study in various fields depending on the student's interests. The M.S. thesis option requires 32 credits, including 6 to 8 credits of thesis research and 24 to 26 credits of course work. The non-thesis option includes 32 credits of course work and is reserved for students who have had extensive professional experience after the B.S. degree. Candidates for the M.S. degree must fulfill all degree requirements of the graduate office and also the program requirements. Each student must elect a specialization in geology or in geological engineering.

Geology Specialization Requirements

Core Courses:

GEOL 604 Advanced Field Geology
 GEOL 633 Sedimentation

One course from:

GEOL 517 Geospatial Databases
 GEOL 519 Advanced Geospatial Analysis
 GEOE 766 Digital Modeling of Ground-Water
 MEM 533 Comp Apps in Geoscience Modeling

One course from:

GEOL 621 Advanced Structural Geology
 GEOL 622 Geotectonics

One course from:

GEOE 552 Geochemical Exploration
 GEOE 626 Environmental Geophysics
 GEOE 641 Geochemistry
 GEOE 664 Advanced Ground Water

Geological Engineering Specialization Requirements

Core Courses:

GEOL 633 Sedimentation
 GEOE 766 Digital Modeling of Ground Water

Geological Engineering students focus on one of three areas. Typical course work recommended for focus is shown below.

Ground Water and Environmental Focus

GEOE 641 Geochemistry
 GEOE 664 Advanced Ground Water
 CEE 634 Surface Water Hydrology
 GEOE 682 Fluvial Processes

Geomechanics Focus

GEOE 668 Eng. Geology of Surficial Deposits
 CEE 643 Advanced Soil Mechanics I
 CEE 646 Stability of Soil and Rock Slopes
 CEE 647 Earth Structures
 MEM 533 Comp Apps in Geoscience Modeling

Energy and Mineral Resources Focus

GEOE 531 Principles of Well Logging
 GEOE 552 Geochemical Exploration

GEOE 525 Engineering Geophysics II
GEOE 641 Geochemistry
GEOE 661 Petroleum Geology
GEOL 652 Problems in Ore Deposits

Doctor of Philosophy Program

Admission to the PhD program in geology and geological engineering is normally limited to qualified students who have already earned an M.S. degree in geology, geological engineering, paleontology, or a related field. Students holding an MS but with extensive undergraduate deficiencies may be placed into the M.S. program in geology and geological engineering until these deficiencies are remedied. Students with a B.S. degree who apply to the Ph.D. program will be admitted to the M.S. program in geology and geological engineering until they have accumulated sufficient course credits for an M.S. degree. Students placed into the M.S. under one of these two circumstances will be admitted to the Ph.D. program after passing the qualifying exam.

Qualifying Exam

All Ph.D. students are expected to take a qualifying exam to demonstrate their potential for independent research. Students entering with a B.S. degree will take the examination in the semester immediately following the completion of 24 credits of graduate course work. Students placed in the M.S. due to undergraduate deficiencies must take it in the semester immediately following the completion of the deficiencies. Students entering with a completed M.S. degree will take it before the end of their second semester in residence.

To pass the qualifying exam, the student must 1) complete all undergraduate deficiency requirements, 2) submit a valid Ph.D. Program of Study to the department head; 3) complete a literature search and paper on a topic related to the student's area of concentration; and 4) present and defend the paper in an oral examination by the department faculty. The paper should reflect a sustained effort during the student's first year and culminate in an analysis of potential significant

research problems. The identified problems need not match the eventual dissertation topic.

Curriculum

A minimum of 80 credit hours are required beyond the B.S. degree. At least 50 of these credits must be for course work. Up to 24 course credits and 6 research credits from the M.S. degree can be applied toward the total required credits if the student's committee agrees.

The student's committee will work with the student to devise a program of courses appropriate to the student's area of study. It is recommended that at least 10 credits are related to the student's research specialty and that 6 to 12 hours of course work be taken outside the department. Students must choose between the geology specialization and the geological engineering specialization.

Geology Specialization

Core Courses:

GEOL 633 Sedimentation
GEOL 604 Advanced Field Geology
GEOL 808 Fundamental Problems in
Geol/GeoE

One course from:

GEOL 517 Geospatial Databases
GEOL 519 Advanced Geospatial Analysis
GEOE 766 Digital Modeling of Ground Water
MEM 533 Computer Applications in
Geoscience Modeling

One course from:

GEOL 621 Advanced Structural Geology
GEOL 622 Geotectonics

One course from:

GEOE 626 Environmental Geophysics
GEOE 641 Geochemistry
GEOE 664 Advanced Ground Water
GEOL 652 Problems in Ore Deposits

Geological Engineering Specialization

All Ph.D. students in the geological engineering specialization are expected to focus in one of the three areas of groundwater/ environmental, geomechanics, or energy/mineral

resources. Recommended courses for each focus are listed below.

Required of all GEOE students:

- GEOE 766 Digital Modeling of Ground Water
- GEOL 633 Sedimentation
- GEOL 808 Fundamental Problems in Geol/GeoE

Ground Water and Environmental Focus:

- GEOE 664 Advanced Ground Water
- GEOE 641 Geochemistry
- GEOE 663 Ground-Water Geochemistry
- CEE 634 Surface Water Hydrology
- CEE 523 Environmental Systems Analysis
- GEOL 517 Geospatial Databases
- GEOL 519 Advanced Geospatial Analysis
- CEE 730 Statistical Methods in Water Resources
- CEE 731 Topics in Water Quality Assessment
- CEE 526 Environmental Engineering Physical/Chemical Process Design
- CEE 621 Env. Contaminant Fate and Transport
- CHEM 480 Toxicology

Geomechanics Focus:

- GEOE 668 Eng. Geology of Surficial Deposits
- CEE 647 Earth Structures
- CEE 646 Stability of Soil and Rock Slopes
- CEE 643 Advanced Soil Mechanics I
- MEM 550 Rock Slope Engineering
- MINE 512 Rock Mechanics III
- GEOE 664 Advanced Ground Water
- CEE 645 Advanced Foundations
- CEE 647 Earth and Earth Retaining Structures
- CEE 784 Modeling and Comp in Civil Engr

Energy and Mineral Resources Focus:

- GEOE 525 Engineering Geophysics II
- GEOE 531 Principles of Well Logging
- GEOE 552 Geochemical Exploration
- GEOE 661 Petroleum Geology
- GEOL 652 Problems in Ore Deposits⁴
- GEOL 513 Ore Microscopy

- GEOE 626 Environmental Geophysics
- GEOE 641 Geochemistry
- MEM 533 Comp App in Geoscience Modeling
- GEOE 665 Bioremediation of Hazardous Materials
- GEOE 663 Ground-Water Geochemistry
- CEE 725 Treatment, Disposal, and Management of Hazardous Waste
- GEOL 650 Seminar in Ore Deposits
- CEE 784 Modeling and Comp in Civil Engr

Dissertation Proposal Defense

The dissertation proposal is part of the comprehensive examination. All Ph.D. students are required to prepare a research proposal for the work to be accomplished for the dissertation. The proposal is due one month prior to the comprehensive examination, so that the candidate's committee may review the proposal to assure that it is defensible. If not, then the student will have an opportunity to resubmit, although this may alter the final date of the comprehensive examination.

Comprehensive Examination: Summary of Rules and Organizations

When the student's program of course work has been substantially completed and dissertation proposal prepared, he/she will undertake the comprehensive examination for admission to candidacy. This examination should normally occur after the student has spent four semesters in the Ph.D. program, but must take place at least four months prior to the final defense. The comprehensive examination will consist of written and oral examinations covering the student's field of study and related subjects. It will be prepared by the student's advisory committee, with potential suggestions from any faculty member from whom the student has taken a graduate course. The oral examination is open to any faculty member, but must include the candidate's full committee.

If the student has not completed all requirements for the Ph.D. degree by the fifth year following the comprehensive examination, his/her

active status will be automatically terminated and the comprehensive examination must be repeated.

1. No later than two months prior to the examination date the student must make a request to the student's committee to take the comprehensive examination. The dissertation research proposal must be submitted at least one month prior to the examination date.
2. The examination will consist of four parts, all of which must be completed within one working week. The examination may be scheduled for spring and fall semesters only, but not during the week of final examinations or the last week of classes.
3. The written examinations will be graded prior to the oral examination.
4. The oral examination will last three hours. It will begin with an oral presentation of the dissertation proposal by the student, who will then undergo an oral examination by the committee that may include questions concerning the proposal, the written exam topics, and any relevant subject area related to the student's research.
5. The written examination will consist of three parts: one general, and two specific topics. Each part of the written examination will be three hours in length.

| | |
|--------------------------|------------|
| General (written) | 25 percent |
| Specific Topic (written) | 25 percent |
| Specific Topic (written) | 25 percent |
| Oral Examination | 25 percent |

Geology Specialization:

The General part will include General Geology. Specific topics will be chosen from the following list:

- Structural geology
- Sedimentation/stratigraphy
- Paleontology
- Igneous/metamorphic petrology
- Economic geology/mineral exploration

- Crystal chemistry/mineralogy
- Geomorphology
- Geophysics
- Glacial and Pleistocene Geology

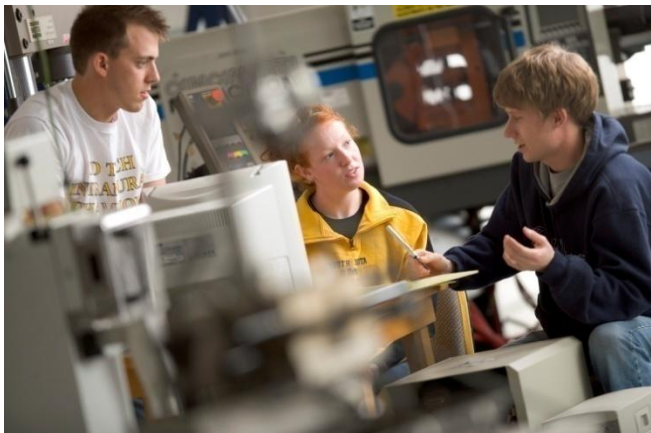
Geological Engineering Specialization:

The general part will include geological engineering, general geology, and fundamentals of engineering. Specific topics will be chosen from the following list:

- Ground Water
- Engineering Geology
- Petroleum Engineering
- Minerals
- Hydrology and Hydraulic Engineering
- Geophysical Exploration
- Geochemistry
- Geomorphology
- Rock Mechanics
- Geotechnical Engineering

A student may substitute successful completion of the Fundamentals of Engineering (F.E.) examination for one of these three parts. A student also may propose hybrid fields with other disciplines if approved by his or her graduate committee.

Materials Engineering and Science M.S.



Contact Information

Dr. Jon J. Kellar

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Steering Committee

Steering Committee members are from the Departments of Materials and Metallurgical Engineering, Physics, and Chemistry.

Faculty

Professors Boyles, Foygel, Howard, Douglas Fuerstenau Professor Kellar, and Petukhov; Associate Professors Corey, Cross, Heglund, Medlin, and Sobolev; Assistant Professors Fong, Meyer, West and Zhu; Emeritus Professor Stone, Distinguished Professor Emeritus Han.

Master of Science in Materials Engineering and Science

This interdisciplinary degree program works in concert with other colleges and the Ph.D. in materials engineering and science (Ph.D./MES).

The M.S./MES degree offers an education in the broad area of materials. Students pursuing this degree will expand their knowledge and understanding of the science and technology of

materials synthesis, behavior, and production. Graduates of the program formulate solutions to materials problems through the use of multi-disciplinary approaches made possible with a broad background in basic materials science and engineering coupled with an area of specialization.

Two options are available in this degree program: one option involves a thesis component and the other option involves course work only. In the thesis option, 24 hours of course work and a minimum 6 credit hours of thesis research are required. With the second option, 32 hours of course work must be taken. In the latter option however, the students are required to undertake a project under the supervision of a faculty member. Because students graduating with this degree are expected to have a broad-based fundamental knowledge in both materials engineering and materials science, every student is required to take the following core courses.

MES 601 Fundamentals of Materials Engineering (4 cr.hr.)

MES 603 Condensed Matter Physics (4 cr.hr.)

MES 604 Chemistry of Materials (4 cr.hr.)

In addition MES 790 Seminar (1 cr.hr.), is a required course.

Areas of research currently carried out include inorganic, organic, and biological behavior/synthesis/treatments of materials, polymer chemistry, solid state physics, interfacial chemistry/physics, thermal, magnetic and transport properties of semiconductors, superconductors, metals and alloys, dielectric and composite materials, recovery and processing of minerals/materials/scrap, process simulation and optimization, thermodynamics of various materials, corrosion and corrosion inhibition, strengthening mechanisms, deformation induced transformation plasticity, artificial intelligence, and behavior/properties/synthesis of composites.

Undergraduate Degrees That Prepare Students for the M.S. MES Program

The breadth of the field of materials

engineering and science is such that graduates from any of the following disciplines should be prepared for graduate study in the M.S. MES program: chemistry, physics, metallurgical engineering, chemical engineering, materials engineering, mechanical engineering, civil engineering, and electrical engineering. Students with baccalaureate degrees in other disciplines may gain admission to the program but may require remedial undergraduate work prior to beginning their graduate course work.



Mines Matters: The South Dakota School of Mines and Technology Career Center assists students with sharpening interview skills, finding internships, and by hosting a Career Fair in fall and spring of each year. Ninety-eight percent of 2007-08 graduates are working in their career field or are pursuing graduate/professional degrees and are working for 124 employers in 28 states.

Materials Engineering and Science Ph.D.



Contact Information

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Advisory Council

Advisory Council members are from the Departments of Civil and Environmental, Mechanical, Materials and Metallurgical Engineering, and the Departments of Physics, and Chemistry.

Materials Engineering and Science

The doctor of philosophy program in materials engineering and science (MES) offers a student the opportunity to expand his/her knowledge and understanding of the science and technology of materials production, behavior, and applications. The student will undertake multidisciplinary approaches, combining the basic elements of both engineering and science, to the solution of materials-related problems. Because such problems are found in every science and engineering discipline, the degree applicant has considerable flexibility in the selection of the department in which to pursue dissertation research, within the confines of the applicant's academic preparation and interests. Candidates will study either a science or engineering emphasis within the MES Ph.D. program. For example, research emphasis may be placed on

improving processes for the production of metallic, polymeric, ceramic, or other structural or electronic materials. Alternatively, the degree candidate may investigate mechanisms for improving material properties, which in turn, could lead to new or better applications. Classroom and individualized instruction will provide the necessary theory to complement such creative activities.

Example areas of specialization include but are not limited to

- Activities of Multicomponent Systems
- Computational Modeling
- Polymer Synthesis
- Concrete Technology
- Corrosion Inhibition
- Development of Multiphase Materials
- Fiber Reinforced Composites
- Geotechnology
- Magnetic Nanocomposites
- Nanoscale Electronic Materials
- Polymer Matrix Composites
- Reaction Kinetics
- Semiconductor Materials and Devices
- Strengthening Mechanisms
- Surface Chemistry of Flotation
- Thermophysical Properties
- Thin Films

The program is administered directly by the Dean of Graduate Education and sponsored programs, with the head of the MES Ph.D. advisory council serving as program coordinator. The advisory council currently comprises faculty members from the Departments of Civil and Environmental, Mechanical, Materials and Metallurgical Engineering, and the Departments of Physics, and Chemistry.

The Graduate Record Examination (GRE), three letters of recommendation, and a GPA of 3.00 or better are required of all applicants for the MES Ph.D. program. The TOEFL exam is required for students whose native language is not English.

All candidates for the MES Ph.D. program are required to successfully complete the following minimum credits and earn a grade of "C" or better, except for a final grade of "S" in MES 800:

| Category | Credits |
|--|---------|
| Analytical Mathematics | 3 |
| Numerical Mathematics | 3 |
| Program Major Emphasis (Engineering or Science) | 44-54 |
| Dissertation Research | 20-30 |
| Total beyond the B.S. degree | 80 |

General Program Requirements

(Minimum program requirements: 80 credits)

M.S. Degree (24 credits)

Programs-major courses may be used to satisfy course work hour requirements for analytical mathematics, numeral mathematics, or fundamental science courses taken in the M.S. program of study (subject to approval).

Analytical Mathematics (3 credits)

| | | |
|----------|-------|--------------------------------|
| ME 673 | (3-0) | Applied Engineering Analysis I |
| PHYS 581 | (3-0) | Mathematical Physics |

Numerical Mathematics (3 credits)

| | | |
|---------------|-------|---|
| CEE 784 | (3-0) | Modeling and Computation in Civil Engineering |
| CEE 785 | (3-0) | Applications of Finite Element Methods in Civil Engineering |
| MATH 547 | (3-0) | Design and of Experiments |
| ME 773 | (3-0) | Applied Engineering Analysis II |
| MET 614 | (3-0) | Advanced Metallurgical Simulation Techniques |
| MEM 533 (3-1) | | Computer Applications in Geoscience Modeling |

Program Emphasis (30 credits)

Two program emphasis areas are available: materials science and materials engineering. See sections below.

| | |
|----------|-------------------|
| Research | (20 credits) |
| MES 898 | (19) Dissertation |
| MES 890 | (1-0) Seminar |

A maximum of 10 additional research credits may be included within the hours specified for the program major, subject to approval by the student's advisory committee. The courses listed

in Sections II and III below are suggested courses for the science of engineering emphasis, but students are not limited to this selection. Students may take courses out of each emphasis when developing their programs of study.

Science Emphasis Requirements

(Minimum program requirements: 30 credits)

Thermodynamics of Solids (3 credits)

| | | |
|----------|-------|---------------------------|
| MES 712 | (3-0) | Interfacial Phenomena |
| PHYS 743 | (3-0) | Statistical Mechanics |
| CBE 613 | (3-0) | Transport Phenomena: Heat |
| CBE 714 | (3-0) | Transport Phenomena: Mass |
| MES 728 | (3-0) | Heterogeneous Kinetics |

Crystal Structure/Chemistry of Solids

| | | |
|-------------|-------|--------------------------|
| (3 credits) | | |
| MES 603 | (4-0) | Condensed Matter Physics |
| MES 604 | (4-0) | Chemistry of Materials |
| MES 737 | (3-0) | Solid State Physics I |
| PHYS 777 | (3-0) | Quantum Mechanics I |

Bulk or Surface Analysis (3 credits)

| | | |
|---------------|-------|--|
| MES 708/708L | (3-1) | Advanced Instrumental Analysis |
| NANO 703/703L | (3-1) | Instrumentation and Characterization of Nano-Materials |

Fundamental Engineering Mechanics

(6 credits)

Courses from the engineering emphasis section can also be used to fulfill this requirement.

| | | |
|-------------|-------|---------------------------------------|
| ME 425 | (3-0) | Probabilistic Mechanical Design |
| MET 450 | (3-0) | Forensic Engineering |
| MET 440/540 | (3-0) | Mechanical Metallurgy |
| ME/MET 443 | (3-0) | Composite Materials |
| MET 625 | (3-0) | Strengthening Mechanisms in Materials |

Dissertation Related Topics (12 credits)

Engineering Emphasis Requirements

(minimum program requirements: 30 credits)

Analytical Mechanics

- ME 623 (3-0) Advanced Mechanical
Vibrations
ME 613 (3-0) Transport Phenomena: Heat
MES 713 (3-0) Adv Solid Mechanics I
MES 770 (3-0) Continuum Mechanics

Elasticity/Plasticity

- CEE 643 (3-0) Advanced Soil Mechanics I
CEE 644 (3-0) Advanced Soil Mechanics II
CEE 646 (3-0) Stability of Soil and Rock
Slopes
CEE 749 (1-2) Experimental Soil
Mechanics
MES 713 (3-0) Advanced Solid
Mechanics I
MINE 412/512
(3-0) Rock Mechanics III
MINE 450/550
(3-0) Rock Slope Engineering

Failure Analysis Fracture Mechanics

- ME 715 (3-0) Advanced Composite Materials
Fundamental Materials Science (6 credits)

Courses from the science emphasis section
can also be used to fulfill this requirement.

- CHEM 420 (3-0) Organic Chemistry III
CHEM 452/552
(3-0) Inorganic Chemistry
CHEM 426/526
(3-0) Polymer Chemistry
MES 603 (4-0) Chemistry of Materials
MES 601 (4-0) Fundamentals of Materials
Engineering
MES 604 (4-0) Condensed Matter Physics
CBE 474/574
(2 to 3) Polymer Technology
PHYS 439 (4-0) Solid State Physics
MET 445/545 (3-0) Oxidation and Corrosion of
Metals
MET 421/521
(3-0) Refractories and Ceramics

An assessment of the student's qualifications
will be undertaken early in their program. The
assessment is comprised of performance in pre-
determined courses and a dissertation proposal.
Further information is available in the School of
Mines materials engineering and science Ph.D.
Handbook.

Each student is also required to pass a
comprehensive examination. There is no
language requirement for the MES doctoral
program.

For program supervision purposes, the MES
Ph.D. program coordinator is the graduate advisor
until the major professor is appointed. The major
professor is the person responsible for the
student's dissertation research. The graduate
office representative on the student's dissertation
committee must be selected from outside of the
department with which the major professor is
affiliated, and should also be a member of the
MES Ph.D. Advisory Council. The MES Ph.D.
Advisory Council must approve all programs of
study. It is not necessary that the student be
associated with the department of affiliation of his
or her major professor. The detailed information
on examination policy, admission to candidacy,
and defense of dissertation are included in the
School of Mines Materials Engineering and
Science Ph.D. Handbook.

Mechanical Engineering M.S.



Contact Information

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Department of Mechanical Engineering

Civil Mechanical 172

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Faculty

Professors Buck, Dolan, Kalanovic, Kjerengtroen, Korde, Krause, Langerman, Muci-Kuchler, and Thubrikar; Assistant Professor Yoon; Professors Emeritus Gnirk and Pendleton; Instructor Ash.

Mechanical Engineering

The Department of Mechanical Engineering offers a graduate program leading to the master of science degree in mechanical engineering. The primary goals of the program are to develop the scholastic ability, independent creativity, and professional competence of an individual to a higher level than is possible in an undergraduate program.

The graduate program offers opportunities for instruction and research in manufacturing, solid mechanics, transport phenomena, hydrodynamic stability, computational mechanics, multiphase thermal-hydraulics, vibrations, controls, experimental mechanics, fracture mechanics, composite materials, finite element analysis, advanced materials processing, micro machines, and probabilistic design. The graduate program

features courses in continuum mechanics, computational methods in transport phenomena, advanced heat transfer, advanced fluid mechanics, engineering analysis, advanced solid mechanics, integrated manufacturing systems, robotics, applied intelligent control, theory of materials behavior, composite materials, advanced mechanical vibrations, advanced mechanical system control, and statistical approaches to reliability.

The mechanical engineering department is one of the largest programs on campus and has well-equipped laboratories. Several faculty members within the department are associated with the Computational Mechanics Laboratory (CML), where high-end workstations are available for pursuing research and design in modeling. Several faculty members are associated with the Center for Advanced Manufacturing and Production (CAMP), where research in advanced manufacturing, advanced composites, and advanced design methodologies is conducted. The department has a strong relationship with the Advanced Materials Processing (AMP) center. Other labs include the Fluid Mechanics and Heat Transfer Lab, which houses a mach 3 supersonic wind tunnel, Vibrations Lab, Neural Networks and Controls Lab, and Micromechanics Lab. The campus fosters interdisciplinary research, and state-of-the-art equipment such as an electron microscope, atomic force microscope, x-ray diffractometer, Raman spectrometer, laser Vibration Pattern Imager, FADAL VMC40 Vertical Machining Center, Bridgeport Romi CNC lathe, Coordinate Measuring Machine, Injection Molding Machine, IBM 7540 Industrial Robot, and Universal Testing Machines are available in the department or on the campus. Graduate research laboratories also include equipment for modern digital controls and machine vision and thermal image analysis.

The graduate program in mechanical engineering can be pursued using either of two equal options. They are:

- 1. Non-Thesis:**

| | |
|-----------------------------|----|
| Total credit hours required | 32 |
| Seminar ME 790 | 1 |

| | |
|--|----|
| Project ME 788 | 4 |
| Remaining 27 hours are taken maximum at the 400 ¹ /500 level | 9 |
| minimum at the 600/700 level | 18 |
| 2. Thesis: | |
| Total credit hours required | 30 |
| Seminar ME 790 | 1 |
| Thesis ME 798 | 6 |
| Remaining 23 hours are taken maximum at the 400 ¹ /500 level | 9 |
| minimum at the 600/700 level | 14 |

Curriculum Notes

1. 300 level acceptable if outside department and on approved blanket waiver list.

2. Students may enroll in 300/400 level courses only if 500/600 level courses within the major are not being offered or by written permission of the student's major professor and the department head.

It is the belief and policy of the mechanical engineering department that these two options are equivalent in educational value to the student. Within the first semester in residence, each student is requested to carefully evaluate their preference after discussion with the mechanical engineering faculty, and a decision must be made shortly after the beginning of the second semester in residence. In either case the student must by then choose a major professor, and with the major professor's assistance develop a plan of study. The plan is due by the end of the first full calendar month of the student's second semester (end of September or end of January) in residence. The plan will be submitted to:

1. Graduate office
2. The department head
3. Major professor
4. Copy to the student

Each master's degree candidate must select a advisory committee. In addition to the candidate's major professor, the committee must consist of at least one other mechanical engineering professor and a graduate office

representative. The graduate office representative, whose appointment must be approved by the graduate dean, must be selected from outside of the mechanical engineering department. The student and his/her supervising professor will nominate the out-of-department committee member after the student has received the nominee's consent.

The core curriculum required of all M.S. students includes:

| | |
|---------|---------------------------------|
| ME 673 | Applied Engineering Analysis I |
| ME 773 | Applied Engineering Analysis II |
| MES 770 | Continuum Mechanics |

In addition, students should select one course from each of the three areas listed below (or approved substitutions) for a total of six core courses.

Thermal Sciences

| | |
|--------|-------------------------------------|
| ME 612 | Transport Phenomena: Momentum |
| ME 613 | Transport Phenomena: Heat |
| ME 616 | Computations in Transport Phenomena |

Mechanical Systems

| | |
|---------|--------------------------------|
| ME 623 | Advanced Mechanical Vibrations |
| ME 722 | Advanced Mechanical Design |
| EM 680 | Advanced Strength of Materials |
| MES 713 | Advanced Solid Mechanics I |

Manufacturing and Controls

| | |
|--------|------------------------------------|
| ME 683 | Advanced Mechanical System Control |
| ME 781 | Robotics |
| ME 782 | Integrated Manufacturing Systems |

The details of the actual course selections must be developed by the student, the student's academic advisor, and the student's committee. Although there is a fair degree of flexibility, it is assumed that the program will have some meaningful focus. Students should consult the Mechanical Engineering Department Graduate Studies Policy Manual for additional important details.

Entering students usually have a bachelor's degree in mechanical engineering. Qualifying

examinations may be required of entering students. A minimum GPA of 3.00 is expected for regular (non-probationary) admission. Applicants who are graduates of institutions that are not accredited by the Accreditation Board of Engineering and Technology (ABET) are required to sit for the Graduate Record Exam and have their scores submitted prior to consideration for admission.

Final Examination Thesis Program

Upon completion of the thesis, mechanical engineering graduate students electing this option will be examined orally over the written thesis and course work as prescribed in the Graduate section. A mechanical engineering graduate student with an accumulated GPA of 3.4 or better in those courses in their graduate program will have their course work exam combined with the thesis defense. For students having an accumulated GPA of less than 3.4 in courses in their graduate program, a separate focused course work oral examination will be administered by the student's graduate committee. The GPA will be computed using midterm grades for the semester in which the student is currently enrolled. The course work examination will examine primarily concepts and fundamentals of those courses selected, rather than the mechanics of problem solution and will, in general, attempt to establish the student's in-depth knowledge of the course content. The student's graduate committee will select specific courses from the student's graduate program in which the student has indicated possible deficiencies. The major professor will inform the student no less than three weeks prior to the examination what courses have been selected. However, it is the student's responsibility to secure this information from the major professor.

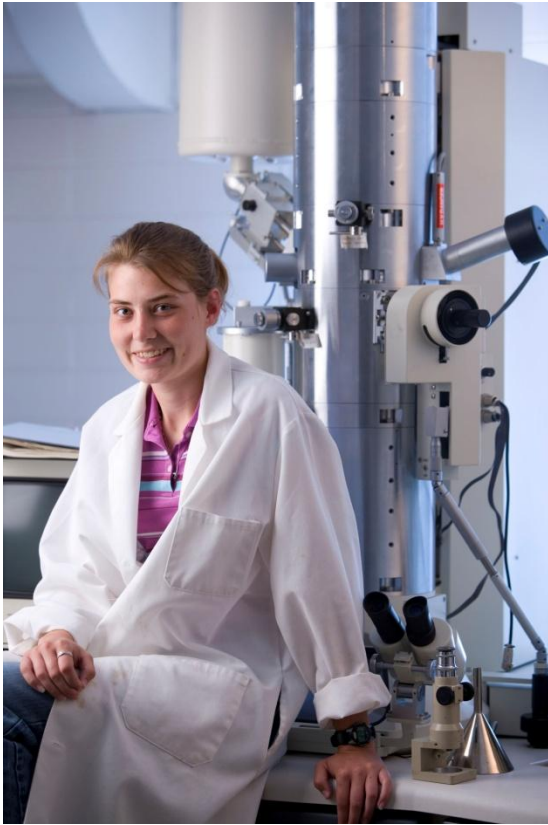
Final Examination Non-Thesis Option

Mechanical engineering graduate students selecting a non-thesis option will be required to pursue a special investigation under the direction of a faculty member. The report on this study will be written and formal although not of thesis

quality nor extent. Upon the completion of the special investigation and with the approval of the directing faculty member, the student will be given a formal oral examination over the investigation. Rules concerning an oral examination over course work taken by the student in their graduate program will be identical to the rules stipulated above for those students taking the thesis option.

Graduate Study in Metallurgical Engineering

programs include those in nanoscience and nanoengineering and biomedical engineering.



Contact Information

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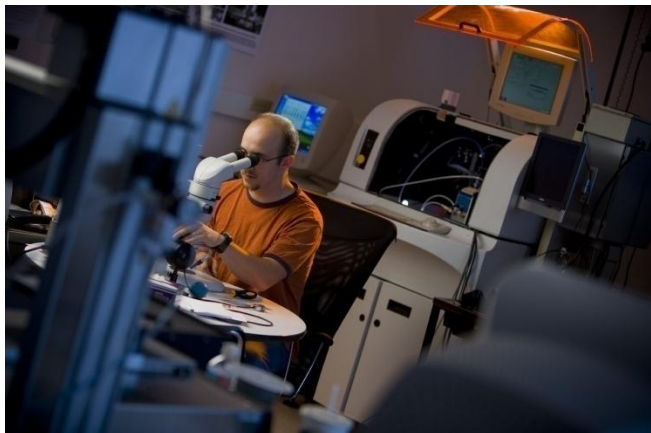
Faculty

Douglas W. Fuerstenau Professor Kellar;
Professor Howard; Associate Professor Medlin;
Associate Professor Cross; Assistant Professor West; Professor Emeritus Stone; Distinguished Professor Emeritus Han; Research Scientist Hong.

Metallurgical Engineering

Students interested in pursuing graduate studies focusing on materials engineering and science, please see master of science in materials engineering and science. Other relevant graduate

Nanoscience and Nanoengineering Ph.D.



Contact Information

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Advisory Council

Professors Boyles, and Kjerengtroen; Sandvig Professor Puszynski and Miller Professor Whites; Professors Petukhov; Associate Professor Smith; Assistant Professor Michael West, Printed Center for Accelerated Applications at the Nanoscale (CAAN) / Electronics Applied Research Laboratory (PEARL) Director Decker.

Nanoscience and Nanoengineering

The Nano Science and Engineering Ph.D. (Nano SE Ph.D.) Program at the South Dakota School of Mines and Technology is an interdisciplinary Ph.D. program focusing on the science and engineering of nanomaterials. The goal of nanoscience and nanotechnology is to manipulate matter at the atomic and “nano” length scales (dimensions from a few to 100’s of atomic radii), e.g. the molecular to mesoscopic levels, where new materials and phenomena have been discovered. The ability to engineer systems at these length scales will require professionals with a broad understanding of fundamental principles and the ability to cross-over into other fields. The

nano program provides the training to allow scientists and engineers to address these challenges, and the opportunity for students to engage in such research at the School of Mines while pursuing the Ph.D.

The Nano SE Ph.D. program offers a research-intensive degree focused on nanoscience and nanotechnology, with an emphasis on nano-scale materials. A multi-disciplinary core curriculum is taken by students from diverse science and engineering backgrounds. These “core” courses are intended to introduce students to contemporary topics in nanoscience and nanotechnology, and to initiate a cross-disciplinary approach to research and learning. These courses can usually be completed in one, or at most two years. In addition to this core, students entering with an M.S. degree are required to take at least two electives outside the student’s traditional area of training. Students entering at the B.S. level will be expected to pursue, or take course work equivalent to, an M.S. degree, in addition to the nano core curriculum.

Students from traditional science and engineering backgrounds enter the program with well-defined research interests and affiliate themselves with a research group and a faculty mentor. Current nano program participants draw from the Departments of Chemistry and Physics, and Chemical, Electrical, Materials and Metallurgical, and Mechanical Engineering. Students with traditional training in these areas participate in cross-disciplinary research with a nano focus. Examples of active research areas are: synthesis and characterization of nanocomposite materials, photo-activated nano-inks for direct write applications, nano-energetic materials, polymer chemistry, theory of spintronic devices, and structural and optical characterization of nano-materials for solar energy, bio-fuels and other forms of renewable energy.

The nano SE Ph.D. program builds on traditional science and engineering disciplines, and offers a "core" curriculum which introduces students from varying science and engineering backgrounds to contemporary topics in nanoscience and nanotechnology. Students are expected to obtain graduate level training in a

traditional discipline, designated as the "program major emphasis", and take a minimum of 6 elective credits outside their own area. Students entering the program with an MS may apply up to 24 transfer credits towards fulfilling the program major emphasis requirements. More information is available in the Nano SE Ph.D. Program Handbook.

Students with an M.S. degree in science or engineering are eligible for admission. However, students with a B.S. degree only will also be considered for admission when the student has proven to possess exceptional qualifications. The Graduate Record Examination (GRE), three letters of recommendation, and a GPA of 3.00 or better are required of all applicants for the Ph.D. program. The TOEFL exam is required for students whose native language is not English.

All candidates for the Ph.D. program are required to successfully complete the following minimum credits and earn a grade of "C" or better, except for a final grade of "S" in NANO 898:

The program of study must be filed with the graduate office, and approved by the Nano SE PhD program director before midterm of the second semester of residence, and again before the qualifying exam. Below is the summary of the required course of study.

| Category | Credits | |
|-----------------|--|-----------|
| NANO 701 | Nano Materials | 3 |
| NANO 702 | Theory and Applications of Nanoscale Material Systems | 3 |
| NANO 703 | Instrumentation and Characterization of Nano-Materials | 5 |
| NANO 890 | Seminar | 3 |
| | Program Major Emphasis | 26-36 |
| | Dissertation Research | 30-40 |
| TOTAL | | 80 |

General Program Requirements

(Minimum program requirements: (80 credits))

M.S. Degree (24 credits)

Students entering the Ph.D. program with a previous M.S. degree in a relevant discipline are allowed to apply a maximum of 24 semester course credit hours toward the course credit requirements subject to approval of the Dean of Graduate Education.

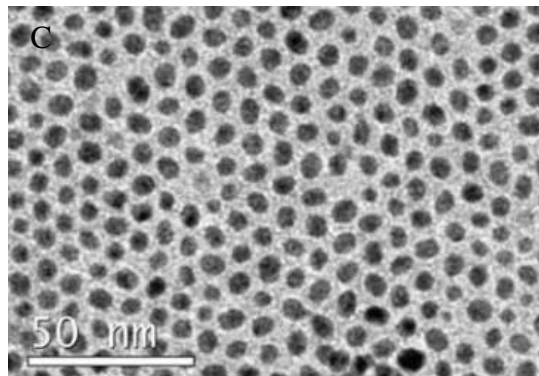
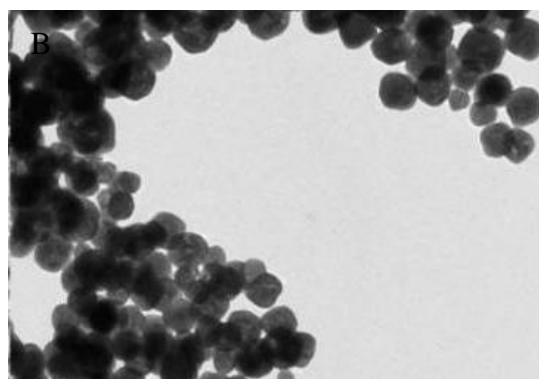
The following is a list of electives for each focus area of the program. Graduate level courses which serve the needs of our other graduate programs are also available as electives.

Category Credits

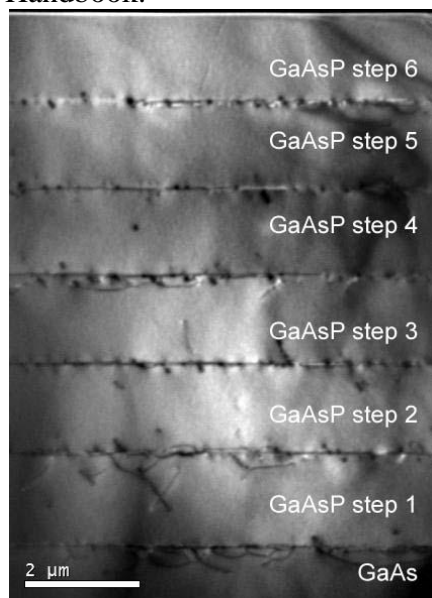
| | | |
|--------------|--|--------|
| NANO 445/545 | Introduction to Nanomaterials | (3-0) |
| NANO 504 | Nanophotonics | 3 |
| NANO 604 | Nanophotonic Materials | 3 |
| NANO 704 | Crystallography and Structure of Nanomaterials | 3 |
| NANO 705 | Nanoelectronics | 3 |
| NANO 706 | Diffraction Methods for Nanomaterials Research | 3 |
| NANO 707 | Defects in Nanoscaled Materials | 3 |
| NANO 708 | Nanomaterials for Photovoltaics | 3 |
| NANO 711 | Introduction to Direct Write Technology | 3 |
| NANO 712 | Electromagnetic Properties of Heterogeneous Materials | 3 |
| NANO 713 | Dielectric and Magnetic Properties of Nano-Scale Materials | 3 |
| NANO 714 | Functional Fillers and Nanoscale Minerals | 3 |
| NANO 715 | Polymeric Nanomaterials | 3 |
| NANO 716 | Nanotechnology of Engineering and Construction Materials | 3 |
| NANO 717 | Nano Chemistry | 3 |
| NANO 718 | Small Scale Mechatronics | 3 |
| NANO 719 | Atomic Force Microscopy/ Nano-Mechanics | 3 |
| NANO 720 | Contemporary Condensed Matter Physics | 3 |
| NANO 791 | INDEPENDENT STUDY | 1 to 3 |
| NANO 792 | TOPICS | 1 to 3 |
| MES 601 | Fundamentals of Materials Engineering | 4 |
| MES 603 | Condensed Matter Physics | 4 |
| MES 604 | Chemistry of Materials | 4 |
| MES 708/708L | Adv Instrumental Analysis | (3-1) |

| | | |
|------------|--------------------------------|---|
| ME/ChE 612 | Transport Phenomena – Momentum | 3 |
| ME/ChE 613 | Transport Phenomena – Heat | 3 |
| ChE 614 | Transport Phenomena – Mass | 3 |
| Phys 721 | Adv Electricity and Magnetism | 3 |
| Phys 743 | Statistical Mechanics | 3 |
| Phys 777 | Quantum Mechanics I | 3 |
| Phys 779 | Quantum Mechanics II | 3 |
| MES 712 | Interfacial Phenomena | 3 |
| MES 713 | Advanced Solid Mechanics | 3 |
| MES 728 | Heterogeneous Kinetics | 3 |
| MES 737 | Solid State Physics I | 3 |
| MES 770 | Continuum Mechanics | 3 |

For program supervision purposes, the nano SE Ph.D. program director is the graduate advisor until the major professor is appointed. The major professor is responsible for the student's dissertation research. The graduate office representative on the student's dissertation committee must be selected from outside of the department with which the major professor is affiliated, and should also be a member of the Nano Ph.D. Advisory Council. It is not necessary that the student be associated with the department of affiliation of his or her major professor. Detailed information on examination policy, admission to candidacy, and defense of dissertation are included in the School of Mines nano science and engineering Ph.D. Program Handbook.



Examples of Nanomaterials synthesized and characterized at School of Mines: A: Nano-engineered III-V materials for solar cells, B: Upconverting nano-particle phosphors for solar cells, C: Gold Nano-particles used in nano-composite materials.



Paleontology M.S.



Contact Information

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Faculty

Professor Martin, Associate Professor Price,
Assistant Professor Haslem Post-doctoral Fellow
Pagnac. Professor Emeritus Fox.

Supporting Faculty

Assistant Professors Terry and Sawyer.

Paleontology

The master's program in paleontology emphasizes the opportunity for combining field work in western South Dakota with study of the extensive collections of the Museum of Geology. Fossiliferous deposits range from the Jurassic through the Holocene. A student may enter this program with an undergraduate degree in geology, anthropology, one of the biological sciences, or other science disciplines, but for the latter majors, deficiencies must be completed as listed below.

Candidates for the M. S. degree must fulfill all degree requirements of the graduate office. The

thesis option is the only option for the M.S. in paleontology.

1. All incoming students are expected to present one semester of college-level physics and two semesters each of college-level calculus and chemistry as part of their undergraduate record. Deficiencies in these areas must be remedied by taking the necessary course work prior to or in the first year of enrollment in the graduate program.
2. All incoming students are expected to have completed courses in, or to develop proficiency in, the following areas. Additional subjects may be required by the student's graduate committee depending on the student's area of interest. The student and the graduate committee will arrange how these requirements can best be met.

- Statistics
- Mineralogy
- Historical Geology
- Invertebrate Paleontology
- Field Geology
- Stratigraphy and Sedimentation

No graduate credit will be granted for making up undergraduate-level deficiencies.

The GRE exam is required of all applicants except School of Mines graduates. The TOEFL exam is required for students whose native language is not English.

Thirty-two semester credits are required for the M.S. degree. The following courses must be taken as part of the graduate program of study:

GEOL 631 Rocky Mountain Stratigraphy I

OR

632 Rocky Mountain Stratigraphy II

GEOL 633 Sedimentation

PALE 671 Advanced Field

Paleontology

PALE 673 Comparative Osteology

PALE 676 Vertebrate Paleontology

PALE 678 Vertebrate Biostratigraphy

PALE 798 Master's Thesis

(a minimum of 6 credits)

PALE 770 Seminar in Vertebrate

Paleontology

The following courses are recommended:

- GEOL 572 Museum Conservation and Curation
- GEOL 573 Museum Preparation Techniques and Exhibit Design
- GEOL 517 Geospatial Databases
- GEOL 643 Intro to Microbeam Instruments
- PALE 672 Micropaleontology
- PALE 684 Pale environments
- GEOL 604 Advanced Field Geology or other appropriate courses in geology.

The candidate will pass a reading examination in one of the following languages: French, German, Spanish, or Russian. The examination will consist of translating a paleontology abstract or similar-length passage of technical writing into acceptable English. The student will have one hour to complete the translation and is permitted the use of a bound (not electronic) standard foreign language dictionary.

All thesis samples, specimens, and their documentation collected while at School of Mines must be curated into the systematic collections of the Museum of Geology for future students, scientists, and technologies.



Physics M.S.



Contact Information

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Faculty

Professors M. Foygel, A. Petukhov, and V. Sobolev; Associate Professor R. Corey; Assistant Professor X. Bai.

Physics

The mission of physics graduate program is to provide students with quality graduate instruction and research experience suitable in many physics-related careers. Required course work in physics along with elective courses selected from other disciplines such as mathematics, computer science, chemistry and engineering support a number of career options in industry, education and applied research. Graduates with this degree may also pursue a Ph.D. degree in physics. Areas of research concentration include astrophysics, condensed matter, materials science, nuclear and elementary particle physics, and theoretical physics.

Available Options for Degrees

A (thesis) and B (non-thesis). Option A requires a thesis based on research, while Option B

substitutes additional course work and a research paper/project for the thesis requirement. The non-thesis options are deemed appropriate for students who do not require Ph.D. preparation in physics in order to be successful in their careers. Examples of career tracks not requiring study in physics beyond the master's level include medical physics, science education at the k-12 and "community college" level as well as various industrial applications. While deemed less appropriate for students advancing to doctoral study in physics, the non-thesis options are a viable and even preferred course of study for some students.

Students should expect that completion of an M.S. degree take two academic years of full-time study.

Degree requirements

M.S. Physics Option A requires 19 credit hours of required core courses, 6 credit hours of electives, and 7 credit hours for thesis which leads to total of 32 credit hours.

M.S. Physics Option B requires 19 credit hours of required core courses, 11 credit hours of electives, and 2 credit hours for research/design paper which leads to total of 32 credit hours.

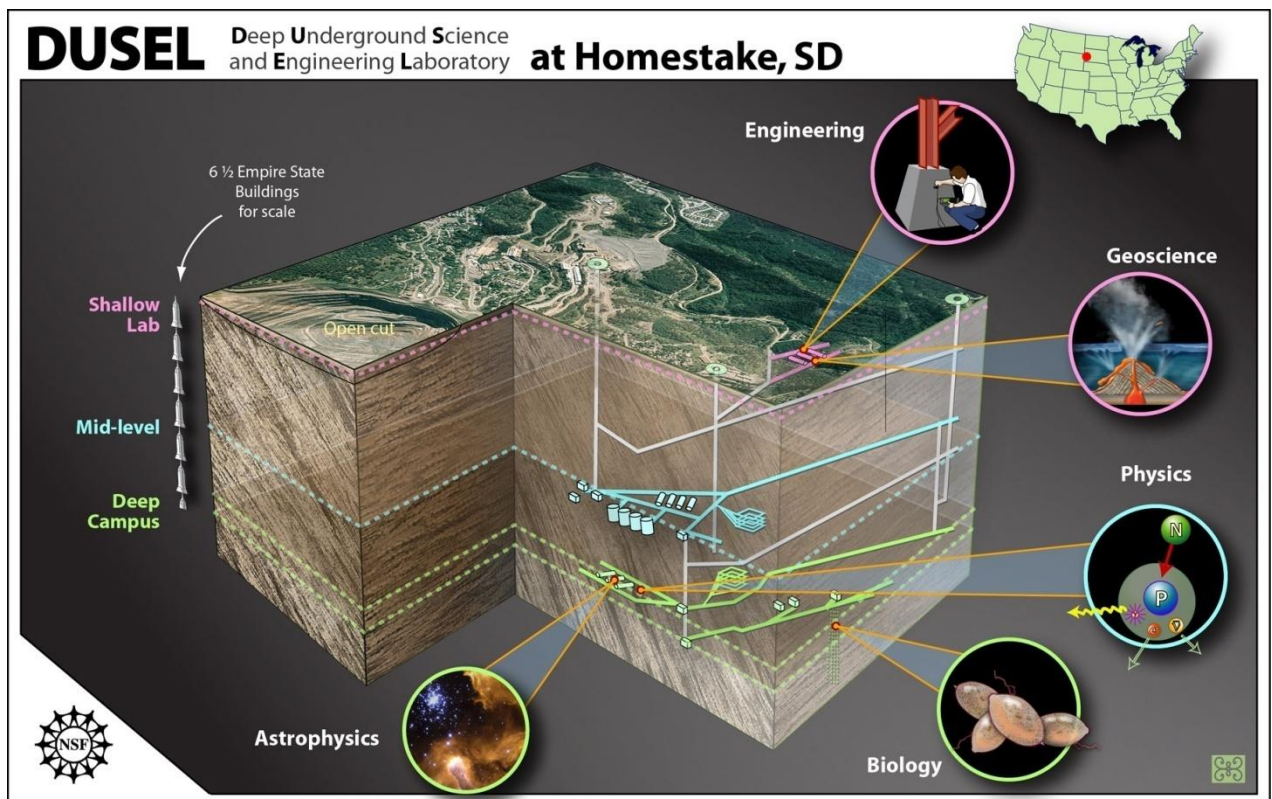
Required Core Courses

| | |
|--------------------------------|----|
| PHYS 721 Electrodynamics I | 3 |
| PHYS 723 Electrodynamics II | 3 |
| PHYS 743 Statistical Mechanics | 3 |
| PHYS 751 Classical Mechanics | 3 |
| PHYS 771 Quantum Mechanics I | 3 |
| PHYS 773 Quantum Mechanics II | 3 |
| PHYS 590 Graduate Seminar | 1 |
| Subtotals | 19 |

Electives

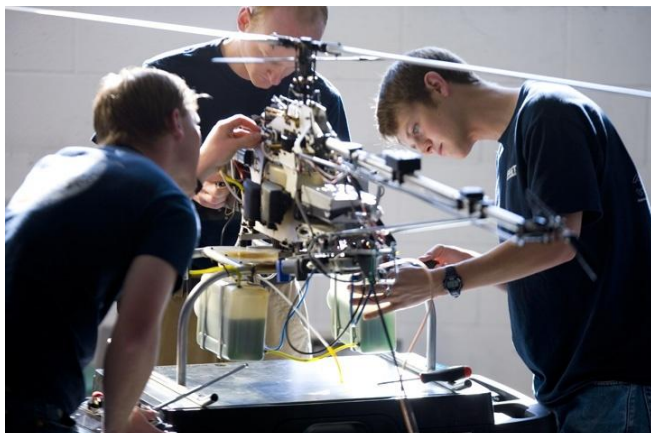
| | |
|---------------------------------------|-----|
| PHYS 533 Nuclear and Particle Physics | 3 |
| PHYS 539 Solid State Physics I | 4 |
| PHYS 581 Mathematical Physics I | 4 |
| MES 603 Condensed Matter Physics | 4 |
| PHYS 683 Mathematical Physics II | 3 |
| PHYS 691 Independent Study | 1-3 |

| | | | |
|---------------------------------------|-----|------------------------------|-------|
| PHYS 692 Special Topics | 1-3 | PHYS 791 Independent Studies | 1-4 |
| PHYS 739 Condensed Matter Physics I | 3 | PHYS 792 Topics | 1-4 |
| PHYS 749 Condensed Matter Physics II | 3 | PHYS 798 Thesis | 1-12 |
| PHYS 775 General Relativity | 3 | Subtotal | 29-58 |
| PHYS 779 Group Theory | 3 | | |
| PHYS 781 Nuclear and Particle Physics | 3 | | |
| PHYS 783 Quantum Field Theory | 3 | | |
| PHYS 785 Astrophysics and Cosmology | 3 | | |
| PHYS 787 Research | 1-9 | | |
| PHYS 788 Research or Design Paper | 1-9 | | |



Mines Matters: The National Science Foundation selected the former Homestake gold mine as the site for a multipurpose Deep Underground Science and Engineering Laboratory (DUSEL). To learn more about the history of Homestake and DUSEL visit www.lbl.gov/nsd/homestake.

Robotics and Intelligent Autonomous Systems M.S.



Contact Information

Dr. Jeff McGough

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Faculty

Professors Batchelder, Corwin, Dolan, Kalanovic, Korde, Logar, Penaloza, and Weiss; Associate Professors McGough, Tolle; Assistant Professors Hoover and Zong; Instructors Kanth and Linde.

Robotics and Intelligent Autonomous Systems

The Master of Science in Robotics and Intelligent Autonomous Systems (RIAS) is an interdisciplinary, research-oriented degree in an emerging technical area. Students in the program will be required to take courses in computer science, computer engineering, Electrical engineering and mechanical engineering. The primary objective of the RIAS program is to give students a basic understanding of the mechanical, electrical and computing systems required to participate in advanced mobile intelligent robotics applications.

The program covers the essentials of robotics, artificial intelligence, control, communications, sensors and signal processing. Students have the

opportunity to gain advanced knowledge in focus areas such as pattern recognition, computer vision, nonlinear control, digital signal processing, and communications. Graduates of this program should have a variety of career options in industrial applications, defense, homeland security, space exploration, or they can pursue study of a more advanced degree. The design and development of intelligent autonomous systems capable of interacting with the environment to complete complex tasks is a rare skill and the discipline is an emerging field.

General Background

Ideally, the entering student will normally have completed a four year degree (B.S.) in either computer engineering, computer science, electrical engineering or mechanical engineering or a closely related field of study. However, any capable and highly motivated student interested in this program is encouraged to apply regardless of academic background. This masters degree is a multidisciplinary degree and it is not expected that students will have the background in all the disciplines that are involved in the program. Leveling courses are offered to help the student gain skills to be successful in the academic areas outside their undergraduate training. Credit by examination is available. In the case of deficits in background, the student may be admitted on a probationary status while they make up missing course work.

Mathematics Background

- Year of Calculus (Calculus I and II)
- One semester of Multivariate Calculus (Calculus III)
- One semester of Differential Equations
- One semester of probability and statistics is suggested but not required.

Physics Background

- Two semesters of calculus based physics are suggested but not required

Programming Background

- Introductory programming course

Exams

- TOEFL – required for international students
- GRE – recommended but not required

The candidate who qualifies for the degree must satisfy the following requirements:

1. A minimum of 30 credits is required.
2. A minimum of 6 credits of CSC 798, Master's Thesis, and 24 credits of course work is required.
3. The twenty four credits course work is divided into core and specialization courses.
 - a. Completion of the 15 credits of core courses. See listing below.
 - b. A minimum of 9 credits of specialization courses taken from one of the four specialization areas: Computer Engineering, Computer Science, Electrical Engineering or Mechanical Engineering. Each master's specialization course is typically 3 credits, however some may be 4 credits. Courses for each specialization are listed below.
4. The student must participate in one of the RIAS team projects.
5. The student must pass an oral course work examination in the last semester of study. Additional information on the examination is found in the Graduate Handbook, which can be accessed through the RIAS website by clicking on Graduate Handbook.

A satisfactory thesis based on individual research. The student must present a formal defense of his or her thesis research.

Language Requirements

1. Students whose native language is not English are generally required to take the Test Of English as a Foreign Language (TOEFL).
2. Graduate students with a TOEFL score below 560 are required to attend a remedial course in English.
3. There is no foreign language requirement for the M.S. in RIAS degree.

Curriculum Leveling

Incoming students are not expected to have multiple undergraduate degrees. To address missing pre-requisites for core courses, two "leveling" courses are offered to help prepare students and act as prerequisites for the core classes. These courses do not count towards the 30 required credits. The two leveling courses are EE 505 Survey of Circuits and Systems and CSC 505 Survey of Data Structures and Algorithms.

Students who have taken the equivalent of EE 220, EE 221 and EE 311 will not need to take EE 505.

Students who have taken the equivalent of CSC 250, CSC 300 and CSC 372 will not need CSC 505.

We anticipate that students will need to take at least one leveling course. The student's advisor will determine which leveling courses are needed and advise the student accordingly.

Core Curriculum (Total of 15 credits):

| | |
|--------------|------------------------------------|
| CSC/CENG 515 | Robotics |
| CSC 547 | Artificial Intelligence |
| CSC/CENG 516 | Introduction to Autonomous Systems |
| EE 552 | Robotic Controls |
| EE 618 | Sensors and Signal Processing |

Computer Science Specialization (complete at least 9 credits):

| | |
|----------|----------------------------------|
| CSC 564 | Image Processing/Computer Vision |
| CSC 549 | Pattern Recognition |
| CENG 544 | Communications/Networking |
| CSC 533 | Graphics |
| CSC 521 | Graphical User Interfaces |
| CS 510 | Parallel Computing |

Computer Engineering Specialization (complete at least 9 credits):

| | |
|----------|---|
| CENG 544 | Communications/Networking |
| CENG 547 | Embedded and Real Time Computer Systems |
| CENG 420 | Digital Signal Processing |

| | |
|---------|------------------------------------|
| EE 624 | Advanced Digital Signal Processing |
| EE 643 | Advanced Digital Systems |
| CSC 564 | Image Processing/Computer Vision |
| CSC 549 | Pattern Recognition |

Electrical Specialization (complete at least 9 credits):

| | |
|----------|------------------------------------|
| CENG 544 | Communications/Networking |
| EE 651 | Digital Controls |
| EE 652 | Non-linear Controls |
| CENG 420 | Digital Signal Processing |
| EE 624 | Advanced Digital Signal Processing |
| EE 643 | Advanced Digital Systems |

Mechanical Engineering Specialization (complete at least 9 credits):

| | |
|--------|------------------------------------|
| ME 623 | Advanced Mechanical Vibrations |
| ME 68 | Advanced Mechanical System Control |
| EE 651 | Digital Controls |
| EE 652 | Non-linear Controls |
| ME 722 | Advanced Mechanical Design |
| ME 781 | Robotics |

Sample Program of Study

First Year

| | | |
|----------------------|----------|----------|
| Fall Semester | | |
| CSC 515 | Robotics | 3 |
| Leveling | | 3 |
| Specialization | | 3 |
| TOTAL | | 9 |

Spring Semester

| | | |
|----------------|-----------------------------|----------|
| CSC 516 | Intro to Autonomous Systems | 3 |
| CSC 547 | Artificial Intelligence | 3 |
| Specialization | | 3 |
| TOTAL | | 9 |

Second Year

| | | |
|----------------------|------------------|---|
| Fall Semester | | |
| EE 552 | Robotic Controls | 3 |

| | |
|-----------------|----------|
| Thesis research | 3 |
| Specialization | 3 |
| TOTAL | 9 |

Spring Semester

| | | |
|-----------------|-------------------------------|----------|
| EE 618 | Sensors and Signal Processing | 3 |
| Thesis research | | 3 |
| TOTAL | | 6 |

Note: There is room in the current course rotation for two leveling or background courses without having to extend the time of the degree or overload in hours.

Research Areas and Resources

Robotics and Intelligent Autonomous Systems offers a very extensive and diverse base of research areas. These areas include but are not limited to pattern recognition; computer vision and perception; navigation and localization; embedded systems and digital design; digital and nonlinear control; digital signal processing and sensor fusion; communications; manufacturing; and advanced materials and micromachines. School of Mines has a variety of computing platforms, labs and manufacturing facilities available. Resources include PC/Linux labs, Robotics Labs, Embedded Systems lab, general purpose electronics test labs, Neural Networks and Controls Lab, Micromechanics lab, and the Center for Excellence for Advanced Manufacturing and Production (CAMP). The institution encourages its students to use the facilities in the creative and efficient solution of scientific and engineering problems.

Technology Management M.S.



Contact Information

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Civil Mechanical 126
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School of Mines Faculty

Ervin Pietz Professor Kellogg, Professor Kerk, Associate Professors Matejcek and Karlin; and Assistant Professor Jensen.

Technology Management

The M.S. degree in technology management (MSTM) is designed to provide a program of advanced study in technically oriented disciplines for candidates anticipating a managerial career. It is a multi-disciplinary applications-oriented degree, which draws from the fields of

engineering, management, business, operations research and management science.

The intent of the program is to provide an interface between training received in engineering and scientific disciplines with the management of resources and personnel in a technical environment. In addition to being available in distance mode, flexibility is built into the program in order to provide an optimum educational experience to students. Graduates of the TM program are likely to find an initial position as a mid level supervisor within a broad range of applications requiring the use of quantitative models to integrate human and material resources necessary to perform an integrated function. Program specific information and resources may be found at the department of industrial engineering web site website:
<<http://ie.sdsmt.edu>>.

Application should be made through the graduate office at School of Mines. Alternatively, students may apply for the program online by visiting School of Mines website at:
<<http://ie.sdsmt.edu/tmweb/tm.htm>>. All candidates for this degree must possess a bachelor's degree from a four-year accredited institution, in which satisfactory performance has been demonstrated. In addition to these requirements, the following minimum bachelor's level credits shall have been completed:

1. Mathematics one year minimum, to include algebra and basic calculus (Equivalent to School of Mines MATH 123).
2. Six semester hours of natural and physical science (fields of geology, astronomy, biology, meteorology, chemistry, and physics) and which must include at least 3 credit hours of chemistry or physics.
3. Three semester hours of probability and statistics. (Students may complete prerequisite requirements in probability and statistics through an Internet-based study option. Students desiring this option should contact the program coordinator.)

In addition, individual elective courses may have additional prerequisite requirements. A maximum of 12 semester hours of credit may be transferred into the candidate's program from another institution. This must be from a regionally accredited institution. Application materials will be evaluated by an admission committee composed of the program director and such other faculty as deemed appropriate for the review. Recommendations from this committee will be made to the Dean of Graduate Education and research at the School of Mines.

Requirements for the degree include the completion of a minimum of 24 credits of course work and 6 credits of research for the thesis option, or 32 credits of course work for the non-thesis option. A cumulative GPA of 3.0 must be obtained by the end of the program of study and other general and master's level grade requirements must be maintained as specified in this catalog. The probation policy outlined in this catalog applies to all credits taken.

The continuing registration requirement must be satisfied at the School of Mines campus. Students utilizing transfer credits should plan accordingly and ensure that they are officially enrolled in a minimum of the two credits from the School of Mines the semester in which they graduate.

In the early stages of the candidate's program, a student advisor will be appointed by the program director of School of Mines. The advisor will meet with the student to prepare a program along the direction of the specific emphasis desired. The advisor and student will then organize a advisory committee, and file their committee program of study with the School of Mines graduate office according to the directions specified under "Supervision of the Master's Program" of the Master of Science Programs section of this catalog.

Core Course Requirements

A minimum of 3 semester hours of required course work must be completed in each of four discipline areas. Discipline areas and allowable courses are shown below.

Business/Finance

| | |
|--------|------------------------------------|
| TM 661 | Engineering Economics for Managers |
| TM 640 | Business Strategy |

Management

| | |
|----------|--|
| TM 742 | Engineering Management and Labor Relations |
| IENG 566 | Project Planning and Control |

Quantitative Methods

| | |
|--------|--|
| TM 631 | Optimization Techniques |
| TM 732 | Stochastic Models in Operations Research |
| TM 745 | Forecasting for Business and Technology |

Operations Management

| | |
|--------|---------------------|
| TM 663 | Operations Planning |
| TM 620 | Quality Management |

Students wishing to utilize transfer courses to satisfy core requirements should contact their advisor or the program coordinator for suitability of transfer credits. In some cases, agreements with other state institutions are already available.

Recommended Elective Courses

Any core course not used to satisfy core requirements may be used as an elective. Students may use any graduate School of Mines course provided it is approved by their committee. TM courses are available in distance learning mode and are listed below.

School of Mines Courses

| | | |
|--------|--|---|
| TM 625 | Innovation and Commercialization | 3 |
| TM 640 | Business Strategies | 3 |
| TM 650 | Safety Management | 3 |
| TM 655 | Ergonomics for Managers | 3 |
| TM 675 | Ethics and Professionalism for Technology Managers | 3 |
| TM 720 | Statistical Process Control | 3 |
| TM 732 | Stochastic Models in Operations Research | 3 |

| | | | | | |
|---|---|---|------------------|---|----------|
| TM 745 | Forecasting for Business and Technology | 3 | Student B | | |
| TM 792 | Advanced Topics in Technology Management | 3 | TM 661 | Engineering Economics for Managers | 4 |
| | | | TM 742 | Engineering Management and Labor Relations | 3 |
| Approved USD Elective and Core Courses | | | IENG 566 | Project Planning and Control | 3 |
| BADM 611 | Investments | 3 | TM 663 | Operations Planning | 3 |
| BADM 701 | Readings and Business Problems | 3 | TM 631 | Optimization Techniques | 3 |
| BADM 720 | Quantitative Methods | 3 | ECON 782 | Managerial Economics | 3 |
| BADM 722 | Advanced Information Systems | 3 | | | |
| BADM 726 | Decision Support Systems | 3 | TM 732 | Stochastic Models in Operations Research | 3 |
| BADM 727 | Database Management Administration | 3 | TM 720 | Statistical Process Control | 3 |
| BADM 728 | Microcomputers and Small Business Management Systems | 3 | ME 685 | Statistical Approaches to Reliability | 4 |
| BADM 761 | Organizational Theory and Behavior | 3 | MATH 687 | Statistical Design and Analysis of Experiments | 3 |
| BADM 762 | Business and its Environment | 3 | Total | | 3 |
| BADM 770 | Marketing Administration | 3 | | | |
| BADM 780 | Administrative Policy | 3 | | | |
| BADM 781 | Managerial Accounting | 3 | | | |
| BADM 794 | Research Problems | 3 | | | |

The following are sample programs for the project option for a student with a mining engineering degree (Student A), and a non-thesis option for a student contemplating a career as a laboratory manager in a government laboratory (Student B).

Student A

| | | |
|--------------|---|-----------|
| TM 661 | Engineering Economics for Managers | 3 |
| TM 742 | Engineering Management and Labor Relations | 3 |
| IENG 566 | Project Planning and Control | 3 |
| TM 663 | Operations Planning | 3 |
| TM 631 | Optimization Techniques | 3 |
| ECON 782 | Managerial Economics | 3 |
| TM 620 | Quality Management | 3 |
| TM 732 | Stochastic Models in Operations Research | 3 |
| TM 650 | Safety Management | 3 |
| TM 745 | Forecasting for Business and Technology | 3 |
| TM 7788 | Master Research Problems/ Project | 2 |
| Total | | 32 |

DEFINITIONS OF ABBREVIATIONS USED IN COURSE DESCRIPTIONS

Abbreviation Definition

| | |
|------|--|
| ACCT | Accounting |
| AES | Atmospheric and Environmental Sciences |
| ANTH | Anthropology |
| ART | Art |
| ARTH | Art History |
| ATM | Atmospheric Sciences |
| BADM | Business Administration |
| BIOL | Biology |
| BME | Biomedical Engineering |
| CBE | Chemical and Biological Engineering |
| CEE | Civil and Environmental Engineering |
| CENG | Computer Engineering |
| CHEM | Chemistry |
| CP | Career Planning |
| CSC | Computer Science |
| ECON | Economics |
| EE | Electrical Engineering |
| EM | Engineering Mechanics |
| ENGL | English |
| ENTR | Entrepreneurship |
| ENVE | Environmental Engineering |
| EXCH | Student Exchange - International |
| FREN | French |
| GE | General Engineering |
| GEOE | Geological Engineering |
| GEOG | Geography |
| GEOL | Geology |
| GER | German |
| GES | General Engineering and Science |
| HIST | History |
| HUM | Humanities |
| IENG | Industrial Engineering |
| IDL | Interdisciplinary Learning |
| IS | Interdisciplinary Sciences |
| LAKL | Lakota |
| MATH | Mathematics |
| ME | Mechanical Engineering |
| MEM | Mining Engineering and Management |

| | |
|------|-----------------------------------|
| MES | Materials Engineering and Science |
| MET | Metallurgical Engineering |
| MSL | Military Science |
| MUAP | Applied Music |
| MUEN | Music Ensemble |
| MUS | Music |
| NANO | Nanoscience and Nanoengineering |
| PALE | Paleontology |
| PE | Physical Education |
| PHIL | Philosophy |
| PHYS | Physics |
| POLS | Political Science |
| PSYC | Psychology |
| READ | Reading |
| REL | Religion |
| SOC | Sociology |
| SPAN | Spanish |
| SPCM | Speech |
| TM | Technology Management |

Courses above 400 level are normally reserved for graduate studies; however, in some cases, undergraduate students may take graduate level courses.

Students must receive a passing grade of “D” or better for any prerequisite course unless specifically stated.

COURSES

ACCT 210 PRINCIPLES OF ACCOUNTING I (3-0) 3 credits each. Prerequisite: Sophomore standing or permission of instructor. A study of fundamental accounting principles and procedures such as journalizing, posting, preparation of financial statements, and other selected topics. Accounting is emphasized as a service activity designed to provide the information about economic entities that is necessary for making sound decisions. This course cannot count as social science/humanities credit. This course is taught by Black Hills State University.

ACCT 211 PRINCIPLES OF ACCOUNTING II (3-0) 3 credits each. Prerequisite: ACCT 210. A continuation of ACCT 210 with emphasis on partnership and corporate structures, management

decision-making, cost control, and other selected topics. This course cannot count as social science/humanities credit. This course is taught by Black Hills State University.

ACCT 406/506 ACCOUNTING FOR ENTREPRENEURS

(3-0) 3 credits. Accounting concepts and practices for entrepreneurs/small business owners. Emphasis given to the use of accounting tools to solve small business problems. Students enrolled in ACCT 506 will be held to a higher standard than those enrolled in ACCT 406. This course is cross-listed with BADM 406/506 and ENTR 406/506. This course cannot count as a social science/humanities credit. This course is taught by Black Hills State University.

AES 790 SEMINAR

(1-0) 1 credit. Not to exceed 1 credit toward fulfillment of Ph.D. degree requirements. Preparation, oral presentation, and group discussion of a research problem. Enrollment required of all graduate students in residence.

AES 791 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or field work, and preparation of papers, as agreed to in advance, by student and instructor.

AES 792 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

AES 808 FUNDAMENTAL PROBLEMS IN ENGINEERING AND SCIENCE

(3-0) 3 credits. The course, available only for doctoral candidates, involves description, analysis, and proposed methods of attack of long-standing, fundamental problems in science and engineering. Independent work is emphasized with goals of understanding these basic questions and proposing practical designs and experiments for the solution. This course is cross-listed with GEOL 808.

AES 898 DISSERTATION

Credit to be arranged; not to exceed 12 credits toward fulfillment of Ph.D. degree requirements. Open only to doctoral candidates. Supervised original research investigation of a selected problem, with emphasis on independent work, culminating in an acceptable dissertation. Oral defense of dissertation and research findings is required.

ANTH 210 CULTURAL ANTHROPOLOGY

(3-0) 3 credits. Introduces the nature of human culture as an adaptive ecological and evolutionary system, emphasizing basic anthropological concepts, principles, and problems. Draws data from both traditional and industrial cultures to cover such concepts as values and beliefs, social organization, economic and political order, science, technology, and aesthetic expression.

ART 111/111A DRAWING I

(3-0) 3 credits. Introduces various drawing concepts, media, and processes developing perceptual and technical skills related to accurate observing and drawing.

ART 112/112A DRAWING II

(3-0) 3 credits. Prerequisite: ART 111. Emphasizes the continuing development of essential drawing skills and perceptual abilities as drawing concepts, compositional complexity, and creativity gain importance.

ART 491 INDEPENDENT STUDY

1 to 12 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study that include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

ARTH 211 HISTORY OF WORLD ART I

(3-0) 3 credits. Art and architecture in the historical and contextual development of the role

of visual arts, including crafts, drawing, painting, sculpture and architecture, in the historical and cultural development of world civilization from prehistory through the 14th century.

ARTH 321 MODERN AND CONTEMPORARY ART

(3-0) 3 credits. An exploration of technological and cultural influences on materials and content of art from the late 1800s to the present.

ARTH 491 INDEPENDENT STUDY

1 to 9 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study that include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

ARTH 492 TOPICS

1 to 6 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits of special topics will be allowed for degree credit.

ATM 301 INTRODUCTION TO ATMOSPHERIC SCIENCES

(3-0) 3 credits. Prerequisite: PHYS 111 or PHYS 113 or equivalent. Basic physical principles are applied to the study of atmospheric phenomena. Topics covered include the structure of the atmosphere, radiative processes, atmospheric motions, meteorological processes, air masses, fronts, weather map analysis, weather forecasting, and severe storms including thunderstorms, hail, tornadoes, hurricanes, and blizzards.

ATM 391 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. May be repeated to a total of 6 credit hours.

ATM 392 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. May be repeated to a total of 6 credit hours.

ATM 401/501 ATMOSPHERIC PHYSICS

(3-0) 3 credits. Prerequisites: PHYS 213, MATH 321, or equivalent. An introduction to physical processes that govern the behavior of the atmosphere. Topics will include atmospheric thermodynamics; absorption, scattering and radiative transfer; convective motion, tropospheric chemistry, and cloud and precipitation development; and atmospheric electricity. Satisfies the meteorology distribution requirement for the ATM M.S. program. Students enrolled in ATM 501 will be held to a higher standard than those enrolled in ATM 401.

ATM 402/502 THE GLOBAL CARBON CYCLE

(3-0) 3 credits. Prerequisite: One semester each of college level biology, chemistry, and physics. The fundamental processes that describe the keystone position of carbon and life in the earth system will be covered in detail. The majority of the course will focus upon photosynthesis and respiration on land and in the oceans, and how these processes have shaped earth's evolution.

The interrelationships of the biogeochemical cycles that couple photosynthesis and respiration will be introduced. Topics will cover scales from sub-cellular to global in scope. ATM 502 satisfies the Earth Systems distribution requirement for the ATM M.S. program. Students enrolled in ATM 502 will be held to a higher standard than those enrolled in ATM 402.

ATM 403/503 BIOGEOCHEMISTRY

(3-0) 3 credits. Prerequisite: ATM 402/502 or permission of instructor. The earth system is tightly connected through biogeochemical interactions. This course will present a multi-disciplinary array of intermediate and advanced topics in terrestrial, aquatic, and atmospheric biogeochemistry. Instantaneous to decadal time-scale interactions of carbon, water, and multiple nutrient cycles will be discussed, and a critical survey of the state-of-the-art field, modeling, and remote sensing methods for studying biogeochemical cycles will be presented. ATM 503 satisfies the Earth Systems distribution requirement for the ATM M.S. program. Students enrolled in ATM 503 will be held to a higher standard than those enrolled in ATM 403.

ATM 404/504 ATMOSPHERIC THERMODYNAMICS

2 or 3 credits. Prerequisites: PHYS 211 and MATH 225 or permission of instructor. This course will cover topics related to the thermodynamics of the atmosphere, particularly as they apply to a parcel of air. It will include the history of gas laws leading to the ideal gas law, the first and second laws of thermodynamics, adiabatic transformations and the introduction of entropy, the thermodynamic properties of water in its three phases, and the effects of water vapor on the thermodynamics of atmospheric processes. The final third of the course will introduce vertical stability and atmospheric thermodynamic diagrams. Students enrolled in ATM 504 will be held to a higher standard than those enrolled in ATM 404.

ATM 405/505 AIR QUALITY

(3-0) 3 credits. Prerequisites: Math 125 or equivalent and one semester of college chemistry.

Up-to-date problems and trends in urban air quality, global effects of environmental pollution, effects of air pollutants on weather processes, the technology of pollutant production, and pollutant dispersal. A treatment of the chemistry and physics of reactions involving primary air pollutants is included. Satisfies the Earth Systems distribution requirement for the ATM M.S. program. Students enrolled in ATM 505 will be held to a higher standard than those enrolled in ATM 405.

ATM 406 GLOBAL ENVIRONMENTAL CHANGE

(3-0) 3 credits. Prerequisite: CHEM 112 or equivalent, PHYS 111 or PHYS 113, BIOL 311, or permission of instructor. Major global environmental changes will be addressed using an interdisciplinary approach. Topics will include basic processes and principles of ecosystems, biogeochemical cycles, major climate controls, and atmospheric chemistry and feedbacks between climate and various earth system processes. This course is cross-listed with BIOL 403.

ATM 450/450L SYNOPTIC METEOROLOGY I

(2-1) 3 credits. Prerequisite: ATM 301. Analysis of surface synoptic weather, upper air, and vertical temperature-moisture soundings; the structure of extratropical storms, synoptic-scale processes responsible for development of precipitation and severe weather phenomena.

ATM 460/560 ATMOSPHERIC DYNAMICS

(3-0) 3 credits. Prerequisites: MATH 321 and PHYS 211. Equations of motion, kinematics of fluid flow, continuity equation, vertical motion, theorems of circulation and vorticity, quasi-geostrophic systems, and wave motions in the atmosphere. Satisfies the meteorology distribution requirement for the ATM M.S. program. Students enrolled in ATM 560 will be held to a higher standard than those enrolled in ATM 460.

ATM 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of

instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. May be repeated to a total of 3 credit hours.

ATM 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. May be repeated to a total of 5 credit hours.

ATM 515/515L EARTH SYSTEMS MODELING

(2-1) 3 credits. Prerequisite: MATH 125 or equivalent. This course provides the background for earth systems and climate modeling, with student projects on 0-D, 1-D, and 2-D models. The course will cover: radiation balance, climate feedback mechanisms, greenhouse gases, biogeochemical coupling, land and ocean surface processes, ecosystems, ocean circulations, and sea ice. Course will include familiarization of systems modeling using the STELLA modeling package. Students will also collaborate to develop components of a larger modeling project. Satisfies the Techniques distribution requirement for the ATM M.S. program.

ATM 520/520L REMOTE SENSING FOR RESEARCH

(2-1) 3 credits. Prerequisites: Math 125 or equivalent, CSC 150 or equivalent, or permission of instructor. Radiative transfer with respect to satellite remote sensing. Basic IDL programming. Image processing. Image enhancement. Image classification and interpretation. Satellite operations. Overview of operational and research

satellite platforms and select applications. The remote sensing of surface and atmospheric features. Labs and student projects. Satisfies the Techniques distribution requirement for the ATM M.S. program.

ATM 530 RADAR METEOROLOGY

(3-0) 3 credits. Prerequisites: MATH 125 and PHYS 213. Fundamentals of radar, scattering of electromagnetic waves by water drops and other hydrometeors, radar equations and the quantitative study of precipitation echoes, hydrometeor size distributions, Doppler weather radars, and applications of radar in meteorology. Satisfies the Techniques distribution requirement for the ATM M.S. program.

ATM 540 ATMOSPHERIC ELECTRICITY

(3-0) 3 credits. Prerequisites: PHYS 213 or equivalent or permission of instructor. This course will cover topics in fair weather electricity including ions, conductivity, currents, and fields making up the global circuit. In addition, topics in thunderstorm electricity including charge separation theories and the microphysical and dynamic interactions responsible for charging, current balances, and the lightning discharge will be introduced. Satisfies the meteorology distribution requirement for the ATM M.S. program.

ATM 550/550L SYNOPTIC METEOROLOGY II

(2-1) 3 credits. Prerequisites: ATM 450 and concurrent enrollment in corresponding laboratory module, or permission of instructor. Study and application of modern techniques for forecasting the development and movement of weather systems and for forecasting various weather phenomena. Includes discussion of numerical weather prediction and suite of forecasting models run daily by the National Centers for Environmental Prediction; use of current software packages such as McIDAS and GEMPAK for analyzing observed data and model output: interpreting weather phenomena in terms of dynamical theories; forecasting of convective weather phenomena; and understanding the use of Model Output Statistics (MOS). Satisfies the

meteorology distribution requirement for the ATM M.S. program.

ATM 570 WILDFIRE METEOROLOGY

(3-0) 3 credits. Prerequisite: ATM 301 or equivalent. In this course students will learn about basic physical processes related to fire behavior and fire weather. Topics include combustion and heat, forest fuels, fire danger, fire behavior and spread, fire spread models, smoke management, prescribed fire, and case studies of significant large wildfires in recent history. Some outdoor field instruction is included.

ATM 591 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor.

ATM 592 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

ATM 599/599L COMPUTING METHODS IN ATMOSPHERIC SCIENCES

(2-1) 3 credits. Prerequisite: CSC 150 or equivalent. Introduction to the Linux operating system from the user's perspective. Fundamentals of the Fortran 90/95 programming languages. Introduction to scientific data formats commonly used in the meteorology community (netCDF, GRIB, Climate and Forecast (CF) Metadata Conventions). Additional material may include shell scripts, and visualization of meteorological data using community based software (IDV, NCAR Command Language). This experimental course is a candidate for the ATM MS Techniques requirement but has not been formally established as such. (Experimental)

ATM 603 BIOSPHERE-ATMOSPHERE INTERACTIONS

(3-0) 3 credits. Prerequisite: Permission of instructor. The biosphere and the atmosphere are intimately connected. In this course, the

biogeochemical sources and sinks of a wide range of gases affecting atmospheric chemistry, climate, and ecosystem health are examined in detail.

Microbial, plant, and animal processes relating to nitrogen, sulfur, and carbon trace gas production and consumption will be covered in detail.

Relevant biophysical phenomena occurring in vegetation canopies, soils, wetlands, and oceans will be discussed. The role of humans in altering these natural processes will be revisited throughout the course, and overviews of trace gas measurement techniques will be presented.

Satisfies the Earth Systems distribution requirement for the ATM M.S. program.

ATM 608/608L AIR QUALITY MODELING

(2-1) 3 credits. Prerequisites: MATH 125 or equivalent. A treatment of diffusion and dispersion modeling for point and area emissions. Gaussian diffusion, climatological screening techniques, dispersion in complex terrain, and physical basis of dispersion model will be treated. Current EPA regulatory models will be emphasized. Some knowledge of computer programming is desirable. Satisfies the Techniques distribution requirement for the ATM M.S. program.

ATM 612 ATMOSPHERIC CHEMISTRY

(3-0) 3 credits. Prerequisite: One year of college chemistry. Radiative, chemical, and biological processes associated with formation of stratospheric ozone, tropospheric ozone, biogenic emissions and human-caused emissions, "greenhouse" effects, and aqueous-phase equilibria in clouds. The approach will include aspects of classical chemistry, nucleation, instrumentation, and modeling of effects of chemical pollutants on cloud microphysics. Interactions of biological and human-caused emission of trace gases with radiation and oxidant balance of the earth's atmosphere. Topics to be addressed include: stratospheric ozone formation and the "ozone hole," Tropospheric ozone formation, field techniques to measure chemical fluxes, and photochemistry of the remote troposphere. Satisfies the Earth Systems distribution requirement for the ATM M.S.

program.

ATM 625/625L SCALING IN GEOSCIENCES

(2-1) 3 credits. Prerequisites: MATH 125, CSC 150, or equivalent; MATH 441 or equivalent.

Issues regarding the scaling of geophysical processes across various problem domains in the geosciences will be presented and explored through lectures, labs and course projects. Topics include Fourier Analysis, Taylor/Moment Expansion, Fractals, Power Laws, and Upscaling/Downscaling Techniques.

Applications include Climate, Turbulence, Weather and Climate Prediction, Remote Sensing and GIS, Ecosystem Studies, Geology, and Hydrology. Satisfies the Techniques distribution requirement for the ATM M.S. program.

ATM 643 PRECIPITATION PHYSICS AND CLOUD MODIFICATION

(3-0) 3 credits. Prerequisite: ATM 501 or equivalent. Aerosols, condensational drop growth, growth of ice particles by deposition of vapor, accretion, and cloud modification techniques. Emphasis on problem solving with aid of computers. Satisfies the meteorology distribution requirement for the ATM M.S. program.

ATM 644/644L NUMERICAL DYNAMICS AND PREDICTION

(2-1) 3 credits. Prerequisite: ATM 560. Basic governing equations, wave motions, baroclinic instability, numerical methods, numerical prediction models; boundary layer, moisture and radiation parameterization, and data assimilation. Satisfies the Techniques distribution requirement for the ATM M.S. program.

ATM 651/651L MEASUREMENT AND INSTRUMENTATION

(2-1) 3 credits. Prerequisite: Permission of instructor. An overview of the principles of measurement will be covered, in combination with detailed investigations into instruments designed to measure some of the following phenomena: radiation, temperature, humidity, wind, precipitation, photosynthesis, surface reflectance, and concentrations and fluxes of trace

gases. Multiple scale measurement techniques will be addressed. Students will learn to collect, log, and download field data using both manual and automatic methods. An integral part of the course will be a field-based measurement project. The topics covered in this course will vary depending on the research interests of students enrolled and the contributing professors. Satisfies the Techniques distribution requirement for the ATM M.S. program.

ATM 660 ATMOSPHERIC DYNAMICS II

(3-0) 3 credits. Prerequisite: ATM 560.

Derivation, solution, and physical interpretation of the fundamental hydrothermodynamic equations as applied to atmospheric waves, mesoscale motions, atmospheric energetics, general circulation, tropical and stratospheric flows. Introduction to numerical prediction. Satisfies the meteorology distribution requirement for the ATM M.S. program.

ATM 670 BOUNDARY LAYER PROCESSES

(3-0) 3 credits. Prerequisites: ATM 501, ATM 560, or permission of instructor. Atmospheric structure and processes near the ground. Turbulence and the closure problem, buoyancy and stress-driven mixed layers, mixed layer growth, heat, moisture, and momentum transfer, surface balance of radiation, heat and moisture, parameterization, and modeling of the boundary layer. Satisfies the meteorology distribution requirement for the ATM M.S. program.

ATM 673 MESOMETEOROLOGY

(3-0) 3 credits. Prerequisites: ATM 560 or permission of instructor. Observations and analysis of basic meteorological fields on the mesoscale. Dynamics, phenomenology, and forecasting of mesoscale weather phenomena: Internally generated circulations, mesoscale convective systems, externally forced circulations. Mesoscale modeling and nowcasting. Satisfies the meteorology distribution requirement for the ATM M.S. program.

ATM 690 SEMINAR

(1-0) 1 credit. Not to exceed 1 credit toward fulfillment of M.S. degree requirements.

Enrollment required of all graduate students in residence each spring semester.

ATM 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or field work, and preparation of papers, as agreed to in advance, by student and instructor.

ATM 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

ATM 798 MASTER'S THESIS

Credit to be arranged. Not to exceed 6 credits toward fulfillment of M.S. degree requirements. Open only to students admitted to the ATM M.S. program. Supervised original or expository research culminating in an acceptable thesis. Oral defense of thesis and research findings are required. Graduate research assistants and students under faculty supervision for their research are required to enroll in this course each semester.

BADM 101 SURVEY OF BUSINESS

(3-0) 3 credits. This course is an introduction to the basic business disciplines and the organization and management of the American enterprise system. It also introduces students to the necessary college level skills of critical thinking, effective communication and cooperative and effective learning. This course cannot count as social science/humanities credit. This course is taught by Black Hills State University.

BADM 221 MANAGERIAL STATISTICS

(3-0) 3 credits. Prerequisite: MATH 281. The course is designed to provide students with an understanding of the computations and subsequent application of statistical methods used in business management and economics. Particular emphasis is placed on such areas as: sampling methods (e.g. estimates for simple random, stratified, cluster, and systematic sampling), Total Quality Management (e.g. statistical process control and

its application to monitoring process variables), times series analysis and forecasting, smoothing techniques, and multiple regression techniques. This course cannot count as social science/humanities credit. This course is taught by Black Hills State University.

BADM 293 WORKSHOP

1 to 3 credits. Prerequisite: Permission of instructor. Special, intense sessions in specific topic areas. Approximately 45 hours of work is required for each hour of credit. Workshops may vary in time range but typically use a compressed time period for delivery. They may include lectures, conferences, committee work, and group activity. This course cannot count as social science/humanities credit. This course is taught by Black Hills State University.

BADM 310 BUSINESS FINANCE

(3-0) 3 credits. Prerequisites: ACCT 211. Business finance is an overview of financial theory including the time value of money, capital budgeting, capital structure theory, dividend policies, asset pricing, risk and return, the efficient markets hypothesis, bond and stock valuation, business performance evaluation, and other financial topics. This course cannot count for humanities/social science credit. This course is taught by Black Hills State University.

BADM 336 ENTREPRENEURSHIP I

(3-0) 3 credits. This course is an introduction to the concepts, terminology, and process of new venture creation, operation and growth, as well as the introduction of entrepreneurial management practices into existing businesses. New ventures include public and non-profit institutions as well as for profit businesses. This course will assist in the identification of entrepreneurial opportunities and strategies and the role of personal factors (including creativity). Legal, ethical, and social responsibilities are emphasized. This course is cross-listed with ENTR 336. This course cannot count as a social science/humanities credit. This course is taught by Black Hills State University.

BADM 350 LEGAL ENVIRONMENT OF BUSINESS

(3-0) 3 credits. This is a study of legal topics as they apply to the business environment. Topics include an introduction to the law, the U.S. court system, legal process, government regulation, and criminal, tort, and contract issues. This course is taught by Black Hills State University.

BADM 360 ORGANIZATION AND MANAGEMENT

(3-0) 3 credits. This course is a study of management, including the planning, directing, controlling and coordinating of the various activities involved in operating a business enterprise. This course is taught by Black Hills State University.

BADM 370 MARKETING

(3-0) 3 credits. This course introduces the student to the basic concepts and practices of modern marketing. Topics include marketing and its linkages to business, consumer behavior, marketing research, strategy and planning, product and pricing decisions, distribution and promotion decisions, marketing management, and evaluation and control aspects for both consumer and industrial goods. This course cannot count as social science/humanities credit. This course is taught by Black Hills State University.

BADM 406/506 ACCOUNTING FOR ENTREPRENEURS

(3-0) 3 credits. Accounting concepts and practices for entrepreneurs/small business owners. Emphasis given to the use of accounting tools to solve small business problems. Students enrolled in BADM 506 will be held to a higher standard than those enrolled in BADM 406. This course is cross-listed with ACCT 406/506 and ENTR 406/506. This course cannot count as a social science/humanities credit. This course is taught by Black Hills State University.

BADM 438/538 ENTREPRENEURSHIP II

(3-0) 3 credits. This course focuses on the process of screening an opportunity, drafting a personal entrepreneurial strategy, and understanding the business plan writing process.

Building the entrepreneurial team and the acquisition and management of financial resources are emphasized along with venture growth, harvest strategies, and valuation. Students enrolled in BADM 538 will be held to a higher standard than those enrolled in BADM 438. This course is cross-listed with ENTR 438/538. This course cannot count as a social science/humanities credit. This course is taught by Black Hills State University.

BADM 489 BUSINESS PLAN WRITING AND COMPETITION

(1-0) 1 credit. Students will write a business plan and present it to a panel of faculty and business community members. The top three business plan presenters will move on to a statewide competition. This course is cross-listed with ENTR 489. This course is taught by Black Hills State University.

BADM 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. This course cannot count as social science/humanities credit. This course is taught by Black Hills State University.

BADM 493 WORKSHOP

1 to 3 credits. Special, intense sessions in specific topic areas. Approximately 45 hours of work is required for each hour of credit. Workshops may vary in time range but typically use a compressed time period for delivery. They may include lectures, conferences, committee work, and group activity. This course cannot count as social science/humanities credit. This course is taught by Black Hills State University.

BIOL 121 BASIC ANATOMY

(3-0) 3 credits. Anatomy of the human body to

include basic biological principles and medical nomenclature. This course is specifically designed for students in the pre-nursing curriculum.

BIOL 121L BASIC ANATOMY LAB

(0-1) 1 credit. Prerequisite or corequisite: BIOL 121. Laboratory experience that accompanies BIOL 121. Exercises to complement material in BIOL 121 with special emphasis on the anatomy of the cat.

BIOL 123 BASIC PHYSIOLOGY

(3-0) 3 credits. The physiology of the human body. This course is specifically designed for students in a pre-nursing curriculum.

BIOL 123L BASIC PHYSIOLOGY LAB

(0-1) 1 credit. Prerequisite or corequisite: BIOL 123. Laboratory exercises to accompany BIOL 123 including non-invasive experimentation and computer demonstration materials.

BIOL 151 GENERAL BIOLOGY I

(3-0) 3 credits. The introductory course for those majoring in biology and microbiology. Presents the concepts of cell biology, evolution, heredity, molecular genetics, and ecology.

BIOL 151L GENERAL BIOLOGY I LAB

(0-1) 1 credit. Prerequisite or corequisite: BIOL 151. Laboratory experience that accompanies BIOL 151. Laboratory exercises designed to reinforce subject material covered in BIOL 151 lectures.

BIOL 153 GENERAL BIOLOGY II

(3-0) 3 credits. Prerequisite: BIOL 151. A continuation of BIOL 151, the introductory course for those majoring in biology and microbiology. Presents the concepts of animal and plant structure and function, energetics, and reproduction.

BIOL 153L GENERAL BIOLOGY II LAB

(0-1) 1 credit. Prerequisite or corequisite: BIOL 153. Laboratory experience that accompanies BIOL 153. Laboratory exercises designed to reinforce subject material covered in BIOL 153

lectures.

BIOL 231 GENERAL MICROBIOLOGY

(3-0) 3 credits. Prerequisites: CHEM 106. Principles of basic and applied microbiology. Topics covered are bacteriology, virology, microbial genetics, immunology, and disinfection.

BIOL 231L GENERAL MICROBIOLOGY LAB

(0-1) 1 credit. Prerequisites: CHEM 106/106L. Prerequisite or corequisite: BIOL 231. Laboratory experience that accompanies BIOL 231. Basic laboratory skills necessary for general microbiology. Emphases are made on techniques of aseptic bacterial transfer, serial dilutions in bacterial cell counts, bacterial staining, and serology.

BIOL 298 UNDERGRADUATE RESEARCH

1 to 3 credits. Prerequisite: Permission of instructor. Includes senior project, and capstone experience. Independent research problems/projects or scholarship activities. The plan of study is negotiated by the faculty member and the student. Contact between the two may be extensive and intensive. Does not include research courses that are theoretical.

BIOL 311 PRINCIPLES OF ECOLOGY

(3-0) 3 credits. Basic principles of ecology including the sub disciplines of physiological ecology, population ecology, community ecology, evolutionary ecology, and ecosystems ecology from both a theoretical and applied aspect.

BIOL 341 MICROBIAL PROCESSES IN ENGINEERING AND NATURAL SCIENCES

(3-0) 3 credits. Prerequisite: CHEM 112. This course introduces and develops important fundamental topics including: microbial structure and chemistry; cellular metabolism; and intercellular processes and extracellular conditions that control microbial behavior, leading to applications such as biocatalysis, biofuels production, environmental bioremediation, food processing, microbial ecology, pharmaceuticals production, environmental microbiology, and wastewater

renovation.

BIOL 371 GENETICS

(3-0) 3 credits. Principles governing the nature, transmission and function of hereditary material with application to plants, animals, humans, and microorganisms.

BIOL 403 GLOBAL ENVIRONMENTAL CHANGE

(3-0) 3 credits. Prerequisite: CHEM 112 or equivalent, PHYS 111 or PHYS 113, BIOL 311, or permission of instructor. Major global environmental changes will be addressed using an interdisciplinary approach. Topics will include basic processes and principles of ecosystems, biogeochemical cycles, major climate controls, atmospheric chemistry, and feedbacks between climate and various earth system processes. This course is cross-listed with ATM 406.

BIOL 423 PATHOGENESIS

(3-0) 3 credits. Prerequisites: BIOL 231 and CHEM 112. Lecture/discussion course on principles of medical microbiology including the molecular basis of pathogenesis, host-parasite relationship, and pathology of animal and human diseases. Emphasis on current literature in pathogenesis.

BIOL 423L PATHOGENESIS LAB

(0-1) 1 credit. Prerequisites: BIOL 231L or equivalent; pre- or corequisite: BIOL 423. Basic laboratory skills necessary for pathogenic microbiology. Emphasis is on bacteriological, biochemical and serological tests of medically important pathogens.

BIOL 431 INDUSTRIAL MICROBIOLOGY

(3-0) 3 credits. Prerequisite: BIOL 231 or equivalent. The roles of microbes in nature, industry, and public health are considered. Application of microbiology to engineering is emphasized. Concurrent registration in BIOL 431L recommended but not required.

BIOL 431L INDUSTRIAL MICROBIOLOGY LABORATORY

(0-1) 1 credit. Prerequisites: BIOL 231L or

equivalent; pre- or corequisite: BIOL 431. Basic laboratory skills necessary for applied environmental microbiology. Emphasis is on sampling of environmental microorganisms, bacterial growth curve, analysis of water quality, isolation of coliphages, and Ames test for chemical mutagens.

BIOL 491 INDEPENDENT STUDY

1 to 4 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

BIOL 492 TOPICS

1 to 5 credits. Includes current topics, advanced topics, and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

BIOL 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory, or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor.

BIOL 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

BME 601 BIOMATERIALS

(3-0) 3 credits. This course will provide students with an overview of the field of biomaterials with the knowledge necessary to conduct biomedical product development and/or biomaterials

research. The first portion of the course will provide an introduction to the major classes of materials used in medical devices including metals, polymers, ceramics, composites, and natural materials. Topics covered will include material properties, material processing, testing, corrosion, biocompatibility, tissue responses, etc. The second portion of the course will cover specific biomaterial applications such as dental, orthopedic, cardiovascular, drug delivery, and tissue engineering. The topics of implant cleanliness and sterilization methods will also be discussed. In addition, the topic of national and international governmental regulations and requirements will be reviewed including examples of investigative devices exemptions and 510k submissions. This course is cross-listed with MET 601.

BME 602 ANATOMY AND PHYSIOLOGY FOR ENGINEERS

(3-0) 3 credits. Introduces biomedical engineering students to fundamentals of human anatomy and physiology. Topics include engineering anthropometry, the skeletal system, skeletal muscle, the neuromuscular control system, the respiratory system, the circulatory system, the metabolic system, the thermoregulatory system, body rhythms, and an introduction to reengineering the human body.

BME 603 MOLECULAR BIOLOGY FOR ENGINEERS

(3-0) 3 credits. This course is designed to provide a basic knowledge on molecular biology and bioinformatics that is directly applicable to engineering and related science fields. Up-to-date techniques in genetic engineering biotechnology, and bioinformatics will be introduced for the understanding of biological problems using engineering concepts or engineering/mechanical problems through biological tools. This course is cross-listed with CBE 603

BME 604 SENSING AND SIGNAL PROCESSING

(3-0) 3 credits. Presentation of principles, characteristics, and applications of instrumentation systems including, sensors, filters,

instrumentation amplifiers, analog-to-digital and digital-to-analog conversions, and noise. This course will be useful to graduate students beginning their laboratory thesis research. It is available to students from other departments with permission of instructor.

BME 606 OCCUPATIONAL BIOMECHANICS

(3-0) 3 credits. Anatomical and physiological concepts are introduced to understand and predict human motor capabilities, with particular emphasis on the evaluation and design of manual activities in various occupations. Quantitative models are developed to explain muscle strength performance; cumulative and acute musculoskeletal injury; physical fatigue; and human motion control.

BME 607 BIOMECHANICS

(3-0) 3 credits. This course presents and introduction to biomechanics from a continuum mechanics perspective. It covers fundamental concepts of solid and fluid mechanics with applications to living systems. Topics in biosolid mechanics include stress, strain, constitutive relations, equilibrium, response to basic loading modes (extension, bending, and torsion), and buckling. Topics in biofluid mechanics include motion of a continuum, constitutive relations, fundamental balance relations, control volume and semi-empirical methods.

BME 673 APPLIED ENGINEERING ANALYSIS I

(3-0) 3 credits. Advanced topics in engineering analysis. Special mathematical concepts will be applied to mechanical engineering problems. Topics will be selected from the following: Fourier series and boundary value problems applied to heat conduction and convection, Laplace transforms and complex variable analysis applied to vibrations and dynamic system analysis, series solutions of differential equations, partial differential equations, general matrix applications to a variety of large systems of equations in engineering, calculus of variation, and Ritz method for various engineering problems. This course is cross-listed with ME 673.

BME 724 BIOPOLYMERS

(3-0) 3 credits. This course is to survey the structure, function, properties and use of biopolymers. The course has three fifty minute lectures per week on Monday, Wednesday and Friday. Supporting reading materials will be assigned from the textbook and supplementary reading materials (see the list above). Please note that the textbook is meant to supplement the lectures, not to substitute for them; you will ONLY be responsible for the materials presented in the lectures.

BME 725 BIOCOMPOSITES

(3-0) 3 credits. This course focuses on composite materials applied to bioengineering. First part of the course introduces biocomposites for medical applications and biocompatibility. Second part focuses on mechanical design and manufacturing aspects of various fibrous polymer matrix composites in terms of: i) material selection, fabrication, and characterization, ii) mechanics of composite materials, iii) design with composite materials. Third part deals with ceramic or nano composites and their applications in biomedical engineering. Final part introduces various case studies such as dental, orthopedics, prosthetic socket, and external fixator applications.

BME 726 BIOCOMPOSITES BIO/MEMS AND NANO SYSTEMS

(3-0) 3 credits. Course Description: Application of microelectromechanical systems (MEMS) and nano-systems to biological systems, interaction of living cells and tissues with MEMS substrates and nano-engineered materials, microfluidics, engineering of inputs and outputs.

BME 730 VASCULAR MECHANICS AND PATHOLOGY

(3-0) 3 credits. The course focuses on the artery and arterial diseases including the genesis of heart disease. Since the artery serves as both a conduit of blood flow and a container of blood pressure, the course covers both the general principles and the occurrence of stress concentration in the pressure vessel. The topics included are atherosclerosis, structure and mechanics of artery, pressure vessel principles, stress concentration in

the artery, endothelial cells and low density lipoproteins, smooth muscle cells and stretch, stress reduction and atherosclerosis reduction, the vein graft, intracranial aneurysms, and aortic aneurysms.

BME 731 ADVANCED BIOMECHANICS

(3-0) 3 credits. The course presents the fundamentals of continuum mechanics and nonlinear theory of elasticity with applications to the mechanical behavior of soft biological tissues.

BME 732 MEDICAL IMAGING

(3-0) 3 credits. This course covers the physics of the major modalities commonly used in medical imaging. Also covered are the various principles and methods of constructing an image from the physical interactions of energy with living tissue, and the influence on image quality of the different modalities. Medical imaging systems to be analyzed include conventional X-ray, computed tomography (CT), magnetic resonance imaging (MRI), nuclear medicine (PET and SPECT), and ultrasound. Each of these modalities will be introduced from basic physical principles to the process of image formation. The primary focus is on the physical principles, instrumentation methods, and imaging algorithms; however, the medical interpretation of images, and clinical, research and ethical issues are also included where possible to give students a deeper understanding of the medical imaging field.

BME 733 CARDIOVASCULAR FLUID DYNAMICS

(3-0) 3 credits. Mechanics of blood circulation, fluid mechanics of the heart, blood flow in arteries, unsteady flow in veins, current concepts in circulatory assist devices, biofluidics, and other selected topics. Review of cardiovascular physiology; introduction to fluid mechanics; Models of blood flow and arterial wall dynamics; Fluid mechanics and arterial disease; heart valve fluid dynamics; Ventricular assist devices.

BME 734 TRANSPORT PHENOMENA IN BIOMEDICAL ENGINEERING

(3-0) 3 credits. The study of transport phenomena in biomedical systems including analysis of

engineering and physiological systems and incorporation of these principles into the design of such systems. The objective of this course is for students to learn to think about, understand and model the dynamic behavior of complex biological systems. The scope of the systems to be studied is restricted to an analysis of biotransport phenomena in the human body.

BME 735 CAD/CAM IN MEDICINE AND SURGERY

(3-0) 3 credits. Introduction to computer aided design and modeling of prosthetic devices, and their subsequent manufacture using computer aided manufacturing techniques. Applications in orthopedic implant design and fabrication, dental implant design and fabrication, as well as other types of prosthetics. An advanced level review of current computer modeling and manufacturing technology for medical applications.

BME 736 ADVANCED FINITE ELEMENT METHODS

(3-0) 3 credits. Variational and weighted residual approach to finite element equations. Emphasis on two- and three-dimensional problems in solid mechanics. Isoparametric element formulations, higher order elements, numerical integration, imposition of constraints, convergence, and other more advanced topics. Introduction to geometric and material nonlinearities. Introduction to the solution of dynamic problems and time integration. Use of finite element computer programs.

BME 737 ADVANCED SIGNAL PROCESSING AND IMAGING

(3-0) 3 credits. This course develops the theory essential to understanding the algorithms that are increasingly found in modern signal processing applications, such as speech, image processing, digital radio and audio, statistical and adaptive systems. Topics include: analysis of non-stationary signals, transform techniques, Wiener filters, Kalman filters, multirate systems and filter banks, hardware implementation and simulation of filters, and applications of multirate signal processing. Matlab will be used extensively.

BME 738 INFORMATION TECHNOLOGY IN MEDICINE

(3-0) 3 credits. Software techniques used in medical treatment and diagnosis, including transform techniques. Medical reference software engineering. Data mining. Hardware and connectivity issues. Bioinformatics.

BME 745 MOLECULAR MACHINES

(3-0) 3 credits. This course studies forces that determine molecular structure, transport, and diffusion, macromolecular assemblies, protein synthesis, structural biology, molecular genetics, enzymology.

BME 746 BIOMIMETICS

(3-0) 3 credits. This course will survey recent research at the intersection of biology and mechanical/structural engineering, in particular, applications where nature's design philosophies are applied in human-engineered structures. Multi-functional materials, hierarchical design, adaptive materials within closed loop systems, self-healing of natural structures, with a view to self-healing human engineered structures. Applications in aerospace and rehabilitation engineering.

BME 751 DRUG DELIVERY

(3-0) 3 credits. This course focuses on the engineering and biomolecular principles of drug therapy. Students will be introduced to the fundamentals of drug delivery, materials used for drug delivery, and controlled/targeted drug delivery strategies.

BME 773 APPLIED ENGINEERING ANALYSIS II

(3-0) 3 credits. Applications of numerical methods to mechanical engineering problems. Topics will include data processing techniques, curve fitting and interpolation of experimental information, solutions to systems of ordinary differential equations, solutions to partial differential equations, and numerical integration both of known functions and functions described only by experimental data. This course is cross-listed with ME 773.

BME 790 SEMINAR

(1-0) 1 credit. May not be repeated for degree credit. Preparation, oral and/or written presentation, and group discussion of a research problem. The student is expected to present orally the results of his/her own research. This presentation normally will directly precede the final defense of the thesis. Enrollment is generally limited to fewer than 20 students.

BME 792 TOPICS

1 to 4 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

BME 798 MASTER'S THESIS

Credit to be arranged; not to exceed 6 credits toward fulfillment of M.S. degree requirements. Open only to students pursuing the M.S. thesis option. Supervised original or expository research culminating in an acceptable thesis. Oral defense of these and research findings are required. This course will be the basis for the student's thesis required in partial fulfillment of the requirements for the master of science degree in the Biomedical Engineering program.

BME 896 FIELD EXPERIENCE

(0-1) 1 credit. Students will spend a minimum of three hours per week in a hospital or another program-approved health care facility. They will observe and/or work with the technical and clinical staff in order to develop insights into the health care profession and the role of engineering in medicine as it applies to their focus area of study and research. Required of doctoral students only.

BME 898 DISSERTATION

Credit to be arranged; not to exceed 30 credits toward fulfillment of Ph.D. degree requirements. Open only to doctoral candidates. Supervised original research investigation of a selected problem, with emphasis on independent work, culminating in an acceptable dissertation. Oral defense of dissertation and research findings are required.

CBE 111 INTRODUCTION ENGINEERING MODELING

(0-1) 1 credit. Prerequisite or corequisites: CHEM 112. The primary objectives of this course are: introduction to mathematical modeling of physical and chemical systems; verification of mathematical models by experiment; development and interpretation of engineering drawings, process flow diagrams (PFD's), and piping and instrumentation diagrams (P&ID's); use of a drawing program, such as Visiotec; and an introduction to the process simulator AspenPlus.

CBE 117/117L PROFESSIONAL PRACTICES IN CHEMICAL ENGINEERING

(1-1) 2 credits. Prerequisite or corequisite: MATH 123. An introduction to chemical engineering through the development of computational and laboratory skills. The extended use of spreadsheets, programming, and computational software packages will be covered. Elementary numerical methods will be utilized in process modeling and laboratory experiments. Students will participate in hands-on programming exercises in a computer laboratory, or in a lab, using a tablet-pc.

CBE 200 UNDERGRADUATE RESEARCH

1 to 3 credits. Prerequisite: Permission of instructor and freshman or sophomore standing. Directed research or study of a selected problem culminating in an acceptable written report.

CBE 217 CHEMICAL ENGINEERING I

(3-0) 3 credits. Prerequisites or corequisite: CHEM 114 and CBE 117 or permission of instructor. The first course on the theory and practice of chemical engineering with emphasis on material and energy balances. This course is cross-listed with ENVE 217.

CBE 218 CHEMICAL ENGINEERING II

(3-0) 3 credits. Prerequisites: CBE 217, MATH 125. The second course on the theory and practice of chemical engineering with emphasis on momentum transfer.

CBE 222 CHEMICAL ENGINEERING THERMODYNAMICS I

(3-0) 3 credits. Prerequisites: CBE 217, concurrent registration in MATH 225. A study of the principles and applications of thermodynamics with emphasis on the first law, the energy balance.

CBE 250 COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING

(2-0) 2 credits. Prerequisites: CBE 117, CBE 217, concurrent with MATH 321 or permission of instructor. The application of digital computer techniques to the solution of chemical engineering problems.

CBE 317 CHEMICAL ENGINEERING III

(3-0) 3 credits. Prerequisites: CBE 217, concurrent registration in MATH 321. The third course on the theory and practice of chemical engineering with emphasis on heat transfer. Heat transfer by conduction, convection, and radiation is studied. This course is cross-listed with ENVE 315.

CBE 318 CHEMICAL ENGINEERING IV

(3-0) 3 credits. Prerequisite: CBE 317 or ENVE 315 or permission of instructor. The fourth course on the theory and practice of chemical engineering with emphasis on molecular diffusion, membranes, convective mass transfer, drying, humidification, and continuous gas-liquid separation processes. This course is cross-listed with ENVE 318.

CBE 321 CHEMICAL ENGINEERING THERMODYNAMICS II

(3-0) 3 credits. Prerequisite: CBE 222. A continuation of CBE 222 with emphasis on the second and third laws of thermodynamics. Emphasis on thermodynamic properties of fluids, flow processes, phase and chemical equilibria.

CBE 333 PROCESS MEASUREMENTS AND CONTROL

(1-0) 1 credit. Prerequisite: CBE 218 or permission of instructor. A study of the equipment and techniques used in monitoring process measurements and the design of feedback

control systems.

CBE 343 CHEMICAL KINETICS AND REACTOR DESIGN

(3-0) 3 credits. Prerequisites: CBE 217, CBE 321. A study of chemical kinetics and reactor design, including techniques for analyzing kinetic data, choosing reactor operating parameters, economic optimization of homogeneous reactions, and reactor modeling.

CBE 361 CHEMICAL ENGINEERING LABORATORY II

(0-2) 2 credits. Prerequisite or corequisite: CBE 218 and CBE 333. Laboratory experiments in process measurements, feedback control loops, industrial data acquisition and control, fluid flow, fluid flow measurements, and design of fluid handling systems.

CBE 362 CHEMICAL ENGINEERING LABORATORY III

(0-1) 1 credit. Prerequisite: CBE 317. Laboratory experiments on heat transfer.

CBE 417 CHEMICAL ENGINEERING V

(2-0) 2 credits. Prerequisite: CBE 321. The fifth course on the theory and practice of chemical engineering with emphasis on equilibrium staged separations.

CBE 433 PROCESS CONTROL

(3-0) 3 credits. Prerequisite: MATH 321 and senior standing. Analysis and design of process control systems for industrial processes, including controller tuning and design of multivariable control schemes. This course is cross-listed with MET 433.

CBE 434/434L DESIGN OF SEPARATION PROCESSES

(1-1) 2 credits. Prerequisite: CBE 318. Separation technology and processes are studied with application to current industrial design problems. Topics and design case studies may include: absorption, adsorption, biological separations, crystallization, distillation, environmental separations, ion exchange, membrane separations, molecular distillation,

pervaporation, solid separations, supercritical extraction, thermal stripping, and others.

CBE 444/544 REACTOR DESIGN

(3-0) 3 credits. Prerequisites: CBE 343, CBE 250. Applications of chemical engineering principles to reactor design. Emphasis includes: non-isothermal reactor modeling, homogeneous and heterogeneous reactors, economic and performance optimization, catalysis, and computer simulation. Students enrolled in CBE 544 will be held to a higher standard than those enrolled in CBE 444.

CBE 445/545 OXIDATION AND CORROSION OF METALS

(3-0) 3 credits. Prerequisites: MET 320, or CBE 222 or ME 211 or permission of instructor. Initially, the thermodynamics of electrochemical processes are covered; use of the Nernst equation and Pourbaix diagram is presented in this material. Fundamentals of electrode kinetics are then discussed with special emphasis on the derivation of the Butler-Volmer equation and application of the Evan's diagram. Following presentation of these fundamental concepts, phenomena observed in corrosion and oxidation such as uniform attack, pitting, stress corrosion cracking, and corrosion fatigue are discussed. Finally, selection of materials for site specific applications is covered. Students enrolled in CBE 545 will be held to a higher standard than those enrolled in CBE 445. This course is cross-listed with ENVE 445/545 and MET 445/545.

CBE 450/550 SYSTEMS ANALYSIS APPLIED TO CHEMICAL ENGINEERING

2 to 3 credits. Prerequisite or corequisites: CBE 417, CBE 433, or permission of instructor. The development of mathematical models for dynamic and steady state chemical engineering systems; simulation of these complex systems using computers and software, such as AspenPlus; estimation of physical and equilibrium properties; and analysis of results. Students enrolled in CBE 550 will be held to a higher standard than those enrolled in CBE 450.

CBE 455/555 POLLUTION PHENOMENA AND PROCESS DESIGN

(3-0) 3 credits. Prerequisites: CBE 218, CBE 317, and CBE 417, or equivalent, or permission of instructor. The study of the industrial sources of and treatment of air, water, and land pollutants. The chemical and physical phenomena operating in pollution control equipment and the design of pollution control equipment will be examined. Waste minimization and pollution prevention strategies will be considered. Students enrolled in CBE 555 will be held to a higher standard than those enrolled in CBE 455. This course is cross-listed with ENVE 455/555.

CBE 461 CHEMICAL ENGINEERING LABORATORY IV

(0-1) 1 credit. Prerequisite: CBE 318. Laboratory experiments on mass transfer.

CBE 464 CHEMICAL ENGINEERING DESIGN I

(4-0) 4 credits. Prerequisites: CBE 317, CBE 318. A comprehensive treatment of problems involved in the design of a chemical process plant. The design of plant equipment with emphasis upon the selection of materials and the elements of cost. Overall plant design with consideration of economics, political, and personnel factors.

CBE 465 CHEMICAL ENGINEERING DESIGN II

(3-0) 3 credits. Prerequisite: CBE 464. A continuation of CBE 464.

CBE 474/574 POLYMER TECHNOLOGY

2 to 3 credits. Prerequisite: Senior standing or permission of instructor. A study of the engineering aspects of polymer synthesis and reactor design, polymer testing, polymer characterization, rheology, macro-properties, and fabrication. Students may enroll for 2 or 3 credits, depending upon the particular level of course matter that matches their interest. Students taking 2 credits will take two-thirds of the course material. The instructor, in conjunction with the department head, will monitor student credit hours. Course is not repeatable for credit. Students enrolled in CBE 574 will be held to a

higher standard than students enrolled in CBE 474.

CBE 474L/574L EXPERIMENTAL POLYMER TECHNOLOGY

(0-1) 1 credit. Prerequisite or corequisite: CBE 474 or 574. Laboratory experiments in polymer synthesis, chemical and mechanical property testing, extrusion, and modeling. Students enrolled in CBE 574L will be held to a higher standard than students enrolled in CBE 474L.

CBE 476/576 ORGANOSILICON POLYMER CHEMISTRY AND TECHNOLOGY

(1-0) 1 credit. Prerequisite: Senior standing or permission of instructor. An introduction to the engineering and science aspects of silicone-organic polymer chemistry from an industrial viewpoint. The course covers basic silicone nomenclature, monomer and polymerization reactions, curing, reinforcement, general applications, and hands-on laboratory exercises, which includes making things like elastomeric (bouncy) putty and hi-bouncing balls. The course is held during a one week period. Students enrolled in CBE 576 will be held to a higher standard than students enrolled in CBE 476.

CBE 484/584 FUNDAMENTALS OF BIOCHEMICAL ENGINEERING

(3-0) 3 credits. Prerequisite: CBE 343 and BIOL 231 or BIOL 341. An introduction to the characterization of microorganisms, fermentation pathways, unit processes in fermentation, biochemical kinetics, and batch and continuous fermentation. The basic engineering concepts of fermentation, separation, control, and operations will be discussed. Students enrolled in CBE 584 will be held to a higher standard than those enrolled in CBE 484.

CBE 484L/584L BIOCHEMICAL ENGINEERING LABORATORY

(0-1) 1 credit. Corequisite: CBE 484/584. Laboratory experiments in biochemical engineering. May include fermentation, dissolved oxygen mass transfer measurements, bioseparations, and other experiments to correlate with selected lecture topics. Students enrolled in

CBE 584L will be held to a higher standard than those enrolled in CBE 484L.

CBE 487 GLOBAL AND CONTEMPORARY ISSUES IN CHEMICAL ENGINEERING

(1-0) 1 credit. Prerequisite or corequisite: CBE 465. A study of contemporary global and societal issues in the field of chemical engineering.

CBE 488/588 APPLIED DESIGN OF EXPERIMENTS FOR THE CHEMICAL INDUSTRY

(2-0) 2 credits. Prerequisite: Senior standing or permission of instructor. An introduction to the engineering concepts of statistics and design of experiments as applied to chemical and biological engineering problems. Includes set up and experiments for product development or for process trials. Includes critical analysis of results of an experimental design project. The course is held during a time period that will accommodate class members and industrial speakers. Students enrolled in CBE 588 will be held to a higher standard than students enrolled in CBE 488.

CBE 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

CBE 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits of special topics will be allowed for degree

credit.

CBE 498 UNDERGRADUATE RESEARCH/SCHOLARSHIP

Credit to be arranged. Prerequisite: Permission of instructor. Includes senior project, and capstone experience. Independent research problems/projects or scholarship activities. The plan of study is negotiated by the faculty member and the student. Contact between the two may be extensive and intensive. Does not include research courses which are theoretical. A maximum of 6 credits of undergraduate research will be allowed for degree credit.

CBE 603 MOLECULAR BIOLOGY FOR ENGINEERS

(3-0) 3 credits. This course is designed to provide a basic knowledge on molecular biology and bioinformatics that is directly applicable to engineering and related science fields. Up-to-date techniques in genetic engineering biotechnology, and bioinformatics will be introduced for the understanding of biological problems using engineering concepts or engineering/mechanical problems through biological tools. This course is cross-listed with BME 603

CBE 612 TRANSPORT PHENOMENA: MOMENTUM

(3-0) 3 credits. Introduction to momentum transport. Equations of continuity and motion. Velocity distributions. Boundary layer theory. Turbulent transport compressible flow. This course is cross-listed with ME 612.

CBE 613 TRANSPORT PHENOMENA: HEAT

(3-0) 3 credits. Prerequisites: ME 313, MATH 373 (concurrent). An in-depth study of the fundamental laws of heat transfer. Major areas considered are: heat conduction, free and forced convection, and radiative heat transfer. Emphasis is placed on the formulation and solution of engineering problems by analytical and numerical methods. This course is cross-listed with ME 613.

CBE 616 COMPUTATIONS IN TRANSPORT PHENOMENA

(3-0) 3 credits. Prerequisite: MATH 373 or permission of instructor. Various computerized techniques, including finite difference and finite element, will be used to solve transient and steady state heat transfer problems involving conduction and convection. This course is cross-listed with ME 616.

CBE 621 ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS I

(3-0) 3 credits. Prerequisite: CBE 321 or permission of instructor. A mathematical development of fundamental laws of thermodynamics and their application to chemical engineering operations and processes. Equilibrium and thermal effects in homogeneous and heterogeneous systems.

CBE 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor.

CBE 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor. A maximum of 6 credits of advanced special topics will be allowed for degree credit.

CBE 714 TRANSPORT PHENOMENA: MASS

(3-0) 3 credits. Prerequisite: Permission of instructor. An in-depth study of the fundamental laws of mass transfer. Emphasis is placed on the formulation and solution of Chemical and Biological Engineering processes and problems by analytical and numerical methods.

CBE 728 HETEROGENEOUS KINETICS

(3-0) 3 credits. Principles of Absolute Rate Theory are combined with thermodynamics to study the mechanisms of homogeneous and

heterogeneous reactions in metallurgical systems. This course is cross-listed with MES 728.

CBE 735 BIOSEPARATIONS

3-0) 3 credits. Prerequisite: CBE 318 or permission of instructor. This course introduces students to the principles and techniques used to recover and purify biologically-produced molecules, especially proteins, nucleic acids, and organic acids, from bacterial, mammalian, and agricultural production systems. The course will focus on centrifugation and filtration, membrane processing, two-phase extraction, precipitation and crystallization, adsorption and chromatography, and electrophoresis. Analysis will include micro and macro scale process modeling and simulation.

CBE 788 MASTER'S RESEARCH PROB/PROJECTS

Credit to be arranged; not to exceed 6 credits toward fulfillment of M.S. degree requirements. Open only to students pursuing the M.S. non-thesis option. Directed research investigation of a selected problem culminating in an acceptable written report. Oral defense of the report and research findings are required.

CBE 790 SEMINAR

(0.5-0) 0.5 credit. Prerequisite: Permission of instructor. This course may be repeated for credit and is designed to support the M.S. in Chemical Engineering. The course may consist of presentations by graduate students, faculty, and invited speakers, followed by questions and discussions. This course is cross-listed with CBE 890.

CBE 791 INDEPENDENT STUDY

1 to 4 credits. Prerequisite: Permission of instructor. Directed independent study of topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance by student and instructor.

CBE 792 TOPICS

1 to 4 credits. Prerequisite: Permission of instructor. Lecture course or seminar on topic or

field of special interest, as determined by the instructor.

CBE 798 MASTER'S THESIS

Credit to be arranged; not to exceed 6 credits toward fulfillment of M.S. degree requirements. Prerequisite: Approval of advisor. An original investigation of a chemical engineering subject normally presented as a thesis for the master of science degree in chemical engineering.

CBE 890 SEMINAR

(0.5-0) 0.5 credit. Prerequisite: Permission of instructor. This course may be repeated for credit and is designed to support the Ph.D. in Chemical and Biological Engineering. The course may consist of presentations by graduate students, faculty, and invited speakers, followed by questions and discussions. This course is cross-listed with CBE 790.

CBE 894 ADVANCED TECHNICAL INTERNSHIP

1 to 6 credits. Prerequisite: Approval of advisor. A single semester work experience in conjunction with an industrial, state, governmental, or national laboratory employer. Each student will be asked to prepare a written report of their work experience.

CBE 898D DISSERTATION

1 to 12 credits. Prerequisite: Approval of advisor. An original investigation of a chemical/biological engineering subject, which culminates in the oral and written presentation of a dissertation for the Ph.D. degree in Chemical and Biological Engineering.

CEE 117/117L COMPUTER AIDED DESIGN AND INTERPRETATION IN CIVIL ENGINEERING

(1-1) 2 credits. Students will learn to construct drawing documents using AutoCAD, the use of engineering and architectural scales, lettering practices, geometric construction (manually and AutoCAD), and the ability to visualize in three dimensions.

CEE 206/206L CIVIL ENGINEERING PRACTICE AND ENGINEERING SURVEYS I

(2-2) 4 credits. Prerequisite: An acceptable score on the Trigonometry Placement Examination; or trigonometry completed with a grade of “C” or better; or permission of instructor. An orientation to the civil engineering profession including historical development, civil engineering careers, professional practice and ethics, and specialties in the profession. Mensuration with the application of surveying techniques; basic surveying computations and field practice; theory of error propagation and its analysis; fundamental concepts of horizontal, angular, and vertical measurements; control systems related to engineering-construction surveys. Horizontal and vertical curves. Traverse computations.

CEE 284/284L DIGITAL COMPUTATION APPLICATIONS IN CIVIL ENGINEERING

(3-1) 4 credits. Prerequisite: MATH 123. A one semester introductory course in programming with a language (Visual Basic) and with a spread sheet and MathCad. Elementary numerical methods and their application to civil engineering problems will be illustrated by the programming technique.

CEE 316/316L ENGINEERING AND CONSTRUCTION MATERIALS

(2-1) 3 credits. Prerequisites: Preceded by or concurrent with EM 321, and CEE 284. Principles that govern physical and mechanical properties of ferrous and nonferrous metals, plastics, bituminous materials, portland cement, aggregates, concrete, and timber. Laboratory exercises to demonstrate basic principles and standard laboratory tests (ASTM Standards) of structural materials. Computer-aided graphics and word processing are required for lab reports.

CEE 326 INTRODUCTORY ENVIRONMENTAL ENGINEERING DESIGN

(3-0) 3 credits. Prerequisites: CHEM 114 and junior standing. As the first course in the theory and practice of environmental engineering, emphases are on the acquisition of introductory knowledge pertaining to natural and engineered

environmental engineering systems, identification and mitigation of societal impacts upon the Earth, and application of environmental engineering principles in the design and analysis of systems for water and wastewater treatment and solid/hazardous waste management. This course is cross-listed with ENVE 326.

CEE 327/327L ENVIRONMENTAL ENGINEERING PROCESS ANALYSIS

(2-1) 3 credits. Prerequisite or corequisite: CEE 284 or CBE 250 and one of the following: EM 328, EM 331, CBE 218 or ME 331. As the second course in the theory and practice of environmental engineering, emphasis is on application of material balance concepts in environmental analysis and design with consideration of water chemistry, environmental process kinetics, ideal and non-ideal reactors, and biological process fundamentals. These fundamental principles are applied in selected natural and engineered environmental contexts spanning air, water and land systems and the effects of society on environmental systems. Laboratory exercises will be completed and reports with computer-generated text, tables and figures will be written. This course is cross-listed with ENVE 327/327L.

CEE 336/336L HYDRAULIC SYSTEMS DESIGN

(2-1) 3 credits. Prerequisites: EM 331 and CEE 284. Analysis of flow in pipe systems, open channels, measuring devices, and model studies. Design of hydraulic systems associated with water supply, flood control, water storage and distribution, sewer systems, and other water resources.

CEE 337 ENGINEERING HYDROLOGY

(3-0) 3 credits. Prerequisite: CEE 336 or EM 327 or EM 328 or permission of instructor. A quantification study of the components of the hydrologic cycle with emphasis on engineering applications involving the design of water supplies, reservoirs, spillways, floodways, and urban drainage with computer applications. This course is cross-listed with ENVE 337.

CEE 346/346L GEOTECHNICAL ENGINEERING

(2-1) 3 credits. Prerequisites: EM 321. Composition, structure, index, and engineering properties of soils; soil classification systems; introduction to soil engineering problems involving stability, settlement, seepage, consolidation, and compaction; and laboratory work on the determination of index and engineering properties of soils. Computer-aided graphics and word processing required for lab reports.

CEE 347 GEOTECHNICAL ENGINEERING II

(3-0) 3 credits. Prerequisite: CEE 346. Composition of soils, origin, and deposition, exploration, frost problems, swelling of soils, erosion protection, soil improvement, groundwater flow and dewatering, slope stability of retaining structures, and rigid and flexible pavement design. The application of these topics to highway engineering will be stressed.

CEE 353 STRUCTURAL THEORY

(3-0) 3 credits. Prerequisites: EM 321 and CEE 284. Basic concepts in structural analysis of beams, trusses, and frames. Determination of governing load conditions for moving loads by use of influence lines. Development of basic virtual work concept to obtain deflections for beams, trusses, and frames. Introduction to approximate analysis.

CEE 357/357L THEORY AND DESIGN OF METAL STRUCTURES I

(2-1) 3 credits. Prerequisite: CEE 353. Correlation of analysis and design using the current building code requirements for steel structures. Design techniques are formulated for axial, transverse and combined loading conditions, for individual members and for connections between components of a structure. Comparisons between design requirements of materials to illustrate relative benefits in structural systems.

CEE 358 APPLIED STRUCTURAL DESIGN

(3-0) 3 credits. Prerequisite: CEE 353 or

permission of instructor. Elements of structural design utilizing concrete, steel, or wood. Applied methods emphasizing practical, conservative, and economical solutions will be emphasized. Intended for students who will take no other structural design course.

CEE 368/368L INTRODUCTION TO TRANSPORTATION ENGINEERING

(2-1) 3 credits. Prerequisite: PHYS 211 and EM 214 or permission of instructor. Content includes fundamentals fundamentals of transportation engineering: air, marine, highway, and/or pipeline systems; design, operation, and planning of transportation facilities; the basics of driver, vehicle, and roadway system characteristics; elementary traffic flow theory, and introduction to capacity and level of service analyses. Current transportation engineering software is applied in the laboratory.

CEE 421/521 ENVIRONMENTAL SYSTEMS ANALYSIS

(3-0) 3 credits. Prerequisites: CEE/ENVE 327 or graduate standing. Course emphasis is on applications of environmental chemistry and material balance in quantitative characterizations of operative processes in selected air, water, and land systems and environmental health impacts. Analytical and computer solutions are performed. Students enrolled in CEE 521 will be held to a higher standard than those enrolled in CEE 421. This course is cross-listed with ENVE 421/521.

CEE 425/525 SUSTAINABLE ENGINEERING

(3-0) 3 credits. Prerequisites: Junior standing. This course will serve as an introduction to the emerging field of sustainable engineering, with focus on understanding interactions between industrial processes and the environment. Identification and implementation of strategies to reduce the environmental impacts of products and processes associated with industrial systems will be explored and evaluated using tools such as life cycle analyses and materials balances. The course will also explore appropriate sustainable technologies employed within both developing and first world countries. Students enrolled in

CEE 525 will be held to a higher standard than those enrolled in CEE 425.

CEE 426/526 ENVIRONMENTAL ENGINEERING PHYSICAL/CHEMICAL PROCESS DESIGN

(3-0) 3 credits. Prerequisites: CEE/ENVE 326 and CEE/ENVE 327, graduate standing, or permission of instructor. A third course in the theory and practice of environmental engineering. Emphases are on the design and analysis of physical/chemical environmental engineering unit operations and processes. Students enrolled in CEE 526 will be held to a higher standard than those enrolled in CEE 426. This course is cross-listed with ENVE 426/526.

CEE 426L/526L ENVIRONMENTAL PHYSICAL/CHEMICAL PROCESS LABORATORY

(0-1) 1 credit. Prerequisite or co-requisite: CEE/ENVE 426/526 or permission on instructor. A laboratory course to accompany CEE/ENVE 426/526. Examination of processes employed in design of environmental physical and chemical systems for renovation of contaminated waters and soils. Various bench-scale experiments will be performed with laboratory analysis using standard environmental web chemical and instrumental analytical techniques. Laboratory reports employing word processing, numerical and statistical analysis, and interpretation of process performance data will be written. Students enrolled in CEE 526L will be held to a higher standard than those enrolled in CEE 426L. This course is cross-listed with ENVE 426L/526L.

CEE 427/527 ENVIRONMENTAL ENGINEERING BIOLOGICAL PROCESS DESIGN

(3-0) 3 credits. Prerequisites: CEE/ENVE 326 and CEE/ENVE 327, graduate standing, or permission of instructor. A fourth course in the theory and practice of environmental engineering. Emphases are on the design and analysis of biological environmental engineering unit operations and processes. Students enrolled in CEE 527 will be held to a higher standard than

those enrolled in CEE 427. This course is cross-listed with ENVE 427/527.

CEE 427L/527L ENVIRONMENTAL BIOLOGICAL PROCESS LABORATORY

(0-1) 1 credit. Prerequisite or corequisite: CEE/ENVE 427/527 or permission of instructor. A laboratory course to accompany CEE/ENVE 427/527. Examination of processes employed in design of environmental biological systems for renovation of contaminated waters and soils. Various bench-scale experiments will be performed with laboratory analysis using standard environmental web chemical, microbiological, and instrumental analytical techniques. Laboratory reports employing word processing, numerical and statistical analysis, and interpretation of process performance data will be written. Students enrolled in CEE 527L will be held to a higher standard than those enrolled in CEE 427L. This course is cross-listed with ENVE 427L/527L.

CEE 428/528/428L/528L ENVIRONMENTAL ENGINEERING OPERATIONS AND PROCESSES LABORATORY

(1-1) 2 credits. Prerequisite: CEE/ENVE 327 or graduate standing. Co-requisite: CEE/ENVE 426/526. Bench-scale experiments are performed in examination of physical/chemical operations and biological processes employed in systems for treatment of waters, wastewaters, and soils. Standard chemical and instrumental analytical techniques are employed. Data are acquired, processed, analyzed both numerically and statistically, and interpreted. Formal laboratory reports are written. Students enrolled in CEE 528/528L will be held to a higher standard than those enrolled in CEE 428/428L. This course is cross-listed with ENVE 428/428L/528/528L.

CEE 433/533 OPEN CHANNEL FLOW

(3-0) 3 credits. Prerequisite: CEE 336. Application of continuity, momentum, and energy principles to steady flow in open channels; flow in the laminar and transition ranges; specific energy and critical depth; energy losses; channel controls; gradually and rapidly varied flow; and high velocity flow. Students enrolled in CEE 533 will

be held to a higher standard than those enrolled in CEE 433.

CEE 437/437L/537/537L WATERSHED AND FLOODPLAIN MODELING

(2-1) 3 credits. This course will consist of the application of the HEC-HMS Flood Hydrograph Package and HEC-RAS Water Surface Profiles computer programs. Each model is applied to an actual watershed and conveyance channel. The student is responsible for two project reports, one for each model application. Data compilation and model development and execution will be conducted in the lab portion of the class. Development of the model inputs will include review of hydrologic and hydraulic processes relating to model options. Students enrolled in CEE 537/537L will be held to a higher standard than those enrolled in CEE 437/437L.

CEE 447/547 FOUNDATION ENGINEERING

(3-0) 3 credits. Prerequisite: CEE 346. Application of the fundamental concepts of soil behavior to evaluation, selection, and design of shallow and deep foundation systems. Related topics such as temporary support systems for excavations and pile driving are also included. Students enrolled in CEE 547 will be held to a higher standard than those enrolled in CEE 447.

CEE 448/548 APPLIED GEOTECHNICAL ENGINEERING

(3-0) 3 credits. Prerequisites: CEE 346 and CEE 347. Content will include the application of principles taught in CEE 346 and 347 to practical geotechnical engineering problems in the civil engineering Profession, such as exploration, pavement design, slope stability, geosynthetics, geotechnical problems unique to the region, and dam design. Students enrolled in CEE 548 will be held to a higher standard than those enrolled in CEE 448.

CEE 451/451L/551/551L DESIGN OF WOOD STRUCTURES

(2-1) 3 credits. This course will cover the behavior and properties of timber, lumber and pre-engineered structural wood products.

Students will learn to design members and systems using current methods and appropriate codes and specifications. An additional research requirement will be included for those taking the class for graduate credit. The course includes a lecture component complemented by a computational laboratory. Students enrolled in CEE 551 will be held to a higher standard than those enrolled in CEE 451.

CEE 453/453L DESIGN OF STEEL STRUCTURES

(2-1) 3 credits. Prerequisite: CEE 358 and CEE 457/457L. Analysis and design of structural elements and connections for buildings, bridges, and specialized structures that utilize structural metals. Behavior of structural systems under elastic and plastic design.

CEE 456/456L CONCRETE THEORY AND DESIGN

(2-1) 3 credits. Prerequisite: CEE 353. Properties and behavior of concrete and reinforcing steel. Analysis and design of structural slabs, beams, girders, columns, and footings with use of strength methods. Deflection of flexural members. Development of reinforcement.

CEE 457/457L INDETERMINATE STRUCTURES

(2-1) 3 credits. Prerequisite: CEE 353. Analysis of indeterminate structures by classical and matrix methods. The classical methods are the force method, the slope-deflection equations and the moment-distribution method. The classical methods also are used to determine influence lines for indeterminate structures. Stiffness matrices for truss and beam elements are derived and used to analyze trusses, beams, and frames.

CEE 463 CIVIL ENGINEERING PROFESSION

(1-0) 1 credit. Prerequisite: Senior in civil engineering. Lecture and discussion with emphasis on current civil engineering topics with emphasis on professional, personal, and ethical development.

**CEE 464 CIVIL ENGINEERING
CAPSTONE DESIGN I**

(0-1) 1 credit. Prerequisite: Senior standing or permission of instructor. Content will include major engineering design experience integrating fundamental concepts of mathematics, basic science, engineering science, engineering design, communications skills, humanities, and social science.

**CEE 465 CIVIL ENGINEERING CAPSTONE
DESIGN II**

(0-2) 2 credits. Prerequisite: CEE 464. Content will include major engineering design experience integrating fundamental concepts of mathematics, basic science, engineering science, engineering design, communications skills, humanities, and social science.

CEE 468/568 HIGHWAY ENGINEERING

(3-0) 3 credits. Prerequisite: CEE 368 or equivalent, graduate standing or permission of instructor. This course addresses highway location, drainage, and safety; earthwork volumes; design of cross-section alignment; and intelligent transportation system concepts and applications. Students enrolled in CEE 568 will be held to a higher standard than those enrolled in CEE 468 and complete additional design work or projects.

**CEE 474/574 ENGINEERING PROJECT
MANAGEMENT**

(3-0) 3 credits. Prerequisite: Senior standing or permission of instructor. Study of owner, engineer, and contractor organizational structures, project work break down structures, resource and asset allocation, computer and non-computer scheduling by Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT). Students enrolling will be required to perform an engineering project with written and oral presentations. Students enrolled in CEE 574 will be held to a higher standard than those enrolled in CEE 474.

CEE 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and

special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

CEE 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

**CEE 498 UNDERGRADUATE
RESEARCH/SCHOLARSHIP**

1 to 6 credits. Prerequisite: Permission of instructor. Includes senior project, and capstone experience. Independent research problems/projects or scholarship activities. The plan of study is negotiated by the faculty member and the student. Contact between the two may be extensive and intensive. Does not include research courses which are theoretical.

**CEE 621 ENVIRONMENTAL
CONTAMINANT FATE AND TRANSPORT**

(3-0) 3 credits. Prerequisites: CEE 421 or CEE 521 or permission of instructor. Mathematical analysis of the processes governing the fate and movement of anthropogenic contaminants in natural systems. Topics include: liquid-solid, vapor-solid, and vapor-liquid partitioning; liquid and vapor phase convection and diffusion; biotic and abiotic transformations; and mathematical modeling of coupled processes.

**CEE 622 ADVANCED TREATMENT
PLANT DESIGN**

(3-0) 3 credits. Prerequisites: CEE 327, CEE 336, and CEE 426, or permission of instructor. Advanced topics relating to the design of systems for the renovation of contaminated waters. Several major design problems will be completed.

CEE 627 TREATMENT, DISPOSAL, AND MANAGEMENT OF HAZARDOUS WASTE

(3-0) 3 credits. Study of the types, sources and properties of hazardous waste generated from various industrial plants. Engineering systems and technologies for hazardous waste including: on-site handling, storage and processing; transfer and transportation; treatment and reuse; and ultimate disposal and destruction. Federal regulations, especially those developed under the Resource Conservation and Recovery Act will be described.

CEE 628/628L ENVIRONMENTAL ENGINEERING MEASUREMENTS

(2-1) 3 credits. Prerequisite: Senior or graduate standing. It is highly recommended that the student have completed CEE 421 or CEE 521 or an equivalent course prior to enrolling in this course. Topics include: methods employed in assessment of environmental contamination and remediation effectiveness; methods used in obtaining and handling of water and soil samples; applications of analytical instrumentation (GC, LC, AAS, UV/Vis, and total carbon) to assays of environmental samples; field and lab QA/QC; preparation of investigative reports.

CEE 634 SURFACE WATER HYDROLOGY

(3-0) 3 credits. Prerequisites: CEE 337 or permission of instructor. Review and advanced study of hydrologic cycle including precipitation, infiltration, evapotranspiration, and runoff. Applications to analysis and design of water supplies, reservoirs, spillways, floodways, urban runoff, and protection systems.

CEE 643 ADVANCED SOIL MECHANICS I

(3-0) 3 credits. Prerequisite: CEE 346 or permission of instructor. One- and two-dimensional consolidation theory; field consolidation behavior; anisotropic consolidation; geotechnical material failure criteria; constitutive laws for geotechnical materials; flexible and rigid beams on elastic foundations; analysis of single and group piles under various loadings; stress development in soil mass.

CEE 644 ADVANCED SOIL MECHANICS II

(3-0) 3 credits. Methods of geotechnical analysis; composite finite element method; movement dependent lateral earth pressure development; limiting equilibrium method of soil-structure analysis for bearing capacity, slope stability and retaining structures; and earth reinforcing techniques.

CEE 645 ADVANCED FOUNDATIONS

(3-0) 3 credits. Prerequisites: CEE 284 and CEE 346 or permission of instructor. Application of the principles of soil mechanics to foundation engineering; subsurface exploration; lateral earth pressures and retaining structures; bearing capacity and settlement of shallow and deep foundations; field instrumentation and performance observation; and case studies.

CEE 646 STABILITY OF SOIL AND ROCK SLOPES

(3-0) 3 credits. Prerequisite: CEE 346 or permission of instructor. Geologic aspects of slope stability; shear strength of geologic materials; soil and rock mechanics approaches to slope stability analysis; two-dimensional limiting equilibrium methods of slope stability analysis including sliding block methods, Fellenius' and Bishop's methods of slices, and the Morgenstern-Price method of slices; introduction to three-dimensional methods of stability analysis; field instrumentation and performance observations; and case studies.

CEE 647 EARTH AND EARTH RETAINING STRUCTURES

(3-0) 3 credits. Prerequisite: CEE 346 or permission of instructor. Engineering properties of compacted soils; use of the triaxial test in soil stability problems; methods of slope stability analysis with emphasis on Bishop's simplified method of slices; design considerations for earth embankments; field instrumentation and performance observations; and case studies. Application of principles of geotechnical engineering to the design of retaining structures. Areas covered are lateral earth pressure theories, rigid and flexible retaining walls, anchored bulkheads, earthquake induced earth pressures,

and braced excavations. Stabilization of slopes and reinforced earth applications are also treated, along with instrumentation observations.

CEE 652 PRESTRESSED CONCRETE

(3-0) 3 credits. Prerequisite: CEE 358 or CEE 456 or permission of instructor. Principles of linear and circular prestressing. Behavior of steel and concrete under sustained load. Analysis and design of pretensioned and post-tensioned reinforced concrete members and the combination of such members into an integral structure.

CEE 653 REINFORCED CONCRETE DESIGN

(3-0) 3 credits. Prerequisite: CEE 456. Design for torsion, simple space structural elements such as corner beams, curved beams, and free-standing staircases. Yield line theory and design of two-way reinforced slabs and floor systems. Design of a multi-story frame building system.

CEE 655/655L APPLIED COMPOSITES

(2-1) 3 credits. Prerequisite: CEE 353 or permission of instructor. Basic properties and principles of advanced composite materials such as fiberglass and graphite, and aramic design and testing of primary structural members including prestressing elements. Application of composite materials to engineering.

CEE 656/656L ADVANCED STRUCTURAL ANALYSIS

(2-1) 3 credits. Prerequisite: Senior or graduate standing. Analysis of statically indeterminate structural systems. Flexibility and stiffness methods of analysis for two- and three-dimensional orthogonal and non-orthogonal structures with reference to digital computer procedures. Special solution procedures including use of substructures. Energy methods of structural analysis and introduction to finite element method.

CEE 668 ADVANCED HIGHWAY SYSTEMS ENGINEERING

(3-0) 3 credits. Prerequisite: CEE 368 or equivalent, graduate standing, or permission of instructor. This course focuses on advanced

traffic flow theory including traffic distributions, car-following models, and traffic stream models, and includes highway traffic operation analyses involving planning and management of highway systems.

CEE 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Senior or graduate standing and permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor. A description of the work to be performed must be filed in the department office.

CEE 692 TOPICS

1 to 3 credits. Prerequisite: Senior or graduate standing. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

CEE 730 STATISTICAL METHODS IN WATER RESOURCES

(3-0) 3 credits. Stochastic process, probability and statistics applied to hydrologic problems. Data synthesis, frequency analysis, correlation, time series, and spectral analysis.

CEE 731 CURRENT TOPICS IN WATER QUALITY ASSESSMENT

(3-0) 3 credits. Prerequisite: Permission of instructor. A review and discussion of federal programs concerning water quality and of current literature on national and regional water-quality assessments. Technical subjects covered may include but are not limited to: hydrologic and hydraulic modeling of watersheds, numerical water quality modeling, and total maximum daily loads (TMDL's); eutrophication; urban runoff; non-point-source pollution. Oral presentations, detailed literature review, and term paper are required.

CEE 733/733L TECHNIQUES OF SURFACE WATER RESOURCE AND WATER QUALITY INVESTIGATIONS I

(1-2) 3 credits. Prerequisites: CEE 326, CEE 327 and CEE 336 or permission of instructor. A study

of the theory, design and techniques used in hydrologic and water quality investigations by environmental engineers, hydrologists, and hydraulic engineers. Topics to be covered include, but are not limited to: surface water stream flow measurements and records compilation, water quality monitoring, storm water runoff sampling and permit process, bioassessment of water quality, sediment sampling, lake water quality assessment, and non parametric statistics.

CEE 784 MODELING AND COMPUTATION IN CIVIL ENGINEERING
(3-0) 3 credits. Prerequisite: CEE 284 or permission of instructor. Applications of statistical and advanced numerical and digital computation methods to various problems in all disciplines of civil engineering.

CEE 785 APPLICATIONS OF FINITE ELEMENT METHODS IN CIVIL ENGINEERING
(3-0) 3 credits. An introduction to the basic concepts including: interpolation functions, element stiffness and load matrices, assembly of element matrices into global matrices, and solution techniques. Several one and two dimensional elements are studied and used to solve problems in solid mechanics, soils, and fluid mechanics using the variational method and Galerkin's method.

CEE 788 MASTER'S RESEARCH PROB/PROJECTS
Credit to be arranged; not to exceed 3 credits toward fulfillment of M.S. degree requirements. Open only to students pursuing the M.S. non-thesis option. Directed research investigation of a selected problem culminating in an acceptable written report. Oral defense of the report and research findings are required.

CEE 790 SEMINAR
(1-0) 1 credit. May not be repeated for degree credit. Preparation and presentation of oral seminar. Group discussion of a research problem or current civil engineering project.

CEE 791 INDEPENDENT STUDY
1 to 3 credits; not to exceed 3 credits toward fulfillment of M.S. degree requirements. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor. A description of the work to be performed must be filed in the department office.

CEE 792 TOPICS
1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

CEE 798 MASTER'S THESIS
Credit to be arranged; not to exceed 6 credits toward fulfillment of M.S. degree requirements. Open only to students pursuing the M.S. thesis option. Supervised original or expository research culminating in an acceptable thesis. Oral defense of the thesis and research findings are required.

CENG 244/244L INTRODUCTION TO DIGITAL SYSTEMS
(3-1) 4 Credits. This course is designed to provide computer engineering, electrical engineering, and computer science students with an understanding of the basic concepts of digital systems and their hardware implementation. Topics covered include combinational logic circuits, sequential logic circuits, and CPU control.

CENG 291 INDEPENDENT STUDY
1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. A maximum of 6 credits of independent studies is allowed for degree credits.

CENG 292 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits of special topics is allowed for degree credits.

CENG 314/314L ASSEMBLY LANGUAGE

(1.5-1.5) 3 credits. Prerequisite: CSC 250. A thorough introduction to assembly language programming and processor architecture. A study of low-level programming techniques, and the layout of a typical computer. The student will gain insight into the memory layout, registers, run-time stack, and global data segment of a running program. This course is cross listed with CSC 314/314L. Graduation credit will not be allowed for both this course and CSC 314/314L.

CENG 342/342L DIGITAL SYSTEMS

(3-1) 4 credits. Prerequisite: CENG 244. Presents the basic concepts and mathematical tools that are applicable to the analysis and design of digital systems, particularly state machines and digital processing systems. The VHDL hardware description language is also introduced as a design tool.

CENG 391 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. A maximum of 6 credits of special topics is allowed for degree credits.

CENG 392 TOPICS

1 to 3 credits. Includes current topics, advanced

topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits of special topics is allowed for degree credits.

CENG 420/420L DESIGN OF DIGITAL SIGNAL PROCESSING SYSTEMS

(3-1) 4 credits. Prerequisite: EE 312. An introduction to the design of digital signal processing systems. Topics include discrete-time signals and systems, the Z transform, infinite impulse-response digital filters, finite impulse-response digital filters, discrete Fourier transforms, fast Fourier transforms. (Design content - 2 credits)

CENG 440/440L VLSI DESIGN

(3-1) 4 credits. Prerequisite: EE 320. Provides an introduction to the technology and design of VLSI integrated circuits. Topics include MOS transistors, switch and gate logic, scalable design rules, speed and power considerations, floor planning, layout techniques, and design tools.

CENG 442/442L MICROPROCESSOR-BASED SYSTEM DESIGN

(3-1) 4 credits. Prerequisite: CENG 342. Presents the concepts required for the design of microprocessor-based systems. Emphasis is given to the problems of system specification, choice of architecture, design trade-offs and the use of development tools in the design process. Design projects will be implemented in the laboratory.

CENG 444/444L/544/544L COMPUTER NETWORKS

(3-1) 4 credits. Prerequisite: CENG 244, MATH 381 or MATH 441. This course presents the basic principles of computer networks design and analysis. Topics covered include the layers of the OSI reference model. Current and proposed implementations of local, metropolitan and wide area networks are presented; inter-networking is discussed. The different implementations are

compared and their performance evaluated. Students enrolled in CENG 544/544L will be held to a higher standard than those enrolled in CENG 444/444L. Graduation credit will not be allowed for both this course and CSC 463.

CENG 446/446L ADVANCED COMPUTER ARCHITECTURES

(3-1) 4 credits. Prerequisite: CENG 342. This course covers the basic principles of pipelining, parallelism and memory management. Topics covered include cache and virtual memory, pipelining techniques and vector processors, multiprocessors and distributed computing systems. Graduation credit will not be allowed for both this course and CSC 440.

CENG 447/447L/547/547L EMBEDDED AND REAL-TIME COMPUTER SYSTEMS

(3-1) 4 credits. Prerequisites: EE 351 and CSC 150. This course provides an introduction to programming embedded and real-time computer systems. It includes design of embedded interrupted driven systems and the use of commercial (for example: QNX) or open-source (for example: Linux RT) RTOS operating systems. Students registered for 547 will be held to a higher standard than those registered for 447.

CENG 464 COMPUTER ENGINEERING DESIGN I

(2-0) 2 credit. Prerequisites: CENG 342, EE 320. Prerequisite or corequisite: EE 311, EE 312, CSC 470, and ENGL 289. This course will focus on the design process and culminate with the faculty approval of design projects (including schematics and parts list) for CENG 465. Typical topics included are the development of a product mission statement, identification of the customer and customer needs, development of target specifications, consideration of alternate designs using a decision matrix, project management techniques, legal and ethical issues, FCC verification and certification, use of probability and statistics for reliable design, interpretation of data sheets, and component selection.

CENG 465 COMPUTER ENGINEERING DESIGN II

(2-0) 2 credits. Prerequisite: CENG 464. The course requires students to conduct their own design projects in a simulated industrial environment. Requirements include detailed laboratory notebook, periodic written and oral progress reports, and a written and oral presentation of a final project report.

CENG 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. A maximum of 6 credits of special topics is allowed for degree credits.

CENG 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits of special topics is allowed for degree credits.

CENG 498 UNDERGRADUATE RESEARCH/SCHOLARSHIP

Credits to be arranged; not to exceed 4 credits toward fulfillment of B.S. degree requirements. Prerequisite: Permission of instructor. Includes senior project, and capstone experience. Independent research problems/projects or scholarship activities. The plan of study is negotiated by the faculty member and the student. Contact between the two may be extensive and intensive. Does not include research courses which are theoretical.

CHEM 106 CHEMISTRY SURVEY

(3-0) 3 credits. Prerequisite: MATH 101. A one-

semester survey of chemistry. Not intended for those needing an extensive chemistry background. Introduction to the properties of matter, atomic structure, bonding, stoichiometry, kinetics, equilibrium, states of matter, solutions, and acid-base concepts. May not be used for credit toward an engineering or science degree (except Interdisciplinary Science and Associate of Arts).

CHEM 106L CHEMISTRY SURVEY LAB
(0-1) 1 credit. Prerequisite or corequisite: CHEM 106. Laboratory designed to accompany CHEM 106. May not be used for credit toward an engineering or science degree (except Interdisciplinary Science and Associate of Arts).

CHEM 108 ORGANIC AND BIOCHEMISTRY
(4-0) 4 credits. Prerequisites: CHEM 106. A survey of the chemical principles important to biological systems. For students who do not plan to take additional chemistry. Not a prerequisite for any 200 level and above course. May not be used for credit toward an engineering or science degree (except Interdisciplinary Science and Associate of Arts).

CHEM 108L ORGANIC AND BIOCHEMISTRY LAB
(0-1) 1 credit. Prerequisite: CHEM 106L, Prerequisite or corequisite: CHEM 108
Laboratory designed to accompany CHEM 108. May not be used for credit toward an engineering or science degree (except Interdisciplinary Science and Associate of Arts).

CHEM 112 GENERAL CHEMISTRY I
(3-0) 3 credits. Prerequisite: MATH 102. An introduction to the basic principles of chemistry for students needing an extensive background in chemistry (including chemistry majors, science majors, and pre-professional students). Completion of a high school course in chemistry is recommended.

CHEM 112L GENERAL CHEMISTRY I LAB
(0-1) 1 credit. Prerequisite or corequisite: CHEM 112.

Laboratory designed to accompany CHEM 112.

CHEM 114 GENERAL CHEMISTRY II
(3-0) 3 credits. Prerequisite: CHEM 112 and MATH 102. A continuation of CHEM 112. An introduction to the basic principles of chemistry for students needing an extensive background in chemistry.

CHEM 114L GENERAL CHEMISTRY II LAB
(0-1) 1 credit. Prerequisite: CHEM 112L, Prerequisite or corequisite: CHEM 114

CHEM 200 INTRODUCTION TO RESEARCH
1 to 3 credits. Prerequisite: Permission of instructor. Directed research in chemistry including library and laboratory work supplemented with conferences with the instructor.

CHEM 220L EXPERIMENTAL ORGANIC CHEMISTRY IA
(0-1) 1 credit. Prerequisite: CHEM 114L. A one-semester laboratory course. Experiments demonstrating techniques for the separation, characterization and synthesis of organic compounds are performed. Functional groups are derivatized.

CHEM 230 ANALYTICAL CHEMISTRY FOR ENGINEERS
(2-0) 2 credits. Prerequisite: CHEM 114. An introduction to modern analytical chemistry. Topics include the theory and application of acid-base and solubility equilibria, titrimetric and gravimetric analysis, statistical treatment of data, and an introduction to spectroscopy (UV-Vis, IR, and AA).

CHEM 252 SYSTEMATIC INORGANIC CHEMISTRY
(3-0) 3 credits. Prerequisite: CHEM 114. A systematic survey of the chemistry of elements. Periodic properties of the elements; fundamental chemical bonding and structure; acid-base and redox reactions; solid state chemistry; nonaqueous

solvents; introduction to materials science.

CHEM 290 SEMINAR

(0.5-0) 0.5 credits. A highly focused, and topical course. The format includes student presentations and discussions of reports based on literature, practices, problems, and research. Seminars may be conducted over electronic media such as Internet and are at the upper division or graduate levels. Enrollment is generally limited to fewer than 20 students.

CHEM 316 FUNDAMENTALS OF ORGANIC CHEMISTRY

(3-0) 3 credits. Prerequisite: CHEM 114. A one-semester introductory course in organic chemistry. Functional classes of organic compounds are discussed in terms of characteristic functional group, properties, structure, nomenclature, synthesis, and reactivity.

CHEM 326 ORGANIC CHEMISTRY I

(3-0) 3 credits. Prerequisite: CHEM 114. A systematic treatment of the chemistry of carbon compounds, including nomenclature, structure-reactivity relationships, reaction mechanisms, synthesis, and spectroscopy.

CHEM 326L ORGANIC CHEMISTRY I LAB

(0-2) 2 credits. Prerequisites CHEM 114L Prerequisite or corequisite CHEM 326. A laboratory designed to accompany CHEM 326. Introduction to organic functional groups and methods for the separation and purification of organic compounds.

CHEM 328 ORGANIC CHEMISTRY II

(3-0) 3 credits. Prerequisite: CHEM 326. A continuation of CHEM 326. A systematic treatment of the chemistry of carbon compounds, including nomenclature, structure-reactivity relationships, reaction mechanisms, synthesis, and spectroscopy.

CHEM 328L ORGANIC CHEMISTRY II LAB

(0-2) 2 credits. Prerequisite: CHEM 326L, Prerequisite or corequisite: CHEM 328. Laboratory designed to accompany CHEM 328.

Syntheses of organic compounds. Structural characterization is performed by instrumental methods of analysis including infrared and nuclear magnetic resonance spectrometry.

CHEM 332 ANALYTICAL CHEMISTRY

(3-0) 3 credits. Prerequisite: CHEM 114. Fundamental concepts and principles of quantitative chemical analysis including quantitative chemical equilibrium calculations and error analysis applied to the evaluation of experimental measurements and data.

CHEM 332L ANALYTICAL CHEMISTRY LAB

(0-1) 1 credit. Prerequisite or corequisites: CHEM 114L and CHEM 332 or CHEM 230. Laboratory to accompany CHEM 332 and CHEM 230. Experimental methods and techniques of gravimetry, titrimetry, pH, and UV-Vis and AA spectrometry.

CHEM 341 PHYSICAL CHEMISTRY FOR ENGINEERS I

(2-0) 2 credits. Prerequisite: CBE 222. Prerequisite or corequisite: PHYS213. Physical transformations of pure substances; simple mixtures and phase diagrams; chemical equilibrium and equilibrium electrochemistry. Duplicate credit for CHEM 341 and CHEM 342 not allowed.

CHEM 342 PHYSICAL CHEMISTRY I

(3-0) 3 credits. Prerequisites: CHEM 114 and MATH 321. Prerequisite or corequisite: PHYS 213. A study of the fundamental principles governing the behavior of chemical systems. Topics covered in the two-semester sequence include thermodynamics, chemical kinetics, quantum mechanics, and statistical mechanics. Properties of gases; first and second laws of thermodynamics; physical transformations of pure substances; simple mixtures and phase diagrams; chemical equilibrium and equilibrium electrochemistry. Duplicate credit for CHEM 341 and CHEM 342 not allowed.

**CHEM 342L PHYSICAL CHEMISTRY I
LAB**

(0-1) 1 credit. Prerequisite or corequisite CHEM 342. Laboratory designed to accompany CHEM 342.

**CHEM 343 PHYSICAL CHEMISTRY FOR
ENGINEERS II**

(2-0) 2 credits. Prerequisites: PHYS 213 and CHEM 341 or CHEM 342. Kinetic theory of gases; statistical thermodynamics and properties of solids; chemical kinetics and kinetics at interfaces. Duplicate credit for CHEM 343 and CHEM 344 not allowed.

CHEM 344 PHYSICAL CHEMISTRY II

(3-0) 3 credits. Prerequisites: CHEM 342 and PHYS 213. A continuation of Physical Chemistry I. A study of the fundamental principles governing the behavior of chemical systems. Kinetic theory of gases; statistical thermodynamics and properties of solids; chemical kinetics and kinetics at interfaces; quantum mechanics and spectroscopy. Duplicate credit for CHEM 343 and CHEM 344 not allowed.

**CHEM 344L PHYSICAL CHEMISTRY II
LAB**

(0-1) 1 credit. Prerequisite: CHEM 342L. Prerequisite or corequisite CHEM 344. Corequisite course to CHEM 344. Laboratory designed to accompany CHEM 344. This course is cross-listed with CHEM 345L.

**CHEM 345L PHYSICAL CHEMISTRY FOR
ENGINEERS LAB**

(0-1) 1 credit. Prerequisites: CHEM 220, CHEM 332L, and CHEM 341. Prerequisite or corequisite: CHEM 343. Experimental methods used in modern physical chemistry. Spectroscopic, kinetic, thermostatic, and electrochemical techniques are studied. This course is cross-listed with CHEM 344L.

CHEM 370 CHEMICAL LITERATURE

(1-0) 1 credit. Prerequisites: CHEM 230 or CHEM 332 and CHEM 252. Prerequisite or corequisite: CHEM 328. The use of the chemical

library. Character of the various chemical journals, dictionaries, reference books, computer literature searching, and other sources of information. Written reports on chemical literature.

CHEM 420/520 ORGANIC CHEMISTRY III

(3-0) 3 credits. Prerequisite: CHEM 328. Advanced considerations of organic chemistry. Case studies in the synthesis of complex organic molecules are drawn from historical and recent organic chemical literature, which exemplify particular conformational, synthetic, and technical challenges to the organic student. Students enrolled in CHEM 520 will be held to a higher standard than those enrolled in CHEM 420.

**CHEM 421/521 SPECTROSCOPIC
ANALYSIS**

(3-0) 3 credits. Prerequisites: CHEM 328 and CHEM 230 or CHEM 332. Determination of the structure of organic compounds using spectroscopic methods. Problems involving library and laboratory work. Students enrolled in CHEM 521 will be held to a higher standard than those enrolled in CHEM 421.

CHEM 426/526 POLYMER CHEMISTRY

(3-0) 3 credits. Prerequisites: CHEM 328 and CHEM 342. An introduction to the fundamental chemistry, characterization, and fabrication of polymeric substances. Students enrolled in CHEM 526 will be held to a higher standard than those enrolled in CHEM 426.

CHEM 434 INSTRUMENTAL ANALYSIS

(3-0) 3 credits. Prerequisites: CHEM 230 or CHEM 332 and CHEM 342. Theory and application of modern instrumental methods to chemical analysis.

**CHEM 434L INSTRUMENTAL ANALYSIS
LAB**

(0-2) 2 credits. Prerequisite or corequisite: CHEM 434. The laboratory designed to accompany CHEM 434. This laboratory includes an introduction to laboratory methods and techniques of potentiometry, conductimetry, electrogravimetry, voltametry, TLC, GC, and

HPLC.

CHEM 452/552 INORGANIC CHEMISTRY
(3-0) 3 credits. Prerequisites: CHEM 252, CHEM 328, CHEM 342. Theoretical and periodic aspects of inorganic chemistry. Discussion of the important models and concepts of modern inorganic chemistry. Students enrolled in CHEM 552 will be held to a higher standard than those enrolled in CHEM 452.

CHEM 452L/552L INORGANIC CHEMISTRY LAB

(0-1) 1 credit. Prerequisites: CHEM 328L, Prerequisite or corequisite: CHEM 452. Synthesis and characterization of inorganic compounds. Laboratory techniques in inorganic chemistry including: synthesis of air-sensitive compounds, transition metal complexes and silicon polymers, chemical characterization of inorganic compounds using spectroscopic, magnetic and analytical approaches. Students enrolled in CHEM 552L will be held to a higher standard than those enrolled in CHEM 452L.

CHEM 460/560 BIOCHEMISTRY
(3-0) 3 credits. Prerequisite: CHEM 328. A one-semester course in biomolecules, metabolism, and transmission of genetic information. The structures, properties, and biochemical functions of mono- and polysaccharides, lipids, amino acids, proteins, and nucleic acids are introduced. Metabolic pathways and cycles for the catabolism and anabolism of sugars, triglycerides, steroids, amino acids, proteins, and polynucleotides are detailed. Energetics, the potential fates of chemical intermediates, and information storage and transmission are studied. Students enrolled in CHEM 560 will be held to a higher standard than those enrolled in CHEM 460.

CHEM 482/582 ENVIRONMENTAL CHEMISTRY
(3-0) 3 credits. Prerequisites: CHEM 316 or CHEM 328. Examination of the chemistry and chemical processes of the environment, including the role of chemistry in current environmental issues. Students enrolled in CHEM 582 will be held to a higher standard than those enrolled in

CHEM 482.

CHEM 490 SEMINAR
(0.5-0)0.5 credits. A highly focused, and topical course. The format includes student presentations and discussions of reports based on literature, practices, problems, and research. Seminars may be conducted over electronic media such as Internet and are at the upper division or graduate levels. Enrollment is generally limited to fewer than 20 students. Repeatable for a maximum of 2 credits.

CHEM 491 INDEPENDENT STUDY
1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. A maximum of 6 credits of special topics and independent study credits will be allowed for degree credit.

CHEM 492 TOPICS
1 to 3 credits. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. A maximum of 6 credits of special topics and independent study credits will be allowed for degree credit.

CHEM 498 UNDERGRADUATE RESEARCH/SCHOLARSHIP
1 to 3 credits. Prerequisite: Permission of instructor. Includes senior project, and capstone experience. Independent research problems/projects or scholarship activities. The plan of study is negotiated by the faculty member

and the student. Contact between the two may be extensive and intensive. Does not include research courses which are theoretical. A maximum of 6 credit hours of undergraduate research will be allowed for degree credit.

CP 297/397/497 COOPERATIVE EDUCATION

1 to 3 credits. Prerequisite: Permission of instructor. Applied, monitored and supervised, field-based learning experience for which the student may or may not be paid. Students gain practical experience; they follow a negotiated and or directed plan of study established between the student, instructor and field experience supervisor. Due to the presence of a field experience supervisor, a lower level of supervision is provided by the instructor in these courses than is the case with an internship or practicum course. Students must satisfy departmental co-op requirements, which include a written report of the co-op work experience and an employer's evaluation, to earn credit for the course. Minimum GPA and other co-op eligibility requirements vary among employers. Because the work performed by a student while on co-op is equivalent to the workload of a full-time student, a student on co-op assignment who is registered for CP credit shall be considered to have full-time status.

CP 697 COOPERATIVE EDUCATION

1 to 3 credits. A single semester work experience at the employer's location. Students will be asked to utilize specialized skills learned in the classroom and will be permitted to develop human relations skills and maturity in a degree-relevant work environment. Each student must satisfy departmental requirements in order to earn credit for the course. Requirements will include but not be limited to a written report of the work experience and an employer's evaluation of work performance. Students must have the approval of their graduate committee in order to enroll.

CSC 105 INTRODUCTION TO COMPUTERS

(3-0) 3 credits. Overview of computer applications with emphasis on word processing,

spreadsheets, database, presentation tools and Internet-based applications. May not be used for credit toward an engineering or science degree (except interdisciplinary sciences and associate of arts).

CSC 150/150L COMPUTER SCIENCE I

(2-1) 3 credits. Prerequisite and corequisite: MATH 123. An introduction to computer programming. Focus on problem solving, algorithm development, design, and programming concepts. Topics include sequence, selection, repetition, functions, and arrays.

CSC 210 WEB AUTHORIZING

(3-0) 3 credits. Prerequisite: CSC 105 or permission of instructor. This course focuses on techniques and methods for writing specifically for the Internet. Topics will include designing and creating documents for the World Wide Web, design considerations, and publishing and maintaining websites. Students will use HTML, web authoring software, and other software for web development.

CSC 250 COMPUTER SCIENCE II

(4-0) 4 credits. Prerequisite: CSC 150 completed with a minimum grade of "C". Problem solving, algorithm design, standards of program style, debugging and testing. Extension of the control structures and data structures of the high-level language introduced in CSC 150. Elementary data structures and basic algorithms that include sorting and searching. Topics include more advanced treatment of functions, data types such as arrays and structures, and files.

CSC 251 FINITE STRUCTURES

(4-0) 4 credits. Prerequisite: CSC 150 or permission of instructor. Selected topics from Boolean algebra, set theory, congruencies, equivalence relations, complexity, graph theory, combinatorics, induction, difference equations, and logic. This course is cross-listed with MATH 221.

CSC 284 DATABASE PROCESSING

(3-0) 3 credits. Prerequisite: CSC 211; corequisite: CSC 212 or permission of instructor.

Student will learn the fundamentals of database management with specific attention to the most popular database systems currently in use on both NT and UNIX systems (Access, Sequel, and Oracle). Students will learn how data is stored and retrieved, the basics of the entity-relationship design methodology and table design, and an introduction to performance issues. This course emphasizes using existing systems rather than writing these systems. Students interested in the programming details should take CSC 484.

CSC 291 INDEPENDENT STUDY

1 to 5 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. May be repeated to a total of 5 credit hours.

CSC 292 TOPICS

1 to 5 credits. Includes current topics, advanced topics, and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. May be repeated to a total of 6 credit hours.

CSC 300 DATA STRUCTURES

(4-0) 4 credits. Prerequisite: CSC 250 completed with a minimum grade of "C" and CSC 251. A systematic study of data structures and the accompanying algorithms used in computing problems; structure and use of storage; methods of representing data; techniques for implementing data structures; linear lists; stacks; queues; trees and tree traversal; linked lists; and other structures.

CSC 314/314L ASSEMBLY LANGUAGE

(2-2) 4 credits. Prerequisite: CSC 250. A thorough introduction to assembly language programming and processor architecture. A study of low-level programming techniques, and the layout of a typical computer. The student will gain insight into the memory layout, registers, run-time stack, and global data segment of a running program. This course is cross listed with CENG 314/314L. Graduation credit will not be allowed for both this course and CENG 314/314L.

CSC 317/317L COMPUTER ORGANIZATION AND ARCHITECTURE

(3-1) 4 credits. Prerequisite: CSC 314 and CENG 244. A course in computer organization with emphasis on the hierarchical structure of computer systems. Covers such topics as: components of computer systems and their configuration, design of basic digital circuits, the microprogram level, the conventional machine level, the operating system level, assembly language, addressing modes, interpreters/translators, computer arithmetic.

CSC 372 ANALYSIS OF ALGORITHMS

(3-0) 3 credits. Prerequisites: CSC 300 and MATH 125. Design and analysis of algorithms for numeric and nonnumeric problems, general problem-solving approaches, theory of computation. Topics will be selected from searching, sorting, graph algorithms, numerical algorithms, geometric algorithms, cryptography, and parallel algorithms.

CSC 391 INDEPENDENT STUDY

1 to 5 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. May be repeated to a total of 5 credit hours.

CSC 392 TOPICS

1 to 5 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments usually 10 or fewer students. May be repeated to a total of 6 credit hours.

CSC 410/510 PARALLEL COMPUTING

(3-0) 3 credits. Prerequisite: CSC 456. The fundamental ideas and issues involved in programming and using parallel computers. A survey of modern architectures and operating systems. Parallel programming applications in business, economic modeling, and science. The School of Mines emphasizes scientific applications. Students enrolled in CSC 510 will be held to a higher standard than those enrolled in CSC 410.

CSC 412/512 CRYPTOGRAPHY

(3-0) 3 credits. Prerequisite: MATH 413 and CSC 250, or permission of instructor. This course provides an introduction to cryptography and the mathematics behind current encryption algorithms. It covers classical cryptosystems, private-key cryptosystems (such as DES and AES), and public-key cryptosystems (such as RSA).

CSC 415/415L/515/515L INTRODUCTION TO ROBOTICS

(2-1) 3 credits. Prerequisites: CSC 300 and MATH 321 or permission of instructor. An introduction to mechatronic systems and embedded systems for robotics. This course will cover the basics required for autonomous mobile robotics. The course will begin with a survey of existing systems and some background mathematics. Core course topics will include electromechanical components, electronics for motor control, sensors and instrumentation, mobile robotic kinematics and movement, microcontrollers, real time computing, and embedded system design and development. Course projects will include student teams building task oriented mobile robots which

emphasis on the hardware development. Students enrolled in CSC 515 will be held to a higher standard than those enrolled in CSC 415.

CSC 416/416L/516/516L INTRODUCTION TO AUTONOMOUS SYSTEMS

(2.5-0.5) 3 credits. Prerequisites: CSC 415/515 or permission of instructor. An introduction to autonomous systems. This course will cover the basics behind intelligent autonomous machines focusing on autonomous mobile robotics. Core course topics will include perception and vision, robot localization, mapping, navigation, standard mobile robot tasks and environmental issues. Course projects will include student teams building task oriented mobile robots. Student enrolled in CSC 516 will be held to a higher standing than those enrolled in CSC 416.

CSC 421/521 GRAPHICAL USER INTERFACES

(3-0) 3 credits. Prerequisite: CSC 300. This introductory course in graphical user interface concepts will cover graphical user interface elements and style, events, component and object oriented user interface models, and graphical application programming issues. Topics will be covered in the context of common graphical user interface environments and programming languages. Possible topics include current GUI development languages such as Java, web interfaces, GUI design principles and standards, and the role of the GUI in the overall application. Students enrolled in CSC 521 will be held to a higher standard than those enrolled in CSC 421.

CSC 433/533 COMPUTER GRAPHICS

(3-0) 3 credits. Prerequisites CSC 300 and MATH 225. Graphical programming concepts. Display media and device characteristics. Point, line, and circle plotting. Coordinate systems and transformations. Polygon clipping and filling. Spline methods, hidden surface elimination, and shading. Students enrolled in CSC 533 will be held to a higher standard than those enrolled in CSC 433.

CSC 440/440L ADVANCED DIGITAL SYSTEMS

(3-1) 4 credits. Prerequisites: CSC 317 or permission of instructor. Memory and disk systems, bus and I/O systems, parallel processing. Applications of digital systems in real-time processing. Graduation credit will not be allowed for both this course and CENG 446.

CSC 445/545 INTRO TO THEORY OF COMPUTATION

(3-0) 3 credits. Prerequisite: CSC 251. Introduction to a series of models for computation and their relationship to formal languages that are useful in the definition of programming languages along with a look at the theoretical limits of computers. Topics include finite and pushdown automata, Turing machines, grammars, decidability and computational complexity. Students enrolled in CSC 545 will be held to a higher standard than those enrolled in CSC 445.

CSC 447/547 ARTIFICIAL INTELLIGENCE

(3-0) 3 credits. Prerequisite: CSC 300. Concepts in Artificial Intelligence: programming in languages such as Prolog or LISP; knowledge representation; search algorithms. Students enrolled in CSC 547 will be held to a higher standard than those enrolled in CSC 447.

CSC 448/548 MACHINE LEARNING

(3-0) 3 credits. Prerequisite: CSC 300. A systematic study of the theory and algorithms that constitute machine learning. It covers learning based on examples including genetic algorithms, case-based reasoning, decision trees, and Bayesian methods. Students enrolled in CSC 548 will be held to a higher standard than those enrolled in CSC 448.

CSC 449/549 PATTERN RECOGNITION

(3-0) 3 credits. Prerequisites: CSC 300, MATH 225 and MATH 381 or MATH 441 or permission of instructor. Introduction to pattern recognition algorithms. Topics covered include statistical pattern recognition, machine learning, and neural networks. Students enrolled in CSC 549 will be held to a higher standard than those enrolled in

CSC 449.

CSC 456/456L OPERATING SYSTEMS

(3-1) 4 credits. Prerequisites: CSC 314 and CSC 300. A study of the functions and structures associated with operating systems with respect to process management, memory management, auxiliary storage management, and processor management. Topics include concurrent and distributed computing, deadlock, real and virtual memory, job and processor scheduling, security and protection. Graduation credit will not be allowed for both this course and CENG 456.

CSC 461 PROGRAMMING LANGUAGES

(4-0) 4 credits. Prerequisite: CSC 300. This course consists of two parts. The first part introduces how programming languages are designed, including an introduction to the concepts of parsing and compiling. Issues related to implementation such as type checking, binding, and memory management are discussed. Secondly, the course will survey the spectrum of programming languages paradigms, including traditional imperative, object oriented, functional, and logic languages.

CSC 463/563 DATA COMMUNICATIONS

(4-0) 4 credits. Prerequisite: CSC 250. A study of the principles of data communications, computer networks, and open systems, following the outline provided by the ISO/OSI model. Students enrolled in CSC 563 will be held to a higher standard than those enrolled in CSC 463.

CSC 464/564 INTRODUCTION TO DIGITAL IMAGE PROCESSING AND COMPUTER VISION

(3-0) 3 credits. Prerequisites: CSC 300 and MATH 125. Introduction to digital image processing and computer vision, including image digitization and display, image enhancement and restoration, frequency domain techniques using the Fourier transform, image encoding, segmentation, and feature detection. Students enrolled in CSC 564 will be held to a higher standard than those enrolled in CSC 464.

CSC 465 SENIOR DESIGN I

(2-0) 2 credits. Prerequisites: CSC 470 and senior standing or permission of instructor. This is a team-based project-design course. This course will focus on the design process and culminate with the faculty approval of design projects. Typical topics included are the development of a design document, identification of customer needs, development of specifications, consideration of alternate designs using a decision matrix, project management techniques, legal, global and ethical issues.

CSC 467 SENIOR DESIGN II

(2-0) 2 credits. Prerequisites: CSC 465 or permission of instructor. This course is a continuation of CSC 465. The student will complete the project approved in CSC 465. It will require that the students implement the design projects in a simulated industrial environment. Specific requirements may include detailed laboratory notebook, periodic written and oral progress reports, and a written and oral presentation of the final project report.

CSC 470 SOFTWARE ENGINEERING

(3-0) 3 credits. Prerequisites: CSC 300 or permission of instructor. An introduction to the software engineering process, including lifecycle phases, problem analysis, specification, project estimation and resource estimation, design, implementation, testing/maintenance, and project management. In particular, software validation and verification as well as scheduling and schedule assessment techniques will be discussed.

CSC 476 THEORY OF COMPILERS

(3-0) 3 credits. Prerequisites: CSC 314 and CSC 461 or permission of instructor. Course covers formal languages, parsing, design of compilers, assemblers, and translators.

CSC 484 DATABASE MANAGEMENT SYSTEMS

(3-0) 3 credits. Prerequisite: CSC 300. The study of formalized database design. This course will focus on relational model design and the use of SQL. Students will use a modern relational database to implement designs and learn the

basics of data management.

CSC 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems, and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. May be repeated to a total of 5 credit hours.

CSC 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics, and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. May be repeated to a total of 6 credit hours.

CSC 498 UNDERGRADUATE RESEARCH/SCHOLARSHIP

Credit to be arranged; not to exceed 6 credits toward fulfillment of B.S. degree requirements. Prerequisite: Permission of instructor. Includes senior project, and capstone experience. Independent research problems/projects or scholarship activities. The plan of study is negotiated by the faculty member and the student. Contact between the two may be extensive and intensive. Does not include research courses which are theoretical. May be repeated to a total of 6 credit hours.

CSC 505 SURVEY OF DATA STRUCTURES AND ALGORITHMS

(3-0) 3 credits. Prerequisite: CSC 150. This is the CSC leveling course for non-CSC majors who are entering the graduate program in the computer science department. It will lay the necessary foundation in data structures and Algorithms to prepare students from other disciplines to take

advanced courses in the Computer Science department. Topics covered in this course include recursion, linked lists, stacks, queues, trees, graphs, searching, sorting, and the basics of software development. This course may not be used for credit towards the B.S. in computer science. Students may not obtain credit for this course and CSC 300.

CSC 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Student should have obtained permission of an instructor in the Department of Mathematics and Computer Science prior to registering for this course. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor. May be repeated to a total of 5 credit hours.

CSC 692 TOPICS

1 to 3 credits. Student should have obtained permission of an instructor in the Department of Mathematics and Computer Science prior to registering for this course. Lecture course or seminar on a topic or field of special interest, as determined by the instructor. May be repeated to a total of 6 credit hours.

CSC 713 ADVANCED SOFTWARE ENGINEERING

(3-0) 3 credits. Prerequisite: CSC 300 or permission of instructor. This course covers concepts and techniques within the different phases of the software life cycle: requirements, specifications, design, implementation, testing, operation, and management. The emphasis will be on the study of activities related to software configuration management and maintenance.

CSC 731 ADVANCED COMPUTER GRAPHICS

(3-0) 3 credits. Prerequisites: CSC 433 or permission of instructor. Topics considered in this course include the viewing/rendering pipeline, interaction strategies, curve and surface models, visible-surface determination, illumination and shading models, antialiasing.

Also included will be project development using PHIGS and GKS (C programming required).

CSC 752 COMPUTER VISION

(3-0) 3 credits. Prerequisites: Permission of instructor. Low-level processing for extraction of intrinsic image features (edges, range, surface orientation, motion and optical flow, texture), relaxation methods, image segmentation, pattern recognition, geometric and relational structures, knowledge representation, and neural network approaches.

CSC 761 ADVANCED ARTIFICIAL INTELLIGENCE

(3-0) 3 credits. Prerequisites: Permission of instructor. The objective of this course is to provide students with a background in advanced artificial intelligence problem solving methods. Topics covered include: Expert systems, fuzzy logic and fuzzy expert systems, genetic algorithms, case-based reasoning, and current research work on new areas of problem solving.

CSC 762 NEURAL NETWORKS

(3-0) 3 credits. Prerequisites: CSC 300 or permission of instructor. This course presents a survey of the architecture and algorithms of neural networks. Topics covered include perceptrons, competitive learning, multi-layer networks, back propagation, and selected topics from pattern recognition.

CSC 772 ADVANCED OPERATING SYSTEMS

(3-0) 3 credits. Prerequisites: CSC 456 or permission of instructor. Advanced topics in operating systems design for multiprocessing and distributed systems. Topics will include areas such as methods of interprocess communication, reliability, maintainability, security, and large-scale design considerations.

CSC 784 DATABASE DESIGN

(3-0) 3 credits. Prerequisites: CSC 300 or permission of instructor. This course will include an overview of the relational and entity relationship (E-R) models. It will cover database design, advanced data models, emerging trends in

the database field, including data warehouse, data mining, and distributed and parallel databases. Oracle database design tools and programming will be taught.

CSC 788 MASTER'S RESEARCH PROBLEMS/PROJECTS

Credit to be arranged; not to exceed 3 credits toward fulfillment of M.S. degree requirements. Open only to students pursuing the M.S. non-thesis option. Directed investigation of a selected problem culminating in an acceptable written report. Oral defense of the report and findings are required.

CSC 790 SEMINAR

(1-0) 1 credit. May not be repeated for degree credit. Preparation of an oral and/or written presentation and group discussion of a research problem.

CSC 791 INDEPENDENT STUDY

1 to 5 credits. Prerequisite: Permission of instructor. Student should have obtained permission of an instructor in the Department of Mathematics and Computer Science prior to registering for this course. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor. May be repeated to a total of 5 credit hours.

CSC 792 TOPICS

1 to 5 credits. Student should have obtained permission of an instructor in the Department of Mathematics and Computer Science prior to registering for this course. Lecture course or seminar on a topic or field of special interest, as determined by the instructor. May be repeated to a total of 6 credit hours.

CSC 798 MASTER'S THESIS

Credit to be arranged; not to exceed 6 credits toward fulfillment of M.S. degree requirements. Open only to students pursuing the M.S. thesis option. Supervised original or expository research culminating in an acceptable thesis. Oral defense of thesis and research findings are required.

ECON 201 PRINCIPLES OF MICROECONOMICS

(3-0) 3 credits. Principles of microeconomics studies basic economic concepts as they relate to consumer, worker, and business decisions. Emphasis is given to satisfaction maximizing behavior by individuals and profit maximization by firms. Market structures are thoroughly analyzed regarding their effect on price, output, and competitiveness. This course is taught by Black Hills State University.

ECON 202 PRINCIPLES OF MACROECONOMICS

(3-0) 3 credits. Principles of macroeconomics considers the economy as a whole, how its sectors interact, and how monetary and fiscal policy can influence output, inflation, interest rates, unemployment, poverty, debt, and other factors. This course is taught by Black Hills State University.

EE 220/220L CIRCUITS I

(3-1) 4 credits. Prerequisites: MATH 125 completed with a grade of "C". Corequisite: MATH 321. This course is designed to provide the electrical engineering student with an understanding of the basic concepts of the profession. Topics covered include resistive circuits, transient circuits, and sinusoidal analysis. Students also investigate essential principles by conducting laboratory experiments related to the topics studied in the classroom. P-spice is used to analyze electrical circuits using personal computers.

EE 221/221L CIRCUITS II

(3-1) 4 credits. Prerequisites: EE 220 completed with a grade of "C" and MATH 321. This course is designed to provide the electrical engineering student with an understanding of the basic concepts of the profession. Topics covered include resistive circuits, transient circuits, and sinusoidal analysis. Students also investigate essential principles by conducting laboratory experiments related to the topics studied in the classroom. P-spice is used to analyze electrical circuits using personal computers.

EE 264/264L SOPHOMORE DESIGN

(1-1) 2 credits. Prerequisite: sophomore standing. This course focuses on the design process including project management and teamwork; formal conceptual design methods; acquiring and processing information; design management tools; design for manufacturability, reliability, maintainability, sustainability; design communication: reports and presentations; ethics in design; prototyping designs; case studies. This course is cross-listed with ME 264/264L.

EE 291 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

EE 292 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

EE 301/301L INTRODUCTORY CIRCUITS, MACHINES, AND SYSTEMS

(3-1) 4 credits. Prerequisites: GE 115 or equivalent, MATH 125 completed with a grade of "C" or better, and MATH 321 completed or concurrent. Not for majors in electrical engineering or computer engineering. Introduces the essential concepts of electrical engineering concerning circuits, machines, electronics, and systems.

EE 303/303L BASIC CIRCUITS

(2-1) 3 credits. Not for majors in Electrical or Computer Engineering. Introduces basic concepts

in electrical DC and AC circuits including analysis techniques and applications. Concepts will be reinforced through lab work.

EE 311/311L SYSTEMS

(3-0.5) 3.5 credits. Prerequisites: EE 221 completed with a grade of "C" or better, EM 216 completed or concurrent. Mathematical, topological, and circuit models of electro-systems, such as electromagnetic, electromechanical, electro thermal, etc.

EE 312/312L SIGNALS

(3-0.5) 3.5 credits. Prerequisites: EE 221 completed with a grade of "C" or better. Characterization of signals; the complex plane as a representative of the transient and frequency responses, continuous and discrete signal processing.

EE 320/320L ELECTRONICS I

(3-1) 4 credits. Prerequisite or corequisite: EE 221. Presents concepts of electronic devices and circuits including modeling of semiconductor devices, analysis and design of transistor biasing circuits, and analysis and design of linear amplifiers. Use of computer simulation tools and breadboarding as part of the circuit process is emphasized. Students are introduced to methods for designing circuits that still meet specifications even when there are statistical variations in the component values.

EE 322/322L ELECTRONICS II

(3-1) 4 credits. Prerequisite: EE 221 and EE 320. A continuation of EE 320 with emphasis on design applications of linear and nonlinear integrated circuits.

EE 330/330L ENERGY SYSTEMS

(3-1) 4 credits. Prerequisite: EE 221. Production, transmission, and utilization of energy in systems with major electrical subsystems, with particular emphasis on electromagnetic and electromechanical systems and devices.

EE 351/351L MECHATRONICS AND MEASUREMENT SYSTEMS

(3-1) 4 credits. Prerequisite: CSC 150 and EE

220 or EE 301. This course will encompass general measurement techniques found in mechanical and electrical engineering. These include measurement of force, strain, frequency, pressure flow rates, and temperatures. Elements of signal conditioning and data acquisition will be introduced. In addition to this material, the course will have a mechatronics approach reflected in the combined applications of electronic mechanical and control systems. This course is cross-listed with ME 351/351L.

EE 362 ELECTRIC AND MAGNETIC PROPERTIES OF MATERIALS

(3-0) 3 credits. Prerequisites: MATH 225, MATH 321, and PHYS 213. This course studies the behavior of materials of interest to electrical engineers and covers fundamental issues such as energy band theory, density of states, Fermi-Dirac statistics, equilibrium statistics in semiconductors, and Fermi energy. This foundation is then used to study a variety of topics such as conduction, semiconductor devices, ferromagnetism, lasers, gaseous electronics, and thermoelectric phenomena.

EE 381 ELECTRIC AND MAGNETIC FIELDS

(3-0) 3 credits. Prerequisites: MATH 225, MATH 321, and PHYS 213. Fundamentals of field theory (i.e., Maxwell's equations) as applied to static electric and magnetic phenomena. Also, theory and applications of lossless transmission lines are covered.

EE 382/382L APPLIED ELECTROMAGNETICS

(2.5-0.5) 3 credits. Prerequisite: EE 381. Field theory (e.g., Maxwell's equations) for time-varying electromagnetic phenomena. Applications include transmission lines, plane waves, and antennas. Students are introduced to typical laboratory equipment associated with applied electromagnetics (e.g., vector network analyzer).

EE 391 INDEPENDENT STUDY

1 to 4 credits. Prerequisite: Permission of instructor. Includes directed study, problems,

readings, directed readings, special problems, and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

EE 392 TOPICS

1 to 4 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

EE 421/421L COMMUNICATION SYSTEMS

(3-1) 4 credits. Prerequisites: EE 312 and EE 322. Fundamentals of analog- and digital-signal transmission. Performance characteristics such as channel loss, distortion, bandwidth requirements, signal-to-noise ratios, and error probability.

EE 431/431L POWER SYSTEMS

(3-1) 4 credits. Prerequisite: EE 311 and EE 330. The principles of energy conversion and transmission in modern power systems. Specialized problems of design, control, and protection are included.

EE 432/432L POWER ELECTRONICS

(3-1) 4 credits. Prerequisites: EE 330. The conversion, regulation, and control of electric power by means of electronic switching devices; inverter and chopper circuits; pulse width modulation; motor drives.

EE 451/451L CONTROL SYSTEMS

(3-1) 4 credits. Prerequisite: ME 352 or EE 311. Analysis and design of automatic control and process systems by techniques encountered in modern engineering practice, including both linear and nonlinear systems with either continuous or discrete signals. This course is

cross-listed with ME 453/453L

EE 464 SENIOR DESIGN I

(2-0) 2 credits. Prerequisites: Senior standing and prerequisite or corequisite EE 311, EE 312, EE 322 and ENGL 289. This course will focus on the design process and culminate with the EE faculty approval of design projects (including schematics and parts list) for EE 465. Typical topics included are the development of a product mission statement, identification of the customer and customer needs, development of target specifications, consideration of alternate designs using a decision matrix, project management techniques, legal and ethical issues, FCC verification and certification, use of probability and statistics for reliable design, interpretation of data sheets, and component selection.

EE 465 SENIOR DESIGN II

(2-0) 2 credits. Prerequisites: EE 464. Sequel to EE 464. Seniors build project in simulated environment incorporating engineering standards and realistic constraints. Requirements include laboratory notebook, progress reports, final oral presentation, and written report.

EE 481/481L MICROWAVE ENGINEERING

(3-1) 4 credits. Prerequisite: EE 382. Presentation of basic principles, characteristics, and applications of microwave devices and systems. Development of techniques for analysis and design of microwave circuits.

EE 483/483L ANTENNAS FOR WIRELESS COMMUNICATIONS

(3-1) 4 credits. Prerequisite: EE 382. Introduction to antenna design, measurement, and theory for wireless communications including fundamental antenna concepts and parameters (directivity, gain, patterns, etc.), matching techniques, and signal propagation. Theory and design of linear, loop, and patch antennas, antenna arrays, and other commonly used antennas. Students will design, model, build, and test antenna(s).

EE 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of

instructor. Includes directed study, problems, readings, directed readings, special problems, and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

EE 492 TOPICS

1 to 4 credits. Includes current topics, advanced topics, and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

EE 498 UNDERGRADUATE RESEARCH/SCHOLARSHIP

Credit to be arranged: not to exceed 4 credits toward fulfillment of B.S. degree requirements. Prerequisite: Permission of instructor. Includes senior project, and capstone experience. Independent research problems/projects or scholarship activities. The plan of study is negotiated by the faculty member and the student. Contact between the two may be extensive and intensive. Does not include research courses which are theoretical.

EE 505/505L SURVEY OF CIRCUITS AND SYSTEMS

(2-1) 3 credits. Prerequisites: CSC 150, Math 321 or permission of instructor. This course provides the necessary foundation in circuits, circuit analysis, transient circuits, sinusoidal analysis, electromechanical systems, electromagnetic systems, topological and mathematical models for the study of robotic and autonomous systems. May not be used for credit by computer engineering, electrical engineering, and mechanical engineering majors.

EE 552/552L ROBOTIC CONTROL SYSTEMS

(2.5-0.5) 3 credits. Prerequisites: CSC 150, Math 321, EE 311 or EE 505 or permission of instructor. Applications of discrete control systems for robotics and autonomous systems: analysis and design of automatic control systems, including both linear and nonlinear systems with continuous and discrete signals.

EE 612/612L HIGH-SPEED DIGITAL DESIGN

(2.5-0.5) 3 credits. Prerequisites: EE 220 and EE 320 or equivalent courses in introductory circuits and introductory electronics. This course is an introduction to signal integrity and the design of high-speed circuits and interconnects. Topics include signal Integrity issues such as ringing, ground bounce, clock skew, jitter, crosstalk, and unwanted radiation, time-domain analysis and spice simulation of lumped and distributed high speed circuits, micro-strip and strip-line design, ground and power plane design, proper capacitor decoupling, line termination, and multi-layer routing strategies. The student is also introduced to high-speed measurement techniques and equipment.

EE 618/618L SENSORS AND SIGNAL PROCESSING

(2-1) 3 credits. Presentation of principles, characteristics, and applications of instrumentation systems including sensors, filters, instrumentation amplifiers, analog-to-digital and digital-to-analog conversions, and noise. This course will be useful to graduate students beginning their laboratory thesis research. It is available to students from other departments with permission of instructor.

EE 621 INFORMATION AND CODING THEORY

(3-0) 3 credits. Principles and techniques of information theory and coding theory and their application to the design of information handling systems. Topics include: Entropy, Shannon theory, channel capacity, coding for data translation, compaction, transmission and

compression, block codes, and Markov processes.

EE 622 STATISTICAL COMMUNICATION SYSTEMS

(3-0) 3 credits. Concepts of probability and random processes; linear systems and random processes; performance of amplitude angle and pulse modulation systems in noisy environments; digital data transmission; and basic concepts of information theory.

EE 623 RANDOM SIGNALS AND NOISE

(3-0) 3 credits. Prerequisite: Permission of instructor. Selected topics in the theory of probability and statistics; spectral analysis; shot noise and Gaussian processes; noise figures; signal-to-noise ratios; random signals in linear systems; optimum linear systems. Taught as required.

EE 624/624L ADVANCED DIGITAL SIGNAL PROCESSING

(2.5-0.5) 3 credits. Prerequisites: CENG 420 or equivalent. This course develops the theory essential to understanding the algorithms that are increasingly found in modern signal processing applications, such as speech, image processing, digital radio and audio, statistical and adaptive systems. Topics include: analysis of non-stationary signals, transform techniques, Wiener filters, Kalman filters, multirate rate systems and filter banks, hardware implementation and simulation of filters, and applications of multirate signal processing. Matlab will be used extensively.

EE 633 POWER SYSTEM ANALYSIS I

(3-0) 3 credits. Prerequisite: EE 431 or equivalent. Synchronous machine theory and modeling; short-circuit, load flow, and stability studies in large scale systems. Taught as required.

EE 634 POWER SYSTEM ANALYSIS II

(3-0) 3 credits. Prerequisite: EE 633. Advanced topics in power system analysis; excitation and speed-control systems; protective relaying and relay applications. Taught as required.

EE 641 DIGITAL SYSTEMS DESIGN

(3-0) 3 credits. Prerequisite: Permission of instructor. Design of digital systems (including computer systems) and implementation by fixed logic and programmed logic (microprocessors and microprogramming). Taught as required.

EE 643 ADVANCED DIGITAL SYSTEMS

(3-0) 3 credits. Study of current advanced topics in digital systems; multiprocessors; computer networks; digital communication; pattern recognition systems. Taught as required.

EE 644 FAULT TOLERANT COMPUTING

(3-0) 3 credits. Prerequisite: CENG 342 or equivalent or permission of instructor. The objective of this course is to provide students with a background in the various techniques used in fault tolerant approaches. After an introduction to fault tolerance, deterministic testing and probabilistic testing will be presented. Important topics in the area of fault tolerant computing will be covered, such as random testing, error detection and correction, reliability analysis, fault-tolerant design techniques, and design faults including software reliability methods.

EE 647/647L HDL DESIGN

(2.5-0.5) 3 credits. Prerequisite: CENG 342 or permission of instructor. This course explores modern design techniques utilizing hardware description languages (HDLs) such as VHDL, VHDL-A, and Verilog. Fundamental language syntax will be covered in addition to advanced language constructs. Various hierarchical design styles such as dataflow, structural, and behavioral descriptions will be presented. Emphasis will be placed on both design simulation and synthesis. Synthesis platforms (e.g., FPGAs and ASICs) will also be examined. Other current issues will also be discussed such as reconfigurability, system-on-a-chip solutions, testbenches, soft processors, etc.

EE 648/648L ADVANCED VLSI DESIGN

(2.5-0.5) 3 credits. Prerequisite: CENG 440. This course presents more advanced material related to the technology and design of modern VLSI integrated circuits including topics such as mixed logic design, BiCMOS logic design, memory

design, low power design, silicon-on-insulator chips, deep sub-micron design issues, crosstalk, parasitic parameter extraction and optimization, gallium arsenide logic devices, design-for-test, fault-tolerant VLSI architectures, etc.

EE 651 DIGITAL CONTROL SYSTEMS

(3-0) 3 credits. Prerequisite: EE 451 or equivalent. Study of topics in digital control systems, digital compensation techniques; real-time digital control of dynamic systems; optimization of digital systems; digital control of robotic systems, digital to continuous system interfacing. Taught as required.

EE 652 NONLINEAR AND OPTIMAL CONTROL SYSTEMS

(3-0) 3 credits. The study of nonlinear and optimal systems using the phase plane method, describing functions, Lyapunov's theory, nonlinear control systems design, linear, dynamic and integer programmer, parameter optimization, and system optimization using calculus of variation.

EE 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor.

EE 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

EE 791 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor.

EE 792 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by

the instructor.

EE 798 MASTER'S THESIS

Credit to be arranged; not to exceed 6 credits toward fulfillment of the M.S. degree requirements. Supervised original or expository research culminating in an acceptable thesis. Oral defense of the thesis and research findings are required.

EM 214 STATICS

(3-0) 3 credits. Corequisite: MATH 125. The study of the effects of external forces acting on stationary rigid bodies in equilibrium. Vector algebra is used to study two and three dimensional systems of forces. Trusses, frames and machines, shear and moment in beams, friction, centroids, moments of inertia, and mass moments of inertia are discussed.

EM 215 DYNAMICS

(3-0) 3 credits. Prerequisite: EM 214. Newton's laws of motion are applied to particles and rigid bodies. Absolute and relative motion; force, mass and acceleration; work and energy; and impulse and momentum.

EM 216 STATICS AND DYNAMICS

(4-0) 4 credits. Prerequisite: MATH 125. Statics: the study of effects of external forces acting on stationary rigid bodies in equilibrium. Frames and machines, friction, centroids and moments of inertia of areas and mass are discussed. Dynamics: Newton's laws of motion are applied to particles and rigid bodies. Topics considered are absolute and relative motion; force, mass, and acceleration (of particles and rigid bodies); work and energy; and impulse and momentum (of particles).

EM 321 MECHANICS OF MATERIALS

(3-0) 3 credits. Prerequisite: EM 214. Basic concepts of stress and strain that result from axial, transverse, and torsional loads on bodies loaded within the elastic range. Shear and moment equations and diagrams; combined stresses; Mohr's circle; beam deflections; and column action and equations.

EM 327 APPLIED FLUID MECHANICS

(4-0) 4 credits. Prerequisites: EM 321, EM 217, or permission of instructor. An introduction to the static and dynamic properties of real and ideal fluids; application of continuity, energy, and momentum principles to laminar, turbulent, compressible, and incompressible flows; laminar and turbulent flow of fluids in closed conduits and open channels; flow through orifices, weirs, and venturi meters; and flow in pipe networks and pumping systems.

EM 328 APPLIED FLUID MECHANICS

(3-0) 3 credits. Prerequisites: EM 214 or concurrent enrollment in EM 217, or EM 216. Topics will include an introduction to the static and dynamic properties of real and ideal fluids; application of continuity, energy, and momentum principles to laminar, turbulent, compressible, and incompressible flows; laminar and turbulent flow of fluids in closed conduits and open channels; flow through orifices, weirs, and venturi meters. Flow in pipe networks and pumping systems will be investigated using a projectized team approach.

EM 331 FLUID MECHANICS

(3-0) 3 credits. Prerequisites or corequisite: EM 321. An introduction to the static and dynamic properties of real and ideal fluids; application of continuity, energy, and momentum principles to laminar, turbulent, compressible, and incompressible flows; and laminar and turbulent flow of fluids in closed conduits and around immersed bodies.

EM 680 ADVANCED STRENGTH OF MATERIALS

(3-0) 3 credits. Prerequisites: EM 321, MATH 225, MATH 321. Study of advanced concepts in strength of materials. Topics will be selected from the following: theories of stress and strain, failure criteria, energy methods, torsion, nonsymmetrical beams on elastic foundation, plates, shells, stress concentrations, contact stresses, finite element methods, and plastic behavior of solids.

ENGL 003 ENGLISH AS A SECOND LANGUAGE: GRAMMAR REVIEW AND INTERMEDIATE COMPOSITION

(3-0) 3 credits. Conversations, listening and reading comprehension, vocabulary and idioms, grammar review and intermediate composition. Does not count toward graduation

ENGL 013 ENGLISH AS A SECOND LANGUAGE: MORE COMPLEX STRUCTURAL PATTERNS AND ADVANCED COMPOSITION

(3-0) 3 credits. Prerequisite: ENGL 003 or placement. Conversation, listening and reading comprehension, vocabulary and idioms, more complex structural patterns, and advanced composition. Does not count toward graduation.

ENGL 023 ENGLISH AS A SECOND LANGUAGE: LISTENING AND READING, GRAMMAR, COMPREHENSION.

(3 to 5) 3 to 5 credits. Prerequisite: Placement or permission of the instructor. Written and oral responses to written and oral sources. Reading and listening comprehension, vocabulary building, pronunciation, grammar and sentence structure, and formal and informal written and spoken English. Does not count toward graduation.

ENGL 031 BASIC WRITING

(1-0) 1 credit. Prerequisite: Appropriate student placement based on entry level assessment. Intensive work in grammar and usage, punctuation, and paragraph development. Does not count toward graduation.

ENGL 032 BASIC WRITING

(2-0) 2 credits. Prerequisite: Prerequisite: Appropriate student placement based on entry level assessment. Intensive work in grammar and usage, punctuation, and paragraph development. Does not count toward graduation.

ENGL 033 BASIC WRITING

(3-0) 3 credits. Prerequisite: Prerequisite: Appropriate student placement based on entry level assessment. Intensive work in grammar and usage, punctuation, and paragraph development.

Does not count toward graduation.

ENGL 101 COMPOSITION I

(3-0) 3 credits. Appropriate student placement based on entry level assessment or completion of ENGL 031, 032, or 033. Practice in the skills, research, and documentation needed for effective academic writing. Analysis of a variety of academic and non-academic texts, rhetorical structures, critical thinking, and audience will be included.

ENGL 201 COMPOSITION II

(3-0) 3 credits. Prerequisite: ENGL 101 or permission of instructor. Study of and practice in writing persuasive prose, with the aim to improve writing skills in all disciplines. Includes literary analysis and requires a research report.

ENGL 221 BRITISH LITERATURE I

(3-0) 3 credits. A chronological survey of British literature from Old English through the 18th Century. ENGL 221 and ENGL 222 need not be taken in sequence.

ENGL 222 BRITISH LITERATURE II

(3-0) 3 credits. A chronological survey of British literature from the 19th century to the present. ENGL 221 and ENGL 222 need not be taken in sequence.

ENGL 241 AMERICAN LIT I

(3-0) 3 credits. Background to and survey of major works from the beginnings to the Civil War. ENGL 241 and ENGL 242 need not be taken in sequence.

ENGL 242 AMERICAN LIT II

(3-0) 3 credits. Background to and survey of major works from the Civil War to the present. ENGL 241 and ENGL 242 need not be taken in sequence.

ENGL 250 SCIENCE FICTION

(3-0) 3 credits. A survey of short stories and novels from the 19th century to the present.

ENGL 279 TECHNICAL COMMUNICATIONS I

(3-0) 3 credits. Prerequisites: ENGL 101 or equivalent and sophomore standing. Introductory written and oral technical communications with emphasis on research and explanations of scientific and engineering topics.

ENGL 289 TECHNICAL COMMUNICATIONS II

(3-0) 3 credits. Prerequisites: ENGL 279 or equivalent and sophomore standing. Advanced written and oral technical communications with emphasis on the research, preparation, and delivery of complex technical documents.

ENGL 300 THE LITERARY EXPERIENCE OF NATURE

(3-0) 3 credits. Prerequisite: Junior or senior standing. An interdisciplinary survey of writing about nature, examining the relationship between literary, cultural, and scientific perspectives.

ENGL 330 SHAKESPEARE

(3-0) 3 credits. Prerequisite: ENGL 101 or permission of instructor. Representative comedies, tragedies, and histories of Shakespeare.

ENGL 343 SELECTED AUTHORS

(1-0) 1 credit. Prerequisite: ENGL 101 or permission of instructor. A study of the work of one or several major literary figures. Authors may change each time the course is offered. May be taken up to three (3) times with different authors.

ENGL 350 HUMOR IN AMERICAN CULTURE

(3-0) 3 credits. Prerequisite: Junior or senior standing. The interdisciplinary study of American literary humor and its relationship to significant historical and regional issues.

ENGL 360 STUDIES IN EUROPEAN LITERATURE

(3-0) 3 credits. Prerequisite: Junior or senior standing. The interdisciplinary study of a facet of European literature through focus on literature of a particular century, a specific country or

individual authors such as 19th century nationalism, literature of France, or James Joyce. May be repeated to maximum of credit of six hours on different topics.

ENGL 374 STUDIES IN AMERICAN LITERATURE

1 to 3 credits. Prerequisite: Junior or senior standing. The interdisciplinary study of American literature through focus on a particular facet of the American experience, such as a national issue or concern, a unique historical period or literary genre, or a distinct segment of U.S. society. May be repeated to maximum credit of six (6) hours on different topics.

ENGL 383 CREATIVE WRITING

(3-0) 3 credits. Prerequisite: Junior standing. Study and practice in the techniques of writing fiction, poetry, and/or drama.

ENGL 391 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

ENGL 392 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits of special topics will be allowed for degree credit.

ENTR 336 ENTREPRENEURSHIP I

(3-0) 3 credits. This course is an introduction to the concepts, terminology, and process of new

venture creation, operation and growth, as well as the introduction of entrepreneurial management practices into existing businesses. New ventures include public and non-profit institutions as well as for profit businesses. This course will assist in the identification of entrepreneurial opportunities and strategies and the role of personal factors (including creativity). Legal, ethical, and social responsibilities are emphasized. This course is cross-listed with BADM 336. This course is taught by Black Hills State University.

ENTR 406/506 ACCOUNTING FOR ENTREPRENEURS

(3-0) 3 credits. Accounting concepts and practices for entrepreneurs/small business owners. Emphasis given to the use of accounting tools to solve small business problems. Students enrolled in BADM 506 will be held to a higher standard than those enrolled in BADM 406. This course is cross-listed with ACCT 406/506 and BADN 406/506. This course cannot count as a social science/humanities credit. This course is taught by Black Hills State University.

ENTR 438/538 ENTREPRENEURSHIP II

(3-0) 3 credits. This course focuses on the process of screening an opportunity, drafting a personal entrepreneurial strategy, and understanding the business plan writing process. Building the entrepreneurial team and the acquisition and management of financial resources are emphasized along with venture growth, harvest strategies, and valuation. Students enrolled in ENTR 538 will be held to a higher standard than those enrolled in ENTR 438. This course is cross-listed with BADM 438/538. This course is taught by Black Hills State University.

ENTR 489 BUSINESS PLAN WRITING AND COMPETITION

(1-0) 1 credit. Students will write a business plan and present it to a panel of faculty and business community members. The top three business plan presenters will move on to a statewide competition. This course is cross-listed with BADM 489. This course is taught by Black Hills State University.

ENVE 120 INTRODUCTION TO MINING , SUSTAINABLE DEVELOPMENT AND INTRODUCTORY MANAGEMENT

(2-0) 2 credits. This course presents an introductory overview of current surface and underground mining practices, new and emerging mining technology, mining terminology, and mining economics. Mining engineering faculty members are introduced and career paths available to the mining engineering graduate are discussed. The concept of sustainable development as it relates to minerals venture is introduced, and the interrelationships between mining, the environment, societal needs, and governance is discussed. Also included is an introduction to management concepts, presentation skills, meeting skills, negotiation skills, and basic project management tools. This course is cross-listed with MEM 120.

ENVE 204 SURFACE MINING METHODS AND UNIT OPERATIONS

(3-0) 3 credits. Prerequisites: ENVE/MEM 120 or permission of instructor. A study of surface mining techniques and unit operations applicable to metal mining, coal mining, quarrying and other surface mining operations. Topics include mine design and planning, surface drilling and blasting, the applicability and performance characteristics of earthmoving equipment, and an introduction of mine drainage. This course is cross-listed with MEM 204.

ENVE 217 CHEMICAL ENGINEERING I

(3-0) 3 credits. Prerequisite or corequisite: CHEM 114 and CBE117 or permission of instructor. The course on the theory and practice of chemical engineering with emphasis on material and energy balances. This course is cross-listed with CHE 217.

ENVE 220 MINERAL PROCESSING AND RESOURCE RECOVERY

(3-0) 3 credits. Prerequisite: Sophomore standing. An introductory course in mineral processing highlighting unit operations involved including comminution, sizing, froth flotation, gravity separation, electrostatic separation, magnetic separation and flocculation. Other topics

discussed include remediation of contaminant effluents and the unit operations associated with recycling of post-consumer materials using mineral processing techniques. This course is cross-listed with MET 220.

ENVE 220L MINERAL PROCESSING AND RESOURCE RECOVERY LABORATORY

(0-1) 1 credit. An introductory laboratory course in mineral processing highlighting relevant unit operations. This course is cross-listed with MET 220L.

ENVE 302 MINERAL ECONOMICS AND FINANCE

(3-0) 3 credits. Prerequisite: Junior standing. An introduction to the concepts of the time value of money and the application of time value of money decision criteria to mineral project evaluation situations. Both before-tax and after-tax investment situations are discussed. A discussion of the financing options available to a company for expansion, new project development or acquisitions. This course is cross-listed with MEM 302.

ENVE 307 ENVIRONMENTAL GEOSTATISTICS

(2-0) 2 credits. Prerequisite: GEOE 221. The application of the theory of geostatistics to quantify the concepts of (1) area of influence of a sample, (2) the continuity of the regionalized variable within a deposit, (3) the lateral changes in the regionalized variable according to the direction. Basic concepts and theory of probability and statistics will be introduced, including probability distributions, sampling distributions, treatment of data, the mean, variance, and correlation. Computer techniques will be extensively used for geostatistical estimation of sampling attributes. This course constitutes the first two-thirds of and is cross-listed with MEM 307.

ENVE 310 AQUEOUS EXTRACTION, CONCENTRATION, AND RECYCLING

(3-0) 3 credits. Prerequisites: MET 220 and MET 320. Scientific and engineering principles involved in the winning of metals from ores and

scrap. Areas covered include the unit operations of comminution, sizing, solid/liquid separations, leaching, ion exchange, solvent extraction, and surface phenomena as related to flocculation, froth floatation, and electrostatic separation. This course is cross-listed with MET 310.

ENVE 310L AQUEOUS EXTRACTION, CONCENTRATION, AND RECYCLING LAB

(0-1) 1 credit. Prerequisites: Concurrent registration in ENVE 310 or permission of instructor. Laboratory experiments in design of processing equipment and cost estimation, zeta potential, surface tension, leaching kinetics, electrowinning, and solvent extraction. This course is cross-listed with MET 310L.

ENVE 315 FUNDAMENTALS OF HEAT TRANSFER

((2-0) 2 credits. Prerequisites: CBE/ENVE 217, completion of or concurrent registration in MATH 321. Course topics address theory and application of principles of heat transfer by conduction, convection and radiation. Completion of ENVE 315 will not meet the requirement for completion of CBE 317 for a B.S. in chemical engineering. This course is cross-listed with CBE 317.

ENVE 317 CHEMICAL ENGINEERING III

(3-0) 3 credits. Prerequisites: CBE 217, concurrent registration in MATH 321. The third course on the theory and practice of chemical engineering with emphasis on heat transfer. Heat transfer by conduction, convection, and radiation is studied. This course is cross-listed with CBE 317.

ENVE 318 CHEMICAL ENGINEERING IV

(3-0) 3 credits. Prerequisite: CBE 317 or ENVE 315 or permission of instructor. The fourth course on the theory and practice of chemical engineering with emphasis on molecular diffusion, membranes, convective mass transfer, drying, humidification, and continuous gas-liquid separation processes. This course is cross-listed with CBE 318.

ENVE 320 METALLURGICAL THERMODYNAMICS

(4-0) 4 credits. Prerequisites: PHYS 211, CHEM 114, MATH 125. The principles of chemical thermodynamics and their application to metallurgical engineering processes. Topics covered include the zeroth, first, and second laws of thermodynamics, the fundamental equations of state for open and closed systems, criterion of equilibrium, heat capacities, reaction equilibrium constants and their dependence upon temperature and pressure, chemical potential, standard and reference states, stability diagrams, and solution thermodynamics. This course is cross-listed with MET 320.

ENVE 321/321L HIGH TEMPERATURE EXTRACTION, CONCENTRATION, AND RECYCLING

(3-1) 4 credits. Prerequisite: MET 320. Thermodynamic principles involved in the winning of metals. Areas covered include calcination, oxidation, reduction processes, smelting, high -temperature refining, electrorefining, slags, and slag-metal interactions. This course is cross-listed with MET 321/321L.

ENVE 322/322L STRUCTURAL GEOLOGY

(2-1) 3 credits. Prerequisites GEOL 201 and GEOL 201L, or GEOE 221; and GEOL 341. A study of the character and genesis of large-scale and small-scale deformational structures and their patterns in the earth's crust. Laboratory work includes various trigonometric, geometric, and stereographic methods applicable to structural analysis and presents open-ended problems in geologic, structure contour, and isopach map interpretation, as well as engineering design problems including drilling exploration projects. This course is cross-listed with GEOE 322/322L.

ENVE 324/324L ENGINEERING GEOPHYSICS I

(2-1) 3 credits. Prerequisites MATH 125 and PHYS 213. Application of the more commonly used methods of geophysical prospecting in mineral exploration, petroleum exploration, and engineering construction. Includes field design and interpretation of surveys using the

engineering seismograph, gravity meter, electrical resistivity equipment, scintillometers, and magnetometers. Extensive use of computers is made in the laboratory work. This course is cross-listed with GEOE 324/324L.

ENVE 326 INTRODUCTORY ENVIRONMENTAL ENGINEERING DESIGN

(3-0) 3 credits. Prerequisites: CHEM 114 and junior standing. As the first course in the theory and practice of environmental engineering, emphases are on the acquisition of introductory knowledge pertaining to natural and engineered environmental engineering systems, identification and mitigation of societal impacts upon the Earth, and application of environmental engineering principles in the design and analysis of systems for water and wastewater treatment and solid/hazardous waste management. This course is cross-listed with CHE 326.

ENVE 327/327L ENVIRONMENTAL ENGINEERING PROCESS ANALYSIS

(2-1) 3 credits. Prerequisite or corequisite: CEE 284 or CBE 250 and one of the following: EM 328, EM 331, CBE 218 or ME 331. As the second course in the theory and practice of environmental engineering, emphasis is on application of material balance concepts in environmental analysis and design with consideration of water chemistry, environmental process kinetics, ideal and non-ideal reactors, and biological process fundamentals. These fundamental principles are applied in selected natural and engineered environmental contexts spanning air, water and land systems and the effects of society on environmental systems. Laboratory exercises will be completed and reports with computer-generated text, tables and figures will be written. This course is cross-listed with CEE 327/327L.

ENVE 331/331L STRATIGRAPHY AND SEDIMENTATION

(2-1) 3 credits. Prerequisites: GEOL 201 and GEOL 201L, or GEOE 221, or permission of instructor. The principles of correlation and sediment analysis are discussed. A background in

sedimentary source materials, depositional environments, nomenclature and classification of stratigraphic units, and the interpretation of stratigraphic units will be presented. Emphasis is placed on modern depositional systems and their ancient counterparts. Laboratory exercises stress field trips to local sections, facies descriptions, rock analysis, and interpretation of an exploration prospect. This course is cross-listed with GEOL 331/331L.

ENVE 337 ENGINEERING HYDROLOGY

(3-0) 3 credits. Prerequisites: CEE 336 or EM 327 or EM 328 or permission of instructor. A quantification study of the components of the hydrologic cycle with emphasis on engineering applications involving the design of water supplies, reservoirs, spillways, floodways, and urban drainage with computer applications. This course is cross-listed with CEE 337.

ENVE 390 SEMINAR

0 to 1 credit. Prerequisite: Sophomore standing. A highly focused, and topical course. The format includes student presentations and discussions of reports based on literature, practices, problems, and research. Seminars may be conducted over electronic media such as Internet and are at the upper division or graduate levels. Enrollment is generally limited to fewer than 20 students. The course is repeatable up to three times for a total of 1 credit.

ENVE 405 MINE PERMITTING AND RECLAMATION

(3-0) 3 credits. Prerequisite: Junior standing. A study of environmental problems associated with both surface and underground mining and the reclamation practices that have been developed or are being evaluated to alleviate these problems. Federal, state and local reclamation regulations are examined for their effects on present and future mining practices and costs. Field trips to mining operations in the Black Hills region or the Powder River Basin will be taken for on-site observation of actual reclamation practices. This course is cross-listed with MEM 405.

ENVE 421/521 ENVIRONMENTAL SYSTEMS ANALYSIS

(3-0) 3 credits. Prerequisites: CEE/ENVE 327 or graduate standing. Course emphasis is on applications of environmental chemistry and material balance in quantitative characterizations of operative processes in selected air, water, and land systems and environmental health impacts. Analytical and computer solutions are performed. Students enrolled in ENVE 521 will be held to a higher standard than those enrolled in ENVE 421. This course is cross-listed with CEE 421/521.

ENVE 426/526 ENVIRONMENTAL ENGINEERING PHYSICAL/CHEMICAL PROCESS DESIGN

(3-0) 3 credits. Prerequisites: CEE/ENVE 326 and CEE/ENVE 327, graduate standing, or permission of instructor. A third course in the theory and practice of environmental engineering. Emphases are on the design and analysis of physical/chemical environmental engineering unit operations and processes. Students enrolled in ENVE 526 will be held to a higher standard than those enrolled in ENVE 426. This course is cross-listed with CEE 426/526.

ENVE 426L/526L ENVIRONMENTAL PHYSICAL/CHEMICAL PROCESS LABORATORY

(0-1) 1 credit. Prerequisite or corequisite: CEE/ENVE 426/526 or permission on instructor. A laboratory course to accompany CEE/ENVE 426/526. Examination of processes employed in design of environmental physical and chemical systems for renovation of contaminated waters and soils. Various bench-scale experiments will be performed with laboratory analysis using standard environmental web chemical and instrumental analytical techniques. Laboratory reports employing word processing, numerical and statistical analysis, and interpretation of process performance data will be written. Students enrolled in ENVE 526L will be held to a higher standard than those enrolled in ENVE 426L. This course is cross-listed with CEE 426L/526L.

ENVE 427/527 ENVIRONMENTAL ENGINEERING BIOLOGICAL PROCESS DESIGN

(3-0) 3 credits. Prerequisites: CEE/ENVE 326 and CEE/ENVE 327, graduate standing, or permission of instructor. A fourth course in the theory and practice of environmental engineering. Emphases are on the design and analysis of biological environmental engineering unit operations and processes. Students enrolled in ENVE 527 will be held to a higher standard than those enrolled in ENVE 427. This course is cross-listed with CEE 427/527.

ENVE 427L/527L ENVIRONMENTAL BIOLOGICAL PROCESS LABORATORY

(0-1) 1 credit. Prerequisite or corequisite: CEE/ENVE 427/527 or permission of instructor. A laboratory course to accompany CEE/ENVE 427/527. Examination of processes employed in design of environmental biological systems for renovation of contaminated waters and soils. Various bench-scale experiments will be performed with laboratory analysis using standard environmental web chemical, microbiological, and instrumental analytical techniques. Laboratory reports employing word processing, numerical and statistical analysis, and interpretation of process performance data will be written. Students enrolled in ENVE 527L will be held to a higher standard than those enrolled in ENVE 427L. This course is cross-listed with CEE 427L/527L.

ENVE 428/428L/528/428L528L ENVIRONMENTAL ENGINEERING OPERATIONS AND PROCESSES LABORATORY

(112-1) 2 credits. Prerequisite: CEE/ ENVE 327 or graduate standing. Co-requisite: CEE/ENVE 426/526. Bench-scale experiments are performed in examination of physical/chemical operations and biological processes employed in systems for treatment of waters, wastewaters, and soils. Standard chemical and instrumental analytical techniques are employed. Data are acquired, processed, analyzed both numerically and statistically, and interpreted. Formal laboratory reports are written. Students enrolled in ENVE

528/528L will be are held to a higher standard than those enrolled in ENVE 428/428L. This course is cross-listed with CEE 428/528/428L/528L.

ENVE 433/433L/533/533L COMPUTER APPLICATIONS IN GEOSCIENCE MODELING

(3-1) 4 credits. Prerequisite: Junior standing. The use of computer techniques in modern geoscience modeling of mining, geology and environmental problems such as exploration, geological characterization and mining exploitation. Practical application of state-of-the-art Vulcan modeling software will be essential part of the course. Students enrolled in ENVE 533 will be held to a higher standard than those enrolled in ENVE 433. This course is cross-listed with MEM 433/433L/533/533L.

ENVE 440/540 ENVIRONMENTAL AND RECLAMATION PRACTICES IN THE MINING INDUSTRY

(3-0) 3 credits. A study of various environmental problems that is associated with mining and the reclamation practices that have been developed or are being evaluated to alleviate these problems. Federal, state, and local reclamation regulations are examined for their effects on present and future mining practices and costs. Field trips to several mining operations are taken for on-site observation of actual reclamation problems and the mining practices used to resolve these problems. Students enrolled in ENVE 540 will be held to a higher standard than those enrolled in ENVE 440.

ENVE 441 ECONOMICS OF MINING

(3-0) 3 credits. Prerequisite: Junior standing. The significance of the mineral industries in the economy, mineral and engineering economics with special emphasis on the valuation of mineral properties, and mine administration economic decision methodologies.

ENVE 445/545 OXIDATION AND (3-0) 3 credits. Prerequisites: MET 320 or CBE 222 or ME 211 or permission of instructor. Initially, the thermodynamics of electrochemical processes are

covered; use of the Nernst equation and Pourbaix diagram is presented in this material. Fundamentals of electrode kinetics are then discussed with special emphasis on the derivation of the Butler-Volmer equation and application of the Evan's diagram. Following presentation of these fundamental concepts, phenomena observed in corrosion and oxidation such as uniform attack, pitting, stress corrosion cracking, and corrosion fatigue are discussed. Finally, selection of materials for site specific applications is covered. Students enrolled in ENVE 545 will be held to a higher standard than those enrolled in ENVE 445. This course is cross-listed with MET 445/545 and CBE 445/545.

ENVE 450/550 ROCK SLOPE ENGINEERING

(3-0) 3 credits. Prerequisite: MEM 304 or CEE 346 or equivalent. Modes of slope failure. Economic consequences of instability in mining and construction. Geological factors controlling stability of rock slopes. Shear strength of highly jointed rock mass and discontinuities. Projection methods. Vectorial analysis of 3-D problems by means of the stereographic projection method. Analytical, graphical and computer analysis of planar, wedge and toppling failures. Probabilistic methods. Students enrolled in ENVE 550 will be held to a higher standard than those enrolled in ENVE 450. This course is cross-listed with MEM 450/550.

ENVE 455/555 POLLUTION PHENOMENA AND PROCESS DESIGN

(3-0) 3 credits. Prerequisites: CBE 218, CBE 317, and CBE 417, or equivalent, or permission of instructor. The study of the industrial sources of and treatment of air, water, and land pollutants. The chemical and physical phenomena operating in pollution control equipment and the design of pollution control equipment will be examined. Waste minimization and pollution prevention strategies will be considered. Students enrolled in ENVE 555 will be held to a higher standard than those enrolled in ENVE 455. This course is cross-listed with CBE 455/555.

ENVE 464 ENVIRONMENTAL ENGINEERING DESIGN I

(0-2) 2 credits. Prerequisites: Senior standing. Students in this course will undertake a design effort integrating principles from prior course work into completion of an overall project that will require both individual and team efforts. This first design course will concentrate on definition of the design problem, preliminary design with investigation of various options, and screening of the various design options prior to undertaking detailed design. Economic and legal constraints, general social considerations and personnel factors will be considered along with the technical aspects of the design. Both oral and written engineering reports delineating project activities and results will be completed.

ENVE 465 ENVIRONMENTAL ENGINEERING DESIGN II

(0-2) 2 credits. Prerequisites: ENVE 464. Students in this course will undertake a design effort integrating principles from prior course work into completion of the overall project that will require both individual and team efforts. This second design course will involve completion of the detailed design, construction of bench or pilot-scale units in accord with detailed design and demonstration of design effectiveness. Economic and legal constraints, general social considerations and personnel factors will be considered along with the technical aspects of the design. Both oral and written engineering reports delineating project activities and results will be completed.

ENVE 466/466L/566/566L ENGINEERING AND ENVIRONMENTAL GEOLOGY

(2-1) 3 credits. Prerequisite: Junior or senior standing. The application of geology to engineering, including topics such as landslides, earthquakes, fluvial processes, land subsidence, and their global context. Field trips and laboratory exercises illustrate the influence of geology on the environment. Computer applications are required for problem assignments and a final comprehensive report (oral and written) involving the design of engineering works in complex geological terrain. Students

enrolled in ENVE 566 will be held to a higher standard than those enrolled in ENVE 466. This course is cross-listed with GEOE 466/466L/566/566L.

ENVE 475/475L GROUND WATER

(2-1) 3 credits. Prerequisites: GEOL 201 or GEOE 221 and MATH 225, or permission of instructor. Note: engineering majors must complete the equivalent of Calculus III before registration. Geohydrologic principles, applications, and design considerations concerning ground-water occurrence, flow, and quality. Ground-water and surface-water relations; theory of aquifer tests; flow nets; head distribution by graphical, analytical, and digital models; ground-water contamination. Laboratories include water budgets, chemistry of ground water, design of exploration programs and aquifer tests, computer solutions, and field trips to areas of geohydrologic interest. A design project with written and oral presentations is required. This course is cross-listed with GEOE 475/475L.

ENVE 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

ENVE 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

ENVE 498 UNDERGRADUATE RESEARCH/SCHOLARSHIP

1 to 6 credits. Prerequisite: Permission of instructor. Includes senior project, and capstone experience. Independent research problems/projects or scholarship activities. The plan of study is negotiated by the faculty member and the student. Contact between the two may be extensive and intensive. Does not include research courses which are theoretical.

EXCH 289 STUDENT EXCHANGE-INTERNATIONAL

0 to 18 credits. This course allows students to register as full-time School of Mines students while taking part in an Exchange Program. Students will register on the School of Mines campus for the amount of credit hours they intend to take while enrolled at another campus.

EXCH 389 STUDENT EXCHANGE-INTERNATIONAL

0 to 16 credits. This course allows students to register as full-time School of Mines students while taking part in an Exchange Program. Students will register on the School of Mines campus for the amount of credit hours they intend to take while enrolled at another campus.

EXCH 487 STUDY ABROAD

(0-0) 0 credits. Designed to keep a student active at the School of Mines if out for one to two semester(s) for study abroad program and not enrolling in credit at the School of Mines. Does not guarantee eligibility for financial aid. Repeatable, but for no more than three consecutive terms at any one point.

EXCH 489 STUDENT EXCHANGE-INTERNATIONAL

0 to 18 credits. This course allows students to register as full-time School of Mines students while taking part in an Exchange Program. Students will register on the School of Mines campus for the amount of credit hours they intend to take while enrolled at another campus.

FREN 101 INTRODUCTORY FRENCH I FREN 102 INTRODUCTORY FRENCH II

(4-0) 4 credits each. Prerequisite: for FREN 102 is FREN 101. Fundamentals of language structure

and introduction to French culture enabling students to converse, read, and write simple French. Class work may be supplemented with required aural/oral practice outside of class.

GE 100 ENTERPRISE TEAMS

0 credits. This zero credit course will be used to track student participation in enterprise teams, i.e. teams of two or more students working under the direction of faculty member on a project that involves the participation of an external company, government agency, etc.

GE 130/130L INTRODUCTION TO ENGINEERING

(1-1) 2 credits. Prerequisite: MATH 102. This course serves as an introduction to engineering profession and to its various disciplines. This course is designed to give students the opportunity to learn how to solve engineering analysis and design problems. Students will develop various computational skills, sharpen communication skills, and be exposed to professional development in the form of team building, technology tools, and project management. In addition, students will have the opportunity to learn from professional engineers and scientists through interaction with industry.

GE 498 INTERDISCIPLINARY CAPSTONE SENIOR DESIGN

(0-3) 3 credits. Prerequisite: Senior standing or permission of instructor. Content will include major interdisciplinary engineering design experience integrating fundamental concepts of mathematics, basic science, engineering science, engineering design, communications skills, humanities and social science.

GEOE 211/211L EARTH SYSTEMS ENGINEERING ANALYSIS

(1-1) 2 credits. Application of computational analysis using spreadsheets to geological engineering problems in the earth system. Typical problems will include those found in energy systems, ground water and environmental systems, and economic evaluations having a significant geologic aspect. Examples and problems from the Black Hills region will be

emphasized.

GEOE 221/221L GEOLOGY FOR ENGINEERS

(2-1) 3 credits. Basic concepts in the study of the earth, with emphasis on geological processes acting on the earth's surface. Topics include rock forming processes and identification, mass wasting, ground water, streams, glaciers, coastal erosion, and earthquakes. Emphasis is given to engineering significance of processes and their resulting deposits.

GEOE 322/322L STRUCTURAL GEOLOGY

(2-1) 3 credits. Prerequisites GEOL 201 and GEOL 201L, or GEOE 221; and GEOL 341. A study of the character and genesis of large-scale and small-scale deformational structures and their patterns in the earth's crust. Laboratory work includes various trigonometric, geometric, and stereographic methods applicable to structural analysis and presents open-ended problems in geologic, structure contour, and isopach map interpretation, as well as engineering design problems including drilling exploration projects. This course is cross-listed with ENVE 322/322L.

GEOE 324/324L ENGINEERING GEOPHYSICS I

(2-1) 3 credits. Prerequisites MATH 125 and PHYS 213. Application of the more commonly used methods of geophysical prospecting in mineral exploration, petroleum exploration, and engineering construction. Includes field design and interpretation of surveys using the engineering seismograph, gravity meter, electrical resistivity equipment, scintillometers, and magnetometers. Extensive use of computers is made in the laboratory work. This course is cross-listed with ENVE 324/324L.

GEOE 410 ENGINEERING FIELD GEOLOGY

5 to 6 credits. Prerequisite: Completion of junior-year studies. Instruction, practice, and independent work involving field techniques for geological engineering. Includes use of aerial photography and field mapping for completing large-scale and intermediate-scale geologic maps,

structural sections, and structural contour maps of designated areas in the Black Hills region. Written reports will accompany the maps and sections. Three weeks of the five-week course are devoted to engineering problems including surface-water and ground-water hydrology, geotechnics, and minerals. Conducted for five weeks during the summer in the northern Black Hills. Arrangements for transportation, room, and board are made through the Black Hills Natural Sciences Field Station.

GEOE 412/512 SCIENCE AND ENGINEERING FIELD APPLICATIONS

3 to 6 credits. Prerequisite: Permission of instructor. Field course offered by Black Hills Natural Sciences Field Station to accommodate field education needs of scientists and engineers in multiple disciplines such as geology, geological engineering, petroleum engineering, environmental engineering, etc. Course offerings will take place in the summer months and content of each camp will be defined by staff from SDSMT Geol/GEOE department and industry partners. Students enrolled in GEOE 512 will be held to a higher standard than those enrolled in GEOE 412. This course is cross-listed with GEOL 412/512.

GEOE 425/425L/525/525L ENGINEERING GEOPHYSICS II

(2-1) 3 credits. Prerequisites: MATH 125, GEOE 324, and GEOE 211. The course concentrates on geophysical techniques applicable to petroleum exploration and production, including the acquisition of seismic data, its preparation, interpretation, and use in engineering design. Use of computer packages and individual program design is emphasized. Students enrolled in GEOE 525 will be held to a higher standard than those enrolled in GEOE 425.

GEOE 431/531 PRINCIPLES OF WELL LOGGING

(3-0) 3 credits. Fundamentals of borehole measurements. Petrophysical considerations. Wellbore environment. Qualitative log evaluation methods. Interpretation and analysis of formation properties. Students enrolled in GEOE 531 will

be held to a higher standard than those enrolled in GEOE 431.

GEOE 451/451L ECONOMIC GEOLOGY

(2-1) 3 credits. Prerequisites: Junior or senior standing. Corequisite: GEOE 322 Study of the economics and distribution of mineral resources, geologic characteristics and origins of metallic ore deposits, and the application of genetic models, geochemical techniques, and geophysical methods to the design of mineral exploration programs. Laboratory work includes ore mineralogy and textures, sample suites from ore deposits, calculation of ore reserves (manual and computer), and design and implementation of exploration programs (computer exercises). A term paper is required on the design of exploration programs. Field trips are arranged to nearby ore deposits.

GEOE 452/452L/552/552L GEOCHEMICAL EXPLORATION

(2-1) 3 credits. Prerequisites: GEOE 451 or permission of instructor. An integrated application of geochemical principles, trace-element analytical techniques, basic statistical methods, and computer techniques to the design and implementation of geochemical exploration programs for the detection of mineral deposits. An area of the Black Hills will be selected for the design and implementation of a geochemical exploration program. A term paper will result from this study. Students enrolled in GEOE 552 will be held to a higher standard than those enrolled in GEOE 452.

GEOE 461 PETROLEUM PRODUCTION

(3-0) 3 credits. Characteristics of hydrocarbon reservoirs and geological considerations in well completion design. Well in-flow performance. Tubing string and packer completion design. Design and analysis of artificial lift systems. Acidizing and stimulation operations Computer-aided design. Single-phase and multi-phase flow measurements, physical modeling of oil production, and permeability tests. Global oil production and use, and societal implications.

GEOE 462 DRILLING ENGINEERING

(3-0) 3 credits. Prerequisites: EM 321 or permission of instructor. Introduction to oil and gas field terminology. Design and analysis of an oil or gas well drilling operation including equipment, tubulars, completion, casing and cementing. Computer-aided design of well control and rig hydraulics. Rheological properties of drilling fluids will be studied in the laboratory. A comprehensive design project is required. Field trips to a local drilling operation as available.

GEOE 464 GEOLOGICAL ENGINEERING DESIGN PROJECT I

(3-0) 3 credits. Prerequisite: Completion of junior-year studies. Independent engineering design work by students on a comprehensive geological engineering project that integrates 1) ground-water resources and contaminant remediation, or 2) exploration for and development of fuels or minerals. Economic and legal constraints, environmental concerns, safety, and aesthetic considerations will be included. Engineering reports (oral and written) with analysis, specifications, and results are required.

GEOE 465 GEOLOGICAL ENGINEERING DESIGN PROJECT II

(3-0) 3 credits. Prerequisite: Completion of junior-year studies. Independent engineering design work by students on a comprehensive geological engineering project that integrates 1) environmental site planning and natural hazards, or 2) geomechanics and geotechnics. Economic and legal constraints, environmental concerns, safety, and aesthetic considerations will be included. Engineering reports (oral and written) with analysis, specifications, and results are required.

GEOE 466/466L/566/566L ENGINEERING AND ENVIRONMENTAL GEOLOGY

(2-1) 3 credits. Prerequisite: Junior or senior standing. The application of geology to engineering, including topics such as landslides, earthquakes, fluvial processes, land subsidence, and their global context. Field trips and laboratory exercises illustrate the influence of geology on the environment. Computer

applications are required for problem assignments and a final comprehensive report (oral and written) involving the design of engineering works in complex geological terrain. Students enrolled in GEOE 566 will be held to a higher standard than those enrolled in GEOE 466. This course is cross-listed with ENVE 466/466L/566/566L.

GEOE 468/468L/568/568L GEOHAZARDS

(2-1) 3 credits. Prerequisites: CEE 346 or permission of instructor. A comprehensive analysis of the mechanisms behind geologic processes that affect the human environment in catastrophic ways. Topics include earthquake and volcanic hazards, mass movements, and land subsidence. Assignments, labs, and final projects will be focus on rigorous analyses using common industry-utilized software packages to monitor and mitigate these hazards. Field experiences will allow students to apply the principles discussed to real-world situations. Students enrolled in GEOE 568 will be held to a higher standard than those enrolled in GEOE 468.

GEOE 475/475L GROUND WATER

(2-1) 3 credits. Prerequisites: GEOL 201 or GEOE 221, and MATH 225, or permission of instructor. Note: Engineering majors must complete the equivalent of Calculus III before registration. Geohydrologic principles, applications, and design considerations concerning ground-water occurrence, flow, and quality. Ground-water and surface-water relations; theory of aquifer tests; flow nets; head distribution by graphical, analytical, and digital models; ground-water contamination. Laboratories include water budgets, chemistry of ground water, design of exploration programs and aquifer tests, computer solutions, and field trips to areas of geohydrologic interest. A design project with written and oral presentations is required. This course is cross-listed with ENVE 475/475L.

GEOE 482/482L APPLIED GEOMORPHOLOGY

(2-1) 3 credits. Prerequisites: GEOL 201 and GEOL 201L, or GEOE 221; GEOE 322. A systematic analysis of landform evolution with

emphasis on process and terrain analysis. Topics include process-response in geomorphic systems and quantitative techniques used in engineering design applications. Laboratory consists of aerial photos, topographic map interpretation and the application of geomorphology as an engineering tool. Field trips taken to regional areas of interest. Computer solutions in engineering analysis and a design project are required.

GEOE 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems, and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. May be repeated to a total of 3 credit hours. Research findings are required.

GEOE 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A description of the work to be performed must be filed in the Department of Geology and Geological Engineering.

GEOE 615 ADVANCED FIELD METHODS IN GROUND WATER

(0-3) 3 credits. Prerequisites: GEOE 475 or equivalent. Advanced instruction and independent work involving field techniques such as aquifer mapping, water quality sampling and interpretation, piezometer tests, and the design, conduct, and analysis of aquifer tests.

GEOE 626/626L ENVIRONMENTAL GEOPHYSICS

(2-1) 3 credits. The most frequently used

geophysical techniques for the investigation of environmental problems are covered. These include electrical resistivity, electromagnetic surveys, shallow seismic refraction and reflection surveys, and ground-probing radar. The design and performance of field surveys is emphasized.

GEOE 641 GEOCHEMISTRY

(3-0) 3 credits. Geochemical principles, applications, and design considerations, including thermodynamics, kinetics, and transport phenomena. Applications in low-temperature aqueous systems, carbonate equilibria, geothermal and hydrothermal systems, petroleum generation, metamorphism, and igneous processes. Computer solutions to geochemical problems will be used. An engineering design project is required.

GEOE 661 PETROLEUM GEOLOGY

(3-0) 3 credits. Prerequisites: GEOE 322 and GEOL 331. Part 1. Worldwide occurrence, current and future demand, OPEC cartel and prices, and ethics of exploitation. Part 2. Petroleum source rocks and generation, migration, and entrapment. Geology of major oil-producing regions of world. Petroleum exploration methods.

GEOE 662 ANALYTICAL METHODS IN GROUND WATER

(3-0) 3 credits. Prerequisite: GEOE 475 or equivalent. Quantitative methods used to evaluate ground-water resources, including pumping tests as well as physical and computer methods.

GEOE 663/663L GROUND-WATER GEOCHEMISTRY

(2-1) 3 credits. Prerequisite: GEOE 475 or equivalent. A study of the natural chemistry of ground water and the effects of man's activities on ground-water quality. Laboratories include dispersion experiments and several field trips to areas of interest relating to ground-water geochemistry.

GEOE 664/664L ADVANCED GROUND WATER

(2-1) 3 credits. Prerequisites: GEOL 201 or GEOE 221 or equivalent. Basic hydrologic principles with emphasis on hydrologic and

geologic interrelationships. Design problems of location, development, and conservation of ground water. Use of quantitative techniques for aquifer evaluation. Studies of ground-water contamination. Laboratories, field trips, and problem assignments require use of analytical methods.

GEOE 665 BIOREMEDIATION OF HAZARDOUS MATERIALS

(3-0) 3 credits. Main thrust of the course is to introduce various techniques (both in-situ and ex-situ) of bioremediation to the cleanup of hazardous wastes, such as petroleum, heavy metals, cyanide, nitrates, nuclear materials, etc. Fundamentals of bacterial metabolic behavior will be covered. The physiology of bacteria will be emphasized in terms of their physicochemical requirements, pH, etc. Mathematical models for bacterial growth versus material degradation and seeping will be presented. Focus will be on practical application of bioremediation in the field by means of biological and engineering approaches.

GEOE 668 ENGINEERING GEOLOGY OF SURFICIAL DEPOSITS

(3-0) 3 credits. Review of weathering, soils, and Quaternary deposits. Emphasis on engineering design problems such as those found in highway construction, landfills, water supply, waste disposal, landslides, and land subsidence. Engineering geology of surficial deposits including alluvium, loess, clay, and glacial and periglacial deposits. Two field trips are required.

GEOE 682/682L FLUVIAL PROCESSES

(2-1) 3 credits. A systematic study of the evolution of drainage basins and stream systems. Emphasis is placed on basin morphometry, stream channel 'equilibrium', fluvial mechanics and resulting fluvial landforms. Laboratory consists of basin analysis, stream flow, sediment transport and at least two field trips to surrounding areas of interest.

GEOE 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic

or field of special interest. This may involve readings, research, laboratory of fieldwork, and preparation of papers, as agreed to in advance, by student and instructor. A description of the work to be performed must be filed in the Department of Geology and Geological Engineering.

GEOE 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor. A description of the work to be performed must be filed in the Department of Geology and Geological Engineering.

GEOE 766/766L DIGITAL MODELING OF GROUND-WATER FLOW SYSTEMS

(2-1) 3 credits. Prerequisite: GEOE 475 or CEE 634, or equivalent. Practical applications of digital models as tools in the study of ground-water flow systems. Methods of simulating aquifer systems and solute transport will be used. Specific emphasis will be placed on the development, application, and limitations of finite-difference and finite-element computer models.

GEOE 790 SEMINAR

(1-0) 1 credit. May not be repeated for degree credit. Preparation, oral and/or written presentation, and group discussion of a research problem. The student is expected to present orally the results of his/her own research. This presentation normally will directly precede the final oral defense of the thesis.

GEOE 798 MASTER'S THESIS

Credit to be arranged; not to exceed 6 credits toward fulfillment of M.S. degree requirements. Open only to students pursuing the M.S. thesis option. Supervised original or expository research culminating in an acceptable thesis. Oral defense of thesis and research findings are required.

GEOE 898 DISSERTATION

Credit to be arranged; not to exceed 30 credits toward fulfillment of Ph.D. degree requirements. Open only to doctoral candidates. Supervised original research investigation of a selected problem, with emphasis on independent work,

culminating in an acceptable dissertation. Oral defense of dissertation and research findings are required.

GEOG 101 INTRODUCTION TO GEOGRAPHY

(3-0) 3 credits. The course presents a broad, introductory overview of geographic concepts, themes, and elements designed to help students better understand and analyze the world from a geographic perspective. It provides a background to earth's physical and human elements and systems. It also emphasizes the unique quality of world regions, and the spatial interaction of people, elements, and regions, as well as major global and regional problems and prospects.

GEOG 212 GEOGRAPHY OF NORTH AMERICA

(3-0) 3 credits. A regional and topical analysis of the geographic patterns of the United States and Canada. Focus is upon the interaction of groups of people with the natural environment to produce regional differentiation. Geographic aspects of the physical geography, population, culture groups, economy, settlement system, land division, and use of natural resources.

GEOG 400 CULTURAL GEOGRAPHY

(3-0) 3 credits. A detailed analysis of the concept of culture in a geographical context, including such applications as culture and nature, cultural growth and change, cultural universals, culture and economy, cultural relativity, cultural landscape, cultural region, and cultural conflict.

GEOL 103 INTRODUCTION TO BLACK HILLS GEOLOGY

(2-0) 2 credits. An introductory view of geological features unique to Black Hills, e.g., Devil's Tower, Harney Peak granite and pegmatites, gold deposits, caves, and fossils such as those of the Badlands. Also includes an introduction to the general principles used to study the evolution of the Earth.

GEOL 162 WATER RESOURCES OF THE BLACK HILLS

(2-0) 2 credits. A study of the basic concepts of

hydrology with emphasis on precipitation, lakes, streams, and ground water in the Black Hills. The course will concentrate on data collection techniques such as stream gauging and pumping tests and on the use of hydrologic data for watershed, pollution, and management studies. Field trips will emphasize engineering projects such as dams, reservoirs, municipal water supplies, and monitoring well systems.

GEOL 201 PHYSICAL GEOLOGY

(3-0) 3 credits. Basic concepts in the study of the earth and its history. Brief introduction to the earth's place in the universe and solar system and the evolution, composition and structure of the earth. Introduction to minerals, and igneous, sedimentary and metamorphic rocks. Survey of geological processes acting at the surface of the earth such as wind, rivers, glaciers, ground water and the sea; introduction to internal processes regarding plate tectonics theory and growth of mountains. Societal implications of geological processes are emphasized throughout the course. Students taking GEOL 201L should take it concurrently with GEOL 201.

GEOL 201L PHYSICAL GEOLOGY LABORATORY

(0-1) 1 credit. Prerequisite or corequisite: GEOL 201. Classification and identification of the important rocks and minerals. Interpretation of topographic and geologic maps. Field trips to view representative rock types of the Black Hills area.

GEOL 212/212L MINERALOGY AND CRYSTALLOGRAPHY

(2-1) 3 credits. A study of morphological and geometrical crystallography followed by determinative mineralogy. The 32 crystal classes and about 120 minerals are studied in detail. Course includes a brief introduction to optical microscopy. Emphasis in the laboratory is directed toward descriptive and determinative mineralogy.

GEOL 214L MINERALOGY FOR MINING ENGINEERS

(0-1) 1 credit. Prerequisite: CHEM 114.

Systematic description and identification of silicate and non-silicate minerals are address in this course.

GEOL 235 GEOLOGY OF NATIONAL PARKS

(3-0) 3 credits. A survey of the U.S. National Park system to understand the geologic diversity and significance of the preserved natural and historic areas of the United States. Field trip to an area park is required.

GEOL 276 DINOSAURS

(3-0) 3 credits. An introduction to the study of dinosaurs with emphasis on their origin, diversification, ecology, and extinction.

GEOL 316/316L INTRODUCTION TO GIS

(2-1) 3 credits. Introduction to principles and application of geographic information systems (GIS) including data management and analysis. Laboratory work will include introduction to PC-based GIS software and data sets. Students are expected to have basic computer system, word processing, and spreadsheet skills prior to taking this class.

GEOL 321 SEARCH FOR OUR PAST

(3-0) 3 credits. Prerequisite: GEOL 201 or GEOE 221. Study of the geologic history of North America. The formation and early history of the earth, the tectonic evolution of the continents, and the history of evolution of life are studied. Current scientific issues regarding tectonics and the biosphere are also discussed, such as evolutionary theory, the Gaia hypothesis, and biocomplexity.

GEOL 331/331L STRATIGRAPHY AND SEDIMENTATION

(2-1) 3 credits. Prerequisites: GEOL 201 and GEOL 201L or GEOE 221, or permission of instructor. The principles of correlation and sediment analysis are discussed. A background in sedimentary source materials, depositional environments, nomenclature and classification of stratigraphic units, and the interpretation of stratigraphic units will be presented. Emphasis is placed on modern depositional systems and their

ancient counterparts. Laboratory exercises stress field trips to local sections, facies descriptions, rock analysis, and interpretation of an exploration prospect. This course is cross-listed with ENVE 331/331L.

GEOL 341/341L ELEMENTARY PETROLOGY

(2-1) 3 credits. Prerequisites: GEOL 201L or GEOE 221, and GEOL 212 or GEOL 214L. Identification and classification of igneous, metamorphic, and sedimentary rocks in hand sample and thin section. Emphasis is on environments of formation as deduced from textures and structures. Lecture, laboratory, and field trips.

GEOL 351 EARTH RESOURCES AND THE ENVIRONMENT

(3-0) 3 credits. Prerequisites: GEOL 201, or permission of instructor. This course will examine the distribution, origin, use, and future of earth's energy, metallic, and non-metallic resources. Economic, political, sociological, and environmental implications of the resource industries will be emphasized. Resource issues of topical interest will be discussed.

GEOL 361 OCEANOGRAPHY I

(3-0) 3 credits. An introductory course in oceanography that focuses on ocean basins of the world, their composition and processes by which they formed. Other subjects to be examined include the "hot springs" of the deep oceans, patterns of sediment distribution, life in the oceans, the role of the oceans as an integral part of global climatic cycles including the "greenhouse effect."

GEOL 371 FIELD PALEONTOLOGY

(0-2) 2 credits. An introduction to the methods of prospecting, collecting, and documenting fossils for exhibition and research. Field trips will be made to the productive fossil sites in western South Dakota and elsewhere. This course can only be taken twice to fulfill graduation requirements.

GEOL 376 GEOSPATIAL FIELD METHODS

(0-3) 3 credits. Prerequisite: GEOL 316 or permission of instructor. This course covers fundamental methods of gathering spatial information in the field, including navigation, global positioning systems, aerial photo mapping, ground data collection, spatial sampling design, and accuracy assessment.

GEOL 403/503 REGIONAL FIELD GEOLOGY

(0-1) 1 credit. Prerequisites: GEOL 201 or GEOE 211. A one-week guided field trip to an area of outstanding geological interest in a global context. Students enrolled in GEOL 503 will be held to a higher standard than those enrolled in GEOL 403.

GEOL 407/507 GEOLOGY OF THE BLACK HILLS

(0-2) 2 credits. Prerequisites: Junior or senior standing or permission of instructor. A field course which entails inspection of major rock types and structures in the Black Hills area. Daily field trips in the Black Hills and Badlands. Major geologic and scenic features such as Mt. Rushmore, the Needles, Devil's Tower, the Homestake Gold Mine's open cut, pegmatite mines, Spearfish Canyon, the Hot Springs Mammoth Site, and many others will be visited and studied. The cause, composition, unique features, economic potential, the possible alteration of land forms will be emphasized to gain an understanding of how exposed rock forms originated and changed. Taught in the Black Hills Natural Sciences Field Station. Students enrolled in GEOL 507 will be held to a higher standard than those enrolled in GEOL 407.

GEOL 410 FIELD GEOLOGY

(0-6) 6 credits. Prerequisites: Completion of junior year studies. This five-week course focuses on the instruction and practice in the use of surveying instruments and aerial photographs for the purpose of completing large and intermediate-scale geologic maps, structure sections, and structure contour maps of Precambrian metasediments, Phanerozoic sedimentary rocks, and Tertiary intrusions within designated areas of the Black Hills region. A

written geologic report will accompany the maps and sections conducted for five weeks during the summer in the northern Black Hills. Field equipment will be furnished by the department. Arrangements for transportation, room, and board are made through the Black Hills Natural Sciences Field Station.

GEOL 412/512 SCIENCE AND ENGINEERING FIELD APPLICATIONS

3 to 6 credits. Prerequisite: Permission of instructor. Field course offered by Black Hills Natural Sciences Field Station to accommodate field education needs of scientists and engineers in multiple disciplines such as geology, geological engineering, petroleum engineering, environmental engineering, etc. Course offerings will take place in the summer months and content of each camp will be defined by staff from the School of Mines Department of Geology and Geological Engineering and industry partners. Students enrolled in GEOL 512 will be held to a higher standard than those enrolled in GEOL 412. This course is cross-listed with GEOE 412/512.

GEOL 417/517 GEOSPATIAL DATABASES

(3-0) 3 credits. Prerequisite: GEOL 316 or permission of instructor. Building on basic principles of Geographic Information Systems, this course launches students into developing geospatial databases for research projects in science and engineering. Students learn to compile and manage spatial data using industry standard data models. Assignments include hands-on practice downloading, processing, editing, scanning and digitizing data. The class includes an extensive introduction of the software documentation to build independent learning and problem-solving ability. Students are expected to complete a semester project that relates to their own interests. Students enrolled in GEOL 517 will be held to a higher standard than those enrolled in GEOL 417.

GEOL 419/519 ADVANCED GEOSPATIAL ANALYSIS

(3-0) 3 credits. Prerequisites: GEOL 316 and MATH 281 or MATH 381 or MATH 441, or permission of instructor. This course will

introduce those already familiar with GIS and basic statistical principles to advanced spatial analysis techniques including interpolation, sampling, spatial distributions, surface analysis, and geospatial modeling. Emphasis is placed on developing the knowledge to effectively and soundly employ geospatial analysis techniques in a variety of applications. Students enrolled in GEOL 519 will be held to a higher standard than those enrolled in GEOL 419.

GEOL 420/520 INTRODUCTION TO REMOTE SENSING

(3-0) 3 credits. Prerequisites: Junior Standing
An introduction to the theory and applications of remote sensing. Students will study the electromagnetic spectrum as it applies to remote sensing as well as the physical principles of imaging system technologies. Imaging and applications of visible, near-infrared, thermal infrared, and microwave band remote sensing are discussed. Environmental remote sensing applications to be covered include terrestrial and ocean ecology, resource exploration, land use and land cover change, natural hazards, and atmospheric constituents. Image processing techniques will be introduced. Students enrolled in GEOL 520 will be held to a higher standard than those enrolled in GEOL 420.

GEOL 442/442L/542/542L OPTICAL PETROLOGY

(2-1) 3 credits. Prerequisites: GEOL 341. The study of igneous, sedimentary, and metamorphic rocks and ore samples in thin and polished section, with emphasis on their identification, classification, and genesis. Students enrolled in GEOL 542 will be held to a higher standard than those enrolled in GEOL 442.

GEOL 461/461L INVERTEBRATE PALEONTOLOGY

(2-1) 3 credits. A systematic study of the structure and classification of selected invertebrate taxa. The course will provide a useful tool for field and laboratory work involving fossil-bearing rocks and will form a background for advanced work in paleontology or paleontological stratigraphy.

GEOL 464 SENIOR RESEARCH I

(1-0) 1 credit. Prerequisite: GEOL 410. A study of scientific research methodology with emphasis on identifying research problems and formulating a methodology to address a specific research question. Students will identify a topic of study chosen with the advise and approval of an instructor, and develop a proposal for their senior research project.

GEOL 465 SENIOR RESEARCH II

(3-0) 3 credits. Prerequisite: GEOL 464. The student undertakes a field and/or laboratory study of a topic chosen with the advice and approval of an instructor. This work is the basis for a thesis written in a standard format.

GEOL 472/472L/572/572L MUSEUM CONSERVATION AND CURATION

(2-1) 3 credits. Ethics, theories, and methodology behind conservation and curation in natural history museums. Laboratory covers conservation techniques and curation training in systematically organizing a collection, in addition to training in computer database collection management systems. Students enrolled in GEOL 572 will be held to a higher standard than those enrolled in GEOL 472.

GEOL 473/473L/573/573L MUSEUM PREPARATION TECHNIQUES AND EXHIBIT DESIGN

(1-2) 3 credits. Techniques in vertebrate fossil preparation and museum exhibit design will be the focus in this course. Students will be required to prepare fossils and design an exhibit for actual display in the museum or other designated locations. Proposal writing is another important facet of this course and will provide the background needed to those that pursue a museum career. Students enrolled in GEOL 573 will be held to a higher standard than those enrolled in GEOL 473.

GEOL 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete

individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. May be repeated to a total of 3 credit hours.

GEOL 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

GEOL 585 GLACIAL AND PLEISTOCENE GEOLOGY

(3-0) 3 credits. A systematic study of glacial geology and related geologic and climatologic effects during the Pleistocene Epoch. Focus is on glacial mechanics and sedimentary deposits of both continental and alpine settings. An extended field trip to a nearby glaciated region will acquaint the student with glacial settings and resulting landforms. Laboratory work consists of analysis of aerial photos and topographic maps that illustrate glacial principles.

GEOL 604 ADVANCED FIELD GEOLOGY

(0-3) 3 credits. Prerequisite: GEOL 410. Field techniques and related laboratory methods of investigation in moderately complicated geologic environments. Includes data collection, presentation, and interpretation. Laboratory work involving aerial photographs, drilling projects, and miscellaneous work may be introduced during inclement weather in December.

GEOL 621/621L ADVANCED STRUCTURAL GEOLOGY

(2-1) 3 credits. Prerequisite: GEOE 322 or permission of instructor. Examination of selected geologic terrains such as fold-thrust belts, Laramide foreland uplifts and basins, wrench and rift systems, etc., concentrating on geometric

styles, sequential and mechanical development and regional models. Includes selected readings and laboratory examinations of maps regarding the various types of terrains.

GEOL 622 GEOTECTONICS

(3-0) 3 credits. The course examines development of regional and world-wide structures of the earth in regard to plate tectonic processes and current thought regarding concepts of sea-floor spreading, continental drift, paleomagnetism, origin of continents, ocean basins, and mountain building.

GEOL 631 ROCKY MOUNTAIN STRATIGRAPHY I

GEOL 632 ROCKY MOUNTAIN STRATIGRAPHY II

(3-0) 3 credits each. Prerequisite: Senior or graduate standing in geology or geological engineering. Stratigraphic sequences in the Rocky Mountain area are studied with emphasis on the paleoenvironmental and tectonic conditions under which the strata were deposited. First semester considers Paleozoic strata; the second semester considers Mesozoic and Cenozoic rocks.

GEOL 633/633L SEDIMENTATION

(2-1) 3 credits. Sedimentary process-response models are studied. The procedures for classification and description of sedimentary rocks are reviewed. Numerous field trips to localities illustrating a variety of sedimentary facies are conducted. Laboratory determinations are made of such parameters of sedimentary particles as size, shape, and degree of roundness, mineralogy, and chemical composition. An analysis is made of field and laboratory data by graphical and statistical methods and a geological interpretation is made of the results. Natural resources associated with various facies are emphasized.

GEOL 644/644L PETROLOGY OF THE IGNEOUS AND METAMORPHIC ROCKS

(2-1) 3 credits. Prerequisite: GEOL542 or permission of instructor. This course will emphasize phase diagrams, phase equilibria and geochemistry of igneous and metamorphic rocks

from the standpoint of constraining evolutionary models. Problems will involve quantitative modeling of natural samples using field observations, petrographic observations, mineral chemistry, and whole rock chemistry. Field trips are planned.

GEOL 650 SEMINAR IN ORE DEPOSITS

1 to 3 credits. Prerequisite: GEOE 451 or permission of instructor. Studies by a group of advanced students, under the guidance of one or more selected instructors, of topics of special and current interest to the group. Involves a combination of lectures, papers, readings, oral and/or written presentations, and discussions. Course focuses on different themes in ore deposits, and varies each time offered. Themes that will be offered include such topics as the geology of gold deposits, uranium deposits, porphyry copper deposits, volcanogenic massive sulfides, and sediment-hosted metal deposits. Emphasis is placed on gaining an in-depth knowledge on the controls of localization of a specific class of mineral deposits.

GEOL 652 PROBLEMS IN ORE DEPOSITS

(3-0) 3 credits. Prerequisite: GEOE 451 or permission of instructor. Emphasis is placed on the principles of hydrothermal ore deposits, and techniques used to study hydrothermal ore deposits. Modern theories on metallic ore deposition will be applied to the critical study of major classes of metallic ore deposits.

GEOL 670 PRINCIPLES OF X-RAY DIFFRACTION

(3-0) 3 credits. Prerequisites: PHYS 213 and MET 232 or GEOL 212 or permission of instructor. This course will cover the principles of crystallography in materials science, theory and production of x-rays, interaction of x-rays with matter, and the principles of x-ray diffraction. The application of x-ray diffraction methods to analytical measurement techniques in materials science and metallurgical engineering will also be covered. This course is cross-listed with MES 670.

GEOL 672/672L MICROPALEONTOLOGY

(2-1) 3 credits. A study of the morphology, ecology, and stratigraphic significance of selected groups of protozoans and invertebrate and plant microfossils with special emphasis on Foraminifera and conodonts. This course is cross-listed with PALE 672/672L.

GEOL 673/673L COMPARATIVE OSTEOLOGY

(2-1) 3 credits. A comparison of recent and fossil vertebrate skeletons and dentitions with emphasis on the skeletons and teeth of sharks, bony fish, salamanders, frogs, turtles, alligators, lizards, birds, and mammals to establish a thorough understanding of diversity of the form and function of the vertebrate skeleton. A major objective is the identification of vertebrates based on osteology and odontology. This course is cross-listed with PALE 673/673L.

GEOL 676/676L VERTEBRATE PALEONTOLOGY

(3-1) 4 credits. An in-depth assessment of the fossil record of vertebrates with special emphasis on current problems in the evolution of vertebrates and the tangible record preserved in the collections of the Museum of Geology. This course is cross-listed with PALE 676/676L.

GEOL 678/678L VERTEBRATE BIOSTRATIGRAPHY

(3-1) 4 credits. Prerequisite: GEOL/PALE 676. The principles and practices for establishing the distribution of vertebrate fossils in the rock record. This course will include a brief history of biostratigraphy, methodology, and the content and assessment of vertebrate ages, particularly of Mesozoic and Cenozoic mammals. This course is cross-listed with PALE 678/678L.

GEOL 684/684L PALEOENVIRONMENTS

(2-1) 3 credits. This course will integrate topics from paleobotany, vertebrate paleontology, and paleoclimatology in a study of paleontological communities through time. Laboratories will include studies of fossil materials. Note: This course is to be offered both through Black Hills State University and South Dakota School of

Mines and Technology. This course is cross-listed with PALE 684/684L.

GEOL 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or field work, and preparation of papers, as agreed to in advance, by student and instructor. A description of the work to be performed must be filed in the department office. This course is cross-listed with PALE 691.

GEOL 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor. A description of the work to be performed must be filed in the Department of Geology and Geological Engineering. This course is cross-listed with PALE 692.

GEOL 770 SEMINAR IN VERTEBRATE PALEONTOLOGY

(2-0) 2 credits. Studies by a group of advanced students, under the guidance of one or more selected instructors, on topics of special and current interest to the group. Involves a combination of lectures and discussions. Review of current literature in vertebrate paleontology of special topics and/or analysis of new procedures and techniques. Emphasis will be on mammalian paleontology. This course is cross-listed with PALE 770.

GEOL 790 SEMINAR

(1-0) 1 credit. May not be repeated for degree credit. Preparation, oral and/or written presentation, and group discussion of a research problem. The student is expected to present orally the results of his/her own research. This presentation normally will directly precede the final oral defense of the thesis. This course is cross-listed with PALE 790.

GEOL 798 MASTER'S THESIS

Credit to be arranged; not to exceed 6 credits toward fulfillment of M.S. degree requirements. Open only to students pursuing the M.S. thesis option. Supervised original or expository research

culminating in an acceptable thesis. Oral defense of thesis and research findings are required. This course is cross-listed with PALE 798.

GEOL 808 FUNDAMENTAL PROBLEMS IN ENGINEERING AND SCIENCE

(3-0) 3 credits. The course, available only for doctoral candidates, involves description, analysis, and proposed methods of attack of long-standing, fundamental problems in science and engineering. Independent work is emphasized with goals of understanding these basic questions and proposing practical designs and experiments for the solution. This course is cross-listed with AES 808.

GEOL 898 DISSERTATION

Credit to be arranged; not to exceed 30 credits toward fulfillment of Ph.D. degree requirements. Open only to doctoral candidates. Supervised original research investigation of a selected problem, with emphasis on independent work, culminating in an acceptable dissertation. Oral defense of dissertation and research findings are required.

GER 101 INTRODUCTORY GERMAN I GER 102 INTRODUCTORY GERMAN II

(4-0) 4 credits each. Becoming sensitized to authentic listening, speaking, reading, writing and culture skills at the elementary level. Introduction to basic functional grammar and sentence structure. GER 102-Prerequisite: GER 101 or permission of instructor. Continued emphasis on authentic listening, speaking, reading, writing, and culture skills at the elementary level.

GES 115M UNIVERSITY MENTORING

(0-0) 0 credit. This course is designed to provide new college students the opportunity to learn how to succeed at the South Dakota School of Mines and Technology. Students will be introduced and matched to a professional mentor who will provide academic and career advice that will help ensure professional development. In addition, students will have the opportunity to learn from peer advisors who are successful upper-classmen in selected majors.

HIST 121 WESTERN CIVILIZATION I

(3-0) 3 credits. Surveys the evolution of western civilization from its beginnings into the Reformation and religious wars.

HIST 122 WESTERN CIVILIZATION II

(3-0) 3 credits. Surveys the development of western civilization from the Reformation era to the present.

HIST 151 UNITED STATES HISTORY I

(3-0) 3 credits. Surveys the background and development of the United States from its colonial origins to the Civil War and Reconstruction.

HIST 152 UNITED STATES HISTORY II

(3-0) 3 credits. Surveys development of the United States since the Civil War and Reconstruction.

HIST 492 TOPICS

1 to 4 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. May be repeated once for credit when the topic is different and with permission of department head.

HUM 100 INTRODUCTION TO HUMANITIES

(3-0) 3 credits. This interdisciplinary course introduces students to humanistic knowledge, inquiry, and values by focusing on connections among humanities disciplines (such as art, languages, literature, music, philosophy, and religion).

HUM 200 CONNECTIONS: HUMANITIES AND TECHNOLOGY

(3-0) 3 credits. A thematic approach to human values stressing the relationship between technology and the humanities; traces the development and social impact of our major technologies.

HUM 291 INDEPENDENT STUDY

1 to 4 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

HUM 292 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits of special topics will be allowed for degree credit.

HUM 350 AMERICAN SOCIAL HISTORY

(3-0) 3 credits. Prerequisite: Junior or senior standing. A study of the lives, customs, and beliefs of ordinary Americans, using fiction and nonfiction from various periods.

HUM 375 COMPUTERS IN SOCIETY

(3-0) 3 credits. Prerequisite: Junior or senior standing. Examines the social impact of computers with emphasis on the development of the computer establishment, the cultural blueprint being shaped for the future, and the question of values and social responsibility in personal, business, and governmental sectors.

HUM 491 INDEPENDENT STUDY

1 to 4 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans.

Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

HUM 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits of special topics will be allowed for degree credit.

IENG 215 COST ESTIMATING FOR ENGINEERS I

(1-0) 1 credit. Prerequisite: MATH 123. This course covers the fundamentals of financial statements and analysis. Topics include the structure of accounts, the balance sheet, the income statement, changes in owner equity, statement of cash flows, and analysis of financial statements to determine the financial health of a business entity.

IENG 216 COST ESTIMATING FOR ENGINEERS II

(1-0) 1 credit. Prerequisite: MATH 123. This course covers the fundamentals of building the operational budgets needed for modern industrial practice. Topics include sales forecasting, sale budget, production budget, material budget, direct labor budget, factory overhead, cost-of-goods sold, and budget variances.

IENG 217 COST ESTIMATING FOR ENGINEERS III

(1-0) 1 credit. Prerequisite: MATH 123. This course covers the fundamentals of cost accounting and cost estimating. Topics include estimation of factory overhead, operation estimating, product estimating, job order costing, process costing, and activity based costing.

IENG 241L INTRO TO QUALITY METHODS AND TEAMS

(0-2) 2 credits. Prerequisite: Sophomore standing or permission of instructor. Quality improvement methods, team processes, and related ways of thinking are introduced. Students will be exposed to the data collection and analysis tools often used for quality improvement across multiple disciplines. Laboratory activities involve teams and team processes including decision making, communications, and customer relations. This course meets the quality requirement for the six-sigma greenbelt certificate.

IENG 301 BASIC ENGINEERING ECONOMICS

(2-0) 2 credits. Junior or higher standing preferred. Introduces the concepts of economic evaluation regarding capital investments, including the time value of money and income tax effects. Graduation credit cannot be given for both IENG 301 and IENG 302.

IENG 302 ENGINEERING ECONOMICS

(3-0) 3 credits. Junior or higher standing preferred. Studies economic decision making regarding capital investment alternatives. Covers compound interest and depreciation models, replacement and procurement models. Analysis is made variously assuming certainty, risk and uncertainty. Graduation credit cannot be given for both IENG 301 and IENG 302.

IENG 311/311L WORK METHODS AND MEASUREMENT

(2-1) 3 credits. Corequisite: IENG/MATH 381. This course presents the underlying theory and basic methodology for work methods and measurement techniques. Emphasis is placed on knowledge of the basis for selection of a technique appropriate for the individual as related to the task to be performed.

IENG 321/321L ERGONOMICS/HUMAN FACTORS ENGINEERING

(2-1) 3 credits. Prerequisite: PSYC 101. Corequisite: MATH 281 or higher statistics. Topics covered include: Engineering anthropometry methods, workplace design,

electrophysiologic models and measurement, biomechanical modeling, work kinesiology, and hand-tool evaluation.

IENG 331 SAFETY ENGINEERING

(3-0) 3 credits. Prerequisite: Junior or senior standing. Overview to the field of Safety Engineering emphasizing quantitative problem solving. Will draw on fundamental knowledge from the fields of chemistry, physics, mechanics, mathematics, and statistics. Contents: fundamental concepts and terminology, injury and accident statistics, ethics, certification, regulations, standards, hazards and their control, and management aspects.

IENG 345 ENTREPRENEURSHIP

(4-0) 4 credits. Prerequisites: ACCT 211 and IENG 301 or IENG 302 or permission of instructor. Covers topics on the legal aspects, management skills, business plans, and sources of capital as well as case studies of successful and unsuccessful entrepreneurial initiatives.

IENG 352 CREATIVITY AND INNOVATION

(1-0) 1 credit. This course focuses on the Herrmann Whole Brian model and creative thinking to strengthen team processes and the tools necessary for product and process innovations. Students will receive an exposure to the whole brain model and to a variety of problems that will require more creative and innovative thought processes to solve the problem.

IENG 353 COMMERCIALIZATION OF NEW TECHNOLOGY

(1-0) 1 credit. This course provides the student with an understanding of the intellectual property considerations for new innovations as well as how to adapt new technologies for commercialization in the market place. Topics include patents, trademarks, copyrights, trade secrets, technology transfer, SBIR and STTR. This course is required for the Technology Innovation certificate program.

IENG 354 MARKETING TECHNOLOGY INNOVATIONS

(1-0) 1 credit. This course introduces the student to the tools and strategies needed to understand the voice of the customer and provides the rudiments of a marketing plan for commercialization of new or innovative technologies. Topics include environmental analysis, diffusion of technology and innovations, early adoptors, and market research and strategies.

IENG 355 FINANCING TECHNOLOGY INNOVATIONS

(1-0) 1 credit. Prerequisite: IENG 215 and IENG 216 or ACCT 210 or ACCT 406 or TM 661. Beginning with technology business forecasts, this course develops the sales budget, production budget, material budget, overhead expenses, and cash flow budgets in sequence. Proforma income and balance sheets are then derived from these budgets. Sources of capital during different stages of the technology life cycle are also covered. This course is required for the Technology Innovation certificate.

IENG 356 TECHNOLOGY START UPS

(1-0) 1 credit. This course presents timing and innovation to be considered during the early stages of the technology life cycle and provides the basis for the development of a business plan. Topics include technology and innovation strategies, dimensions of technological innovations, new technology ventures, corporate new ventures, organizational structures, and elements of a business plan.

IENG 357 TECHNOLOGY INNOVATION SEMINAR

(1-0) 1 credit. The Technology Innovation Seminar is designed to provide students with an exposure to opportunities and strategies of commercializing a new technology through the seminar program. The seminar will provide students with an exposure to the entrepreneurial culture through guest speakers who have successfully commercialized new technologies and innovations.

IENG 362 STOCHASTIC MODELS

(3-0) 3 credits. Prerequisite: IENG/MATH 381 or permission of instructor. This course covers stochastic models in operations research and is a complementary course to MATH 353. Topics include queuing theory, Markov chains, Pert/CPM, decision theory, dynamic programming and inventory control models.

IENG 366 ENGINEERING MANAGEMENT

(3-0) 3 credits. A course designed to acquaint the student with engineering management discipline through the formation and operation of business and industrial enterprises. In addition to engineering management decision tools, students will be exposed to emergent trends in learning organizations, systems thinking, change management, and processes utilizing all four quadrants of Herrmann Whole Brian model for advanced problem solving.

IENG 375 ETHICS AND PROFESSIONALISM FOR ENGINEERS AND SCIENTISTS

(3-0) 3 credits. Prerequisite: Junior standing or higher preferred. This course will introduce students to many of the professional and ethical issues they will encounter over the course of their career. Professionalism topics include: networking, business etiquette, and professional dress. Ethics topics include: harassment, necessary disclosure, and the Whistle Blower Act.

IENG 381 INTRO TO PROB AND STAT

(3-0) 3 credits. Prerequisite: MATH 125 and prerequisite or corequisite: MATH 225. Introduction to probability, discrete and continuous distributions, sampling distributions, central limit theorem, and general principles for statistical inference. This course is cross-listed with MATH 381. Individuals may apply at most 4 credits toward a degree from the following list of courses: MATH 281, IENG/MATH 381, MATH 441.

IENG 382 PROBABILITY THEORY AND STATISTICS II

(3-0) 3 credits. Prerequisite: IENG 381. Review of general principles for statistical inference,

linear regression and correlation, multiple linear regression, ANOVA, and statistical design of experiments. This course is cross-listed with MATH 382.

IENG 425 PRODUCTION AND OPERATION

(3-0) 3 credits. Prerequisites: MATH 123; IENG/MATH 381 or BADM 221. Management of the production environment. Topics such as bills of materials, inventory control, production control, production scheduling and MRP will be discussed. The impact of production management on the design process and how products can be designed for better manufacture.

IENG 431/531 INDUSTRIAL HYGIENE

(3-0) 3 credits. Prerequisite: Senior or graduate standing or permission of instructor. Principles of industrial hygiene, including the identification and evaluation of chemical, physical, and biological agents which affect the health and safety of employees; the application of control measures for the various agents; study of threshold limit values and occupational health toxicology. Students enrolled in IENG 531 will be held to a higher standard than those enrolled in IENG 431.

IENG 441 SIMULATION

(3-0) 3 credits. Prerequisite: IENG 381 or MATH 441. Development of computer simulation models of real or conceptual systems. Interpretation of results of computer simulation experiments.

IENG 451/451L OPERATIONAL STRATEGIES

(2-1) 3 credits. Prerequisite: Junior standing or permission of instructor. Review of philosophies, systems, and practices utilized by world-class organizations to meet current operational challenges. Focuses include "lean production" in the manufacturing industries, including material flow, plant-floor quality assurance, job design, work and management practices as well as the most effective practices in the service industries. Students complete lab projects and tour organizations to analyze the extent and potential

of the philosophies.

IENG 452 INTRODUCTION TO SIX SIGMA
(1-0) 1 credit. This course introduces students to the philosophy of Six Sigma. Topics include the history of Six Sigma and the Six Sigma problem solving methodology.

IENG 461 SIX SIGMA GREENBELT EXAM
(1-0) 1 credit. This self-paced, pass/fail course culminates in a written exam. Passing this exam is necessary component of the Six Sigma Greenbelt Certification.

**IENG 462 INDUSTRIAL AND
ENGINEERING MANAGEMENT
PROFESSION**

(1-0) 1 credit. Prerequisite: Senior standing or permission of instructor. This course covers professional aspects of the industrial engineering and engineering management professions including personal, professional, and ethical development as well as professional practice.

**IENG 463 SIX SIGMA GREENBELT
PROJECT**

(1-0) 1 credit. Taken in conjunction with another course requiring a project, students in this course will use the Six Sigma problem solving philosophy in the completion of the project. Students will then document how they use the Six Sigma process and the results of the project in a written report.

IENG 464 SENIOR DESIGN PROJECT I
(0-2) 2 credits. Prerequisite: Senior standing or graduation within three semesters. Small groups of students work on original design projects. Topics are solicited from local companies, hospitals, banks, mines, government agencies, thus providing students the opportunity to apply their knowledge and techniques to real problems in business and industry.

IENG 465 SENIOR DESIGN PROJECT II
(0-3) 3 credits. Continuation of IENG 464. Small groups of students work on original design projects. Topics are solicited from local companies, hospitals, banks, mines, government

agencies, thus providing students the opportunity to apply their knowledge and techniques to real problems in business and industry. As applicable, these are continuation projects started in IENG 464.

**IENG 466/566 PROJECT PLANNING AND
CONTROL**

(3-0) 3 credits. Prerequisites: PSYC 101 preferred. Project planning, execution and control of less repetitive types of work. This includes quantitative aspects such as costs, time and performance specifications; and qualitative aspects such as organization structures, psychological and sociological relationships. Students enrolled in IENG 566 will be held to a higher standard than those enrolled in IENG 466.

IENG 471 FACILITIES PLANNING

(3-0) 3 credits. Prerequisite: Senior standing or graduation within three semesters. Topics covered include: material handling, computerized layout planning, storage facilities, flexible manufacturing systems, and "Factory of the Future."

**IENG 475/475L COMPUTER-
CONTROLLED MANUFACTURING
SYSTEMS AND ROBOTICS**

(2-1) 3 credits. Prerequisite: Senior standing or permission of instructor. Fundamental concepts of using computers in the design of a computer integrated, discrete-item, manufacturing facility are covered. Basic ideas of Computer Aided Design (CAD), Group Technology (GT), process planning, integrated production control and computer numerical control are covered. The manufacturability issues and concepts of selecting and using robots in the workplace are explored.

**IENG 486 STATISTICAL QUALITY AND
PROCESS CONTROL**

(3-0) 3 credits. Prerequisites: IENG 381 or MATH 441 or permission of instructor. This course covers the development of statistical methods for application to problems in quality and process control. Statistical topics include: basics of processes and variability, statistically controlled processes, variable and attribute control

charts, moving averages, individual trend and others, process capability, sampling plans for attributes and variables. This course is cross-listed with MATH 486.

IENG 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

IENG 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

IS 110 EXPLORATIONS

(2-0) 2 credits. This course will provide a theme-based interdisciplinary approach to studying the relationships between science and society. The course will consist of lectures, student-led activities, and fieldwork, complemented by visiting lecturers and opportunities to gain regional, national, and global perspectives through organized trips.

IS 191 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements

of the topic. This course cannot be counted for social science/humanities credit.

IS 192 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits will be allowed for degree credit. This course cannot be counted for social science/humanities credit.

IS 201 INTRODUCTION TO SCIENCE, TECHNOLOGY, AND SOCIETY

(3-0) 3 credits. Prerequisites: ENGL 101, IS 110 and sophomore standing. IS 110. Includes study of current issues within the IS specializations. Introduces students to how science and technology affect individual, societal, and global change (e.g., how science and technology influence ethical choices, the political and economic systems, and the relationship between humans and the natural world.) Required for all students seeking a B.S. in interdisciplinary sciences.

IS 291 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems, and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. This course cannot be counted for social science/humanities credit.

IS 292 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular

curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits will be allowed for degree credit. This course cannot count for social science/humanities credit.

IS 380 INTERNSHIP IN INTERDISCIPLINARY STUDIES

1 to 4 credits. Prerequisite: Permission of Instructor. The opportunity for a student to complete a plan for an internship and thereby acquire practical job-related experience. A maximum of 6 credits will be allowed for degree credit. This course cannot be counted for social science/humanities credit.

IS 391 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. This course cannot be counted for social science/humanities credit.

IS 392 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits will be allowed for degree credit. This course cannot be counted for social science/humanities credit.

IS 401 WRITING AND RESEARCH IN THE INTERDISCIPLINARY SCIENCES

(3-0) 3 credits. Prerequisites: IS 201, ENGL 289, and senior standing. Advanced writing in the

interdisciplinary sciences with emphasis on research and explanation of science topics in the IS specializations. This course provides students with a basic understanding of the various styles of science writing, including writing for popular and professional audiences, and the use of library and/or laboratory research in formal research papers. This course is required for all students pursuing the B.S. degree in interdisciplinary sciences.

IS 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. This course cannot be counted for social science/humanities credit.

IS 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits will be allowed for degree credit. This course cannot be counted for social science/humanities credit.

IS 498 UNDERGRADUATE RESEARCH/SCHOLARSHIP

(3-0) 3 credits. Prerequisite: Senior standing, permission of instructor, an approved Letter of Intent on file in the IS Office and successful completion of IS 401. Includes senior project, and capstone experience. Independent research problems/projects or scholarship activities. The plan of study is negotiated by the faculty member and the student. Contact between the two may be extensive and intensive. Does not include

research courses which are theoretical. This course is required for all students pursuing the B.S. degree in interdisciplinary sciences.

IS 691 INDEPENDENT STUDY

.5 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor. This course cannot be counted for social science/humanities credit.

IS 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor. This course cannot be counted for social science/humanities credit.

LAKL 101 LAKOTA LANGUAGE I

(3 or 4) 3 or 4 credits. An introduction to the Lakota language with emphasis on basic conversation, language structure, and vocabulary.

LAKL 102 LAKOTA LANGUAGE II

(3 or 4) 3 or 4 credits. Prerequisite: LAKL 101 or permission of instructor. A continued introduction to the Lakota language with emphasis on basic conversation, language structure, and vocabulary.

MATH 021 BASIC ALGEBRA

(3-0) 3 credits. Prerequisite: Appropriate mathematics placement. This course prepares students for college level mathematics. Topics generally include: basic properties of real numbers, exponents and radicals, rectangular coordinate geometry, solutions to linear and quadratic equations, inequalities, polynomials and factoring. Students may also be introduced to functions and systems of equations. Note: This is remedial level course and no credit for MATH 021 will be granted for graduation.

MATH 101 INTERMEDIATE ALGEBRA

(3-0) 3 credits. Prerequisite: MATH 021 or appropriate mathematics placement. Basic properties of real numbers, linear equations and inequalities, quadratic equations, systems of

equations, polynomials and factoring, rational expressions and equations, and radical expressions and equations, and an introduction to functions such as polynomial, exponential and logarithmic functions. May not be used for credit toward a baccalaureate degree, but may be used toward the associate degree.

MATH 102/102L COLLEGE ALGEBRA

(3-1) 4 credits. Prerequisite: MATH 101 with a minimum grade of "C" or appropriate mathematics placement. Corequisite: MATH 102L. Equations and inequalities; polynomial functions and graphs; exponents, radicals, binomial theorem, zeros of polynomials; systems of equations; exponential, logarithmic, and inverse functions, applications and graphs. Other topics selected from sequences, series, and complex numbers. This course may not be used for credit toward an engineering or science degree (except for interdisciplinary science, chemistry, and associate of arts).

MATH 115 PRECALCULUS

(5-0) 5 credits. Prerequisite: MATH 101 with a minimum grade of "C" or appropriate mathematics placement. A preparatory course for the calculus sequence. Topics include: polynomial, rational, exponential, logarithmic and trigonometric functions and their graphs; systems of equations, inequalities and complex numbers. May not be used for credit toward an engineering or science degree (except for interdisciplinary science, chemistry, and associate of arts).

MATH 120 TRIGONOMETRY

(3-0) 3 credits. Prerequisite: MATH 102 "C" or an acceptable score on the COMPASS Placement Examination. Topics include: trigonometric functions, equations, and identities; inverse trigonometric functions; exponential and logarithmic functions, and applications of these functions. This course may not be used for credit toward an engineering or science degree (except for interdisciplinary science, chemistry, and associate of arts).

MATH 123 CALCULUS I

(4-0) 4 credits. Prerequisite: MATH 115 with a

minimum grade of “C” or appropriate mathematics placement or permission of instructor. Students who are initially placed into MATH 102 or below must complete MATH 102 and MATH 120 with a minimum grade of “C” before enrolling in MATH 123. Students who are placed in MATH 120 should consult their advisor to determine whether their placement score was sufficiently high to allow concurrent registration in MATH 123. The study of limits, continuity, derivatives, applications of the derivative, antiderivatives, the definite and indefinite integral, and the fundamental theorem of calculus.

MATH 125 CALCULUS II

(4-0) 4 credits. Prerequisite: MATH 120 completed with a minimum grade of “C” or appropriate score on departmental Trigonometry Placement Examination and MATH 123 completed with a minimum grade of “C.” A continuation of the study of calculus, including the study of sequences, series, polar coordinates, parametric equations, techniques of integration, applications of integration, indeterminate forms, and improper integrals.

MATH 205 MINING AND MANGEMENT MATHEMATICS I

(2-0) 2 credits. Prerequisite: MATH 125 with a minimum grade of “C” or permission of instructor. A survey of calculus in higher dimensions that includes an introduction to vectors, vector valued functions, and partial derivatives. This course may not be used for credit toward an engineering or science degree (except for mining engineering and management).

MATH 211 MINING AND MANGEMENT MATHEMATICS II

(3-0) 3 credits. Prerequisite: Math 125 with a minimum grade of “C” or permission of instructor. Selected topics from ordinary differential equations including first order, higher order equations and systems of linear equations. The class will also cover a survey of general solutions and solutions to initial-value problems using matrices. This course may not be used for credit toward an engineering or science degree (except for mining engineering and management).

MATH 221 INTRODUCTION TO DISCRETE MATHEMATICS

(2-0) 2 credits. Prerequisite: MATH 123 with a minimum grade of “C” or permission of instructor. The main purpose of this course is to provide background and experience on the structure of proofs. Topics may include: elementary logic, basic set theory, and sequences and summations, functions, matrices, and proof techniques. This course is cross-listed with CSC 251.

MATH 225 CALCULUS III

(4-0) 4 credits. Prerequisite: MATH 125 completed with a minimum grade of “C.” A continuation of the study of calculus, including an introduction to vectors, vector calculus, partial derivatives, and multiple integrals.

MATH 281 INTRODUCTION TO STATISTICS

(3-0) 3 credits. Prerequisite: MATH 102 or MATH 115. A study of descriptive statistics including graphs, measures of central tendency and variability and an introduction to probability theory, sampling and techniques of statistical inference with an emphasis on statistical applications. Individuals may apply at most 4 credits toward a degree from the following list of courses: MATH 281, IENG/MATH 381, MATH 441.

MATH 291 INDEPENDENT STUDY

1 to 5 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. May be repeated to a total of 5 credit hours.

MATH 292 TOPICS

1 to 5 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course

content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. May be repeated to a total of 6 credit hours.

MATH 315 LINEAR ALGEBRA

(3-0) 3 credits. Prerequisite: MATH 225 or permission of instructor. Course topics include: the theory and applications of systems of linear equations, matrices, determinants, vector spaces, linear transformations and applications.

MATH 321 DIFFERENTIAL EQUATIONS

(4-0) 4 credits. Prerequisite: MATH 125 with a minimum grade of "C." Selected topics from ordinary differential equations including development and applications of first order, higher order linear and systems of linear equations, general solutions and solutions to initial-value problems using matrices. Additional topics may include Laplace transforms and power series solutions. MATH 225 and MATH 321 may be taken concurrently or in either order. In addition to analytical methods this course will also provide an introduction to numerical solution techniques.

MATH 353 LINEAR OPTIMIZATION

(3-0) 3 credits. Prerequisites: MATH 321 or MATH 315 or permission of instructor. Convex sets and functions, linear inequalities and combinatorial problems; topics in linear programming from fundamental theorems of simplex method through sensitivity analysis, duality, transportation, and assignment problems.

MATH 373 INTRODUCTION TO NUMERICAL ANALYSIS

(3-0) 3 credits. Prerequisite: MATH 321 and CSC 150 or permission of instructor. This course is an introduction to numerical methods. Topics include elementary discussion of errors, polynomial interpolation, quadrature, non-linear equations, and systems of linear equations. The algorithmic approach and efficient use of the computer will be emphasized. Additional topics may include: calculation of eigenvalues and

eigenvectors, numerical differentiation and integration, numerical solution of differential equations.

MATH 381 INTRO TO PROB AND STAT

(3-0) 3 credits. Prerequisite: MATH 125 and prerequisite or corequisite: MATH 225. Introduction to probability theory, discrete and continuous distributions, sampling distributions and the Central Limit Theorem with general principles for statistical inference and applications of random sampling to hypothesis testing, confidence limits, correlation, and regression. This course is cross-listed with IENG 381. Individuals may apply at most 4 credits toward a degree from the following list of courses: MATH 281, IENG/MATH 381, MATH 441.

MATH 382 PROBABILITY THEORY AND STATISTICS II

(3-0) 3 credits. Prerequisite: MATH 381. Review of general principles of statistical inference, linear regression and correlation, multiple linear regression, ANOVA, and statistical design of experiments. This course is cross-listed with IENG 382.

MATH 391 INDEPENDENT STUDY

1 to 5 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. May be repeated to a total of 5 credit hours.

MATH 392 TOPICS

1 to 5 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer

students with significant one-on-one student/teacher involvement. May be repeated to a total of 6 credit hours.

MATH 402 COMMUNICATING MATHEMATICS

(1-0) 1 credit. Prerequisite: MATH 498. The student will produce a word-processed technical report of research conducted in MATH 498 and give a department colloquium talk summarizing her or his work. Department faculty member(s) will provide guidance in the production of the technical report and in the preparation for the colloquium talk.

MATH 413 ABSTRACT ALGEBRA I

(3-0) 3 credits. Prerequisites: MATH 225 and CSC 251 or MATH 225 and MATH 221 or permission of instructor. Introduction to the theory and applications of algebraic structures including groups, rings, and fields.

MATH 421 COMPLEX ANALYSIS

(3-0) 3 credits. Prerequisite: MATH 225. The algebra of complex numbers; complex functions; contour integration and Cauchy integral theorems; Taylor and Laurent series and the residue theorem; the evaluation of real definite integrals; elementary mapping problems.

MATH 423 ADVANCED CALCULUS I

MATH 424 ADVANCED CALCULUS II

(4-0) 4 credits each. Prerequisite: MATH 225 and CSC 251 or MATH 225 and MATH 221 or permission of instructor. Prerequisite for MATH 424 is MATH 423. A theoretical treatment of Calculus that covers: limits; continuity and differentiability of functions of a single variable and of several variables; convergence of sequences and series; integration; and applications.

MATH 431 DYNAMICAL SYSTEMS

(3-0) 3 credits. Prerequisites: MATH 315 and MATH 321 or permission of instructor. This course is a study of both discrete and continuous dynamical systems. Topics include analysis of planar autonomous systems, stability analysis, bifurcation, chaos, and strange attractors. In

addition, this course may include the study of Van der Pol's equation, Lorenz equations, Duffing's equation, Hamiltonian systems, and Poincare maps.

MATH 432 PARTIAL DIFFERENTIAL EQUATIONS

(3-0) 3 credits. Prerequisites: MATH 225 and MATH 321. Fourier series, partial differential equations, Frobenius series, Bessel functions, and transform methods.

MATH 441 ENGINEERING STATISTICS

(4-0) 4 credits. Prerequisite: MATH 225. An introduction to the core ideas in probability and statistics. Computation of probabilities using, for instance, counting techniques and Bayes' rule. Introduction to discrete and continuous random variables, joint and conditional distributions, expectation, variance and correlation, random sampling from populations, hypothesis tests and confidence intervals, and least squares. Other topics include building multiple regression models, parameter estimation, and reliability. Individuals may apply at most 4 credits toward a degree from the following list of courses: MATH 281, IENG/MATH 381, and MATH 441.

MATH 451 MATH MODELING

(3-0) 3 credits. Prerequisites: MATH 321 or permission of instructor. The primary goal of this course is to present the mathematical formulation and analysis utilized in scientific modeling. Applications from both Science and Engineering will be covered. The types of models will include deterministic and stochastic models. Topics may include: epidemiology, biomass, elasticity, heat flow, electrical circuits, mechanical vibrations and optimization.

MATH 457/557 DESIGN OF EXPERIMENTS

(3-0) 3 credits. Prerequisite: MATH 382 or MATH 441 or permission of instructor. Single and multifactor experiments, analysis of variance, factorial designs, the use of multiple regression, and response surface methodology. Topics may include nonparametric and permutation/randomization alternatives to the traditional parametric tests. Students enrolled in

MATH 557 will be held to a higher standard than those enrolled in MATH 457.

MATH 463 SCIENTIFIC COMPUTING

(3-0) 3 credits. Prerequisite: MATH 373 or CSC 372 or permission of instructor. This course is an introduction to the elements of numerical analysis and modern scientific computing. The primary focus will be on the mathematical analysis of computational methods and the effective use of scientific computation as it relates to the needs of engineering and science. Topics will include: machine arithmetic and error analysis, the approximation of eigenvalues, and numerical solutions of ordinary differential equations. Additional topics in numerical analysis will be included as time permits.

MATH 471 NUMERICAL ANALYSIS I

(3-0) 3 credits. Prerequisite: MATH 373 or CSC 372. Analysis of rounding errors, numerical solutions of nonlinear equations, numerical differentiation, numerical integration, interpolation and approximation, numerical methods for solving linear systems.

MATH 486 STATISTICAL QUALITY AND PROCESS CONTROL

(3-0) 3 credits. Prerequisites: IENG 381 or MATH 441 or permission of instructor. This course covers the development of statistical methods for application to problems in quality and process control. Statistical topics include: basics of processes and variability, statistically controlled processes, variable and attribute control charts, moving averages, individual trend and others, process capability, sampling plans for attributes and variables. This course is cross-listed with IENG 486.

MATH 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans.

Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic. May be repeated to a total of 3 credit hours.

MATH 492 TOPICS

1 to 6 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. May be repeated to a total of 6 credit hours.

MATH 498 UNDERGRADUATE RESEARCH/SCHOLARSHIP

(1-0) 1 credit. Prerequisite: Permission of instructor. Includes senior project, and capstone experience. Independent research problems/projects or scholarship activities. The plan of study is negotiated by the faculty member and the student. Contact between the two may be extensive and intensive. Does not include research courses which are theoretical.

MATH 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Student should have obtained permission of an instructor in the Department of Mathematics and Computer Science prior to registering for this course. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor. May be repeated to a total of 6 credit hours.

MATH 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor. May be repeated to a total of 6 credit hours.

ME 110/110L INTRODUCTION TO MECHANICAL ENGINEERING

(1-1) 2 credits. An introductory course for incoming mechanical engineering freshmen which

will introduce the student to the profession they have chosen. Topics to be covered include: Solid modeling, CAD lab, professional development, engineering design, technical communication, personal development, and academic success skills.

ME 211 INTRODUCTION TO THERMODYNAMICS

(3-0) 3 credits. Prerequisites: MATH 125 and PHYS 211. An introduction to the basic concepts of energy conversion, including the first and second laws of thermodynamics, energy and entropy, work and heat, thermodynamic systems analysis, and the concepts of properties and state. Application of these fundamentals to energy conversion systems will be presented.

ME 216 INTRODUCTION TO SOLID MECHANICS

(3-0) 3 credits. Prerequisite: EM 214. This course covers the fundamental concepts of solid mechanics including the definition of stress, transformations and states of stress; plane stress, plane strain, octahedral stresses, three dimensional stresses, and principal stresses in two and three dimensions. Additional topics include strain analysis, strain measurements and rosette analysis, generalized Hooke's law, and orthotropic materials. Specific applications are an introduction to composite materials, analysis of thin and thick cylinders, statically indeterminate members, torsional loading of shafts, power transmission and the shaft analysis, torsional loads in non-circular components and thin tubes, stress concentrations, and combined loads.

ME 221 DYNAMICS OF MECHANISMS

(3-0) 3 credits. Prerequisites: PHYS 211, EM 214, MATH 125. Brief review of dynamics of a particle. Kinetics and kinematics of two and three-dimensional mechanisms. Emphasis will include free body diagrams, vector methods, and various coordinate systems. Newton's law and energy methods will both be used.

ME 262 PRODUCT DEVELOPMENT

(2-0) 2 credits. Prerequisites ME 110, MATH 123 and sophomore standing. The course presents

in a detailed fashion useful tools and structured methodologies that support the product development practice. Also, it attempts to develop in the students the necessary skills and attitudes required for successful product development in today's competitive marketplace. The cornerstone is a semester-long project in which small teams of students conceive, plan and design a simple physical product. Each student brings his/her own background to the team effort, and must learn to synthesize his/her perspective with those of the other students in the team to develop a marketable product. An introduction to manufacturing aspects that must be taken into consideration during product development is provided in the context of the project.

ME 264/264L SOPHOMORE DESIGN

(1-1) 2 credits. Prerequisite: Sophomore standing. This course focuses on the design process including project management and teamwork; formal conceptual design methods; acquiring and processing information; design management tools; design for manufacturability, reliability, maintainability, sustainability; design communication: reports and presentations; ethics in design; prototyping designs; case studies. This course is cross-listed with EE 264/264L.

ME 312 THERMODYNAMICS II

(3-0) 3 credits. Prerequisites: ME 211 and ME 221. Thermodynamic power cycles using vapors and gases. One-dimensional compressible flow. Energy analysis. Refrigeration cycles. Mixtures and psychrometry. Maxwell's relations. Combustion and thermochemistry.

ME 313/313L HEAT TRANSFER

(2-1) 3 credits. Prerequisites: ME 211 and MATH 373 (concurrent). A study of the transfer of heat by conduction, convection and radiation. Application to thermal systems.

ME 316 SOLID MECHANICS

(3-0) 3 credits. Prerequisites: ME 216 and ME 221. Covers stress analysis and failure theories of both brittle and ductile materials and energy methods. Also includes such topics as elastic impact, stability, axis-symmetric loaded members

in flexure and torsion, and an introduction to plastic behavior of solids.

ME 322 MACHINE DESIGN I

(3-0) 3 credits. Prerequisites: ME 316 and ME 262. Applications of the fundamentals of strength of materials, basic elastic theory, material science and how they apply to the design and selection of machine elements. Elements include shafts, gears, fasteners, and drive components such as gears and chains.

ME 331 THERMO FLUID DYNAMICS

(3-0) 3 credits. Prerequisites: ME 211 and ME 221. A study of the nature of fluids, constitutive relations, fluid statics/buoyancy, and the equations governing the motion of ideal (inviscid) and viscous, incompressible fluids, as well as inviscid, compressible fluids (1-dimensional gas dynamics). Internal and external flows, including viscous pipe flow, the Moody diagram, lift, drag and separation. Laminar and turbulent boundary layer theory, and dimensional analysis, modeling, and similitude.

ME 351/351L MECHATRONICS AND MEASUREMENT SYSTEMS

(3-1) 4 credits. Prerequisite: CSC 150 and EE 220 or EE 301. This course will encompass general measurement techniques found in mechanical and electrical engineering. These include measurement of force, strain, frequency, pressure flow rates and temperatures. Elements of signal conditioning and data acquisition will be introduced. In addition to this material, the course will have a Mechatronics approach reflected in the combined applications of electronic mechanical and control systems. This course is cross-listed with EE 351/351L.

ME 352 INTRODUCTION TO DYNAMIC SYSTEMS

(3-0) 3 credits. Prerequisites: MATH 321, ME 221. This is an introductory course in the control of dynamic systems. The course presents the methodology for modeling and linearizing of electrical, mechanical, thermal, hydraulic and pneumatic systems. The course also covers control system analysis and synthesis in the time

and the frequency domains.

ME 380 INTRODUCTION TO BIOMECHANICS

(3-0) 3 credits. Prerequisites: EM 321 or EM 217, MET 231, and MET 232. This course will provide an introduction to the important field of biomechanics. It will cover topics such as: engineering based on biological design; human anatomy; neural systems; locomotion; and biological materials.

ME 391 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

ME 392 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

ME 402/502 GAS DYNAMICS

(3-0) 3 credits. This course will review fundamental concepts from thermodynamics including isentropic flow and normal shock functions. The equations of motion will be derived in differential form and wave theory will be introduced. Multidimensional flows and oblique shock theory will be discussed. Integral methods for inviscid, compressible flow will be developed and numerical methods (including the method of characteristics for hyperbolic equations) will be employed in the second half of the course. Students enrolled in ME 502 will be held to a higher standard than those enrolled in ME 402.

ME 404 HEATING, VENTILATING, AND AIR CONDITIONING

(3-0) 3 credits. Prerequisites: ME 312 (concurrent), ME 313 (concurrent), ME 331. A study of space heating and cooling systems and equipment, building heating and cooling load calculations, solar radiation concepts, and moist air properties/conditioning processes. Indoor air quality/comfort and health issues will be discussed. Basic heat and mass transfer processes will be introduced; pump and fan performance issues along with duct and piping system design. Heat exchangers and mass transfer devices will also be studied.

ME 411/411L INTERNAL COMBUSTION ENGINES I

(3-1) 4 credits. Prerequisites: ME 312 (concurrent), ME 313 (concurrent), ME 331, ME 351. Otto and diesel cycle analysis; combustion in engines; exhaust gas analysis; engine mechanical design features. Laboratory includes experiments designed to coordinate with the lectures and special investigations to topics of current interest such as noise and pollution.

ME 419/419L THERMO-FLUID SYSTEMS DESIGN

(3-1) 4 credits. Prerequisites: ME 312, ME 313, and ME 331. Investigation and design of thermal and fluid systems and components, emphasizing the major thermal/fluid design issues that arise in internal combustion engine power conversion; analysis and synthesis involving modeling and optimization of thermo-fluid systems, components and processes. Development and application of fundamental numerical tools and algorithms for thermal and fluid problems. A central design problem for a thermal/fluid system or component will be selected to meet an existing or future project need and will be decomposed into the relevant thermal and fluid aspects which will be studied throughout the course. Review of the basics of the design process and physical processes important to thermal-fluid problems (basic thermodynamics, heat transfer and fluid mechanics), the fundamentals of building and solving mathematical models, and design issues and concepts unique to internal combustion

engines will be discussed. Students will be required to implement one or more previously developed Fluent learning modules to study the use of CFD in thermal/fluid system design. The final project will incorporate skills developed in the learning modules into the required design of the system or component. The laboratory will include experiments to compliment the lecture material and provide a means for hands on validation of concepts.

ME 422 MACHINE DESIGN II

(3-0) 3 credits. Prerequisite: ME 322. This course will explore advanced structural design concepts within an integrated framework of theory, simulation, experiment, and materials. Of particular importance will be the study of modern topics, such as plastic materials and their response to service loads. Structural mechanics and materials response will be brought together in support of machine component design.

ME 423 MECHANICAL VIBRATIONS

(3-0) 3 credits. Prerequisite: ME 352. Study of the oscillatory nature and vibration design of mechanical systems. One, two, multi, and infinite degree of freedom systems are analyzed for their response in both free and forced vibration regimes. Particular emphasis is given to designing for vibration control. Brief introductions are made to vibration testing and measurement, and human response to vibrations.

ME 425 PROBABILISTIC MECHANICAL DESIGN

(3-0) 3 credits. Prerequisite: ME 322. Basic concepts of probability and statistics are introduced including Gaussian, Exponential, and Weibul distributions. Primary emphasis is placed on treating stresses, strains, deformations, and strength limitations as random variables and computing probability of failure under required loads. Considerable time is devoted to converting data into meaningful engineering parameters for making engineering decisions. Statistical methods applied to topics in mechanical design. (Design Elective)

ME 426 MECHANICAL SYSTEMS ANALYSIS LABORATORY

(0-1) 1 credit. Prerequisites: ME 423 (concurrent). Use of experimental methods and modern instrumentation techniques to understand the free and forced oscillations of machines and machine components, as well as the control of these vibrations. Laboratory exercises are designed to reinforce material learned in the companion lecture class ME 423, extend knowledge into new areas, and help to make the connection between theory and practice.

ME 427/427L COMPUTER-AIDED DESIGN AND MANUFACTURE

(2-1) 3 credits. Prerequisite: Senior standing or permission of instructor. Discussion of methods and topics in computer-aided design and manufacture. How to bridge the gap between the design/analysis phase and the actual manufacture phase. Database requirements of CNC machine tools and how they can be constructed.

ME 428/428L APPLIED FINITE ELEMENT ANALYSIS

(2-1) 3 credits. Prerequisites: ME 316 or permission of instructor. Basic mathematical concepts of finite element analysis will be covered. The students will learn finite element modeling using state of the art software, including solid modeling. Modeling techniques for beams, frames, two and three-dimensional solids, and thin walled structures will be covered in the course.

ME 443 COMPOSITE MATERIALS

(3-0) 3 credits. Prerequisites: ME 316 or concurrent enrollment in MET 440. This course will cover heterogeneous material systems; basic design concepts and preparation; types of composite materials; advances in filaments, fibers and matrices; physical and mechanical properties; failure modes; thermal and dynamic effects; and application to construction, transportation and communication. This course is cross-listed with MET 443.

ME 453/453L CONTROL SYSTEMS

(3-1) 4 credits. Prerequisite: ME 352 or EE 311. Analysis and design of automatic control and

process systems by techniques encountered in modern engineering practice, including both linear and nonlinear systems with either continuous or discrete signals. This course is cross-listed with EE 451/451L.

ME 454 INDUSTRIAL HYDRAULICS

(3-0) 3 credits. Prerequisites: ME 331, ME 352. Design and use of high pressure hydraulic pumps, valves, systems and computer control systems.

ME 455/455L VEHICLE DYNAMICS

(2-1) 3 credits. Prerequisite: ME 352. Fundamental principles and practices of modern automotive chassis and suspension design, operation and testing are presented in the course. The dynamics of acceleration, braking, ride and handling are covered. Steady-state cornering using the standard bicycle model is covered in detail. Laboratory work involves shock absorber and spring testing and the setup and evaluation of Formula SAE and Baja SAE chassis. Students must complete a chassis design project.

ME 477 MECHANICAL ENGINEERING DESIGN I

(0-2) 2 credits. Prerequisite: Senior standing and ME 312, ME 313, ME 316, ME 322, ME 331, ME 351, ME 352 or permission of instructor. The first semester of a two course sequence in senior design practice. Integrates concepts from all areas in mechanical engineering into a practical design project. Fundamentals of the design process, specifications, decision making, and preliminary design will be the focus, with the major part of the course being the project.

ME 479 MECHANICAL SYSTEMS DESIGN II

(0-2) 2 credits. Prerequisite: ME 477 and senior standing. Corequisite: ME 351. The second semester continuation of Mechanical Systems Design. Integrates concepts from all areas in mechanical engineering into a practical design project. Detailed design and analysis, manufacturing, and assembly will be the focus.

ME 481L ADVANCED PRODUCT DEVELOPMENT LAB I

(0-1) 1 credit. Corequisite: ME 477. Advanced laboratory experience in product development. Students will perform activities in support of preliminary product design and trade studies, including virtual prototyping, computational investigations and proof-of-concept experiments. During the time of this course and in order to broaden their views on globalization, students will be required to attend a seminar series.

ME 482L ADVANCED PRODUCT DEVELOPMENT LAB II

(0-2) 2 credits. Corequisite: ME 479. Advanced laboratory experience in product development. Students will perform activities in support of detailed product design, including virtual prototyping, computational investigations, and testing of components and systems. During the time of this course and in order to broaden their views on globalization, students will be required to attend a seminar series.

ME 499/599 RESEARCH PROBLEMS/PROJECTS

1 to 3 credits. Prerequisite: Permission of instructor. Independent research problems/projects that lead to a research or design paper but not to a thesis. The plan of study is negotiated by the faculty member and the candidate. Contact between the two may be extensive and intensive. Does not include research courses which are theoretical. Students enrolled in ME 599 will be held to a higher standard than those enrolled in ME 499.

ME 555/555L ADVANCED APPLICATIONS IN COMPUTATIONAL MECHANICS

(1-2) 3 credits. Prerequisite: Senior or higher standing. Introduction to solid modeling techniques using advanced solid modeling software. Use of Computational Fluid Mechanics codes for the solution of complex fluid mechanics and heat transfer problems. Use of finite element codes for the solution of non-linear and transient problems in solid mechanics.

ME 612 TRANSPORT PHENOMENA: MOMENTUM

(3-0) 3 credits. Introduction to momentum transport. Equations of continuity and motion. Velocity distributions. Boundary layer theory. Turbulent transport compressible flow. This course is cross-listed with CBE 612.

ME 613 TRANSPORT PHENOMENA: HEAT

(3-0) 3 credits. Prerequisites: ME 313, MATH 373 (concurrent). An in-depth study of the fundamental laws of heat transfer. Major areas considered are: heat conduction, free and forced convection, and radiative heat transfer. Emphasis is placed on the formulation and solution of engineering problems by analytical and numerical methods. This course is cross-listed with CBE 613.

ME 616 COMPUTATIONS IN TRANSPORT PHENOMENA

(3-0) 3 credits. Prerequisite: MATH 373 or permission of instructor. Various computerized techniques, including finite difference and finite element, will be used to solve transient and steady state heat transfer problems involving conduction and convection. This course is cross-listed with CBE 616.

ME 623 ADVANCED MECHANICAL VIBRATIONS

(3-0) 3 credits. Prerequisite: ME 423 or equivalent. Study of the vibration of systems of particles both forced and free. Included is the study of transient vibrations and system natural frequencies. Classical studies of the vibration of continuous systems, free and forced, damped and undamped using computer solutions are emphasized. Introduction to Theoretical and Experiment Modal Analysis. (Design Elective)

ME 673 APPLIED ENGINEERING ANALYSIS I

(3-0) 3 credits. Advanced topics in engineering analysis. Special mathematical concepts will be applied to mechanical engineering problems. Topics will be selected from the following: Fourier series and boundary value problems

applied to heat conduction and convection, Laplace transforms and complex variable analysis applied to vibrations and dynamic system analysis, series solutions of differential equations, partial differential equations, general matrix applications to a variety of large systems of equations in engineering, calculus of variation, and Ritz method for various engineering problems. This course is cross-listed with MBE 673.

ME 683 ADVANCED MECHANICAL SYSTEM CONTROL

(3-0) 3 credits. Prerequisites: Graduate standing or permission of instructor. Derivation of state equations for continuous and discrete control systems. A study of optimal and adaptive control of mechanical systems. (Manufacturing Elective)

ME 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission on instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor.

ME 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

ME 715 ADVANCED COMPOSITE MATERIALS

(3-0) 3 credits. Prerequisite: Permission of instructor. Includes classification and mechanical behavior of composite materials, macro-mechanical behavior of lamina and laminates. Course emphasizes study of advanced composite laminates including failure theories, experimental methods, stresses, strains, and deformations.

ME 722 ADVANCED MECHANICAL DESIGN

(3-0) 3 credits. Prerequisite: ME 422. Study of some advanced concepts required for design of mechanical systems. Included are a review of basic concepts of mechanics and failure theories, in elastic responses, thermal stresses and

introduction into design for composite structures. Special topics such as non-homogeneous beams, twisting of beams, torsion of non-circular sections, beams on an elastic foundation, plates, and shells are covered. (Design Elective)

ME 773 APPLIED ENGINEERING ANALYSIS II

(3-0) 3 credits. Applications of numerical methods to mechanical engineering problems. Topics will include data processing techniques, curve fitting and interpolation of experimental information, solutions to systems of ordinary differential equations, solutions to partial differential equations, and numerical integration both of known functions and functions described only by experimental data. This course is cross-listed with BME 773.

ME 781 ROBOTICS

(3-0) 3 credits. The course covers the following topics as related to modern industrial robots, sensors and actuators, motion trajectories, synthesis, control, computers and languages, available robots, and applications. (Manufacturing Elective)

ME 788 GRADUATE RESEARCH (Non-Thesis)

Credit to be arranged. A course designed to provide an opportunity for the graduate student to do applied research work in his/her major field. This course will be the basis for the project required when the student has opted for the non-thesis option, for the master of science degree in the mechanical engineering department.

ME 790 SEMINAR

(1-0) 1 credit. May not be repeated for credit. Oral presentations followed by group discussions on a weekly basis. Speakers will be drawn primarily from the graduate student body but may also include faculty and invited lecturers.

ME 791 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and

preparation of papers, as agreed to in advanced, by student and instructor.

ME 792 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

ME 798 MASTER'S THESIS

Credit to be arranged. A course designed to provide an opportunity for the graduate student to do research work in his major field. This course will be the basis for the thesis required when the student has opted for the thesis option, for the master of science degree in the mechanical engineering department.

MEM 120 INTRODUCTION TO MINING, SUSTAINABLE DEVELOPMENT AND INTRODUCTORY MANAGEMENT

(2-0) 2 credits. This course presents an introductory overview of current surface and underground mining practices, new and emerging mining technology, mining terminology, and mining economics. Mining engineering faculty members are introduced and career paths available to the mining engineering graduate are discussed. The concept of sustainable development as it relates to minerals venture is introduced, and the interrelationships between mining, the environment, societal needs, and governance is discussed. Also included is an introduction to management concepts, presentation skills, meeting skills, negotiation skills, and basic project management tools. This course is cross-listed with ENVE 120.

MEM 201L SURVEYING FOR MINERAL ENGINEERS

(0-2) 2 credits. Prerequisites: Sophomore standing. Principles of surface and underground surveying, including measurements, data collection, calculations, error analysis, topographic mapping, and applications of the Global Positioning System.

MEM 202 MATERIALS HANDLING AND TRANSPORTATION

(2-0) 2 credits. Prerequisites: MEM 120 and

PHYS 211. The theory of operation of mining equipment, and its selection and application to materials handling in surface and underground mines. Emphasis is on economics, productivity, reliability, maintenance, and safety.

MEM 203 INTRODUCTION TO MINE HEALTH AND SAFETY

(1-0) 1 credit. Prerequisite: Sophomore standing. Instruction in the safety aspects of mining in accordance with MSHA rules. A study of mine regulations and the recognition of mine hazards along with their prevention and control.

MEM 204 SURFACE MINING METHODS AND UNIT OPERATIONS

(2-0) 2 credits. Prerequisites: ENVE/MEM 120 or permission of instructor. A study of surface mining techniques and unit operations applicable to metal mining, coal mining, quarrying and other surface mining operations. Topics include mine design and planning, surface drilling and blasting, the applicability and performance characteristics of earthmoving equipment, and an introduction of mine drainage. This course is cross-listed with ENVE 204.

MEM 301/301L COMPUTER APPLICATIONS IN MINING

(1-1) 2 credits. Prerequisite: GE 130 or permission of instructor. Computer hardware and software. Applications in exploration and resource modeling, equipment selection and simulations, mine planning and design, rock stability analysis, and economics and cost estimates. Emphasis on three-dimensional modeling and visualization. Vulcan software and other software applications.

MEM 302 MINERAL ECONOMICS AND FINANCE

(3-0) 3 credits. Prerequisite: Junior standing. An introduction to the concepts of the time value of money and the application of time value of money decision criteria to mineral project evaluation situations. Both before-tax and after-tax investment situations are discussed. A discussion of the financing options available to a company for expansion, new project development or acquisitions.

This course is cross-listed with ENVE 302.

MEM 303 UNDERGROUND MINING METHODS AND EQUIPMENT

(2-0) 2 credits. Prerequisite: Sophomore or junior standing. A study of underground mining techniques, unit operations, and equipment applicable to coal mining, metal mining, quarrying and tunneling operations. Topics include mining method selection, mine design and planning, drilling and blasting, and novel underground mining methods.

MEM 304/304L THEORETICAL AND APPLIED ROCK MECHANICS

(3-1) 4 credits. Prerequisite: EM 214 or EM 216 or EM 217 or equivalent and junior standing. Principles of rock mechanics and mechanics of materials. Concept of stress, strain and the theory of elasticity. Applications in mining, geological engineering and tunneling. Emphasis on the design of safe structures in rocks. Laboratory experience for determining the basic physical and mechanical properties of rocks.

MEM 305 INTRODUCTION TO EXPLOSIVES ENGINEERING

(3-0) 3 credits. Prerequisite: Junior standing. An introduction to explosives products; the theory of rock breakage by explosives; and the design of blast patterns for different applications including surface blasting techniques, underground blasting techniques, controlled blasting and specialized techniques. The techniques and equipment used to control and/or monitor airblast, ground vibration and flyrock are studied.

MEM 306 MINE POWER AND PUMPING SYSTEMS

(3-0) 3 credits. Prerequisites: MEM 301 and MEM 303. Fundamentals of electric circuits, basic mine power systems, and power distribution system design. Applications of pumping in surface and underground mines.

MEM 307 MINERAL EXPLORATION AND GEOSTATISTICS

(3-0) 3 credits. Prerequisite: Junior standing. The application of the theory of geostatistics to

qualify the geological concepts of (1) area of influence of a sample, (2) the continuity of the regionalized variable within a deposit, and (3) the lateral changes in the regionalized variable according to the direction. Basic concepts and theory of probability and statistics will be introduced, including probability distributions, sampling distributions, treatment of data, the mean, variance, and correlation. Computer techniques will be extensively used for geostatistical estimation of grade, volume, and variance. This course is cross-listed with ENVE 307.

MEM 401/401L THEORETICAL AND APPLIED MINE VENTILATION

(3-1) 4 credits. Prerequisite: MEM 303, ATM 404, EM 328 and senior standing. Analysis of mine atmosphere and the control of airflow in an underground mine. Basic principles of thermodynamics and air conditions. Emphasis is on solutions of airflow networks and the design principles of mine ventilation systems. Laboratory experience for determining the basic pressure and airflow parameters, ventilation network analysis, and fan characteristics.

MEM 405 MINE PERMITTING AND RECLAMATION

(3-0) 3 credits. Prerequisite: Junior standing. A study of environmental problems associated with both surface and underground mining and the reclamation practices that have been developed or are being evaluated to alleviate these problems. Federal, state and local reclamation regulations are examined for their effects on present and future mining practices and costs. Field trips to mining operations in the Black Hills region or the Powder River Basin will be taken for on-site observation of actual reclamation practices. This course is cross-listed with ENVE 405.

MEM 433/433L/533/533L COMPUTER APPLICATIONS IN GEOSCIENCE MODELING

(3-1) 4 credits. Prerequisite: Junior standing. The use of computer techniques in modern geoscience modeling of mining, geology and environmental problems such as exploration,

geological characterization and mining exploitation. Practical application of state-of-the-art Vulcan modeling software will be essential part of the course. Students enrolled in MEM 533 will be held to a higher standard than those enrolled in MEM 433. This course is cross-listed with ENVE 433/433L/533/533L.

MEM 450/550 ROCK SLOPE ENGINEERING

(3-0) 3 credits. Prerequisite: MEM 304 or CEE 346 or equivalent. Modes of slope failure. Economic consequences of instability in mining and construction. Geological factors controlling stability of rock slopes. Shear strength of highly jointed rock mass and discontinuities. Projection methods. Vectorial analysis of 3-D problems by means of the stereographic projection method. Analytical, graphical and computer analysis of planar, wedge and toppling failures. Probabilistic methods. Students enrolled in MEM 550 will be held to a higher standard than those enrolled in MEM 450. This course is cross-listed with ENVE 450/550.

MEM 464 MINE DESIGN AND FEASIBILITY STUDY

(4-0) 4 credits. Prerequisites or corequisite: MEM 302, MEM 304, MEM 401 and senior standing. A complete mine feasibility study conducted as a senior design project. Students will have a choice of designing one of the following: a surface or underground coal mine, a quarry, a surface or underground hard rock metal mine, or a sub-surface underground space (tunneling, large excavations, industrial/environmental underground storage site, or underground science laboratory). A comprehensive study of principles and practices involved in developing an ore deposit (surface or underground) starting with drill hole data following through with a complete feasibility study (based on financial returns on investment and sensitivity analysis) covering ore reserve calculations, and selection of mining methods and equipment. Computerized approach will be an integral part of the course: SurvCADD software and Vulcan software are available to use. In addition to a computerized model of the mine, a

final written report and presentation in front of the class will be required.

MEM 466 MINE MANAGEMENT

(2-0) 2 credits. Prerequisite: Senior standing or permission of instructor. The study of critical management issues of fundamental importance to the mining industry: forms of management, organizational structures, project management and mine administration, risk management, and modern management tools. Development of leadership skills. Management of human resources.

MEM 491 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems, and special projects. Student complete individualized plans of study which include significant one-on-one student/teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting depending on the requirements of the topic.

MEM 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may service as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

MES 601 FUNDAMENTALS OF MATERIALS ENGINEERING

(4-0) 4 credits. Prerequisite: Admission to M.S./MES or Ph.D./MES program or permission of instructor. The course is taught when the required seven student minimum is reached. The objective of this course is to provide students with the working knowledge required to understand principles governing engineering aspects of materials synthesis and manufacturing. Students are able to analyze the effect of transport phenomena, surface chemistry, solution thermodynamics and kinetics on design, control

and process optimization of various materials processes.

MES 603 CONDENSED MATTER PHYSICS

(4-0) 4 credits. Prerequisite: Admission to M.S./MES or MES Ph.D. program or permission of instructor. The objective of this course is to provide students with working knowledge required to understand the principles of condensed matter physics with application to materials science and engineering. The students will be able to analyze basic experiments related to electronic structure of atoms and chemical bonding in solids, diffraction of x-rays and electrons by crystal lattices, lattice dynamics, elastic and thermal properties of solids, electronic band structure, classification of solids, dynamics of electrons in crystals, optical properties of solids, doped semiconductors, p-n junctions and hetero-junctions, dielectric properties of insulators, piezoelectricity, electrostriction, ferroelectricity, and magnetic properties of solids (dia-, para-, and ferro-magnetism).

MES 604 CHEMISTRY OF MATERIALS

(4-0) 4 credits. Prerequisite: Admission to M.S./MES or MES Ph.D. program or permission of instructor. The object of this course is to provide students with the working knowledge required to understand the theoretical chemical basis for chemical and physical properties of crystalline, ceramic, polymeric and metallic materials. Students will be able to analyze macroscopic properties on the basis of underlying chemical concepts.

MES 670 PRINCIPLES OF X-RAY DIFFRACTION

(3-0) 3 credits. Prerequisites: PHYS 213 and MET 232 or GEOL 212 or permission of instructor. This course will cover the principles of crystallography in materials science, theory and production of x-rays, interaction of x-rays with matter, and the principles of x-ray diffraction. The application of x-ray diffraction methods to analytical measurement techniques in materials science and metallurgical engineering will also be covered. This course is cross-listed with GEOL 670.

MES 677 PRINTED ELECTRONICS: MATERIALS AND PROCESSES

(3-0) 3 credits. The principles of interfacial phenomenon, solution thermodynamics and colloid chemistry will be used in illuminated process by which metallic nanoparticulates can be formed and incorporated into inks for use in manufacturing printed electronics by various direct write technologies. Students will learn 1) the methods and science behind the manufacture of a variety of nanoparticles, including gold, silver, copper conducting particles, 2) the methods of incorporating these particles into inks and printing of these inks for printed electronics applications and 3) the interfacial processes involved in line spreading and curing of the printed traces. This course is cross-listed with NANO 677.

MES 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advanced, by student and instructor.

MES 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor. This course is cross-listed with MES 792.

MES 708/708L ADVANCED INSTRUMENTAL ANALYSIS

(3-1) 4 credits. Prerequisites: Admission to M.S./MES or Ph.D./MES program or permission of instructor. The objective of this course is to provide the students a working knowledge of the principles of modern analytical instrumentation. Specific topics of the course include how electromagnetic radiation interacts with matter, atomic and molecular spectroscopy and chromatography. The laboratory portion of this course will include experiments in atomic and molecular spectroscopy. In addition, chromatographic experiments are also covered.

MES 712 INTERFACIAL PHENOMENA

(3-0) 3 credits. A course in the surface properties of solids and liquids. Areas covered include the thermodynamics of surfaces, material transfer across interfaces, nucleation, surface energies of solids, three-phase contact, wetting phenomena, and adsorption.

MES 713 ADVANCED SOLID MECHANICS I

(3-0) 3 credits. Presented and discussed. Emphasis is placed on the mathematical description of phenomenological behavior, deformation and flow. Practical solutions from the classical theories of solid mechanics are discussed.

MES 721 THEORY OF MATERIALS BEHAVIOR I

(3-0) 3 credits. An advanced course covering the properties of crystalline, amorphous, and multiphase solids. Study of the mechanical, thermal, electrical, chemical, magnetic, and optical behavior of metals, semiconductors, ceramics, polymers, concretes, and composites, including time-dependent and environmental effects.

MES 728 HETEROGENEOUS KINETICS

(3-0) 3 credits. Principles of Absolute Rate Theory are combined with thermodynamics to study the mechanisms of homogeneous and heterogeneous reactions in metallurgical systems. This course is cross-listed with CBE 728.

MES 737 SOLID STATE PHYSICS I

(3-0) 3 credits. Prerequisite: PHYS 431 or equivalent. The structure of solids, lattice vibrations, free electron and energy band theory. Applications to the thermal, electrical, magnetic, and optical properties of solids.

MES 770 CONTINUUM MECHANICS

(3-0) 3 credits. Prerequisite: Permission of instructor. Introduction to tensor algebra and calculus. Derivation of kinematic, stress, strain, and thermodynamic field equations governing continuous media. Development of constitutive relations for real materials. Applications to problems in fluid and solid mechanics.

MES 788 MASTER'S RESEARCH PROB/PROJECTS

Credit to be arranged; not to exceed 5 credit hours toward fulfillment of the master of science in materials engineering and science (M.S./MES). Prerequisite: approval of advisor. Directed research investigation of a selected problem culminating in an acceptable written report. Oral defense of the report and research findings are required.

MES 790/890 SEMINAR

(1-0) 1 credit. May not be repeated for degree credit. Preparation, oral presentation, and group discussion of a research problem. Students enrolled in MES 890 will be held to a higher standard than those enrolled in MES 790.

MES 792 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor. This course is cross-listed with MES 692.

MES 798 MASTER'S THESIS

Credit to be arranged; not to exceed 6 credit hours toward fulfillment of the master of science in materials engineering and science (M.S./MES). Prerequisite: approval of advisor. An original investigation of a materials engineering or materials science subject normally presented as a thesis for the M.S./MES degree.

MES 898 DISSERTATION

Credit to be arranged; not to exceed 30 credits toward fulfillment of Ph.D. degree requirements. Open only to doctoral candidates. Supervised original research investigation of a selected problem, with emphasis on independent work, culminating in an acceptable dissertation. Oral defense of dissertation and research findings are required.

MET 220 MINERAL PROCESSING AND RESOURCE RECOVERY

(3-0) 3 credits. Prerequisite: Sophomore standing. An introductory course in mineral processing highlighting unit operations involved including comminution, sizing, froth flotation, gravity

separation, electrostatic separation, magnetic separation and flocculation. Other topics discussed include remediation of contaminant effluents and the unit operations associated with recycling of post-consumer materials using mineral processing techniques. This course is cross-listed with ENVE 220.

MET 220L MINERAL PROCESSING AND RESOURCE RECOVERY LABORATORY

(0-1) credit. An introductory laboratory course in mineral processing highlighting relevant unit operations. This course is cross-listed with ENVE 220L.

MET 231 STRUCTURES AND PROPERTIES OF MATERIALS LAB

(0-1) 1 credit. Prerequisites: Concurrent registration in MET 232, or permission of instructor. A laboratory involving quantitative metallography, heat treating practice, mechanical property measurements and metallurgical design of the thermal mechanical treatment of metals.

MET 232 PROPERTIES OF MATERIALS

(3-0) 3 credits. Prerequisite: MATH 123 and PHYS 111. A course in engineering materials and their applications. The different technological uses of metals, ceramics, plastics, and composite materials are discussed and explained in terms of their basic atomic structure, and mechanical, thermal, optical, electrical, and magnetic properties. Material selection in engineering design is emphasized.

MET 310 AQUEOUS EXTRACTION, CONCENTRATION, AND RECYCLING

(3-0) 3 credits. Prerequisites: MET 320 or CBE 321, or CHEM 342. Scientific and engineering principles involved in the winning of metals from ores and scrap. Areas covered include the unit operations of comminution, sizing, solid/liquid separations, leaching, ion exchange, solvent extraction, and surface phenomena as related to flocculation, froth floatation, and electrostatic separation. This course is cross-listed with ENVE 310.

MET 310L AQUEOUS EXTRACTION, CONCENTRATION, AND RECYCLING LAB

(0-1) 1 credit. Prerequisites: Concurrent registration in MET 310 or permission of instructor. Laboratory experiments in design of processing equipment and cost estimation, zeta potential, surface tension, leaching kinetics, electrowinning, and solvent extraction. This course is cross-listed with ENVE 310L.

MET 320 METALLURGICAL THERMODYNAMICS

(4-0) 4 credits. Prerequisites: PHYS 211, CHEM 112, MATH 125. The principles of chemical thermodynamics and their application to metallurgical engineering processes. Topics covered include the zeroth, first and second laws of thermodynamics, the fundamental equations of state for open and closed systems, criterion of equilibrium, heat capacities, reaction equilibrium constants and their dependence upon temperature and pressure, chemical potential, standard and reference states, stability diagrams, and solution thermodynamics. This course is cross-listed with ENVE 320.

MET 321/321L HIGH TEMPERATURE EXTRACTION, CONCENTRATION, AND RECYCLING

(3-1) 4 credits. Prerequisite: MET 320. Thermodynamic principles involved in the winning of metals. Areas covered include calcination, oxidation, reduction processes, smelting, high -temperature refining, electrorefining, slags, and slag-metal interactions. This course is cross-listed with ENVE 321/321L.

MET 330 PHYSICS OF METALS

(3-0) 3 credits. Prerequisite: MET 232. The fundamental principles of physical metallurgy with emphasis on the mathematical description of mechanisms that control the structure of materials. Topics covered are structure of metals, x-ray diffraction, elementary theory of metals, dislocations, slip phenomena, grain boundaries, vacancies, annealing, and solid solutions.

MET 330L PHYSICS OF METALS LAB

(0-1) 1 credit. Prerequisites: MET 232 and MET 231. Practical laboratory exercises that involve (1) x-ray diffraction methods, (2) transmission electron microscopy as it applies to dislocations in materials, (3) recovery, recrystallization and grain growth as it applies to annealing of materials, (4) optional and scanning electron microscopy as it applies to the microstructure of materials, and (5) thermomechanical processing of metals with limited regions of solid solubility.

MET 332 THERMOMECHANICAL TREATMENT

(3-0) 3 credits. Prerequisites: MET 232 and concurrent registration in MET 330, and MET 320 or ME 211. The relationship between the structure and properties of materials. Topics covered are the iron-carbon system, hardenability of iron base alloys, stainless steels, cast irons, aluminum, copper and magnesium, rubber and copper polymers. Concepts of heat treatment, age hardening, dispersion hardening, and hot and cold working correlated with modification of the structure and physical properties of materials.

MET 351 ENGINEERING DESIGN I

(2-0) 2 credits. Prerequisites: MET 220 and MET 232. Introduction to engineering design. Compare the scientific method with the engineering design method. Define the concept of need as it pertains to the design process. Develop skills associated with the use of modern and classic sources of information. In addition, material selection processes, interaction of materials, and materials processing topics are presented. Focus on the design process, and the design method. The development of interdisciplinary teams is a high priority.

MET 352 ENGINEERING DESIGN II

(1-0) 1 credit. Prerequisite: MET 351. A continuation of the design sequence.

MET 421/521 REFRACTORIES AND CERAMICS

(3-0) 3 credits. Prerequisites: MET 232 and MET 320 or graduate standing. This fundamental course on the properties of refractory and ceramic

materials covers the production of ceramic and refractory materials including concentration, purification, and forming. Refractory selection, practice, and service in high-temperature thermochemical processes and environments; thermal and electrical properties; the relationship among structure, bonding imperfections, and properties; and failure diagnosis and avoidance is included. Students enrolled in MET 521 will be held to a higher standard than those enrolled in MET 421.

MET 422 TRANSPORT PHENOMENA

(4-0) 4 credits. Prerequisite: MATH 321 and concurrent enrollment in MET 320. The principles of momentum, heat and mass transfer and their application to metallurgical engineering. Topics covered include thermal conductivity, mass diffusion, mechanisms of transport, Fourier's and Fick's Laws, shell balance, boundary conditions, equations of change, unsteady-state transport, mass and heat distributions in turbulent flow, and interphase transport.

MET 426/526 STEELMAKING

(3-0) 3 credits. Prerequisites: MET 320 or graduate standing. Chemical reactions and heat and mass transport phenomena associated with the production of steel. Unit operations studied include the blast furnace, the basic oxygen furnace, the electric arc furnace, and selected direct reduction processes. Students enrolled in MET 526 will be held to a higher standard than those enrolled in MET 426.

MET 430/430L WELDING ENGINEERING AND DESIGN OF WELDED STRUCTURES

(2-1)3 credits. Introduces the state-of-art in welding processes and technology. Discusses fundamentals of the fabrication welded structures by introducing basics of solidification in welds, metallurgy of welds, fatigue and fracture in welds, joint design and weld defects and inspection. Laboratory exercises will focus on advanced welding processes, characterization, and materials testing methods.

MET 433 PROCESS CONTROL

(3-0) 3 credits. Prerequisite: MATH 321 and senior standing. Analysis and design of process control systems for industrial processes, including control tuning and design of multi-variable control scheme. This course is cross-listed with CBE 433.

MET 440/540 MECHANICAL METALLURGY

(3-0) 3 credits. Prerequisites: MET 232 and concurrent or completion of ME 216 or EM 321. A course concerned with responses of metals to loads. Areas covered include elastic and plastic deformation under different force systems, dislocation theory, fracture, internal friction, fatigue, creep, residual stresses, and general fundamentals of metal working. Students enrolled in MET 540 will be held to a higher standard than those enrolled in MET 440.

MET 440L/540L MECHANICAL METALLURGY LABORATORY

(0-1) 1 credit. Prerequisites: MET 232, and concurrent or completion of ME 216 or EM 321. A course designed to expose the student to practical experience on the mechanical behavior of metals and alloys including deformation processing and failure analysis.

MET 443 COMPOSITE MATERIALS

(3-0) 3 credits. Prerequisites: ME 316 or concurrent enrollment in MET 440. The course will cover heterogeneous material systems; basic design concepts and preparation; types of composite materials; advances in filaments, fibers and matrices; physical and mechanical properties; failure modes; thermal and dynamic effects; and applications to construction, transportation and communication. This course is cross-listed with ME 443.

MET 445/545 OXIDATION AND CORROSION OF METALS

(3-0) 3 credits. Prerequisites: MET 320 or CBE 222 or ME 211 or graduate standing. Initially, the thermodynamics of electrochemical processes are covered; use of the Nernst equation and Pourbaix diagram is presented in this material.

Fundamentals of electrode kinetics are then discussed with special emphasis on the derivation of the Butler-Volmer equation and application of the Evan's diagram. Following presentation of these fundamental concepts, phenomena observed in corrosion and oxidation such as uniform attack, pitting, stress corrosion cracking, and corrosion fatigue are discussed. Finally, selection of materials for site specific applications is covered. Students enrolled in MET 545 will be held to a higher standard than those enrolled in MET 445. This course is cross-listed with ENVE 445/545 and CBE 445/545.

MET 450/550 FORENSIC ENGINEERING

(3-0) 3 credits. Prerequisites: MET 231, MET 232, EM 321 or ME 216, or permission of instructor. The principles of physical metallurgy, mechanical metallurgy, manufacturing processes, and service environments will be used to determine the cause(s) for failure of metallic, composite, and polymer engineering components. Analytical techniques and procedures to characterize fractographic features and microstructures will also be reviewed, such as optical metallography, macrophotography, and scanning electron microscopy. Actual failed engineering components from a variety of industrial applications will be used as examples and be evaluated in the course. Fundamental engineering concepts, legal procedures of forensic engineering, failure mechanisms, technical report writing, and remedial recommendations will also be discussed. Students enrolled in MET 550 will be held to a higher standard than those enrolled in MET 450.

MET 454/554 AQUEOUS MATERIALS PROCESSING

(3-0) 3 credits. Prerequisites: MET 320 or CBE 321 or CHEM 342. An advanced level course in aqueous materials processing. It covers the physical chemistry of aqueous solutions, ionic processes of solution, complex ions and coordinate compounds, reaction kinetics, high temperature and pressure aqueous chemistry electrolysis and crystallization. Students enrolled in MET 554 will be held to a higher standard than those enrolled in MET 454.

MET 464 ENGINEERING DESIGN III
(0-2) 2 credits. Prerequisite: MET 352. A continuation of the design sequence.

MET 465 ENGINEERING DESIGN IV
(1-0) 1 credit. Prerequisite: MET 464. A continuation of the design sequence, which includes a final technical design report and appropriate display material for the School of Mines Design Fair.

MET 491 INDEPENDENT STUDY
1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

MET 492 TOPICS
1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

MET 601 BIOMATERIALS
(3-0) 3 credits. This course will provide students with an overview of the field of biomaterials with the knowledge necessary to conduct biomedical product development and/or biomaterials research. The first portion of the course will provide an introduction to the major classes of materials used in medical devices including metals, polymers, ceramics, composites, and natural materials. Topics covered will include material properties, material processing, testing, corrosion, biocompatibility, tissue responses, etc. The second portion of the course will cover specific biomaterial applications such as dental, orthopedic, cardiovascular, drug delivery, and

tissue engineering. The topics of implant cleanliness and sterilization methods will also be discussed. In addition, the topic of national and international governmental regulations and requirements will be reviewed including examples of investigative devices exemptions and 510k submissions. This course is cross-listed with BME 601.

MET 614 ADVANCED METALLURGICAL SIMULATION TECHNIQUES
(3-0) 3 credits. An advanced course in the simulation of metallurgical processes. Topics covered include numerical solution of partial differential equations, optimization techniques and numerical integration and interpolation. Although the course is intended primarily for metallurgy majors, the coverage is sufficiently broad that non-metallurgy majors are encouraged to enroll.

MET 624 ADVANCED CHEMICAL METALLURGY
(3-0) 3 credits. Prerequisites: MET 320, MET 321 and MET 422. Application of metallurgical thermodynamics and transport phenomena to extractive metallurgical processes.

MET 625 STRENGTHENING MECHANISMS IN METALS
(3-0) 3 credits. Prerequisite: Permission of instructor. Study of the scientific fundamentals leading to the improvement of the mechanical properties of metallic materials. The treatment includes strengthening by strain hardening, grain and twin boundaries, solute atoms, precipitates, dispersed particles and fibers, martensitic transformations, texturing, point defects, and thermomechanical treatments. Enhancement of fracture, fatigue, and creep behavior is also treated.

MET 632 THEORY OF DISLOCATIONS
(3-0) 3 credits. Prerequisite: MET 440 or permission of instructor. A study of defect theory in solids and their role in governing material behavior. Topics covered include the concept, properties, and mutual interaction of dislocations, point defects, stacking faults, dislocation

dynamics (motion and multiplication). Application of defect theory to the phenomena of slip, plastic yielding, thermally-activated plastic flow, microstrain, internal friction, strain hardening, and mechanical twinning.

MET 791 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor.

MET 792 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

MSL 101 LEADERSHIP AND PERSONAL DEVELOPMENT

(1-0) 1 credit. Corequisite: MSL 101L. Make your first peer group at college one committed to performing well and enjoying the experience. Increase self-confidence through team study and activities in basic drill, physical fitness, rappelling, leadership reaction course, first aid, making presentations and basic marksmanship. Learn fundamental concepts of leadership in a profession in both classroom and outdoor laboratory environments.

MSL 101L LEADERSHIP AND PERSONAL DEVELOPMENT LAB

(0-1) 1 credit. Corequisite: MSL 101. Designed to accompany MSL 101. Provides the students with hands-on experience to supplement and reinforce classroom instruction. Subjects addressed include drill and ceremonies, physical fitness training, marksmanship first aid, rappelling and basic mountaineering skills, voluntary off campus activities reinforce course work. This course will count for 1 credit hour of physical education credit.

MSL 102 INTRODUCTION TO TACTICAL LEADERSHIP

(1-0) 1 credit. Corequisite: MSL 102L. Learn and apply principles of effective leadership.

Reinforce self-confidence through participation in physically and mentally challenging exercise with upper-division ROTC students. Develop communication skill to improve individual performance and group interaction. Relate organizational ethical values to the effectiveness of a leader.

MSL 102L INTRODUCTION TO TACTICAL LEADERSHIP LAB

(0-1) 1 credit. Corequisite: MSL 102. Designed to accompany MSL 102. Provides the students with hands-on experience to supplement and reinforce classroom instruction. Subjects addressed include drill and ceremonies, physical fitness training, marksmanship first aid, rappelling and basic mountaineering skills, voluntary off campus activities reinforce course work. This course will count for 1 credit hour of physical education credit.

MSL 120/120L ORIENTEERING

(1-2) 3 credits. Students participate in in-depth instruction and practical application of land navigation techniques with emphasis on orienteering in both an urban and field setting. Students will participate in one hour of instruction and two (2) hours of lab per week. Practical application will include team orienteering in the local community and in the surrounding Black Hills. Types of orienteering will include Route, Line, Cross Country, and Score Orienteering.

MSL 201 INNOVATIVE TEAM LEADERSHIP

(1-0) 12 credit. Corequisite: MSL 201L. Learn/apply ethics-based leadership skills that develop individual abilities and contribute to the building of effective teams of people. Develop skills in oral presentations, writing concisely, planning events, coordination of group efforts, advanced first aid, land navigation, and basic military tactics. Learn fundamentals of ROTC's leadership assessment program.

MSL 201L INNOVATIVE TEAM LEADERSHIP LAB

(0-1) 1 credit. Corequisite: MSL 201. Students will develop leadership and management skills by

being given the opportunity to perform duties in various leadership positions. Emphasis is placed on the development of leadership and managerial skills. Course is supplemented with instruction on the use of a lensatic compass and a topographic map. As well as various survival skills. Voluntary off campus activities reinforce course work.

MSL 202 FOUNDATIONS OF TACTICAL LEADERSHIP

(1-0) 1 credit. Corequisite: MSL 202L. Introduction to individual and team aspects of military tactics in small unit operations. Includes use of radio communications, making safety assessments, movement techniques, planning for team safety/security and methods of pre-execution checks. Practical exercises with upper-division ROTC students. Learn techniques for training others as an aspect of continued leadership development.

MSL 202L FOUNDATIONS OF TACTICAL LEADERSHIP LAB

(0-1) 1 credit. Corequisite: MSL 202. Students are provided the opportunity to reinforce classroom leadership and management training with practical experience. Students will also receive training in small unit tactics and use of the m-16 rifle. Voluntary off campus activities reinforce course work.

MSL 290 BASIC SMALL UNIT LEADERSHIP

(2-0) 2 credits. Concurrent registration in either MSL 101/111 or MSL 201/211 is required. Provides the student with practical experience in small unit leadership development, team building, and the technical and tactical skills needed to be a professional officer in the United States Army. Course includes instruction in and practical application of rifle marksmanship, orienteering, mountaineering, weapons proficiency, physical training, and small unit leadership skills. May be repeated for a maximum of 4 credit hours.

MSL 291 INTERNSHIP IN LEADERSHIP I
(2-0) 2 credits. This course is designed for ROTC Cadets who have completed M.S. I and II but are

not academically aligned to contract as M.S. III's. The course will expand on their applied leadership skills. Upon approval of the instructor, students will develop training plans, schedules, evaluation outlines and classroom instruction. Students may also do department approved research. The class may be repeated up to two times, for a maximum of 4 credits, with permission of department head.

MSL 294 ROTC SUMMER LEADERSHIP INTERNSHIP

(0-4) 4 credits. The mission of ROTC Basic Camp is to serve as an alternative for the first two years of on-campus ROTC enrollment. Basic Camp offers students who did not take ROTC courses during their first two years of school the opportunity to enroll in ROTC at the start of their junior year. Basic Camp is a six week training period in which the student undergoes basic military training within a regular Army environment. Instruction consists of both classroom instruction and practical exercises along with considerable field training. All students are closely supervised and carefully evaluated by military officers.

MSL 301 ADAPTIVE TEAM LEADERSHIP
(2-0) 2 credits. Corequisite: MSL 301L. Series of practical opportunities to lead small groups, receive personal assessments and encouragement, and lead again in situations of increasing complexity. Uses small unit tactics and opportunities to plan and conduct training for lower division students both to develop such skills and as vehicles for practicing leadership.

MSL 301L ADAPTIVE TEAM LEADERSHIP LAB

(0-2) 2 credits. Corequisite: MSL 301. Provides the student with practical experience to supplement and reinforce classroom instruction. Subjects include drill and ceremonies, physical training instruction techniques and leadership, which will complement the student's preparation for ROTC advanced camp. Off campus.

MSL 302 LEADERSHIP IN CHANGING ENVIRONMENTS

(2-0) 2 credits. Prerequisite: MSL 301.

Continues methodology of MSL 301. Analyze tasks; prepare written or oral guidance for team members to accomplish tasks. Delegate tasks and supervise. Plan for and adapt to the unexpected in organizations under stress. Examine and apply lessons from leadership case studies. Examine importance of ethical decision making in setting a positive climate that enhances team performance.

MSL 302L LEADERSHIP IN CHANGING ENVIRONMENTS LAB

(0-2) 2 credits. Corequisite: MSL 302. Provides student with additional training in land navigation, drill and ceremonies, physical training, instruction techniques and leadership, which will complement the students' preparation for ROTC advanced camp. Off campus training is required.

MSL 394 ADVANCED MILITARY SCIENCE INTERNSHIP

(0-4) 4 credits. Contracted ROTC Advanced Course Cadets will attend a six-week intensified military training phase at Ft. Lewis, Washington which will provide both classroom and practical experience in the military and leadership skills required by a commissioned officer.

MSL 401 DEVELOPING ADAPTIVE LEADERS

(2-0) 2 credits. Corequisite: MSL 401L. Introduces formal management skills including problem analysis, planning techniques, and the delegation and control of activities, providing an understanding of the command and staff organization used in the modern army and creating a forum for discussing professional and ethical decisions faced by commissioned officers.

MSL 401L DEVELOPING ADAPTIVE LEADERS LAB

(0-2) 2 credits. Corequisite: MSL 401. Provides practical experience supplementing and reinforcing classroom instruction, including drill and ceremonies, physical fitness training, instruction techniques, and operation of the cadet battalion. Off-campus training required.

MSL 402 LEADERSHIP IN A COMPLEX WORLD

(2-0) 2 credits. Corequisite: MSL 412. Provides information for transition to active or reserve commissioned service, developing administrative controls essential in managing a military organization, introducing the management of financial and personal affairs, and allowing time for discussion and analysis of the ethical decision-making process.

MSL 402L LEADERSHIP IN A COMPLEX WORLD LAB

(0-2) 2 credits. Corequisite: MSL 402. Provides practical experience supplementing and reinforcing classroom instruction, including drill and ceremonies, physical fitness training, instructional techniques, small unit leadership and familiarization with duties of commissioned officers. Off-campus training is required.

MSL 403 THIRD YEAR ADVANCED MILITARY SCIENCE

(2-0) 2 credits. Prerequisites: MSL 401 and MSL 402. Provides a transition to entering active or reserve commissioned service, including an in-depth study of military decision making, giving experience in planning and conducting squad and platoon level military exercises and leadership.

MSL 404 THIRD YEAR ADVANCED MILITARY SCIENCE

(2-0) 2 credits. Prerequisite: MSL 401 and MSL 402. Provides an in-depth study of military decision-making, giving experience in planning and conducting military exercises at squad and platoon level, including an opportunity to develop leadership techniques.

MSL 411 DEVELOPING SUBORDINATE LEADERS I

(2-0) 2 credits. Corequisite: MSL 401 Provides practical experience supplementing and reinforcing classroom instruction, including drill and ceremonies, physical fitness training, instruction techniques, and operation of the cadet battalion. Off-campus training required.

MSL 412 DEVELOPING SUBORDINATE LEADERS II

(2-0) 2 credits. Corequisite: MSL 402 Provides

practical experience supplementing and reinforcing classroom instruction, including drill and ceremonies, physical fitness training, instructional techniques, small unit leadership and familiarization with duties of commissioned officers. Off-campus training is required.

MSL 480 ADVANCED SMALL UNIT LEADERSHIP

(2-0) 2 credits. Corequisite: MSL 301/301L or MSL 401/411 Provides practical experience in small unit leadership development, team building, and officers' technical/tactical skills, including rifle marksmanship, orienteering, mountaineering, weapons proficiency, physical training, and small unit leadership skills. May be repeated for a maximum of 4 credit hours.

MSL 491 ADVANCED INTERNSHIP IN LEADERSHIP

(2-0) 2 credits. This course is designed for ROTC Cadets who have completed M.S. IV, but have not completed graduation requirements. The course will allow students to fully develop and conduct training on advanced military subjects. Students may also do department approved research. The class may be repeated two times, for a maximum of 4 credits, with the permission of department head.

MSL 494 LEADERSHIP DEVELOPMENT AND ASSESS COURSE

3 to 4 credits. This course is designed for ROTC Cadets who have completed M.S. IV but have not completed graduation requirements. The course will allow students to fully develop and conduct training on advanced military subjects. Students may also do department approved research. The class may be repeated two times, for a maximum of 4 credits, with the permission of department head.

MUAP 102 CLASS INSTRUCTION-VOICE

(1-0) 1 credit. One to two semester hours credit for class instruction is given for two one hour class meetings. Adequate preparation through practice is expected of all students. (May be used to fulfill the humanities credit for graduation.)

MUAP 200 APPLIED MUSIC-VOICE

1 to 4 credits. Prerequisite: Permission of instructor. One to 2 semester hours credit for private lessons is given for one half-hour lesson per week. Music majors studying in the major performance area may elect two half-hour lessons per week for 2 to 4 hours of credit. Adequate preparation through practice is expected of all students. (May be used to fulfill the humanities credit for graduation.)

MUAP 201 APPLIED MUSIC-VOICE

1 to 4 credits. Class voice instruction is open to anyone interested. Emphasis is placed on the development of the fundamental voice techniques. (May be used to fulfill the humanities credit for graduation.)

MUEN 101 CHORAL ENSEMBLES

1 to 2 credits. Prerequisite: Permission of instructor. An ensemble performing accompanied and unaccompanied literature for mixed voices. Membership determined by instructor's permission and audition only. School of Mines does not require an audition. (Any combination of P.E. and MUEN 101/121/122 may be allowed toward fulfillment of the physical education credit for graduation. May not be used to fulfill the humanities credit for graduation.)

MUEN 121 SYMPHONIC BAND

(1-0) 1 credit. Members are selected by audition to perform the finest in original and transcribed literature in concert performances on and off-campus. (Any combination of P.E. and MUEN 101/121/122 may be allowed toward fulfillment of the physical education credit for graduation. May not be used to fulfill the humanities credit for graduation.)

MUEN 122 CONCERT BAND

(1-0) 1 credit. A joint enterprise open to university students and interested area musicians. Includes rehearsals and performance of band literature culminating in a public performance. (Any combination of P.E. and MUEN-101/121/122 may be allowed toward fulfillment of the physical education credit for graduation. May not be used to fulfill the humanities credits

for graduation.)

MUEN 260 NON-CREDIT MUSIC ENSEMBLE

No credit. Development of vocal or instrumental skills and aesthetic perception through the study and performance of music. This course cannot count as social science/humanities credit.

MUS 100 MUSIC APPRECIATION

(3-0) 3 credits. A non-technical discussion designed to increase the enjoyment and appreciation of music. Fulfills the music requirement in the general education program.

MUS 110 BASIC MUSIC THEORY I

2 to 4 credits. An integrated study and application of tonality, melody, harmony, texture and form, from basic notation through modulation. Includes sight singing, ear training, and dictation. Introduction to composition and arranging, i.e.: instrument ranges, transposition, tessitura and preliminary score analysis.

MUS 217/217 MUSIC IN PERFORMANCE I

(2-1) 3 credits. Prerequisite: Permission of instructor. This course introduces the functions and techniques of the craft of music through the study of music from both western and non-western cultures. It establishes fundamental performance tools and develops basic systematic processes and skills in musical analysis that through the study, rehearsal, and performance of ensemble music, developing cultural understandings.

MUS 317/317L MUSIC IN PERFORMANCE II

(2-1) 3 credits. Prerequisite: Three previous semesters of any combination of MUEN 101/122 or MUS 217 and/or permission of instructor. This course builds on concepts introduced in MUS 217 to develop advanced understandings of cultural, historical and aesthetic perceptions through in-depth study and performance of ensemble music of both western and non-west cultures.

NANO 445/545 INTRODUCTION TO NANOMATERIALS

(3-0) 3 credits. Prerequisites: MET 232, EM 321.

This course will introduce the theoretical basis and synthetic processes of nanomaterials. Specifically, this course will focus on the synthesis and fabrication of nanostructures and nanomaterials, and also include content on the nanoscale property measurements. Finally, the course will cover applications of nanomaterials, particularly focusing upon inorganic nanomaterials. Students enrolling in NANO 545 will be held to a higher standard than those enrolled in NANO 445.

NANO 504 NANOPHOTONICS

(3-0) 3 credits. Prerequisites: Introductory quantum mechanics and electricity and magnetism; ability to solve ordinary differential equations and linear systems. The course deals with optical phenomena in materials and structures with subwave-length dimensions. Topics will include the quantum theory of light, laser theory, beam propagation, and the unique properties of nanophotonics structures.

NANO 521 ELECTROMAGNETISM

(4-0) 4 credits. Prerequisite: PHYS 213 and MATH 321. This is a course in the principles of electricity and magnetism, with applications to dielectric and magnetic materials. Topics include the development of Maxwell's equations, and applications. This course is cross-listed with PHYS 421/521.

NANO 551 CLASSICAL MECHANICS

(4-0) 4 credits. Prerequisite: PHYS 113 or PHYS 213 and prerequisite or corequisite MATH 321. This is a systematic introduction to classical mechanics emphasizing motion in three dimensions. Topics include central forces, harmonic oscillations, non-inertial reference frames, rigid body motion, and Lagrangian and Hamiltonian Mechanics. This course is cross-listed with PHYS 451/551.

NANO 571 QUANTUM MECHANICS

(4-0) 4 credits. Prerequisite: MATH 321 or permission of instructor. This is a systematic introduction to quantum mechanics, emphasizing the Schrödinger equation. Topics include simple soluble problems, the hydrogen atom,

approximation methods and other aspects of quantum theory. This course is cross-listed with PHYS 471/571.

NANO 604 NANOPHOTONIC MATERIALS

(3-0) 3 credits. This graduate course will study the analysis and properties of nanostructured photonic materials such as photonic crystals and plasmonic materials.

NANO 677 PRINTED ELECTRONICS: MATERIALS AND PROCESSES

(3-0) 3 credits. The principles of interfacial phenomenon, solution thermodynamics and colloid chemistry will be used in illuminated process by which metallic nanoparticulates can be formed and incorporated into inks for use in manufacturing printed electronics by various direct write technologies. Students will learn 1) the methods and science behind the manufacture of a variety of nanoparticles, including gold, silver, copper conducting particles, 2) the methods of incorporating these particles into inks and printing of these inks for printed electronics applications and 3) the interfacial processes involved in line spreading and curing of the printed traces. This course is cross-listed with MES 677.

NANO 701 NANO MATERIALS

(3-0) 3 credits. This course will focus on the formation of nanomaterials via gas and liquid phase routes. Theory of homogeneous and heterogeneous nucleation, growth mechanisms and kinetics as well as population balances will be discussed. The second part of the course will cover particle surface functionalization, colloidal properties and stability, processing of nanoparticle suspensions, and chemical and physical fabrication techniques. Application of nanostructures and nanomaterials will be discussed as well.

NANO 702 THEORY AND APPLICATION OF NANOSCALE MATERIALS

(3-0) 3 credits. Prerequisites: Introductory quantum mechanics, ability to solve ordinary differential equations and linear systems. The course will survey current research in nanoscience

and nanotechnology, providing the essential background and theory at the level accessible to students from varied scientific and engineering backgrounds. Special emphasis will be placed on nano-scaled materials and their practical applications.

NANO 703/703L INSTRUMENTATION AND CHARACTERIZATION OF NANO-MATERIALS

(3-1) 4 credits. This is an introductory course on instrumentations used in characterization of nano-scaled materials. The course is aimed at entry level graduate students who want to learn characterization of nano-scale materials using state-of-the-art instruments.

NANO 704 CRYSTALLOGRAPHY AND STRUCTURE OF NANOMATERIALS

(3-0) 3 credits. This graduate course covers crystallographic characteristics and structural properties of nanomaterials. Emphasis is placed on electron and x-ray diffraction signatures of nanoparticle size, shape and configuration.

NANO 705 NANOELECTRONICS

(3-0) 3 credits. This graduate course covers the electronic properties and applications of nanomaterials with particular emphasis on quantum semiconductor structures.

NANO 706 DIFFRACTION METHODS FOR NANOMATERIALS RESEARCH

(3-0) 3 credits. This graduate course covers structural, optical, and electronic defects in nano-scaled materials.

NANO 707 DEFECTS IN NANOMATERIALS

(3-0) 3 credits. This graduate course covers the characterization and identification of structural and electronic defects in nano-scaled materials systems.

NANO 708 NANOMATERIALS FOR PHOTOVOLTACIS

(3-0) 3 credits. This graduate course covers the engineering of materials and structures on the nanometer length scale for the photovoltaic power

generation from radiant sources, especially the sun.

NANO 712/712L ELECTROMAGNETIC PROPERTIES OF HETEROGENEOUS MATERIALS

(2-1) 3 credits. Focuses on macroscopic electromagnetic properties of heterogeneous materials and their applications. With nanotechnology, it is possible to manufacture materials with totally new properties that cannot be attained by conventional methods. Through the combined use of analysis (such as mixing theory) and numerical methods, the macroscopic material properties will be computed directly from microscopic composition of the material.

NANO 715 POLYMERIC NANOMATERIALS

(3-0) 3 credits. This course is an introduction of fundamental concepts, synthesis, characterizations, structural and physical properties of polymeric nanomaterials. The contents include, but not limited to, nanofibers, carbon nanotubes, nanocomposites, polymer self-assembly, biopolymers in nanosciences, and nanoparticle coatings.

NANO 716/716L NANOTECHNOLOGY OF ENGINEERING AND CONSTRUCTION MATERIALS

(2-1) 3 credits. This course would cover the nanotechnology of the most widely used building materials such as concrete, asphalt, and wood. Structural design properties, including strength and durability, will be related to nanoscale considerations. Laboratory exercises will relate gross properties, such as strength and permeability, to nanoscale measurements and imaging.

NANO 717 NANOCHEMISTRY

(3-0) 3 credits. The course introduces both the fundamentals and frontiers of the rapidly developing interdisciplinary field of nanomaterials from a chemist's point of view. The course covers synthesis and fabrication methods of nanomaterials including "top-down" nanofabrication, "bottom-up" chemical synthesis,

and self-assembly. The course discusses the unique properties and the structure-property relationship of nanomaterials.

NANO 721 ELECTRODYNAMICS I(3-0) 3

credits. A continuation of PHYS 421. This course treats advanced problems with special emphasis on solutions of the wave equation, Laplace's equation, and Poisson's equation. Through introduction of the methods of special relativity, the unity of electrical and magnetic phenomena and the covariance of Maxwell's equations are demonstrated. If time permits, topics such as MHD and plasma physics are also introduced. This course is cross-listed with PHYS 721.

NANO 743 STATISTICAL MECHANICS

(3-0) 3 credits. Review fundamentals of thermodynamics, introduce Legendre transforms and develop the concepts of phase equilibria and stability, ensembles, partition functions, and the role of fluctuations. Statistical mechanics of non-interacting ideal systems and phase transformations, mean field theory, renormalization group theory and Monte Carlo calculations applied to the Ising Model. This course is cross-listed with PHYS 743.

NANO 751 THEORETICAL MECHANICS

(3-0) 3 credits. Advanced treatment of classical mechanics, including Lagrange's and Hamilton's equations, rigid-body motion, canonical transformations, calculus of variations, and relativity using vectors, matrices, and tensors. This course is cross-listed with PHYS 751.

NANO 771 QUANTUM MECHANICS I

(3-0) 3 credits. Prerequisite: PHYS 471. Physical basis of quantum mechanics, Schroedinger's equation and its solution, matrix mechanics, operator methods, approximate methods with an introduction to the relativistic wave equation. This course is cross-listed with PHYS 771.

NANO 791 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic

or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor.

NANO 792 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

NANO 890 SEMINAR

(1-0) 1 credit. May not be repeated for degree credit. Preparation, oral and/or written presentation, and group discussion of a research problem. The student is expected to present orally the results of his/her own research. This presentation normally will directly precede the final oral defense of the thesis.

NANO 898D DISSERTATION

Credit to be arranged; not to exceed 30 credits toward fulfillment of Ph.D. degree requirements. Open only to doctoral candidates. Supervised original research investigation of a selected problem, with emphasis on independent work, culminating in an acceptable dissertation. Oral defense of dissertation and research findings are required.

PALE 671 ADVANCED FIELD PALEONTOLOGY

(0-2) 2 credits. A field-oriented course stressing collection and detailed documentation of vertebrate fossils. Taphonomic factors, measured sections, and some geologic maps may be required, as well as detailed field notes.

PALE 672/672L MICROPALAEONTOLOGY

(2-1) 3 credits. A study of the morphology, ecology, and stratigraphic significance of selected groups of protozoans and invertebrate and plant microfossils with special emphasis on Formaminifera and conodonts. This course is cross-listed with GEOL 672/672L.

PALE 673/673L COMPARTIVE OSTEOLOGY

(2-1) 3 credits. A comparison of recent and fossil vertebrate skeletons and dentitions with emphasis

on the skeletons and teeth of sharks, bony fish, salamanders, frogs, turtles, alligators, lizards, birds, and mammals to establish a thorough understanding of the diversity of the form and function of the vertebrate skeleton. A major objective is the identification of vertebrates based upon osteology and odontology. This course is cross-listed with GEOL 673/673L.

PALE 676/676L VERTEBRATE PALEONTOLOGY

(3-1) 4 credits. An in-depth assessment of the fossil record of vertebrates with special emphasis on current problems in the evolution of vertebrates and the tangible record preserved in the collections of the Museum of Geology. This course is cross-listed with GEOL 676/676L.

PALE 677 CLADISTICS SEMINAR

(2-0) 2 credits. Prerequisites: PALE 676 or permission of instructor. A seminar including the review of basic principles of cladistic analysis with an emphasis on current biases and benefits associated with computer algorithms, matrix scoring, and choice of MPTs. The seminar combines weekly literature reviews, abstract writing, and power-point presentations by each student and ends with a final written examination, whose subject rests on topics reviewed during the seminar. Students will present a final project that consists of a phylogenetic analysis centered on a taxonomic group of their choice.

PALE 678/678L VERTEBRATE BIOSTRATIGRAPHY

(3-1) 4 credits. Prerequisite: GEOL/PALE 676. The principles and practices for establishing the distribution of vertebrate fossils in the rock record. This course will include a brief history of biostratigraphy, methodology, and the content and assessment of vertebrate ages, particularly of Mesozoic and Cenozoic mammals. This course is cross-listed with GEOL 678/678L.

PALE 684/684L PALEOENVIRONMENTS

(2-1) 3 credits. This course will integrate topics from paleobotany, vertebrate paleontology, and paleoclimatology in a study of paleontological communities through time. Laboratories will

include studies of fossil materials. Note: This course is to be offered both through Black Hills State University and South Dakota School of Mines and Technology. This course is cross-listed with GEOL 684/684L.

PALE 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor. A description of the work to be performed must be filed in the Department of Geology and Geological Engineering. This course is cross-listed with GEOL 691.

PALE 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor. A description of the work to be performed must be filed in the geology and geological engineering office. This course is cross-listed with GEOL 692.

PALE 770 SEMINAR IN VERTEBRATE PALEONTOLOGY

(2-0) 2 credits. Studies by a group of advanced students, under the guidance of one or more selected instructors, on topics of special and current interest to the group. Involves a combination of lectures, and discussions. Review of current literature in vertebrate paleontology of special topics and/or analysis of new procedures and techniques. Emphasis will be on mammalian paleontology. This course is cross-listed with GEOL 770.

PALE 790 SEMINAR

(1-0) 1 credit. May not be repeated for degree credit. Preparation, oral and/or written presentation, and group discussion of a research problem. The student is expected to present orally the results of his/her own research. This presentation normally will directly precede the final oral defense of the thesis. This course is cross-listed with GEOL 790.

PALE 798 MASTER'S THESIS

Credit to be arranged; not to exceed 6 credits toward fulfillment of M.S. degree requirements. Open only to students pursuing the M.S. thesis option. Supervised original or expository research culminating in an acceptable thesis. Oral defense of thesis and research findings are required. This course is cross-listed with GEOL 798.

PE 100 ACTIVITY COURSES

(1-0) 1 credit. Activities stressing individual physical fitness and lifetime activities according to student needs and interests. The same activity course cannot be counted toward graduation credit.

PE 103 NUTRITION FOR EVERYDAY LIVING

(1-0) 1 credit. This course will teach nutritional components of healthy diet, impact on body composition, and overall health. Course includes lecture and activity. This course can only be taken one time for credit.

PE 105 WELLNESS AND PHYSICAL FITNESS

(1-0) 1 credit. For men and women. An activity course with lecture instructing students in many different aspects of personal wellness and physical fitness with practical application. This course can only be taken one time for credit.

PE 113 VARSITY SPORTS I

(1-0) 1 credit. This course is an introduction/conditioning course offered fall semester. A student must be a member of a varsity sports team that is sponsored by the School of Mines to be enrolled in this course. This course can only be taken four times for credit, however it may only be used two times to fulfill physical education graduation requirements.

PE 118 BEGINNING AND INTERMEDIATE SWIMMING (MEN AND WOMEN)

(1-0) 1 credit. This course will provide instruction in basic skills and fundamental strokes of swimming. After developing basic skills, the fundamental strokes are perfected along with elementary forms of rescue. This course can only

be taken one time for credit.

PE 160 MODIFIED PHYSICAL EDUCATION ACTIVITY

(1-0) 1 credit. This course is designed to adapt a variety of activities to the special needs and interests of students who qualify under the Americans with Disabilities Act. The course will seek to adapt physical fitness and sports activities for the special needs student within the limitations of current staffing and facilities. Course can be repeated once for additional credit.

PHIL 100 INTRODUCTION TO PHILOSOPHY

(3-0) 3 credits. Introduces competing philosophical views of reality, perception, learning, and values, emphasizing their relevance to the contemporary world.

PHIL 200 INTRODUCTION TO LOGIC

(3-0) 3 credits. Introduces the formal study of argumentation, including forms of logic, inductive and deductive reasoning, proofs, refutations, and fallacies.

PHIL 220 INTRODUCTION TO ETHICS

(3-0) 3 credits. Examines the major currents and components of ethical theory from classical times to the present, investigating problems arising from specific theories, as well as critically analyzing the validity of these theories for current ethical concerns.

PHIL 233 PHILOSOPHY AND LITERATURE

(3-0) 3 credits. Examination of selected topics from the Western World's literary tradition and analysis of their contributions in the areas of philosophy of life, philosophy of religion, and the concepts of duty and human nature. Study and discussion of topics in relation to their significance for the individual.

PHYS 111 INTRODUCTION TO PHYSICS I

(3-0) 3 credits. Prerequisite: MATH 102 or MATH 123 or permission of instructor. This is the first course in a two semester algebra-level sequence, covering fundamental concepts of

physics. This sequence is appropriate for pre-professional majors requiring two semesters of physics. Topics include classical mechanics, thermodynamics, and waves. The School of Mines covers classical mechanics only. May not be used for credit toward an engineering or science degree (except interdisciplinary science, geology (paleontology emphasis), and associate of arts).

PHYS 111L INTRODUCTION TO PHYSICS I LAB

(0-1) 1 credit. Prerequisite or corequisite: PHYS 111. This laboratory accompanies PHYS 111. May not be used for credit toward an engineering or science degree (except interdisciplinary science, geology (paleontology emphasis), and associate of arts).

PHYS 113 INTRODUCTION TO PHYSICS II

(3-0) 3 credits. Prerequisite: PHYS 111. This course is the second course in a two semester algebra-level sequence, covering fundamental concepts of physics. Topics include electricity and magnetism, sound, light, optics, and some modern physics concepts. The School of Mines course covers electricity and magnetism only. May not be used for credit toward an engineering or science degree (except interdisciplinary science, geology – paleontology emphasis, and associate of arts).

PHYS 113L INTRODUCTION TO PHYSICS II LAB

(0-1) 1 credit. Prerequisite or corequisite: PHYS 113. This laboratory accompanies PHYS 113. May not be used for credit toward an engineering or science degree (except interdisciplinary science, geology - paleontology emphasis, and associate of arts).

PHYS 183 ELEMENTS OF MODERN ASTRONOMY

(3-0) 3 credits. This course presents a broad view of astronomy in a straightforward and descriptive manner without complex mathematics. It introduces students to basic concepts and the historic and modern foundations of the science of astronomy. Students will gain some insight into

the basic physics underlying conclusions drawn from observational and theoretical astronomy, astrophysics, and cosmology. The course provides descriptions of a wide variety of objects found in the universe, from gas and dust particles of stars, planets, and galactic clusters.

PHYS 211 UNIVERSITY PHYSICS I

(3-0) 3 credits. Prerequisite: MATH 123 or permission of instructor. This is the first course in a two semester calculus-level sequence, covering fundamental concepts of physics. This is the preferred sequence for students majoring in physical science or engineering. Topics include classical mechanics and thermodynamics. The School of Mines course covers classical mechanics only.

PHYS 213 UNIVERSITY PHYSICS II

(3-0) 3 credits. Prerequisite: PHYS 211. This course is the second course in a two semester calculus-level sequence, covering fundamental concepts of physics. This is the preferred sequence for students majoring in physical science or engineering. Topics include electricity and magnetism, sound, light, and optics. The School of Mines course covers electricity and magnetism only.

PHYS 213L UNIVERSITY PHYSICS II LABORATORY

(0-1) 1 credit. Prerequisite or corequisite: PHYS 213. This laboratory accompanies PHYS 213. Introduction to physical phenomena and measurements. Recording and processing data, determining uncertainties, reporting results. The experiments supplement the work in PHYS 211 and PHYS 213.

PHYS 275 RELATIVITY

(3-0) 3 credits. Prerequisites: PHYS 111 or PHYS 211 and a working knowledge of elementary algebra and trigonometry. Michelson-Morley experiment, inertial reference frames, the principle of relativity, space-time coordinates of an event, Lorentz Transformations, clock paradox, momentum-energy 4-vector, equivalence of energy and rest mass, the principle of equivalence, curved space-time and qualitative features of

general relativity and cosmology, relevance of relativity to space travel.

PHYS 291 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

PHYS 292 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

PHYS 312 EXPERIMENTAL PHYSICS DESIGN I

PHYS 314 EXPERIMENTAL PHYSICS DESIGN II

(0-2) 2 credits each. Prerequisite: CENG 244 or permission of instructor. This course is structured to acquaint the student with the experimental design methods. The experiments are chosen to cover as many areas as possible in keeping with the backgrounds of faculty and abilities of the students.

PHYS 341 THERMODYNAMICS

(2-0) 2 credits. Prerequisite: PHYS 213 and MATH 225 or permission of instructor. This is an intermediate level thermodynamics course dealing with systems from a macroscopic perspective. Topics include the first and second laws of thermodynamics, phase diagrams, and equilibria.

PHYS 343 STATISTICAL PHYSICS

(2-0) 2 credits. Prerequisite: PHYS 213 and MATH 225 or permission of instructor. This

course provides a systematic introduction to the use of statistical principles applied to the study of thermodynamic systems.

PHYS 361 OPTICS

(3-0) 3 credits. Prerequisite: PHYS 113 or PHYS 213 and MATH 225 or permission of instructor. This is an intermediate level study of geometrical and physical optics. Topics include analysis of refraction phenomena, thick lenses, wave nature of light, interference, diffraction, and polarization.

PHYS 386/386L OBSERVATIONAL ASTRONOMY

(2-1)3 credits. Prerequisite: PHYS 183. This course is designed to help students expand their knowledge of astronomy through interactive seminars and observing sessions. The focus of this course will be developing observational and data collection skills using state of the art telescopes. Background knowledge will be fostered through instructor-supervised seminars led by the students. Students will use current web-based and advanced amateur/professional publications to lead the seminar sessions. Advanced observing sessions will be held off-campus at the Badlands Observatory in Quinn, SD. Observing sessions will incorporate advanced 18 and 26 inch telescopes provided by the instructors; also with CCD cameras and software for data collection and image manipulation. Observing sessions will also involve students in ongoing searches for near-earth asteroids.

PHYS 391 INDEPENDENT STUDY

1 to 4 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

PHYS 392 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

PHYS 412 ADVANCED DESIGN PROJECTS I PHYS 414 ADVANCED DESIGN PROJECTS II

(0-2) 2 credits each. The student designs and carries out original projects. The aim is to involve the student in project design and the application of knowledge to a realistic problem. Students will be significantly engaged in the research efforts of the department.

PHYS 421/521 ELECTROMAGNETISM

(4-0) 4 credits. Prerequisite: PHYS 213 and MATH 321. This is a course in the principles of electricity and magnetism, with applications to dielectric and magnetic materials. Topics include the development of Maxwell's equations, and applications. Students enrolled in PHYS 521 will be held to a higher standard than those enrolled in PHYS 421. This course is cross-listed with NANO 521.

PHYS 433/533 NUCLEAR AND ELEMENTARY PARTICLE PHYSICS

(3-0) 3 credits. Prerequisite: PHYS 471 or permission of instructor. This course covers fundamental topics in nuclear physics and elementary particles. Topics include radioactivity, nuclear spectra and structure, nuclear models, elementary particle theories and high energy physics. Students enrolled in PHYS 533 will be held to a higher standard than those enrolled in PHYS 433.

PHYS 439/539 SOLID STATE PHYSICS

(3-0) 3 credits. Prerequisite: MATH 321 or permission of instructor. This course looks at solid materials from a microscopic level. Topics include basic crystal structure; mechanical and thermal properties; and electronic processes with

reference to electrical properties of metals, semiconductors, and insulators. Students enrolled in PHYS 539 will be held to a higher standard than those enrolled in PHYS 439.

PHYS 445/545 STATISTICAL MECHANICS
(4-0) 4 credits. Prerequisite: PHYS 451 and MATH 321 or permission of instructor. This course provides a systematic introduction to the use of statistical principles applied to the study of thermodynamic systems. Student enrolled in PHYS 545 will be held to a higher standard than those enrolled in PHYS 445.

PHYS 451/551 CLASSICAL MECHANICS
(4-0) 4 credits. Prerequisite: MATH 321. This is a systematic introduction to classical mechanics emphasizing motion in three dimensions. Topics include central forces, harmonic oscillations, non-inertial reference frames, rigid body motion, and Lagrangian and Hamiltonian Mechanics. Students enrolled in PHYS 551 will be held to a higher standard than those enrolled in PHYS 451. This course is cross-listed with NANO 551.

PHYS 471/571 QUANTUM MECHANICS
(4-0) 4 credits. Prerequisite: MATH 321 or permission of instructor. This is a systematic introduction to quantum mechanics, emphasizing the Schrödinger equation. Topics include simple soluble problems, the hydrogen atom, approximation methods and other aspects of quantum theory. Students enrolled in PHYS 571 will be held to a higher standard than those enrolled in PHYS 471. This course is cross-listed with NANO 571.

PHYS 481/581 MATHEMATICAL PHYSICS I
(3-0) 3 credits. Prerequisite: Permission of instructor. The first of a two semester sequence covering mathematical methods essential to the study of Physics. The topics include differential and integral Vector Calculus, theory and applications of complex variables, ordinary differential equations and applications of series and transform methods in their solutions. Students enrolled in PHYS 581 will be held to a higher standard than those enrolled in PHYS 481.

PHYS 491 INDEPENDENT STUDY

1 to 4 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

PHYS 492 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement.

PHYS 590 SEMINAR

1 credit. Preparation, oral and/or written presentation, and group discussion of research problem. The student is expected to present orally the results of his/her own research.

PHYS 683 MATHEMATICAL PHYSICS II

(3-0) 3 credits. Prerequisite: PHYS 581. A continuation of PHYS 581. The topics of emphasis are Partial differential equations, boundary value problems, special functions, Green's Functions, and linear algebra. Additional topics of interest will be chosen; possible topics include differential forms and geometry, tensors in physics, group theory, distributions, statistical methods, integral equations, difference equations, numerical methods, variation techniques etc.

PHYS 691 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor.

PHYS 692 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

PHYS 721 ELECTRODYNAMICS I

(3-0) 3 credits. Prerequisite: PHYS 421 or equivalent. This is the first course of a two semester sequence in Electrodynamics. Topics in the sequence include boundary value problems, Maxwell's equations, multi-pole expansions and gauge transformations. Additional topics will be chosen from such areas as the relativistic formulation of electro-magnetic theory, lagrangian formulations of classical fields, plane and spherical waves, wave guides, multipole radiation, radiation from moving charges, plasma physics, magneto-hydrodynamics, relativistic (synchrotron) radiation, and radiation in collisions and other applications of interest. This course is cross-listed with NANO 721.

PHYS 723 ELECTRODYNAMICS II

(3-0) 3 credits. Prerequisite: PHYS 721. This course is the second course in a two semester sequence and covers advanced topics in Electrodynamics.

PHYS 739 CONDENSED MATTER PHYSICS I

(3-0) 3 credits. Prerequisite: PHYS 439 or equivalent. Topics include crystal structure and the reciprocal lattice, quantum theory of electrons and phonons, x-ray diffraction, crystal binding energies, and energy band theory. Additional topics may be chosen from the properties of metals, semiconductors, and insulators.

PHYS 743 STATISTICAL MECHANICS

(3-0) 3 credits. Prerequisite: PHYS 445 or equivalent. This is a one semester course in classical and quantum statistical mechanics. Topics include ensembles, partition functions, identical particles, Fermi-Dirac and Bose-Einstein statistics. Other topics will be chosen from mean field theory, phase transformations, renormalization group theory, Monte Carlo techniques and other topics of interest. This course is cross-listed with NANO 743.

PHYS 749 CONDENSED MATTER PHYSICS II

(3-0) 3 credits. Prerequisite: PHYS 739. This course is the second course in a two semester sequence and covers advanced topics in condensed matter physics.

PHYS 751 THEORETICAL MECHANICS

(3-0) 3 credits. Prerequisite: PHYS 451 or equivalent. This is a one semester course in classical mechanics. Topics include Newtonian Mechanics, Hamilton's Principle, non-Inertial Frames of Reference, Lagrangian Mechanics. Other topics will be chosen from such areas of study as Rigid Body Motion, Chaos theory, Hamilton-Jacobi theory, Perturbation Theory, Quaternion applications to rotations, Lagrangian/Hamiltonian formulations for Continuous systems and fields, and other topics of interest. This course is cross-listed with NANO 751.

PHYS 771 QUANTUM MECHANICS I

(3-0) 3 credits. Prerequisite: PHYS 471 or equivalent. This is the first course of a two semester sequence in quantum physics. Topics include the Schrodinger equation and its solutions, matrix mechanics, operator methods, the harmonic oscillator, the hydrogen atom, spin and angular momentum. NANO 777.

PHYS 773 QUANTUM MECHANICS II

(3-0) 3 credits. Prerequisite: PHYS 771. This is the second course in a two semester sequence. Additional topics include perturbation methods. Applications will be chosen from such topics as scattering theory, second quantization, theory of identical particles, relativistic quantum mechanics, creation and annihilation operators and other topics of interest.

PHYS 775 GENERAL RELATIVITY

(3-0) 3 credits. Prerequisites: PHYS 421, PHYS 451 or equivalent. This course includes study of Minkowski Space, tensor algebra and calculus, non-Euclidean Geometry, and the Einstein Field Equations. Applications will be chosen from such topics as the Schwarzschild, Kerr, and Reissner-Nordstrom solutions, gravitational waves, Post-

Newtonian Formalisms, 3+1 formalism, and other topics of interest.

PHYS 779 GROUP THEORY

(3-0) 3 credits. Prerequisite: PHYS 471 or equivalent. Topics may include symmetry transformations, continuous groups, finite groups, applications to valence theory, Lorentz group, and fundamental particles

PHYS 781 NUCLEAR AND PARTICLE PHYSICS

(3-0) 3 credits. Prerequisite: PHYS 771 or equivalent. This is a one-semester course in nuclear and elementary particle physics. Nuclear physics topics may include nuclear structure (nuclear form factors, multipole moments, liquid and shell models); nuclear decay; nuclear reactions; and other topics of interest. Elementary particle physics topics may include the role of symmetry in particle physics, Quantum Electrodynamics and Quantum Chromodynamics; the Standard Model of Particle Physics; Strong and Weak interactions; Accelerator and Experimental Particle Physics; and other selected topics beyond the Standard Model.

PHYS 783 QUANTUM FIELD THEORY

(3-0) 3 credits. Prerequisite: PHYS 771 or equivalent. This course is the study of relativistic quantum field theory and its application to the standard model. The course covers quantization of relativistic fields; perturbative theory and Feynman diagram; S-matrix; introduction to gauge theories and the standard model; and other topics of interest.

PHYS 785 ASTROPHYSICS AND COSMOLOGY

(3-0) 3 credits. Prerequisite: 771 or equivalent. This course introduces the broad base of fundamental topics in astrophysics and cosmology. Topics include observational properties of stars; stellar physics, stellar atmospheres; distance scales; galactic structures; interstellar medium, normal and peculiar galaxies and high energy astrophysics; cosmological observations and Friedmann models; the early universe at different epochs; the origin of dark

matter and formation of galaxies and large scale structure.

PHYS 791 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor.

PHYS 792 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor.

PHYS 798 THESIS

(1- 9 credits) Original research in a selected field of physics and the preparation of a thesis.

POLS 100 AMERICAN GOVERNMENT

(3-0) 3 credits. A study of the basic principles of the American system of government with emphasis on problems relating to governmental structure and policies.

POLS 350 INTERNATIONAL RELATIONS

(3-0) 3 credits. Prerequisite: Junior or senior standing or permission of instructor. How nations/states behave and why they behave as they do in their relations with each other.

POLS 407 ENVIRONMENTAL LAW AND POLICY

(3-0) 3 credits. Prerequisite: Junior or senior standing or permission of instructor. An examination of the political issues involved with environmental and ecological concerns such as land use, population, air and water pollution, energy, and public policy.

PSYC 101 GENERAL PSYCHOLOGY

(3-0) 3 credits. This course is an introductory survey of the field of psychology with consideration of the biological bases of behavior, sensory and perceptual processes, learning and memory, human growth and development, social behavior and normal and abnormal behavior.

PSYC 319 TEAMS AND TEAMING

(1-0) 1 credit. The basic processes necessary for individuals to effectively work together are presented with an emphasis including values such as trust, the importance of conflict, interpersonal communications and dynamics of commitment.

PSYC 323 HUMAN DEVELOPMENT THROUGHOUT THE LIFESPAN

(4-0) 4 credits. Prerequisite: PSYC 101 or permission of instructor. Focus will be upon physiological/biological, intellectual, emotional, social, and psychological development. Includes the normal sequence of development as well as developmental irregularities.

PSYC 331 INDUSTRIAL AND ORGANIZATION PSYCHOLOGY

(3-0) 3 credits. Prerequisite: PSYC 101 and junior standing or permission of instructor. This course covers the application of psychological principles to such problems as employee selection, supervision, job satisfaction, and work efficiency.

PSYC 391 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

PSYC 392 TOPICS

1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. May be repeated twice with different topics for a maximum of 6

credits.

PSYC 451 PSYCHOLOGY OF ABNORMAL BEHAVIOR

(3-0) 3 credits. Prerequisite: PSYC 101 or permission of instructor. This course is a comprehensive survey of abnormal personality and behavior. It includes an examination of the origin, symptoms and treatment of psychological disorders.

PSYC 461 THEORIES OF PERSONALITY

(3-0) 3 credits. Prerequisite: PSYC 101 or permission of instructor. Students will learn about the role of philosophy and science and their contributions to the development of personality theory. Students will examine, in depth, the theoretical contributions made in the areas of psychoanalytic, behavioristic, and humanistic personality theories. The students will be able to articulate their own beliefs concerning the development of human personality.

READ 041 READING FOR COLLEGE SUCCESS

(2-0) This course provides students with reading strategies necessary for making the transition to collegiate level reading. The course will present students with multiple strategies to promote comprehension skills, develop vocabulary and enhance metacognition to become strategic readers. This course will be required for students with ACT score in Reading at 17 or below (or a comparable COMPASS score). Does not count toward graduation.

SOC 100 INTRODUCTION TO SOCIOLOGY

(3-0) 3 credits. Comprehensive study of society, with analysis of group life, and other forces shaping human behavior.

SOC 150 SOCIAL PROBLEMS

(3-0) 3 credits. A study of present day problems in contemporary societies, such as racism, sexism, ageism, alcoholism, drug addiction, physical and mental health, war and environmental issues-their significance and current policies and action.

SOC 250 COURTSHIP AND MARRIAGE
(3-0) 3 credits. Courtship and marriage period given special emphasis, as are problems of mate selection, marital adjustments, reproduction, child-parent relations, divorce and later years of marriage.

SOC 351 CRIMINOLOGY
(3-0) 3 credits. Prerequisite: SOC 100 or 150. Focuses on theories of crime, juvenile delinquency and justice, law, systems of criminal behavior, victimization, and corrections.

SOC 391 INDEPENDENT STUDY
1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

SOC 392 TOPICS
1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits of special topics will be allowed for degree credit.

SOC 411/511 LICIT AND ILLICIT DRUGS
(3-0) 3 credits. Prerequisite: SOC 100, 150 or PSYC 101. A survey of the use, abuse, and addictive properties of psychoactive drugs other than alcohol; approaches to prevention, treatment, and identification of use. Will apply toward certification for chemical dependency counseling. Students enrolled in SOC 511 will be held to a higher standard than those enrolled in SOC 411.

SOC 420/520 ALCOHOL USE AND ABUSE
(3-0) 3 credits. Prerequisite: SOC 100, 150 or PSYC 101. A survey of the use, abuse, and addictive nature of beverage alcohol, some of the problems associated with excessive use of alcohol, and approaches to prevention and treatment. Will apply toward certification for chemical dependency counseling. Students enrolled in SOC 520 will be held to a higher standard than those enrolled in SOC 420.

SOC 491 INDEPENDENT STUDY
1 to 3 credits. Prerequisite: Permission of instructor. Includes directed study, problems, readings, directed readings, special problems and special projects. Students complete individualized plans of study which include significant one-on-one student-teacher involvement. The faculty member and students negotiate the details of the study plans. Enrollments are usually 10 or fewer students. Meeting frequency depends on the requirements of the topic.

SOC 492 TOPICS
1 to 3 credits. Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of 6 credits of special topics will be allowed for degree credit.

SPAN 101 INTRODUCTORY SPANISH I
SPAN 102 INTRODUCTORY SPANISH II
(4-0) 4 credits each. Prerequisite for SPAN 102 is SPAN 101 or permission of instructor. Introduces the fundamental elements of Spanish sentence structure and vocabulary. Promotes speaking, listening and writing within a cultural context. Class work may be supplemented with required aural/oral practice outside of class.

SPCM 101 FUNDAMENTALS OF SPEECH
(3-0) 3 credits. Introduces the study of speech fundamentals and critical thinking through

frequent public speaking practice, including setting, purpose, audience, and subject. This course cannot count as social science/humanities credit.

TM 620 QUALITY MANAGEMENT

(3-0) 3 credits. This course is intended as an introduction to the philosophies, concepts, and tools of Total Quality Management. Topics include: An introduction to the philosophies of Juran, Deming, and Taguchi; total quality and quality improvement; quality and technology; and managing a quality environment. Elements of statistical process control, including pareto diagrams, box plots, histograms, and control charts will also be investigated using a commercial software package. Special projects and current readings in quality management will be assigned.

TM 625 INNOVATION AND COMMERCIALIZATION

(3-0) 3 credits. This course covers the practical aspects of developing an innovative idea or new technology from conceptualization through commercialization. Course topics include product innovation, product development, technology forecasting, technology transfer, small business development resources, and commercialization.

TM 631 OPTIMIZATION TECHNIQUES

(3-0) 3 credits. The course develops basic judgment and competence in using quantitative methods in engineering or management decisions. Students will study various types of linear programming techniques, including simplex, transportation and assignment methods and post-optimal sensitivity analysis. In addition, network-type problems, critical-path methods, dynamic and decision tree techniques will be covered. Some basic mathematical theory is taught and the computer is used to solve both assigned problems and problems developed by the student in a particular field of interest.

TM 640 BUSINESS STRATEGY

(3-0) 3 credits. This course provides a financial management approach within a systems context approach. Financial concepts are analyzed from

the perspective of three basic types of decisions for any ongoing business: investment, operations, and financing. Course materials are structured around the viewpoints of major parties interested in the performance of business: managers, owners, and creditors. Financial concepts are reinforced by simulating the impact various business strategies have on the financial health of the virtual enterprise.

TM 650 SAFETY MANAGEMENT

(3-0) 3 credits. Management aspects of occupational safety and health. Topics include: Development and implementation of safety programs and ergonomics programs, risk management, economic impact, legislation (including OSHA, Workers Compensation, and ADA), legal issues, wellness programs, system safety, certification, ethics, and professionalism.

TM 655 ERGONOMICS FOR MANAGERS

(3-0) 3 credits. Management aspects of ergonomics and human factors engineering. Topics include: Introduction to ergonomics and human factors principles, the business case for ergonomics, understanding cumulative trauma and neurovascular disorders, development and implementation of ergonomics programs, economic and regulatory aspects, work organization, job satisfaction, quality and productivity aspects, strategic issues and trends, and certification.

TM 661 ENGINEERING ECONOMICS FOR MANAGERS

Credit: Variable 1 to 4. Students are expected to have prerequisite skills in the time value of money and basic probability. Students not having these skills require the permission of instructor. The course is divided into four 1-credit modules, which include: economic valuation for decision making, problems with uncertainty and risk, budgeting and cost management, and financial statements and enterprise management. (Manufacturing elective)

TM 663 OPERATIONS PLANNING

(3-0) 3 credits. Organization, functions, and responsibilities of the production control

department and some related functions in industry. It includes: planning, authorizing, routing, scheduling, dispatching, and controlling the flow of production. The course also introduces the student to the fundamentals of inventory control, statistical quality control, pert-cpm, and operations research. (Manufacturing elective)

TM 675 ETHICS AND PROFESSIONALISM FOR TECHNOLOGY MANAGERS

(3-0) 3 credits. This course will introduce students to many of the professional and ethical issues from a manager's perspective. Professionalism topics include: networking, business etiquette, professional dress, and helping employees raise their level of professionalism. Ethics topics include: harassment, dealing with an employee's disclosure, and the Whistle Blower Act.

TM 720 STATISTICAL PROCESS CONTROL

(3-0) 3 credits. This course covers the application of statistical methods to problems in quality and process control. Statistical topics include: basics of processes and variability, statistically controlled processes, variable and attribute control charts, moving averages, and process capability.

TM 732 STOCHASTIC MODELS IN OPERATIONS RESEARCH

(3-0) 3 credits. Probabilistic quantitative methods are developed. These include project control (PERT), decision trees, risk analysis, queuing, Markov chains, mathematical modeling and Monte Carlo simulation. Computer programs are used to solve practical problems after the techniques are developed and understood.

TM 742 ENGINEERING MANAGEMENT AND LABOR RELATIONS

(3-0) 3 credits. Principles of management, supervision, administrative policies, human-factors engineering, and labor-management relationships.

TM 745 FORECASTING FOR BUSINESS AND TECHNOLOGY

(3-0) 3 credits. This course provides an introduction to the quantitative and qualitative tools that may be used to identify and assess emerging technological advances. Topics include multiple regression, ARIMA forecast models and estimation, econometric models, and delphi techniques. Special projects and current readings in technology may be assigned.

TM 788 MASTER'S RESEARCH PROBLEMS/PROJECTS

Credit to be arranged: not to exceed 3 credits toward fulfillment of M.S. degree requirements. Open only to students pursuing the M.S. non-thesis option. Directed research investigation of a selected problem culminating in an acceptable written report. An oral defense of the report and research findings is required.

TM 791 INDEPENDENT STUDY

1 to 3 credits. Prerequisite: Permission of instructor. Directed independent study of a topic or field of special interest. This may involve readings, research, laboratory or fieldwork, and preparation of papers, as agreed to in advance, by student and instructor. Student may enroll in this course only twice and for no more than a total of 6 credits.

TM 792 TOPICS

1 to 3 credits. Lecture course or seminar on a topic or field of special interest, as determined by the instructor. Student may enroll in this course only twice and for no more than a total of 6 credits.

TM 798 MASTER'S THESIS

Credits to be arranged; not to exceed 6 credits toward fulfillment of M.S. degree requirements. Open only to students pursuing the master of science in Technology Management thesis option. Supervised original or expository research culminating in an acceptable thesis. Oral defense of the thesis and research findings are required.

**2009-2010 ACADEMIC YEAR
(As of July 2009)**

Executive Council

WHARTON, ROBERT A. (2008) President. B.A., M.A., Humboldt State University; Ph.D., Virginia Polytechnic Institute.

HENDERSON, TIMOTHY G. (1981) Vice President, Business and Administration. B.S., University of South Dakota.

JENSEN, CAROL A. (2004) Assistant to the President. A.A., Chadron State College; B.A., Western Illinois University.

MAHON, PATRICIA G. (2000) Vice President, Student Affairs and Dean of Students. B.S., M.S., Montana State University-Billings; Ph.D., Kansas State University.

PAPPEL, L. ROD (1991) President, South Dakota School of Mines and Technology Foundation. B.S., M.S., South Dakota School of Mines and Technology. Registered Professional Engineer (South Dakota).

SMORAGIEWICZ, JULIE A. (1994) Special Assistant to the President for University and Public Relations. B.A., M.Ed., University of Toledo.

VOTTERO, TIMOTHY J. (1998) Director, Alumni Association. B.S., South Dakota School of Mines and Technology.

HRNCIR, DUANE C. (2006) Interim Provost/Vice President, Academic Affairs. B.S., University of Alabama; M.S., University of Massachusetts; Ph.D., Texas A&M University.

WHITE, RONALD J. Vice President, Research Affairs. B.S., University of Southwestern Louisiana; Ph.D., University of Wisconsin-Madison.

Faculty

ABATA, DUANE L. (2006) Professor, Mechanical Engineering. B.S., M.S., Ph.D., University of Wisconsin-Madison.

AHRENKIEL, SCOTT PHILLIP (2006) Assistant Professor, Physics. M.S. Colorado School of Mines; B.S., Ph.D. University of Colorado.

AMOS, SCOTT J. (2009) Professor, Department of Civil and Environmental Engineering. B.S., University of Utah; M.S., Georgia Institute of Technology; Ph.D., University of Florida.

ANAGNOSTOU, DIMITRIOS E. (2007) Assistant Professor, Electrical and Computer Engineering. B.S., Democritus University of Thrace (Xanthi, Greece); M.S., Ph.D., University of New Mexico.

ANDERSEN, PATRICIA M. (1984) Director, Devereaux Library. B.S., University of South Dakota; M.L.I.S., Louisiana State University.

ANTONEN, KATHY (1988) Professor, Department of Humanities. B.A., M.A., Augustana College, Ph.D., University of Minnesota.

ARNESON-MEYER, LOIS L. (1991) Assistant Professor, Department of Civil and Environmental Engineering. B.S., Dakota State University; B.S., South Dakota School of Mines and Technology; M.S., University of South Dakota.

ASH, JASON T. (2003) Instructor, Department of Mechanical Engineering. B.S., M.S., South Dakota School of Mines and Technology.

BAI, XINHUA (2009) Assistant Professor, Department of Physics. B.S., M.S., Ph.D., Peking University – Beijing.

BANG, SANGCHUL (1985) Professor, Department of Civil and Environmental Engineering. B.S., Seoul National University-Korea; M.S., Ph.D., University of California-

Davis. Registered Professional Engineer (South Dakota).

BANG, SOOKIE S. (1985) Professor, Department of Chemical and Biological Engineering (Biology). B.S., M.S., Seoul National University-Korea; Ph.D., University of California-Davis.

BATCHELDER, MICHAEL J. (1974-1984) (1986) Department Chair and Professor, Department of Electrical and Computer Engineering; Co-Director, Center of Excellence for Advanced Manufacturing and Production. B.S., M.S., Oklahoma State University; Ph.D., Virginia Polytechnic Institute and State University.

BENJAMIN, KENNETH M. (2007) Assistant Professor, Department of Chemical and Biological Engineering. B.S.E., Ph.D., University of Michigan-Ann Arbor; M.S.E., University of Colorado-Boulder.

BOYLES, DAVID A. (1980) Professor, Department of Chemistry. B.S., M.S., South Dakota School of Mines and Technology; Ph.D., Purdue University.

BOYSEN, ALFRED R. (1969) Professor, Department of Humanities. B.A., Augustana College; M.A., Ed.D., University of South Dakota.

BRAMAN, KAREN S. (2004) Assistant Professor, Department of Mathematics and Computer Science. B.S., Rockhurst University; M.A., Ph.D., University of Kansas.

BRUNI, JOHN P. (2004) Assistant Professor, Department of Humanities. B.A., University of Rochester, M.A., Villanova University, Ph.D., University of Kansas.

BRYAN, JEREMY (2006) Assistant Professor, Department of Military Science; Captain. B.S., South Dakota School of Mines and Technology.

BUDD, BRETT T. (2007) Instructor, Department of Civil and Environmental Engineering. B.S., M.S., South Dakota School of Mines and Technology.

BUCK, GREGORY A. (1993) Professor, Department of Mechanical Engineering. B.S., Carnegie Mellon University; M.S., Ph.D., Arizona State University. Registered Professional Engineer (Arizona, Pennsylvania).

BURGOYNE, JANET (1989) Associate Professor, Department of Mathematics and Computer Science. B.S., Arizona State University; M.S., D.A., Idaho State University.

CABRERA, AGAPITO J. (1993) Assistant Professor, Department of Humanities. M.S., Indiana University-Bloomington; B.M.E., Chartrand Conservatory-Havana; B.S., B.A., LaSalle College-Havana; L.L.D., University of Havana.

CAPEHART, WILLIAM J. (1997) Associate Professor, Department of Atmospheric Sciences and Institute of Atmospheric Sciences. B.S., University of North Carolina-Asheville; M.S., Ph.D., Pennsylvania State University.

CHRISTOFFERSON, CABOT-ANN (2003) Instructor, Department of Chemistry. B.S., M.S., South Dakota School of Mines and Technology.

COBLE, LORI D. (1984) Instructor, Department of Chemical and Biological Engineering; Assistant Women's Basketball Coach. B.S., Dakota State College; M.A., University of Minnesota.

COREY, ROBERT L. (1995) Associate Professor, Department of Physics. B.S., University of Missouri, St. Louis; M.A., Ph.D., Washington University-St. Louis.

CORWIN, EDWARD M. (1981) Professor, Department of Mathematics and Computer Science. B.A., M.S., Ph.D., Lehigh University; M.S., Ph.D., Texas Tech University.

CROSS, WILLIAM M. (1993) Associate Professor, Department of Materials and Metallurgical Engineering. B.S., South Dakota School of Mines and Technology; M.S., Ph.D., University of Utah.

DAHL, JULIE J. (1982) Assistant Professor, Department of Mathematics and Computer Science. B.S., M.S., South Dakota School of Mines and Technology.

DAVIES, CINDY L. (1987) Associate Professor, Librarian, Devereaux Library. B.A., University of South Dakota; M.L.I.S., Louisiana State University.

DAVIS, ARDEN D. (1982-83) (1984) Professor, Department of Geology and Geological Engineering. B.A., University of Minnesota; M.S., Ph.D., South Dakota School of Mines and Technology. Registered Professional Engineer (South Dakota).

DENDINGER, ROGER E. (1998) Associate Professor, Department of Social Sciences. B.S., University of Alabama; M.S., South Dakota State University; M.S., Clemson University; Ph.D., University of Tennessee.

DETWILER, ANDREW G. (1987) Professor, Department of Atmospheric Sciences and Institute of Atmospheric Sciences. B.S., University of Michigan; M.S., Ph.D., State University of New York-Albany.

DIXON, DAVID J. (1993) Department Head and Professor, Department of Chemical and Biological Engineering. B.S., M.S., South Dakota School of Mines and Technology; Ph.D., University of Texas.

DOLAN, DANIEL F. (1981) Professor, Department of Mechanical Engineering; Co-Director, Center of Excellence for Advanced Manufacturing and Production. B.S., M.S., Ph.D., University of Minnesota.

DUKE, EDWARD F. (1984) Professor, Department of Geology and Geological

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WEGER, RONALD C. (1967-1991) Professor Emeritus, Department of Mathematics and Computer Science; Research Associate, Institute of Atmospheric Sciences. B.A., William Jewell; M.S., Ph.D., University of Illinois-Urbana.

WHITEHEAD, KAREN L. (1981-2009) Professor Emerita, Department of Mathematics and Computer Science; B.A., Ph.D., University of Minnesota

WILSON, ROBERT W. (1961-1975) Professor Emeritus, Department of Geology and Geological Engineering. B.S., M.S., Ph.D., California Institute of Technology.

ADMINISTRATION

Office of the President

WHARTON, ROBERT A. (2008) President. B.A., M.A., Humboldt State University; Ph.D., Virginia Polytechnic Institute.

JENSEN, CAROL A. (2004) Assistant to the President, A.A. Chadron State College, B.A. Western Illinois University.

RANCOUR, ROBERTA L. (2006) Senior Secretary.

SDSM&T Alumni Association Liaison

VOTTERO, TIMOTHY J. (1998) Director. B.S., South Dakota School of Mines and Technology.

SDSM&T Foundation Liaison

PAPPEL, L. ROD (1991) President. B.S., M.S., South Dakota School of Mines and Technology. Registered Professional Engineer (South Dakota).

ACADEMIC AFFAIRS

HRNCIR, DUANE C. (2006) Interim Provost/Vice President, Academic Affairs. B.S., University of Alabama; M.S., University of Massachusetts; Ph.D., Texas A&M University.

VANBOCKERN, CONNIE (1995) Senior Secretary. A.A., Black Hills State University.

ALLEY, KATHRYN E. (2001) Associate Provost for Assessment and Accountability, Academic Affairs. B.A., University of Cincinnati; M.A., University of Akron; Ph.D., Kent State University.

CHILSTROM, JUDITH (2004) Secretary.

Enrollement Management

GUNN, MICHAEL C. (2009) Associate Provost for Enrollment Management. B.A., Wake Forest University; M.A. University of Nebraska-Lincoln; M.S., National Defense University; Ph.D., Columbia Pacific University.

CHILSTROM, JUDITH (2004) Secretary.

Admissions

TAMARA MARTINZ_ANDERSON (2009) Director. B.A. Utah State University.

CLAYMORE, CHARLES (TEX) D. (2006) Associate Director and Senior Recruiter. B.S., B.A., University of North Dakota.

HONEY, NATALIE M. (2007) Admissions Counselor. B.A., Agnes Scott College; M.A., University of Nottingham.

Financial Aid

MARTIN, DAVID W. (2000) Director. B.A., Tarkio College.

(VACANT)
Assistant Director

The Office of the Registrar and Academic Services

DOLAN, BARBARA F. (1987) Director. B.A., South Dakota State University; B.S., South Dakota School of Mines and Technology; M.B.A., University of South Dakota.

BEU, PAT A. (2004) Director of Retention and Testing. B.S., M.Ed., Brigham Young University, Ed.D., Montana State University.

MILLER, LINN A. (2003) Assistant Coordinator of Academic Support. B.S., South Dakota State University.

Center of Excellence for Advanced Manufacturing and Production (CAMP)

BATCHELDER, MICHAEL J. (1974-1984) (1986) Co-Director; Department Chair and Professor, Department of Electrical and Computer Engineering. M.S., Oklahoma State University; Ph.D., Virginia Polytechnic Institute and State University.

DOLAN, DANIEL F. (1981) Co-Director; Professor, Department of Mechanical

Engineering. B.S., M.S., Ph.D., University of Minnesota.

KOONTZ, RYAN H. (2002) Integrated Manufacturing Specialist. B.S., M.S., South Dakota School of Mines and Technology.

LAWLER, STEVEN J (2006) Electronics Specialist, Department of Electrical and Computer Engineering. A.A.S., University of South Dakota Springfield; B.S., M.S., South Dakota State University .

Summer/Educational Programs and Professional Conferences

ANDERSON-SMITH, NANCY (2005) Director. B.S., St. Cloud State University.

Women In Science and Engineering (WISE)

DECKER, ROYIA A. (2007) Director. A.A., University of Maryland; B.A., Mesa State College; M.A., Adams State College.

Department of Chemical and Biological Engineering

WINTER, ROBB M. (1988) Professor, Department of Chemical and Biological Engineering. B.A., Dickinson State University; M.S., Ph.D., University of Utah.

FILIPOV, IVAN V. (2007) Chemical Equipment and Instrumentation Specialist, Department of Chemical and Biological Engineering. M.S., Professor Assen Zlatarov Higher Institute of Chemical Technology, Bulgaria.

COLEMAN, DAVID R. (2008) Research Scientist I, Department of Chemical and Biological Engineering. A.S., Red Rocks Community College; B.S., University of Colorado Health Sciences Center; Ph.D., University of Texas Health Science Center – Houston.

RASTOGI, GURDEEP (2007) Research Scientist I, Department of Chemical and Biological Engineering. B.S., Ewing Christian

College; M.S., Devi Ahilya University; Ph.D., National Centre for Cell Science

SWIATKIEWICZ, JACEK (2002) Research Scientist III, Department of Chemical and Biological Engineering. M.Sc., Ph.D., Technical University-Wroclaw, Poland.

Department of Civil and Environmental Engineering

MOTT, HENRY V. (1988) Department Chair and Professor, Department of Civil and Environmental Engineering; Coordinator, Environmental Engineering. B.S., South Dakota School of Mines and Technology; M.S., Washington State University; Ph.D., University of Michigan. Registered Professional Engineer (Idaho, Minnesota, North Dakota, South Dakota).

VACANT. Technical Assistance Provider, Department of Civil and Environmental Engineering.

Department of Electrical and Computer Engineering

BATCHELDER, MICHAEL J. (1974-1984) (1986) Department Chair and Professor, Department of Electrical and Computer Engineering; Co-Director, Center of Excellence for Advanced Manufacturing and Production. B.S., M.S., Oklahoma State University; Ph.D., Virginia Polytechnic Institute and State University.

AMERT, ANTHONY (2006) Research Engineer III, Department of Electrical and Computer Engineering. B.S., South Dakota School of Mines and Technology.

Department of Geology and Geological Engineering

PRICE, MARIBETH H. (1995) Department Chair and Associate Professor, Department of Geology and Geological Engineering; Program Coordinator, Ph.D. Atmospheric and Environmental Sciences. B.A., Dartmouth

College; M.A., Ph.D., Princeton University.

Department of Industrial Engineering

KELLOGG, STUART D. (1990) Department Head and Ervin Pietz Professor; Department of Industrial Engineering. B.S., South Dakota State University; M.B.A., University of South Dakota; M.S., South Dakota School of Mines and Technology; Ph.D., University of Texas-Austin. Registered Professional Engineer (South Dakota).

Department of Mechanical Engineering

LANGERMAN, MICHAEL A. (1992) Department Head and Professor, Department of Mechanical Engineering. B.S., M.S., South Dakota School of Mines and Technology; Ph.D., University of Idaho.

HINZ, BRANDON J. (2008) Research Engineer I, Department of Mechanical Engineering. B.S., M.S., South Dakota School of Mines and Technology.

LEE, SANG-BOK (2009) Research Scientist I, Department of Mechanical Engineering. B.S., Ph.D., Pohang University of Science and Technology, South Korea.

Department of Materials and Metallurgical Engineering

KELLAR, JON J. (1990) Department Head and Professor, Department of Materials and Metallurgical Engineering. B.S., M.S., South Dakota School of Mines and Technology; Ph.D., University of Utah.

HONG, HAIPING (2003) Research Scientist III, Department of Materials and Metallurgical Engineering. B.S., Hangzhou University; M.S., Institute of Chemistry-Chinese Academy of Science; Ph.D., Hebrew University-Jerusalem.

Department of Mining Engineering

SHASHIKANTH, S.N. (1994) Department Head, Program Director and Instructor, Department of

Mining Engineering and Management. M.S., South Dakota School of Mines and Technology.

Department of Atmospheric Sciences

HJELMFELT, MARK R. (1988) Department Chair and Professor, Department of Atmospheric Sciences; Professor, Institute of Atmospheric Sciences. B.S., Kansas State University; M.S., South Dakota School of Mines and Technology; Ph.D., University of Chicago.

Department of Chemistry

HEGLUND, DANIEL L. (1997) Department Chair and Associate Professor, Department of Chemistry. B.S., Bemidji State University; M.S., Ph.D., University of North Dakota.

FILIPOVA, TSVETANKA S. (2002) Research Scientist II (Postdoctoral Fellow), Department of Chemistry. M.S., Ph.D., University of Chemical Technology and Metallurgy.

SMALLBROCK, MARGARET (2006) Chemical and Instrumentation Specialist, Department of Chemistry. B.S., South Dakota School of Mines and Technology.

ZHANG, LIFENG (2007) Research Scientist I, Department of Chemistry. B.S., Xi'an Jiaotong University; M.S., Beijing Institute of Technology; Ph.D., University of California at Davis.

Department of Humanities

SHIRLEY, SUE (1992) Department Head, Department of Humanities and Department of Social Science; Professor, Department of Humanities. B.A., University of Utah; M.A., Utah State University; Ph.D., Washington State University.

Department of Military Science

HANSEN, JON P. (2006) Department Chair and Professor, Department of Military Science ROTC; Major. B.A., Stetson University; M.A. Webster University.

RUEDEBUSCH, MITCHELL (2003) Assistant Professor Military Science; Major. B.S., South Dakota School of Mines and Technology; M.A., Webster University-Saint Louis.

BRYAN, JEREMY (2006) Assistant Professor, Department of Military Science; Captain. B.S., South Dakota School of Mines and Technology.

Department of Mathematics and Computer Science

RILEY, KYLE L. (1999) Department Chair and Associate Professor, Department of Mathematics and Computer Science. B.S., University of Wyoming; M.S., Ph.D., Montana State University.

Department of Physical Education

FELDERMAN, BARBARA A. (1981) Chair and Professor, Department of Physical Education; Head Women's Basketball Coach and Assistant Director, Intercollegiate Athletics. B.S., Northern State College; M.S., University of Wyoming.

Department of Physics

PETUKHOV, ANDRE (1994) Department Head and Professor, Department of Physics. M.S., Odessa State University; Ph.D., St. Petersburg Technical University.

Department of Social Sciences

SHIRLEY, SUE (1992) Department Head, Department of Humanities and Department of Social Science; Professor, Department of Humanities. B.A., University of Utah; M.A., Utah State University; Ph.D., Washington State University.

Black Hills Natural Sciences Field Station

UZUNLAR, NURI (2006) Director and Associate Professor, Department of Geology and Geological Engineering. B.S., Black Sea University, Turkey; Ph.D., North Dakota State

University.

Museum of Geology

MINKLER, HEIDI R. (2007) Program Assistant I. Museum of Geology. B.S., Ohio State University-Columbia; M.S., South Dakota School of Mines and Technology.

South Dakota Local Transportation Assistance Program

VACANT. Technical Assistance Provider.

Graduate Education

HELSDON, JR., JOHN H. (1979) Dean of Graduate Education; Professor, Department of Atmospheric Sciences; Director, Institute of Atmospheric Sciences. B.S., Trinity College; M.S., Ph.D., State University of New York - Albany.

Information Technology Services

SCHUMACHER, BRYAN J. (1991) Director. B.S., South Dakota School of Mines and Technology.

BENDER, VICKIE M. (1986) Associate Director of Information Services. A.A., Northern State University.

ERICKSON, JASON R. (2002) Associate Director of Technology Services. B.S., South Dakota School of Mines and Technology.

Library

ANDERSEN, PATRICIA M. (1984) Director. B.S., University of South Dakota; M.L.I.S., Louisiana State University.

DAVIES, CINDY L. (1987) Associate Professor, Library. B.A., University of South Dakota; M.L.I.S., Louisiana State University.

TAYLOR, JANET L. (1973) Coordinator of Library Operations. B.S., National College of

Business.

BUSINESS AND ADMINISTRATION

HENDERSON, TIMOTHY G. (1981) Vice President, Business and Administration. B.S., University of South Dakota.

PAINTER, AUDREY L. (1981) Senior Secretary.

Administrative Services **(Accounting/Budget/Cashiering)**

LAURITSEN, TERRY H. (2007) Controller and Director. B.S., M.S., University of Southern Florida.

STELTER, SUSAN M. (2006) Budget Analyst. A.A.S., Western Dakota Technical Institute.

ROWSE, DEBRA K. (1982) Accounting Manager. B.S., Black Hills State University.

Business Services (Purchasing **/Telecommunications)**

FISCHER, SANDRA R. (1972) Director.

HARGENS, JANET K. (1979) Assistant Director.

Bookstore

KINZER, MARLIN L. (1993) Director. B.S., Black Hills State University.

Campus Environmental Health and Safety

ROBERTS, JERILYN C. (2006) Manager. B.S., South Dakota School of Mines and Technology.

SCHMELZ, TREVOR R. (2009) Campus Chemical Materials Coordinator. B.S., South Dakota School of Mines and Technology.

Dining Services

FREDERIKSEN, JOLEE (2006) Director contracted through ARAMARK.

Facilities Services

MILLER, MITCH M. (2008) Facilities Director contracted through ARAMARK.

Human Resources

SLOAT, DEBORAH L. (1994) Director. B.S., South Dakota School of Mines and Technology; M.S., University of South Dakota; PHR Certified.

SHUMAN, KELLI R. (2004) Assistant Director. B.S., Black Hills State University.

Intercollegiate Athletics

KAISER, RICHARD A. (2009) Director of Athletics, Intercollegiate Athletics. B.A., University of Northern Colorado; M.A., South Dakota State University; and Doctorate of Education: Brigham Young University.

BAIRD, SCOTT J. (2007) Head Certified Athletic Trainer. B.S., Dakota Wesleyan University.

BLUME, BRADLEY D. (2006) Director, Sports Information. B.S., South Dakota State University.

CAMARGO, LUCIANA (2007) Assistant Volleyball Coach. B.A., National American University.

COBLE, LORI D. (1984) Assistant Women's Basketball Coach; Instructor, Department of Chemical and Biological Engineering. B.S., Dakota State College; M.A., University of Minnesota.

DIERINGER, DANIEL J. (2009) Assistant Football Coach/Offensive Coordinator. B.A., Chadron State College; M.A.Ed., Pacific University.

FELDERMAN, BARBARA A. (1981) Head Women's Basketball Coach and Assistant Director Intercollegiate Athletics; Department Chair and Professor, Department of Physical Education. B.S., Northern State College; M.S., University of Wyoming.

GLENN, ERIC M. (2005) Assistant Men's Basketball Coach; Head Men's and Women's Golf Coach. B.S., M.A., Chadron State College.

HENRY, JASON P. (2002) Head Men's Basketball Coach; Assistant Professor, Department of Physical Education. B.S., Minot State University. M.S., North Dakota State University.

JANZEN, RACHEL (2008) Assistant Women's Basketball Coach. B.S., Southern Nazarene University.

KRATZER, DANIEL L. (2005) Head Football Coach; Assistant Professor, Department of Physical Education. B.S., Missouri Valley College. M.S., Central Missouri State University.

MASTIN, TIFFANY J. (2009) Head Volleyball Coach and Assistant Wellness Center Supervisor. B.S., Taylor University.

MESSICK, LONNIE L (2006) Assistant Football Coach/Wellness Center Supervisor. B.S., University of Oklahoma.

RANUM, JENNIFER (2007) Certified Athletic Trainer and Director, Intramural Sports. B.A., National American University.

RUDEBUSCH, THOMAS R. (1980) Executive Director, Hardrock Club and Hardrock Marketing, LLC.

SCHAFFER, JERALD R. (1984) Head Cross Country and Track Coach; Associate Professor, Department of Physical Education. B.A., M.A., Adams State College.

RESEARCH AFFAIRS

WHITE, RONALD J. (2009) Vice President, Research Affairs. B.S., University of Southwestern Louisiana; Ph.D., University of Wisconsin-Madison.

NILSON, JEANETTE R. (1991) Administrative Support Coordinator.

Sponsored Programs

JAMES II, L. ERIC (2008) Director, Sponsored Programs. B.A., Ursinus College; M.S., University of Southern Maine; J.D., University of Maine Law School.

AGA, KARMEN A. (2002) Contracting Officer IV.

Additive Manufacturing Laboratory (AML)

SEARS, JAMES W. (2002) Director. A.S., Black Hawk College; B.S., M.S., Ph.D., University of Illinois.

CARTER, MICHAEL J. (2006) Research Scientist II, Additive Manufacturing Laboratory (AML). B.S., M.S., South Dakota School of Mines and Technology.

Advanced Materials Processing and Joining Laboratory (AMP)

ARBEGAST, WILLIAM J. (2001) Director. B.S., Colorado School of Mines.

Engineering and Mining Experiment Station (EMES)

DUKE, EDWARD F. (1984) Manager of Analytical Services; Professor, Department of Geology and Geological Engineering. B.S., Beloit College; M.A., Ph.D., Dartmouth College.

LINGENFELTER, DAVID R. (1997) Research Scientist I. B.S., Montana Tech.

Center for Accelerated Applications at the Nanoscale (CAAN) / Printed Electronics Applied Research Laboratory (PEARL)

DECKER, SHAWN P. (2004) Director. B.S., Northwestern Oklahoma State University, Ph.D., Kansas State University.

DAGEL, DARYL J. (2009) Research Scientist I (Postdoctoral Associate). B.A., Macalester College; M.S., University of Wisconsin; Ph.D., Cornell University.

Center for Bioprocessing Research and Development (CBRD)

CHRISTOPHER, LEW (2008) Director, B.S., M.S., Higher Institute for Chemical Engineering, Sofia, Bulgaria; Ph.D., Bulgarian Academy of Sciences & Higher Institute for Chemical Engineering, Sofia, Bulgaria.

Office of Technology Transfer (OTT)

SKILLMAN, DALE N. (2004) Director, Office of Technology Transfer; B.S., M.S., South Dakota School of Mines and Technology.

Computational Mechanics Laboratory

LANGERMAN, MICHAEL A. (1992) Co-Director; Professor, Department of Mechanical Engineering. B.S., M.S., South Dakota School of Mines and Technology; Ph.D., University of Idaho.

MUCI, KARIM, H. (2002) Co-Director; Associate Professor, Department of Mechanical Engineering. B.S., M.S., ITESM, Monterrey Campus-Mexico; Ph.D., Iowa State University. Registered Professional Engineer (Mexico).

Composites and Polymer Engineering Laboratory (CAPE)

VACANT. Director.

Institute of Atmospheric Sciences

HELSDON JR., JOHN H. (1979) Director, Institute of Atmospheric Sciences; Dean of Graduate Education; Professor, Department of Atmospheric Sciences. B.S., Trinity College; M.S., Ph.D., State University of New York-Albany.

CAPEHART, WILLIAM J. (1997) Associate Professor, Department of Atmospheric Sciences and Institute of Atmospheric Sciences. B.S., University of North Carolina-Asheville; M.S., Ph.D., Pennsylvania State University.

CRANDALL, CONNIE K. (1988) Publications Production Specialist.

DETWILER, ANDREW G. (1987) Professor, Department of Atmospheric Sciences and Institute of Atmospheric Sciences. B.S., University of Michigan; M.S., Ph.D., State University of New York-Albany.

FARLEY, RICHARD D. (1974) Research Scientist IV. B.S., M.S., South Dakota School of Mines and Technology.

HJELMFELT, MARK R. (1988) Department Chair and Professor, Department of Atmospheric Sciences; Professor, Institute of Atmospheric Sciences. B.S., Kansas State University; M.S., South Dakota School of Mines and Technology; Ph.D., University of Chicago.

KLICHE, DONNA V. (1994) Research Scientist III. B.S., Faculty of Physics-Bucharest, Romania; M.S., Georgia Institute of Technology; Ph.D., South Dakota School of Mines and Technology.

SUNDARSHWAR, PALLAOR V. (2003) Associate Professor, Department of Atmospheric Sciences and Institute of Atmospheric Sciences. B.S., M.S., University of Bombay; Ph.D., University of South Carolina-Columbia.

South Dakota Space Grant Consortium

DUKE, EDWARD F. (1984) Professor,

Faculty, Administration, and Governance

Department of Geology and Geological Engineering. B.S., Beloit College; M.A., Ph.D., Dartmouth College.

DURKIN, THOMAS V. (1999) Deputy Director and Outreach Coordinator. A.S., Nassau Community College; B.S., Adelphi University; M.S., South Dakota School of Mines and Technology. Licensed Professional Geologist (Wyoming); Certified Professional Geologist.

STUDENT AFFAIRS

MAHON, PATRICIA G. (2000) Vice President, Student Affairs and Dean of Students. B.S., M.S., Montana State University-Billings; Ph.D., Kansas State University.

ROMANO, MARIE A. (1999) Senior Secretary.

Alcohol Education

FARRINGTON, MARY JO (2005) Director, Campuses Community Prevention Coalition Program. B.A. Colorado Women's College; M.A. Columbia University.

Campus Ministry

CONROY, JOANN (2001) Lutheran Campus Ministry Representative.

BIEGLER, FR. STEVE (2007) Newman Center.

NAUGEN, NANCY (2007) Newman Center.

DEMEREST, RICK (1987) Inter Varsity Christian Fellowship Representative.

FANNIN, HEATHER (1998) International Students, Inc. Representative.

FANNIN, KEVIN (1998) International Students, Inc. Representative.

HASAM, RAFIG (2004) Muslim Student Association Representative.

HERNANDEZ, PHILLIP (2004) United

Campus Ministry Representative.

STANDISH, KATIE (2008) United Campus Ministry Representative. B.S., M.S. South Dakota School of Mines and Technology.

Career Center

SAWYER, DARRELL R. (1997) Director. B.A., M.A., Ed.D., University of South Dakota.

Child-care Services

Services contracted through Kids Kastle Little Miner's Clubhouse.

Counseling and Student ADA Services

McCOY, JOLIE A. (1997) Director, B.S., M.S.W., University of Texas at Austin.

WILEY, SCOTT R. (2005) Counselor and Prevention Coordinator/Interim Coordinator of Multicultural Affairs. B.S., Indiana Wesleyan University; M.S., South Dakota State University

Health Services

Services contracted through Creekside Family Practice.

Ivanhoe International Center

AADLAND, SUSAN R. (1989) Director. B.S., Northern State University; M.S., University of South Dakota.

Multicultural Affairs

WILEY, SCOTT R. (2005) Coordinator of Multicultural Affairs/Counselor and Prevention Coordinator. B.S., Indiana Wesleyan University; M.S., South Dakota State University.

Residence Life, Surbeck Center, and Scheduling and Conferences

WILSON, MAUREEN C. (1999) Director of Residence Life and Surbeck Center; Student

Conduct Administrator. B.A., Northern State University; M.A., Eastern New Mexico University, Portales.

KELLY, SARAH E. (2007) Residence Hall Director, Peterson Hall.

Student Activities and Leadership Center

KEEGAN, MICHAEL A. (2006) Coordinator. B.S., Saint Cloud State University.

FAUBERT, ROBERT A. (2001) Drama Director, Student Activities and Leadership Center. B.A., M.Ed., Boston College; M.H.A., Ohio State University.

Surbeck Scheduling

LINDSLEY, STEPHANIE (2004) Program Assistant II, Surbeck Center. B.S., Black Hills State University.

UNIVERSITY AND PUBLIC RELATIONS

SMORAGIEWICZ, JULIE A. (1994) Special Assistant to the President for University and Public Relations. B.A., M.Ed., University of Toledo.

DOMINICAK, SHARON F. (2004) Senior Secretary.

BISHOP, BREANNA V. (2005) Public Information Coordinator. B.S., Minnesota State University.

POYOUROW, MELINDA A. (2002) Publications Manager. B.F.A., Kearney State College.

ROBERTS, PETER J. (2007) Regional University and Community Relations Developer, Sioux Falls. B.S., Iowa State University; M.Ed. University of Oklahoma.

VANDER VORST, MITCHELL S. (2006) Director. B.A., Westmont College.

GOVERNANCE

The South Dakota School of Mines and Technology is one of six universities operating under the authority assigned by the Constitution of the State of South Dakota to the nine member Board of Regents. The mission of the university is established by the Legislature of the State of South Dakota with programs and organization approved by the Board of Regents. The president is delegated to administer the operation of the university. The traditional collegial process of shared governance for the formation of policies and oversight includes representative organizations to provide recommendations to the president for implementation as appropriate.

Councils

Executive Council

The Executive Council is the principal administrative unit at the university. The council members are the president, assistant to the president, special assistant to the president for university and public relations, provost and vice president for academic affairs, vice president for business and administration, vice president for student affairs and dean of students, vice president for research, SDSM&T Foundation president, and director of the Alumni Association.

University Cabinet

The University Cabinet meets at the call of the president and advises the president concerning the development of policy, the governance of the university, strategic planning, and the fiscal operation of the university. The University Cabinet consists of: the president, assistant to the president, special assistant to the president for university and public relations, provost and vice president for academic affairs, vice president for business and administration, vice president for student affairs and dean of students, vice president for research, director of athletics, SDSM&T Foundation president, chair of the faculty senate, director of the Alumni Association, dean of graduate education, director of multicultural affairs, chair of the exempt employees council, chair of the career service council, president of the

student association, and the director of facility services.

Career Service Council

The Career Service Act employees elect the Career Service Council members.

Exempt Employees Council

The Exempt Employees Advisory Council is elected by the administrative employees who are exempt from the Career Service Act of the state of South Dakota.

Faculty Senate

The Faculty Senate consists of nine voting members, two non-voting (ex-officio) members and is chaired by the chair of the Faculty Senate. Three voting members each are elected from the engineering, science, and liberal arts faculty. The ex-officio members are the vice president for research and the provost and vice president for academic affairs. All faculty members may vote in the election of representatives from their discipline and each is eligible for election as a discipline representative.

Student Association

The Senate of the Student Association is the elected representative council for the formation of recommendations on behalf of enrolled students, including the fees charged to students and the operation of student activities funded through student fees.

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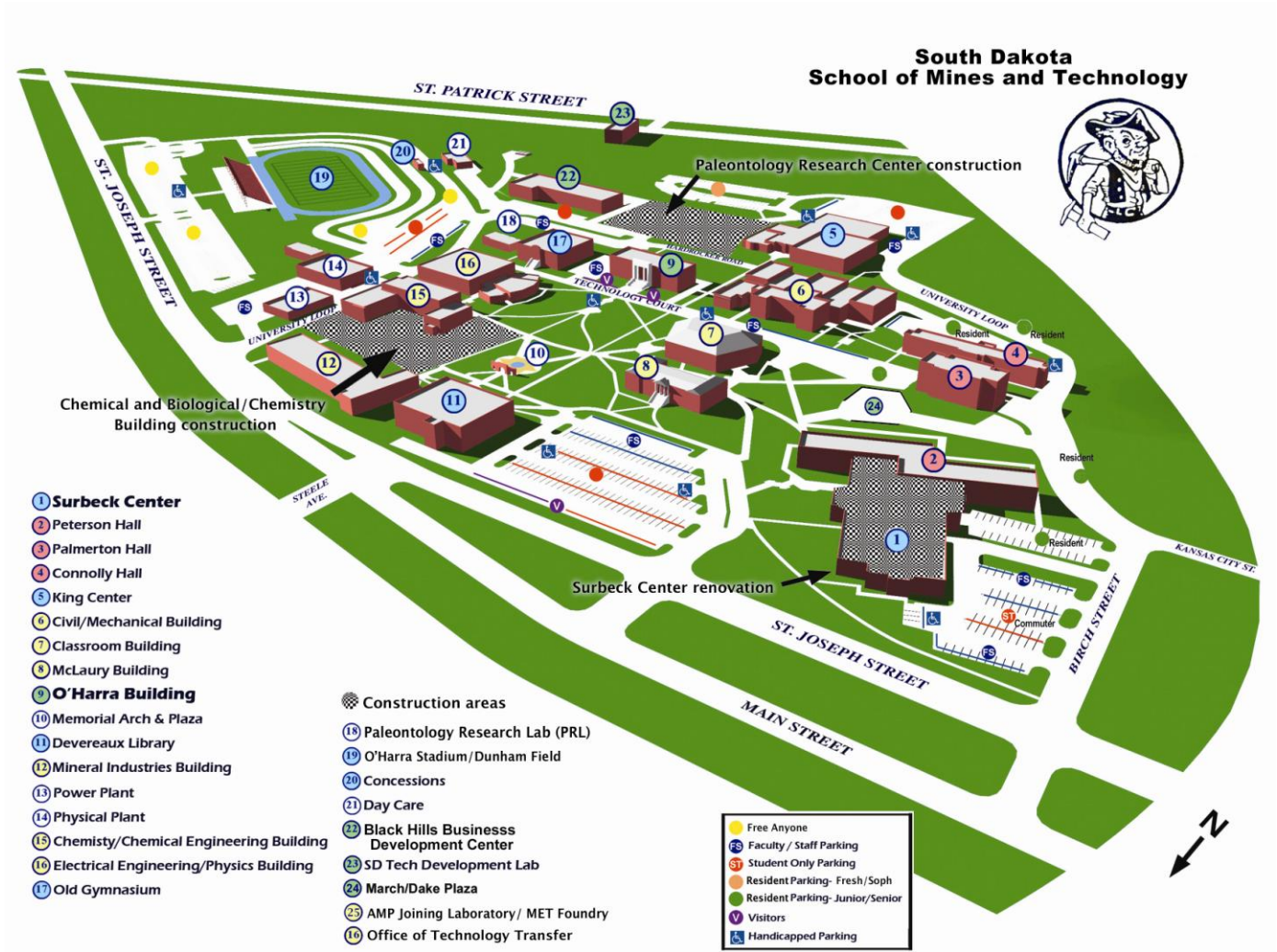
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Campus Map*



*This map is not intended for parking area designations. For current parking information go to: <<http://sdmines.sdsmt.edu/sdsmt/parking>>