Swenson College of Science and Engineering

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Academic Standing

Swenson College of Science and Engineering (SCSE)

Dean: James P. Riehl, 140 Engineering Building, 218-726-6397
Associate Dean: Stanley G. Burns, 140 Engineering Building, 218-726-7585
Interim Associate Dean: Penelope Morton, 140 Engineering Building, 218-726-7585

The Swenson College of Science and Engineering has a fourfold mission: to help each student develop a foundation for a career by learning the substance and methods of an academic discipline; to participate fully in the liberal education mission of the campus; to foster significant scholarly research; and to serve the well-being of the community, state, and region. The college offers students a broad range of curricula covering the natural sciences, mathematical sciences, engineering, and technology. Each student is provided the opportunity to develop competence in a special field of knowledge by learning its principles and perspectives, mastering its methods, and acquiring much of its accumulated knowledge.

In addition to offering formal coursework, the college is committed to providing students with opportunities to learn through participation in research, honors programs, individual study, and special seminars. Such opportunities, which emphasize undergraduate education, are enhanced and complemented by high quality graduate programs. These graduate programs form an integral component of our commitment to scholarship.

Admission

The college has no specific secondary school preparation requirements for admission beyond the preparation standards of the University of Minnesota. However, secondary school students contemplating a baccalaureate degree in a physical or biological science, mathematics, computer science, or engineering are strongly urged to complete a college preparatory program that includes four years (grades 9–12) each of English, mathematics, and science.

The engineering programs have specific college-level course requirements and minimum GPAs that must be satisfied before students can be admitted into the upper division (junior and senior level) program.

For general admission information, see the Policies and Procedures section of this catalog.

Dean’s List of Academic Excellence

Each semester, SCSE students are recognized for high academic achievement by being placed on the SCSE Dean’s List of Academic Excellence. This honor is awarded to students who rank in the top 15 percent of the college based on their semester GPA. To be eligible, students must have completed at least 12 graded credits and have received no final grades of F, N, or I during that semester.

College Honors

At UMD a maximum of 15 percent of the graduating class can graduate with college honors. In SCSE the top 3 percent of the graduating class is designated summa cum laude, the next 5 percent magna cum laude, and the next 7 percent cum laude.

At the beginning of each year, the GPAs necessary to achieve these honors are posted in the Student Affairs Office, 140 Engineering Building. These GPAs are based on those of the previous spring semester’s graduating class. In addition, students receiving honors must have a coefficient of course completion of at least 90 percent. For more information, contact the Student Affairs Office, 140 Engineering Building.

Honors Programs

The objective of the SCSE honors programs is to offer highly motivated students of superior ability a greater challenge than is available through the traditional curriculum. Honors opportunities provide for closer student-faculty relationships, emphasize writing and speaking skills, and offer active learning in the disciplinary and interdisciplinary components.

In the lower division, honors opportunities include seminars and special sections of lecture and lab courses. Students may participate in these by invitation or by consent of the instructor.

Honors opportunities in the upper division are available for students in all departments. Department honors candidates are selected on the basis of coursework completed and potential for independent work. A research project is required.

More information about department honors is available through the departments.

Academic Standing

Good Academic Standing

Students who have a minimum cumulative University of Minnesota GPA of 2.00 or higher are in good academic standing in the University.
Academic Intervention or Warning
Students in good standing with the University but who are not making satisfactory progress as defined by the specific degree program, or whose academic performance declines significantly, may be identified for academic intervention and be required to meet with an academic adviser before registration. In SCSE, if students are not making satisfactory progress in their program, they may have their major changed to undeclared.

Probation
Students with a cumulative University of Minnesota GPA less than 2.00 are placed on academic probation.

Dismissal
Students who fail to achieve a cumulative University of Minnesota GPA of 2.00 during the probationary semester are subject to dismissal from the University. Students with a first-term GPA below 1.00 are subject to dismissal from the University without probation.

Readmission
Students dismissed from the University, who can demonstrate improved academic capability, may petition to be readmitted on a probationary basis after the lapse of one fall or spring semester. Petition forms for readmission and information concerning academic standing are available in the SCSE Student Affairs Office, 140 Engineering Building.

Student Affairs Office
Information on academic matters, including academic standing; admission; advising; academic programs; change of major, college, or adviser; grievance and appeals procedures; honors programs; undergraduate research; student clubs; and tutoring is available in the SCSE Student Affairs Office, 140 Engineering Building.

Baccalaureate Degrees
SCSE offers the bachelor of science (B.S.) see majors below, bachelor of science in chemical engineering (B.S.Ch.E.), bachelor of science in civil engineering (B.S.C.E.), bachelor of science in electrical and computer engineering (B.S.E.C.E.), bachelor of science in industrial engineering (B.S.I.E.), and bachelor of science in mechanical engineering (B.S.M.E.) degrees.

For other minors available to students pursuing a bachelor of science degree, see the Labovitz School of Business and Economics, School of Fine Arts, College of Education and Human Service Professions, and College of Liberal Arts sections of this catalog.

General Requirements
Students must meet all course and credit requirements of the departments and colleges or schools in which they are enrolled. Students seeking two degrees must fulfill the requirements of both degrees; however, two degrees cannot be awarded for the same major.

- Students must complete all requirements of the Liberal Education Program.
- Students must complete a minimum of 120 semester credits.
- Students must earn 30 semester credits or the equivalent awarded by UMD.
- Students must complete at least half of their credits at the 3xxx-level and higher at UMD. Study abroad credits earned through courses taught by UM faculty and at institutions with which UMD has international exchange programs may be used to fulfill this requirement.
- If a minor is required, students must take at least three upper division credits in their minor field from UMD.
- The minimum cumulative UM GPA required for graduation will be 2.00 and will include only University of Minnesota coursework. A minimum UM GPA of 2.00 is required in each UMD undergraduate major and minor. No academic unit may impose additional grade point standards to graduate.
- Diploma, transcripts, and certification will be withheld until all financial obligations to the University have been met.
- Compliance with general regulations governing granting of degrees.

B.S. Requirements
- Completion of a major for the bachelor of science degree and a minor or second major in a different program, with a 2.00 minimum GPA in the major, including supporting courses, and a 2.00 minimum GPA in the minor, including supporting courses.
- A 2.00 minimum GPA in all work attempted at UMD; a 2.00 minimum GPA in all work, including transfer credits.
- If there are multiple majors and/or minors, this requirement holds for each major and minor, calculated separately.
- For students completing two or more majors, a minor is not required.
- If the majors are for different degrees (e.g., a B.S. and a B.A.), the majors must be in different programs (e.g., a student may not receive a B.S. in chemistry and a B.A. in chemistry) and students must complete requirements for both degrees.

B.S.Ch.E. Requirements
- Completion of at least 128 degree credits.
- A 2.00 minimum GPA in all work attempted at UMD; a 2.00 minimum GPA in all work, including transfer credits.
- Completion of UMD liberal education requirements. See the Liberal Education Program section of this catalog.
- Completion of the chemical engineering major. Admission to the upper division program of the chemical engineering major is competitive and granted on a space-available
basis. Application for admission to upper division must be filed with the department upon completion of lower division requirements.

- A 2.00 minimum GPA in all courses taken in the chemical engineering major, including required courses in related fields. This GPA requirement applies to all courses in the major taken at UMD calculated separately and also to all courses in the major when transfer credits are included.

**B.S.C.E. Requirements**

- Completion of at least 130 degree credits
- Completion of UMD liberal education requirements. See the Liberal Education Program section of this catalog.
- Completion of the civil engineering major. Admission to the upper division B.S.C.E. program is competitive and based on performance in lower division courses and space availability. Application for admission to upper division must be filed with the department upon completion of lower division requirements.
- A C- or better is required in all program courses.
- A 2.00 minimum GPA in all courses taken in the civil engineering major, including required courses in related fields. This GPA requirement applies to all courses in the major taken at UMD calculated separately and also to all courses in the major when transfer credits are included.

**B.S.E.E. Requirements**

- Completion of at least 128 degree credits.
- Completion of the electrical and computer engineering major. Admission to the upper division program is competitive and granted on a space available basis. Application for admission to upper division must be filed with the department upon completion of lower division requirements.
- Completion of UMD and ECE liberal education requirements.
- A minimum GPA of 2.00 for all courses taken in the major, including required supporting courses. This average applies to all courses in the major taken at UMD and calculated separately and also to all courses in the major when transfer credits are included.

**B.S.I.E. Requirements**

- Completion of at least 127 degree credits.
- A 2.00 minimum GPA (C) in all work attempted at UMD; a 2.00 minimum GPA in all work, including transfer credits.
- Completion of UMD liberal education requirements. See the Liberal Education Program section of this catalog. Courses for Categories 9 and 10 courses must have different designators.
- Acceptance to the upper division BSIE program. Admission to the upper division program of the industrial engineering major is competitive and granted on a space-available basis. Application for admission to upper division must be filed with the department upon completion of lower division requirements.
- Successful completion of all courses required for the BSIE program and either the industrial and systems engineering sub-plan, including the following:
  - Successful completion (with grades of C- or better or S) of all required programs courses taken at UMD or within the University of Minnesota system.
  - Successful completion with grades of C or better of all required program courses transferred from outside the University of Minnesota system.

**B.S.M.E. Requirements**

- Completion of at least 127 degree credits.
- A 2.00 minimum GPA (C) in all work attempted at UMD; a 2.00 minimum GPA in all work, including transfer credits.
- Completion of UMD liberal education requirements. See the Liberal Education Program section of this catalog. Courses for Categories 9 and 10 courses must have different designators.
- Acceptance to the upper division BSME program. Admission to the upper division program of the mechanical engineering major is competitive and granted on a space-available basis. Application for admission to upper division must be filed with the department upon completion of lower division requirements.
- Successful completion of all courses required for the BSME program including the following:
  - Successful completion (with grades of C- or better or S) of all required programs courses taken at UMD or within the University of Minnesota system.
  - Successful completion with grades of C or better of all required program courses transferred from outside the University of Minnesota system.
- A 2.00 minimum GPA in all courses taken in the mechanical engineering major, including required courses in related fields. This GPA requirement applies to all courses in the major taken at UMD calculated separately and also to all courses in the major when transfer credits are included.

**Upper Division**

Upon competition of lower division requirements, students must apply for admission to the upper division of the engineering program in which they are interested. A minimum cumulative GPA, determined by the department, is required in the lower division courses. Students from other colleges wishing to transfer into UMD engineering programs should have completed the equivalent lower division courses with the required cumulative GPA. The completed application is evaluated on the basis of GPA, curriculum completed, and space availability. Students transferring from Minnesota state community colleges should refer to the list of equivalent lower division courses for their college. This list is available from SCSE or the community college engineering adviser. Courses in which a D has been earned at an institution other than the University cannot be used to meet the specified course requirements of the engineering degrees except when the D is earned in a sequence courses and a C or better is earned in the following course.
The Department of Chemical Engineering strives for nationally recognized excellence in engineering education and research by using modern, hands-on, and active learning experiences to prepare undergraduate students for professional success, and to hold paramount the safety, health, and welfare of the public and protect the environment in performance of their professional duties.

Chemistry and Biochemistry
Email: chem@d.umn.edu
Website: www.d.umn.edu/chem

Professors: Robert M. Carlson, Lester R. Drewes (MED), John F. Evans, Paul Kiprof (department head), Vincent Magnuson, Donald P. Poe, Joseph R. Prohaska (MED), James P. Riehl, Bilin P. Tsai, Kendall B. Wallace (MED), Viktor V. Zhdkankin; Associate Professors: Benjamin L. Clarke (MED), Robert Cormier (MED), Ahmed Heikal, Venkatram Mereddy, Elizabeth Minor, Victor Nemykin, Paul D. Siders, Josef Werner; Assistant Professors: Steven Berry, Peter Grundt, Anne Enhilderter, Joseph L. Johnson, Sangeeta Mereddy; Instructors: Brian Gute, Katherine Swanson

The Department of Chemistry and Biochemistry provides classroom and laboratory learning opportunities and research experiences across the discipline to meet the needs of students in engineering, liberal arts, and pre-professional programs, as well as those of students who wish to pursue careers or graduate studies in chemistry or related disciplines. The department offers two majors, chemistry and biochemistry/molecular biology, which prepares students for a variety of careers in science in a broad range of industries and governmental settings, and provides preparation for graduate school in chemistry, biochemistry, and related subjects as well as a strong foundation for professional programs such as pharmacy and medicine.

Civil Engineering
Email: civileng@d.umn.edu
Website: www.d.umn.edu/civileng

Professors: Eil Kwon, Andrea Schokker (department head); Associate Professor: Carlos Carranza-Torres; Assistant Professors: Katherine Acton, Eshan Dave, Nathan Johnson, Eric Musselman, Rebecca Teasley; Instructors: Brian Kohn, John Rashid, Paul Vogel

The mission of the Department of Civil Engineering at the University of Minnesota Duluth is to prepare graduates for professional practice and graduate study through a program firmly based in strong technical skills, fundamentals, hands-on learning, sustainability, and professionalism.

Computer Science
Email: cs@d.umn.edu
Website: www.d.umn.edu/cs

Professors: Donald B. Crouch, Carolyn J. Crouch, Douglas J. Dunham, Richard Maclin (department head); Associate Professors: Timothy R. Colburn, Linda L. Deneen, Theodore D. Pedersen, Christopher Prince, Gary M. Shute, C. Hudson Turner; Assistant Professors: James Allert, Peter Willemsen; Instructor: Steven Holtz
The Department of Computer Science provides instruction and research experiences for undergraduate and graduate students in preparation for careers in industry or for continuing on in graduate school. The department also provides instruction in computer literacy and software design for non-major students as part of a liberal education.

**Electrical and Computer Engineering**

Email: ece@d.umn.edu  
Website: www.d.umn.edu/ece

Professors: Stanley Burns, Taek Mu Kwon, Marian Stachowicz, Jiann-Shiou Yang (department head);  
Associate Professors: Christopher Carroll, Mohammed Hasan, Imran Hayee;  
Assistant Professors: Jing Bai, Nisha Kondrath, Hua Tang;  
Instructors: Tom Ferguson, Scott Norr

The goals of the Department of Electrical and Computer Engineering are to provide a high quality educational opportunities in electrical and computer engineering for students by delivering a program with a strong hands-on laboratory and design component in conjunction with a thorough foundation in theory; and to provide students with the tools and skills to be major lifelong contributors to their professions and society as a whole.

**Geological Sciences**

Email: geol@d.umn.edu  
Website: www.d.umn.edu/geology

Professors: Erik T. Brown, Steven M. Colman, John W. Goode, Vicki L. Hansen, Timothy B. Holst, Thomas C. Johnson, Howard D. Mooers, Ronald L. Morton (department head);  
Associate Professors: Christina Gallup, Penelope Morton, John B. Swenson, Nigel J. Watruss;  
Assistant Professor: Karen Gran;  
Instructor: Susan Hartley

The Department of Geological Sciences offers three undergraduate programs: 1) a bachelor of science program providing training for a career as a professional geologist, which usually requires graduate study (For students interested in resource geology the department offers a mineral exploration and mining option to the bachelor of science.); 2) a liberal arts bachelor of arts program through the College of Liberal Arts; and 3) a program for those interested in teaching earth sciences through the College of Education and Human Service Professions.

**Mathematics and Statistics**

Email: math@d.umn.edu  
Website: www.d.umn.edu/math

Professors: Dalibor Franczek, Joseph A. Gallian, Richard F. Green, Barry R. James, Kang L. James, Zhuangyi Liu (department head), Bruce Peckman, Ronald R. Regal, Harlan W. Stech;  
Associate Professors: Guihua Fei, John R. Greene, Carmen Latterell, Kathryn E. Lenz, Robert L. McFarland, Yongcheng Qi, Steven A. Trogdon;  
Assistant Professors: Diana Colt, Marshall Hampton;  
Instructors: Randi Crenna, Mingqian Duan, Deanna L. Green, Katherine Niedzielski, Chad Pierson, Angela M. Sharp

The Department of Mathematics and Statistics offers undergraduate degree programs in mathematics and statistics/actuarial science. These programs prepare students for careers in business, industry, government, and teaching, as well as for graduate studies in mathematics, statistics, and biostatistics.

**Mechanical and Industrial Engineering**

Email: mie@d.umn.edu  
Website: www.d.umn.edu/mie

Professor: Richard R. Lindeke;  
Associate Professors: Emmanuel U. Enemuoh, Daniel N. Pope, Ryan G. Rosandich (department head), Xun Yu;  
Assistant Professors: Seraphin C. Abou, Bryan Booker, Hongyi Chen, Robert Feyen, Alison Hoxie, Debao Zhou;  
Instructors: Jose Carrillo, Jacob Dryke, David Keranen, Ryan Taylor, Heidi Zierden

The Department of Mechanical and Industrial Engineering offers accredited bachelor of science degrees in mechanical engineering and industrial engineering to prepare graduates to succeed in industrial careers. The department has a strong commitment to undergraduate education; class sizes are moderate, laboratory sections are small, and the majority of lectures and lab sections are taught by our dedicated, award winning faculty. Many courses have a hands-on laboratory component where students get practical experience with a wide variety of industry-grade equipment and software tools in our excellent facilities. The department also offers unique opportunities for study abroad through a strategic partnership with Luleå University of Technology in Sweden.

**Physics**

Email: phys@d.umn.edu  
Website: www.d.umn.edu/physics

Professors: John R. Hiller, Michael Sydor;  
Associate Professors: Jay A. Austin, Alec T. Habig (department head);  
Assistant Professors: Richard W. Gran, Sergei Katsev, Jonathan Maps;  
Instructor: Darrin E. Johnson

The Department of Physics offers two bachelor of science degrees that provide professional preparation in pure and applied physics as well as a liberal arts degree (B.A.). Students are encouraged to participate in research, with emphases in experimental high energy physics and particle astrophysics; limnological research, including observational studies and modeling of lakes; and computational physics. Additional faculty interests include optics and condensed matter physics. The department also offers courses required for other science and engineering programs.
Swenson College of Science and Engineering

Collegiate Graduate Programs

Professional Master of Engineering (M.Eng.) Degree

The Professional Master of Engineering emphasizes the practice of engineering in either the private or public sector. The program focuses on developing competencies in the areas of engineering design, problem solving, and practice beyond what can be achieved in earning a bachelor of science degree in a given engineering discipline.

An M.Eng. graduate student is expected to have a focus and degree designation in one of the core UMD disciplines of chemical engineering, civil engineering, electrical and computer engineering, industrial engineering, or mechanical engineering.

Faculty are members of the Departments of Chemical Engineering, Civil Engineering, Electrical and Computer Engineering, and Mechanical and Industrial Engineering.

Admission Requirements

Prospective students must have:

- Completed an undergraduate degree in an engineering program, or upon approval by the SCSE M.Eng. director of graduate studies, in a related discipline, e.g. computer science, physics, etc.
- Earned an undergraduate GPA of 3.00 (on a 4.00 scale) for admission. This preferred performance minimum of 3.00/4.00 GPA must be from an ABET accredited program or equivalent. Industrial experience and professional licensure will be considered for applicants with a grade point less than the preferred minimum
- Provided two letters of recommendation—academic and/or professional references.

For international applicants whose native language is not English, a TOEFL score preferred performance minimum is 213 on the computer-based test.

The GRE score is recommended but not required.

Application Procedures

Use the web form to apply at www.d.umn.edu/scse/degrees/MEng/application.html and follow the instructions for submittal. A downloadable PDF is also available if you prefer, and should be sent to:

Director of Graduate Studies, M.Eng. Program
Engineering Building 140
Swenson College of Science and Engineering
1303 Ordean Court
University of Minnesota Duluth
Duluth, MN 55812

Degree and Course Requirements

The M.Eng. degree program is primarily a coursework program with a minimum of 3 credits and a maximum of 6 credits allocated to a design project to be arranged between the departmental adviser and student. The 30-credit required minimum includes 14 credits at 5xxx or higher and a cap of 6 credits on 4xxx courses. There is no requirement for a final exam beyond the exams in individual course.

Deviation from the table below must be agreed upon by the department adviser and student. The resultant program of study must then be approved by the department, the SCSE M.Eng. director of graduate studies and forwarded to the UMD Office of Graduate Education for final approval.

All M.Eng. graduate students will have a departmental adviser. Non-faculty, including members of the industrial community, are invited to collaborate and work with the student and departmental adviser.

Any project report or presentation requirement within the 3–6 credit of the engineering course project are at the option of the departmental adviser and department.

Grading System

The grading system for the M.Eng. follows the University of Minnesota Graduate School policies and procedures.

Course Requirements

<table>
<thead>
<tr>
<th>Course Requirements</th>
<th>Semester Credits</th>
<th>Course Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major plan department: ChE, CE, ECE, ME (within MIE), IE (within MIE)</td>
<td>12 minimum</td>
<td>5xxx or 8xxx*, selected 4xxx**</td>
</tr>
<tr>
<td>Engineering course project within the major plan department: ChE, CE, ECE, ME (within MIE), IE (within MIE)</td>
<td>3 to 6</td>
<td>5xxx to be arranged by the departmental adviser and student</td>
</tr>
<tr>
<td>Other engineering***</td>
<td>6 to 9</td>
<td>Selected 4xxx, 5xxx, 8xxx</td>
</tr>
<tr>
<td>Non-engineering***</td>
<td>3 minimum</td>
<td>Graduate courses—approved list</td>
</tr>
<tr>
<td>TOTAL APPROVED CREDITS</td>
<td>30 minimum</td>
<td></td>
</tr>
</tbody>
</table>

* In consultation with their department adviser, students may choose to include one or more 8xxx courses in their program of study. It should be noted that even though there are no requirements for 8xxx courses, M.Eng. students who meet the course prerequisites for 8xxx courses in computer science, electrical and computer engineering, engineering management, and geological science will be encouraged to include these courses in their degree program.

** Identical/similar courses taken as part of an undergraduate degree either at UMD or at another institution cannot be repeated or applied as part of the M.Eng. program. The departmental adviser and SCSE director of graduate studies will work with the student on this issue when setting up the program of study.

*** Courses selected in collaboration with the department adviser.

**** Non-engineering courses would consist of courses approved for graduate credit by the Departments of Biology, Chemistry, Computer Science, Geological Science, Mathematics and Statistics and Physics.
Master of Environmental Health and Safety

Assistant Professors: Seraphin C. Abou, Robert Feyen
(Program Director): Instructors: Harvey Burski, Mike Marturano, Wade Roseth, James Stauber

The Master in Environmental Health and Safety program will produce highly-regarded and sought-after graduates who have the requisite skills and knowledge to practice environmental health and safety effectively in a diverse range of occupations and will do so in a competent, professional, and ethical manner.

Admission Requirements

By the start of the term for which they are applying, all applicants must have:
• a baccalaureate degree from an accredited college or university;
• taken the General Test of the Graduate Record Examination (GRE);
• obtained a minimum score of 550 on the paper based TOEFL (international students only); and
• a grade of C or better in the following prerequisite college introductory coursework: chemistry with a lab component, calculus and statistics.

Preferred applicants will have:
• a baccalaureate degree in a science, engineering, or other E.H.S. related field;
• a cumulative GPA of 3.00 or better;
• work experience related to E.H.S.;
• obtained a minimum combined score of 1,000 on the verbal and quantitative sections of the GRE and a 4.00 on the analytical writing section;
• completed the following coursework: introductory physics, human biology/physiology, and psychology.

Select candidates with either a cumulative GPA between 2.50 and 3.00 or a deficiency in their prerequisite coursework may be offered a probationary one-semester admission. The probationary period is intended to allow these students to demonstrate their potential for successfully completing the degree program. Students admitted on probation must take two core courses; if they obtain an overall GPA of 3.00 or better, they will be offered full admission and allowed to continue taking courses in the program.

Application Procedure

Applicants must submit the following items:
• Application form (see the website, www.d.umn.edu/mehs)
• Official transcript(s) indicating completion of a Baccalaureate degree program and grades obtained in the prerequisite courses
• Resume or CV
• Three letters of recommendation
• GRE General Test scores
• TOEFL score (international students only)
• Answers to essay question on the E.H.S. related scenarios (See website)

An application package must be completed and received by the M.E.H.S. program office no less than one month prior to the term in which the student wishes to enroll. Packages that are not completed or received less than one month prior to the start of a term will be reviewed for admission effective the following term. Applicants are also responsible for obtaining information on and the following any University-level admission deadlines and requirements.

Degree Requirements

Requirements for the M.E.H.S. include:
• 18 core courses in the M.E.H.S. program
• 9 elective course credits as approved for the M.E.H.S. program
• 3 cooperative internship credits, obtained only once an approved Plan B master’s thesis is submitted to the program office within 12 months of completing the 27 course credits (unless a formal extension is granted)
• a cumulative GPA of 3.00 or better at all times
• a minimum of two semesters for the residence requirement

Required Courses

Core (18 credits)
SAFE 6002—Regulatory Standards and Hazard Control (4 cr)
SAFE 6011—System Safety and Loss Control Techniques (4 cr)
SAFE 6012—Risk Management and Workers’ Compensation (4 cr)
SAFE 6021—Principles of Industrial Hygiene (3 cr)
SAFE 6102—Occupational Ergonomics and Injury Management (3 cr)
SAFE 6201—Fire Prevention and Emergency Preparedness (3 cr)
SAFE 6211—Transportation Safety (3 cr)
SAFE 6212—Noise Control Engineering (3 cr)
SAFE 6213—Principles of Ventilation and Indoor Air Quality (3 cr)
SAFE 6291—Independent Study in Industrial Safety (1–3 cr)
SAFE 6295—Special Topics (1–3)
SAFE 6301—Occupational Biomechanics and Work Physiology (3 cr)
SAFE 6401—Environmental Safety and Legal Implications (3 cr)
Degree Programs

Applied Physics B.S.

Physics
Required credits to graduate with this degree: 120.
Required credits within the major: 75 to 77.
The B.S. in applied physics is primarily for students planning to work in industry and offers flexibility in selection of technical electives. The physics courses emphasize conceptual foundations, problem-solving skills, and experimental and computational techniques.

Students are encouraged to participate in research, with emphasis in experimental high-energy physics and particle astrophysics; limnological research, including observational studies and modeling of lakes; and computational physics. Additional faculty interests include optics and condensed matter physics. The department also offers courses required for other science and engineering programs.

Honors Requirements—To graduate with honors, students must participate in the department honors program, complete and present a research project, and maintain a GPA above 3.00 overall and in the major. They are also expected to attend department colloquia. Interested students should contact the physics honors program coordinator.

Admission Requirements
For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements
Requirements for the B.S. in applied physics include:

• Liberal education requirements.
• A minor or a second major in a different program.
The first math course is determined by math placement exam. The sample plan presupposes placement into MATH 1296.

Courses numbered above 3xxx are offered in alternate years only. Some courses suggested in the sample plan for the junior and senior years may need to be switched to match the course offerings.

Core Courses (29 cr)
The department also recommends the supplementary courses PHYS 2111 and PHYS 2112.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 1021</td>
<td>Exploring Current Topics in Physics</td>
<td>1 cr</td>
</tr>
<tr>
<td>PHYS 2011</td>
<td>General Physics I, LE CAT4</td>
<td>4 cr</td>
</tr>
<tr>
<td>PHYS 2012</td>
<td>General Physics II</td>
<td>4 cr</td>
</tr>
<tr>
<td>PHYS 2021</td>
<td>Relativity and Quantum Physics</td>
<td>4 cr</td>
</tr>
<tr>
<td>PHYS 2022</td>
<td>Classical Physics</td>
<td>4 cr</td>
</tr>
<tr>
<td>PHYS 2033</td>
<td>Classical and Quantum Physics Lab</td>
<td>2 cr</td>
</tr>
<tr>
<td>PHYS 3061</td>
<td>Instrumentation</td>
<td>3 cr</td>
</tr>
<tr>
<td>PHYS 5061</td>
<td>Experimental Methods</td>
<td>3 cr</td>
</tr>
</tbody>
</table>

Electives (8 cr)
Take 8 or more credit(s) from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 5090</td>
<td>Physics Seminar</td>
<td>1 cr</td>
</tr>
<tr>
<td>PHYS 5051</td>
<td>Computational Methods in Physics</td>
<td>3 cr</td>
</tr>
<tr>
<td>PHYS 5053</td>
<td>Data Analysis Methods in Physics</td>
<td>3 cr</td>
</tr>
</tbody>
</table>

Technical Electives (9 cr)
The computational course not selected in Core Courses may be used as a technical elective. Engineering courses approved by the department may also be used.

Take 9 or more credit(s) from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AST 4110</td>
<td>Observational Astronomy</td>
<td>3 cr</td>
</tr>
<tr>
<td>LIM 5101</td>
<td>Physical Limnology</td>
<td>3 cr</td>
</tr>
<tr>
<td>PHYS 5041</td>
<td>Optics</td>
<td>3 cr</td>
</tr>
<tr>
<td>PHYS 5531</td>
<td>Introduction to Solid State Physics</td>
<td>3 cr</td>
</tr>
<tr>
<td>PHYS 5541</td>
<td>Fluid Dynamics</td>
<td>3 cr</td>
</tr>
<tr>
<td>PHYS 5501</td>
<td>Computational Methods in Physics</td>
<td>3 cr</td>
</tr>
<tr>
<td>PHYS 5053</td>
<td>Data Analysis Methods in Physics</td>
<td>3 cr</td>
</tr>
<tr>
<td>PHYS 3561</td>
<td>Astrophysics</td>
<td>3 cr</td>
</tr>
</tbody>
</table>

Courses From Other Programs (29–31 cr)
Two semesters of chemistry are recommended.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1296</td>
<td>Calculus I, LE CAT2</td>
<td>5 cr</td>
</tr>
<tr>
<td>MATH 1297</td>
<td>Calculus II</td>
<td>5 cr</td>
</tr>
<tr>
<td>MATH 3280</td>
<td>Differential Equations with Linear Algebra</td>
<td>4 cr</td>
</tr>
<tr>
<td>MATH 3298</td>
<td>Calculus III</td>
<td>4 cr</td>
</tr>
<tr>
<td>WRIT 3150</td>
<td>Advanced Writing: Science</td>
<td>3 cr</td>
</tr>
<tr>
<td>CHEM 1161</td>
<td>Honors: General Chemistry I, LE CAT4</td>
<td>5 cr</td>
</tr>
<tr>
<td>CHEM 1153</td>
<td>General Chemistry I (4 cr)</td>
<td>5 cr</td>
</tr>
<tr>
<td>AST 4110</td>
<td>Observational Astronomy</td>
<td>3 cr</td>
</tr>
<tr>
<td>CS 1131</td>
<td>Introduction to Programming in FORTRAN, LE CAT3</td>
<td>3 cr</td>
</tr>
</tbody>
</table>

Biochemistry and Molecular Biology B.S.

Chemistry and Biochemistry
Required credits to graduate with this degree: 120.
Required credits within the major: 83.

This program requires summer terms.

Biochemistry and molecular biology is the study of life at the molecular level. This field is both a life science and a chemical science, exploring the chemistry of living organisms and the molecular basis for the processes that occur in living cells. The Department of Chemistry and Biochemistry provides classroom and laboratory learning opportunities and research experiences across the discipline to meet the needs of students in engineering, liberal arts and preprofessional programs as well as those of students who wish to pursue careers or graduate studies in chemistry or related disciplines.

Honors Requirements—The Department of Chemistry and Biochemistry honors program helps outstanding biochemistry and molecular biology majors become competent, independent research workers, encourages student interest in the discipline, and aids in the transition from student to working scientist. Qualified majors may apply after the first semester of their sophomore year.
Participants choose a research adviser and complete two semesters on a jointly developed project. Written reports and an oral presentation of the research are also required.

**Admission Requirements**
For information about UMD admission requirements, visit the UMD Admissions website.

**Program Requirements**
Requirements for the B.S. in biochemistry and molecular biology include:

- Liberal education requirements.
- Advanced writing requirement: WRIT 3xxx.
- A minor from another area of study is required.
- Students who earn a B.S. in biochemistry and molecular biology (BMB) will have met the requirements for the B.A. in chemistry and for the chemistry minor. However, neither the BMB major/B.A. chemistry major combination nor the BMB major/chemistry minor combination satisfies the college degree requirement for a second major or minor.
- The B.S. BMB major/B.S. chemistry major combination does satisfy the college degree requirement.
- Students earning a B.S. degree who wish to have their program certified by the American Chemical Society must take advanced courses that include additional hours of laboratory work.

**Year One**
High school algebra and high school chemistry are required for CHEM 1151 and CHEM 1161.

This schedule presupposes placement into MATH 1296.

**BIOL 1011—General Biology I, LE CAT4 (5 cr)**
**BIOL 1012—General Biology II (5 cr)**
**MATH 1296—Calculus I, LE CAT2 (5 cr)**
**MATH 1297—Calculus II (5 cr)**
**CHEM 1161—Honors: General Chemistry I, LE CAT4, H (5 cr)**
or CHEM 1153—General Chemistry I (4 cr)
and CHEM 1154—General Chemistry Lab I (1 cr)
**CHEM 1162—Honors: General Chemistry II, H (5 cr)**
or CHEM 1155—General Chemistry II (4 cr)
and CHEM 1156—General Chemistry Lab II (1 cr)

**Year Two**
**BIOL 2101—Cell Biology (3 cr)**
**CHEM 2541—Organic Chemistry I (3 cr)**
**CHEM 2543—Organic Chemistry I Laboratory (1 cr)**
**CHEM 2544—Organic Chemistry II Laboratory (1 cr)**
**PHYS 2011—General Physics I, LE CAT4 (4 cr)**
**PHYS 2012—General Physics II (4 cr)**
**CHEM 2222—Quantitative Analysis (3 cr)**
and CHEM 2223—Quantitative Analysis Laboratory (1 cr)
**CHEM 2242—Instrumental Analysis (3 cr)**

**Year Three**
**BIOL 2201—Genetics (3 cr)**
**BIOL 4231—Molecular Biology (3 cr)**
**BIOL 5232—Molecular Biology Laboratory (2 cr)**
**CHEM 4351—Biochemistry I (3 cr)**
**CHEM 4352—Biochemistry II (3 cr)**

**Year Four**
**CHEM 4322—Descriptive Inorganic Chemistry (2 cr)**
**CHEM 4184—Undergraduate Seminar I (1 cr)**
**CHEM 4185—Undergraduate Seminar II (1 cr)**
**CHEM 4373—Physical Biochemistry (3 cr)**

**Elective**
Take 3 or more credit(s) from the following:
**CHEM 4242—Instrumental Analysis (3 cr)**
**CHEM 4436—Inorganic Chemistry (3 cr)**
**BIOL 4501—General Microbiology (4 cr)**
**BIOL 4503—General Microbiology offered in Wroclaw, Poland (4 cr)**
**IBS 5101—Biochemistry and Molecular Biology (3 cr)**
**MATH 5233—Mathematical Foundations of Bioinformatics (3 cr)**
**MDBC 5201—Topics in Biochemistry (3 cr)**
**MDBC 5202—Cellular and Molecular Biology (3 cr)**
**MICB 5545—Immunobiology (3 cr)**

**Biology B.S.**

**Biology**
Required credits to graduate with this degree: 120.
Required credits within the major: 78 to 84.

The B.S. in biology offers preparation for graduate school and a sound basis for professional training in the biological and health sciences. Biology is an unusually broad field, and students can tailor their programs to fit their own needs and interests. To provide flexibility in pursuing personal interests or career preparation, the student chooses 18 credits of upper division biology electives.

The Department of Biology encourages students to develop as active scholars and to participate in undergraduate research. The B.S. degree is detailed and specific with a concentration in science related coursework.

**Admission Requirements**
For information about UMD admission requirements, visit the UMD Admissions website.

**Program Requirements**
Requirements for the B.S. in biology include:

- Liberal education requirements.
- A minor or second major from another area of study; the cell biology major may not be used to meet this requirement.
- Exit interview.

**Biology Core Courses (25 cr)**
**BIOL 1011—General Biology I, LE CAT4 (5 cr)**
**BIOL 1012—General Biology II (5 cr)**
**BIOL 2101—Cell Biology (3 cr)**
**BIOL 2201—Genetics (3 cr)**
**BIOL 2801—General Ecology (3 cr)**
**BIOL 3987—Biology Seminar (1 cr)**
**BIOL 4802—Evolution (3 cr)**
**BIOL 2102—Cell Biology Laboratory (2 cr)**
or BIOL 2202—Genetics Laboratory (2 cr)
or BIOL 2802—Ecology Laboratory (2 cr)

**Chemistry Requirement (17-18 cr)**
**CHEM 2541—Organic Chemistry I (3 cr)**
**CHEM 2543—Organic Chemistry I Laboratory (1 cr)**
General Chemistry
CHEM 1153—General Chemistry I (4 cr)
CHEM 1154—General Chemistry Lab I (1 cr)
CHEM 1155—General Chemistry II (4 cr)
CHEM 1156—General Chemistry Lab II (1 cr)
or CHEM 1161—Honors: General Chemistry I, LE CAT4, H (5 cr)
and CHEM 1162—Honors: General Chemistry II, H (5 cr)

Additional Chemistry
CHEM 2212—Environmental Chemistry (4 cr)
or GEOG 3710—Introduction to Geochemistry (3 cr)
or CHEM 2222—Quantitative Analysis (3 cr)
and CHEM 2223—Quantitative Analysis Laboratory (1 cr)
or CHEM 2542—Organic Chemistry II (3 cr)
and CHEM 2544—Organic Chemistry II Laboratory (1 cr)

Biology Electives 2xxx–5xxx (18 cr)
Take 18 credits from BIOL 2xxx, 3xxx, 4xxx, 5xxx:
BIOL 2xxx or above must include a minimum of two lab courses or courses with a lab component. At least one of these must be BIOL 3601, BIOL 3701, or (BIOL 4501 or BIOL 4503). Two of the following may be used: MDBC 5501, MICB 5545, MICB 5555, PHSL 5601, PHSL 5602.
Two credits of SSP 3002—Teaching Assistant Practicum for supplemental instruction in biology may be substituted for BIOL 3993 an upper division elective with department approval.

Courses From Other Programs (18–23 cr)
First math course is determined by math placement exam. This schedule presupposes placement into MATH 1290/1296. Courses cannot be used to fulfill more than one category.
WRIT 3150—Advanced Writing: Science (3 cr)

Mathematics requirement
MATH 1290—Calculus for the Natural Sciences, LE CAT2 (5 cr)
or MATH 1296—Calculus I, LE CAT2 (5 cr)
or MATH 1596—Honors: Calculus I, LE CAT2, H (5 cr)
and MATH 1297—Calculus II (5 cr)
or STAT 2411—Statistical Methods, LE CAT2 (3 cr)

Physics requirement
PHYS 1001—Introduction to Physics I, LE CAT4 (5 cr)
or PHYS 2011—General Physics I, LE CAT4 (4 cr)
and PHYS 1002—Introduction to Physics II (5 cr)
or PHYS 2012—General Physics II (4 cr)
or CS 1121—Introduction to Programming in Visual BASIC. NET, LE CAT3 (3 cr)
or MATH 1297—Calculus II (5 cr)
or STAT 2411—Statistical Methods, LE CAT2 (3 cr)

Biology Minor

Biology Minor Related to a Major
Required credits in this minor: 35.
Biology has long been recognized as basic to such important areas as environment, agriculture, and medicine.

Minor Requirements
Biology Minor Courses
BIOL 1011—General Biology I, LE CAT4 (5 cr)
BIOL 1012—General Biology II (5 cr)
BIOL 2101—Cell Biology (3 cr)
BIOL 2201—Genetics (3 cr)
BIOL 2801—General Ecology (3 cr)
BIOL 4802—Evolution (3 cr)

Chemistry
CHEM 2541—Organic Chemistry I (3 cr)
CHEM 1151—General Chemistry I, LE CAT4 (5 cr)
or CHEM 1161—Honors: General Chemistry I, LE CAT4, H (5 cr)
CHEM 1152—General Chemistry II (5 cr)
or CHEM 1162—Honors: General Chemistry II, H (5 cr)

Biomedical Sciences B.S.
Swenson College of Science and Engineering, Duluth School of Medicine—Adm
Required credits to graduate with this degree: 90.
Required credits within the major: 90.
Refer to the College of Science and Engineering Student Affairs Office or the University of Minnesota Medical School Duluth Student Affairs Office.

Admission Requirements
For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements
See the College of Science and Engineering Student Affairs Office or the University of Minnesota Medical School Duluth Student Affairs Office.

Individualized Program
Individualized Plan

Cell and Molecular Biology B.S.
Biology
Required credits to graduate with this degree: 120.
Required credits within the major: 81 to 91.
This program requires summer terms.
Cell and molecular biology are two of the most rapidly growing areas of modern biology. This major prepares students for graduate school and careers in cell biology, genetics, developmental biology, physiology, immunology, biotechnology, molecular biology and microbiology. The major is also appropriate for students considering professional schools of medicine, dentistry, pharmacy, and veterinary medicine.
The program is administered by the Department of Biology and involves faculty in both the Swenson College of Science and Engineering and the Medical School Duluth.

Admission Requirements
For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements
Requirements for the B.S. in cell biology include:
• Liberal education requirements.
• A minor or second major from another area of study; biology may not be used to satisfy this requirement.
Biology Core Courses (30–32 cr)
BIOL 1011—General Biology I, LE CAT4 (5 cr)
BIOL 1012—General Biology II (5 cr)
BIOL 2101—Cell Biology (3 cr)
BIOL 2201—Genetics (3 cr)
BIOL 3987—Biological Seminar (1 cr)
BIOL 4231—Molecular Biology (3 cr)
BIOL 4802—Evolution (3 cr)
BIOL 5232—Molecular Biology Laboratory (2 cr)
BIOL 2102—Cell Biology Laboratory (2 cr)
or BIOL 2202—Genetics Laboratory (2 cr)
BIOL 3703—Animal Physiology (3 cr)
or BIOL 4361—Developmental Biology (3 cr)
or BIOL 4501—General Microbiology (4 cr)
or BIOL 4503—General Microbiology offered in Wroclaw, Poland (4 cr)
or BIOL 4603—Plant Physiology (3 cr)
and BIOL 5603—Plant Physiology Laboratory (2 cr)

Courses From Other Programs (41–49 cr)

General Chemistry
CHEM 1153—General Chemistry I (4 cr)
CHEM 1154—General Chemistry Lab I (1 cr)
CHEM 1155—General Chemistry II (4 cr)
CHEM 1156—General Chemistry Lab II (1 cr)
or CHEM 1161—Honors: General Chemistry I, LE CAT4, H (5 cr)
and CHEM 1162—Honors: General Chemistry II, H (5 cr)

Organic Chemistry
CHEM 2541—Organic Chemistry I (3 cr)
CHEM 2542—Organic Chemistry II (3 cr)
CHEM 2543—Organic Chemistry I Laboratory (1 cr)
CHEM 2544—Organic Chemistry II Laboratory (1 cr)

Biochemistry
CHEM 3322—Biochemistry (3 cr)
and CHEM 3324—Biochemistry Laboratory (1 cr)
or CHEM 4351—Biochemistry I (3 cr)
and CHEM 4352—Biochemistry II (3 cr)
and CHEM 4363—Biochemistry Laboratory (2 cr)

Mathematics
MATH 1290—Calculus for the Natural Sciences, LE CAT2 (5 cr)
or MATH 1296—Calculus I, LE CAT2 (5 cr)
or MATH 1596—Honors: Calculus I, LE CAT2, H (5 cr)
MATH 1297—Calculus II (5 cr)
or MATH 1597—Honors: Calculus II, H (5 cr)
or STAT 2411—Statistical Methods, LE CAT2 (3 cr)
or STAT 3611—Introduction to Probability and Statistics (4 cr)

Physics
PHYS 1001—Introduction to Physics I, LE CAT4 (5 cr)
and PHYS 1002—Introduction to Physics II (5 cr)
or PHYS 2011—General Physics I, LE CAT4 (4 cr)
and PHYS 2012—General Physics II (4 cr)

Advanced composition
WRIT 3150—Advanced Writing: Science (3 cr)

Electives (10 cr)
If more than one lab elective (2102, 2202) or cell biology core course(s) 3703, 4361, 4603, (4501 or 4503) are taken the excess may be used for cell biology elective credits. BIOL 3990 and 5990 are accepted for cell biology elective credits only by department approval. Two credits of SSP 3002—TA Practicum Supplemental Instruction in Biology may be substituted for BIOL 3993 as elective credit. Courses cannot be used to fulfill more than one requirement in the major.

Take 10 or more credit(s) from the following:

Cell Biology Electives
Take 5 or more credit(s) from the following:
BIOL 2102—Cell Biology Laboratory (2 cr)
BIOL 2202—Genetics Laboratory (2 cr)
BIOL 3101—Molecular Biology of Cancer (3 cr)
BIOL 3301—Patterning the Embryo (3 cr)
BIOL 3703—Animal Physiology (3 cr)
BIOL 4199—Frontiers in Cell Biology (2 cr)
BIOL 4361—Developmental Biology (3 cr)
BIOL 4511—Medical Microbiology (3 cr)
BIOL 4603—Plant Physiology (3 cr)
BIOL 4807—Plant Physiological Ecology offered in Poland (4 cr)
BIOL 5235—Biotechnology (4 cr)
BIOL 5515—Microbial Diversity and Phylogeny (3 cr)
BIOL 5603—Plant Physiological Ecology Laboratory (2 cr)
BIOL 5772—Mechanisms of Neural Behavior (3 cr)
BIOL 5801—Microbial Ecology (2 cr)
BIOL 5802—Microbial Ecology Laboratory (2 cr)
BIOL 5868—Ecotoxicology (3 cr)
BIOL 4501—General Microbiology (4 cr)
or BIOL 4503—General Microbiology offered in Wroclaw, Poland (4 cr)

Non-Cell Biology Electives
Take 0 or more course(s) totaling 0 or more credit(s) from the following:
BIOL 2763—Biology of Women, LECD CAT5 (2 cr)
BIOL 2769—Human Anatomy (4 cr)
BIOL 2801—General Ecology (3 cr)
BIOL 2802—Ecology Laboratory (2 cr)
BIOL 3601—Plant Diversity (3 cr)
BIOL 3603—Plant Taxonomy (3 cr)
BIOL 3701—Animal Diversity (4 cr)
BIOL 3760—Marine Biology (3 cr)
BIOL 3993—Laboratory Teaching Experience (1–2 cr)
BIOL 3994—Undergraduate Research (1–3 cr)
BIOL 3996—Internship in Biology (1–2 cr)
BIOL 4731—Entomology (3 cr)
BIOL 4761—Ichthyology (3 cr)
BIOL 4763—Ornithology (3 cr)
BIOL 4764—Mammalogy (3 cr)
BIOL 4803—Ecology Field Methods: Identification and Natural History of Terrestrial and Aquatic Organisms (4 cr)
BIOL 4805—Ecological Invasions (2 cr)
BIOL 4891—Animal Behavior (2 cr)
BIOL 5240—Ecological Genetics (3 cr)
BIOL 5401—Coevolution of Plants, Animals and Microbes (3 cr)
BIOL 5777—Plankton Biology (2 cr)
BIOL 5805—Fisheries Ecology (3 cr)
BIOL 5807—Mathematical Ecology (3 cr)
BIOL 5808—Landscape Ecology: Theory and Application (3 cr)
BIOL 5811—Plant Tissue Culture (2 cr)
BIOL 5833—Stream Ecology (4 cr)
BIOL 5839—Coral Reef Field Studies (3 cr)
BIOL 5861—Lake Ecology (3 cr)
BIOL 5862—Advanced Lake Ecology (3 cr)
BIOL 5863—Ecosystems Ecology (3 cr)
BIOL 5865—Conservation Biology (2 cr)
BIOL 5866—Algal Ecology and Physiology (3 cr)
BIOL 5870—Wetland Ecology (3 cr)
MATH 5233—Mathematical Foundations of Bioinformatics (3 cr)
MDBC 5501—Neurobiology (2 cr)
MICB 5545—Immunobiology (3 cr)
MICB 5555—Molecular Pathogenesis: Current Concepts (3 cr)
PHSL 5601—Phylogeny of Organ Systems I (4 cr)
PHSL 5602—Phylogeny of Organ Systems II (2 cr)
Swenson College of Science and Engineering

Chemical Engineering B.S.Ch.E.

Chemical Engineering

Required credits to graduate with this degree: 128.

Required credits within the major: 112.

Vision—The Department of Chemical Engineering strives for nationally recognized excellence in engineering education and research by using modern, hands-on, and active learning experiences to prepare undergraduate students for professional success, and to hold paramount the safety, health and welfare of the public an protect the environment in performance of their professional duties.

Mission—The Department of Chemical Engineering produces engineers with a strong foundation of technical, communication, teamwork, and problem-solving skills required for professional success, consisted with the following objectives.

1. Pursue careers where they apply their engineering and problem solving skills.
2. Pursue advanced studies or other forms of continuing education.
3. Value their UMD chemical engineering education and endorse the program and its students.

This four-year baccalaureate (B.S.Ch.E.) degree program emphasizes the development of the student's ability to analyze and design chemical processing systems. By the end of the program, the student must demonstrate the ability to solve engineering problems, a sensitivity to the social and environmental impacts of the engineering profession, and the ability to maintain a high level of competency.

Chemical engineering graduates are qualified for employment in diverse industries, ranging from those that manufacture inorganic chemicals, petrochemicals, plastics, synthetic fibers, paper and pulp, and pharmaceuticals to those that process minerals, materials, and hazardous wastes.

Graduates are qualified for assignments that include plant operations, process development, process control, project engineering, or technical sales, and frequently pursue engineering management later in their careers. They are also well qualified to continue with professional or graduate education.

The chemical engineering curriculum is based on fundamental sciences including physics, chemistry, and mathematics; traditional chemical engineering sciences such as material and energy balance, transport phenomena, and thermodynamics; and chemical engineering design courses such as reaction engineering, separations, and unit operations, with a capstone design course during the senior year. Students have an opportunity to become involved in research, through either the Undergraduate Research Opportunities Program or the department honors program.

Honors Requirements—To graduate with department honors, students must have a minimum 3.50 GPA and be nominated by the chemical engineering faculty.

Admission Requirements

Students may declare a chemical engineering major as freshmen or sophomores.

Students must complete the majority of the program's lower division requirements (freshman and sophomore years), including CHE 2111, CHEM 2541, MATH 3280, and PHYS 2012, before applying for admission to upper division (junior and senior years). Successful completion of CHE 2111 (with a grade of C+ or better) is required for admission to upper division. Admission is competitive and applicants are admitted on a space-available basis, with priority determined by the cumulative GPA in engineering, physics, mathematics, and chemistry through CHEM 2541.

For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements

Requirements for the B.S.Ch.E:

- 35 credits of liberal education requirements.
- At least 8 credits of advanced chemistry. Courses must be CHEM 25xx (or higher) and may not be satisfied with CHEM 4184, 4185, or 4634.
- At least 10 credits of science or engineering electives, subject to department approval. Must be 2xxx or higher; only 1 2xxx course is allowed; at least 1 course must be 4xxx or higher; maximum of 3 credits of COOP and internship credits allowed; may not be used to satisfy advanced chemistry elective requirements.
- Completion at UMD of at least half of the 3xxx and higher courses required for the degree. Study-abroad credits earned through courses taught by UM faculty and at institutions with which UMD has international exchange programs may be used to fulfill this requirement.
- A 2.00 minimum GPA in all work attempted at UMD; 2.00 minimum GPA in all work, including transfer credits.
- A 2.00 minimum GPA in all courses taken in the chemical engineering major, including required courses in related fields. GPA requirement applies to all courses in the major taken at UMD calculated separately and to all courses in the major when transfer credits are included.

Year One (33 cr)

First math course is determined by math placement exam. This schedule presupposes placement into MATH 1296.

CHE 1011—Introduction to Chemical Engineering, LE CAT5 (3 cr)
CS 1121—Introduction to Programming in Visual BASIC.NET, LE CAT3 (3 cr)
PHYS 2011—General Physics I, LE CAT4 (4 cr)
WRIT 1120—College Writing, LE CAT1 (3 cr)
CHEM 1151—Honors: General Chemistry I, LE CAT4, H (5 cr)
or CHEM 1153—General Chemistry I (4 cr)
and CHEM 1154—General Chemistry Lab I (1 cr)
CHEM 1161—Honors: General Chemistry II, H (5 cr)
or CHEM 1155—General Chemistry II (4 cr)
and CHEM 1156—General Chemistry Lab II (1 cr)
MATH 1295—Calculus I, LE CAT2 (5 cr)
or MATH 1595—Honors: Calculus I, LE CAT2, H (5 cr)
MATH 1297—Calculus II, LE CAT2 (5 cr)
or MATH 1597—Honors: Calculus II, H (5 cr)

www.catalogs.umn.edu/umd
Chemistry B.S.

Chemistry and Biochemistry

Required credits to graduate with this degree: 120.

Chemistry is a body of knowledge that helps explain the physical world and its processes. Chemists study substances—their composition, structures, properties, and reactions. The Department of Chemistry and Biochemistry provides classroom and laboratory learning opportunities and research experiences across the discipline designed to meet the needs of students in engineering, liberal arts and preprofessional programs as well as those who wish to pursue careers or graduate studies in chemistry or related disciplines.

Honors Requirements—The Department of Chemistry and Biochemistry honors program helps outstanding chemistry majors develop into competent, independent research workers, encourages student interest in the discipline, and aids in the transition from student to working scientist. Qualified majors may apply after the first semester of their sophomore year. Participants choose a research adviser and complete two semesters on a jointly developed project.

Written reports and an oral presentation of the research are also required.

Admission Requirements

For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements

Requirements for the B.S. in chemistry include:

• Liberal education requirement.
• A minor from another area of study.
• The B.S. Chemistry major/B.S. BMB major combination satisfies the college degree requirement for a second major or minor.
• Students earning a B.S. degree who wish to have their program certified by the American Chemical Society must take advanced courses that include additional hours of laboratory work.

Year One (20 cr)

High school algebra and high school chemistry are required for CHEM 1153, CHEM 1154 and CHEM 1161. This schedule presupposes placement into MATH 1296.

MATH 1296—Calculus I, LE CAT2 (5 cr)
MATH 1297—Calculus II (5 cr)
CHEM 1153—General Chemistry I, LE CAT4, H (5 cr)
CHEM 1154—General Chemistry I (4 cr)
CHEM 1155—General Chemistry II (4 cr)
CHEM 1156—General Chemistry II Lab I (1 cr)
CHEM 1162—Honors: General Chemistry II, H (5 cr)
CHEM 1155—General Chemistry II (4 cr)
CHEM 1156—General Chemistry II Lab I (1 cr)

Year Two (25 cr)

CHEM 2541—Organic Chemistry I (3 cr)
CHEM 2542—Organic Chemistry II (3 cr)
CHEM 2543—Organic Chemistry I Laboratory (1 cr)
CHEM 2545—Organic Chemistry II Laboratory for B.S. Chemistry Majors (2 cr)
CHEM 2223—Quantitative Analysis Laboratory (1 cr)
CHEM 2222—Quantitative Analysis (3 cr)
CHEM 2223—Quantitative Analysis Laboratory (1 cr)
CHEM 2242—Analytical Chemistry and the Environment in Poland (4 cr)

Year Three (14 cr)

CHEM 3322—Biochemistry (3 cr)
CHEM 3324—Biochemistry Laboratory (1 cr)
CHEM 3432—Descriptive Inorganic Chemistry (2 cr)
CHEM 4641—Physical Chemistry I (3 cr)
CHEM 4642—Physical Chemistry II (3 cr)
CHEM 4643—Physical Chemistry Laboratory I (1 cr)
CHEM 4644—Physical Chemistry Laboratory II (1 cr)

Year Four (11 cr)

CHEM 4644—Physical Chemistry Laboratory II (1 cr)

Course From Other Program (3 cr)

Advanced Writing 31xx
Chemistry Minor
Chemistry and Biochemistry

Minor Related to a Major

Required credits in this minor: 29 to 30.
Chemistry is a body of knowledge that helps explain the physical world and its processes.

Minor Requirements
Chemistry Minor Courses
CHEM 2541—Organic Chemistry I (3 cr)
CHEM 2542—Organic Chemistry II (3 cr)
CHEM 2544—Organic Chemistry II Laboratory (1 cr)
CHEM 1151—General Chemistry I, LE CAT4 (5 cr)
or CHEM 1161—Honors: General Chemistry I, LE CAT4, H (5 cr)
CHEM 1152—General Chemistry II (5 cr)
or CHEM 1162—Honors: General Chemistry II, H (5 cr)
Take the following course pair or course.
CHEM 2222—Quantitative Analysis (3 cr)
and CHEM 2223—Quantitative Analysis Laboratory (1 cr)
or CHEM 2212—Environmental Chemistry (4 cr)
or CHEM 2242—Analytical Chemistry and the Environment in Poland (4 cr)
Take 1 or more course(s) from the following:
CHEM 3222—Biochemistry (3 cr)
CHEM 4351—Biochemistry I (3 cr)
CHEM 4634—Physical Chemistry (3 cr)
CHEM 4641—Physical Chemistry I (3 cr)
Take 1 or more course(s) from the following:
MATH 1296—Calculus I, LE CAT2 (5 cr)
MATH 1297—Calculus II (5 cr)
MATH 3298—Calculus III (4 cr)
CHEM 1153—General Chemistry I (4 cr)
CHEM 1154—General Chemistry Lab I (1 cr)
CHEM 1163—Honors: General Chemistry I (4 cr)
CHEM 1164—Honors: General Chemistry Lab I (1 cr)
CHEM 2543—Organic Chemistry I Laboratory (1 cr)
CHEM 2544—Organic Chemistry II Laboratory (1 cr)
CHEM 2630—Analytical Chemistry (5 cr)
CHEM 2631—Analytical Chemistry Laboratory (2 cr)
Take one course from the following:
CHEM 1154—General Chemistry I (4 cr)
or CHEM 1164—Honors: General Chemistry I (4 cr)
MATH 1296—Calculus I, LE CAT2 (5 cr)
MATH 1297—Calculus II (5 cr)
MATH 3298—Calculus III (4 cr)
CHEM 1153—General Chemistry I (4 cr)
CHEM 1154—General Chemistry Lab I (1 cr)
CHEM 1154—General Chemistry Lab I (1 cr)
CHEM 1163—Honors: General Chemistry I (4 cr)
CHEM 1164—Honors: General Chemistry Lab I (1 cr)
CHEM 2543—Organic Chemistry I Laboratory (1 cr)
CHEM 2544—Organic Chemistry II Laboratory (1 cr)
CHEM 2630—Analytical Chemistry (5 cr)
CHEM 2631—Analytical Chemistry Laboratory (2 cr)
Take one course from the following:
CHEM 1154—General Chemistry I (4 cr)
or CHEM 1164—Honors: General Chemistry I (4 cr)
MATH 1296—Calculus I, LE CAT2 (5 cr)
MATH 1297—Calculus II (5 cr)
MATH 3298—Calculus III (4 cr)
CHEM 1153—General Chemistry I (4 cr)
CHEM 1154—General Chemistry Lab I (1 cr)
CHEM 1154—General Chemistry Lab I (1 cr)
CHEM 1163—Honors: General Chemistry I (4 cr)
CHEM 1164—Honors: General Chemistry Lab I (1 cr)
CHEM 2543—Organic Chemistry I Laboratory (1 cr)
CHEM 2544—Organic Chemistry II Laboratory (1 cr)
CHEM 2630—Analytical Chemistry (5 cr)
CHEM 2631—Analytical Chemistry Laboratory (2 cr)
Take one course from the following:
CHEM 1154—General Chemistry I (4 cr)
or CHEM 1164—Honors: General Chemistry I (4 cr)
MATH 1296—Calculus I, LE CAT2 (5 cr)
MATH 1297—Calculus II (5 cr)
MATH 3298—Calculus III (4 cr)
Chemistry and Biochemistry

Civil Engineering B.S.C.E.

Civil Engineering

Required credits to graduate with this degree: 130.

Required credits within the major: 130.

This program requires summer terms.

The B.S.C.E. program integrates topics from chemistry, physics, advanced mathematics and statistics, geology, and core engineering science to prepare graduates to work professionally in both public and private organizations that design, develop, and construct structures; design, build, and maintain highway systems; and design, operate, and control water resource systems. Graduates are rooted in safe and efficient design skills and show respect for and strive to improve the environment wherever they work.

The program emphasizes four of the core tracks in civil engineering: transportation systems, water resource engineering, structural engineering, and geotechnical engineering. Upper division students are exposed to each of these areas and required to specialize in one by taking additional elective courses.

Civil engineering graduates are qualified for employment in a wide variety of organizations, both public and private, including design, material testing and manufacture, construction, transportation, natural resources development, and energy. Graduates are prepared to begin their first step toward professional registration by taking the FE exam before completing their collegiate degree. They also are well qualified to continue with graduate education in civil engineering or engineering management.

Students in the B.S.C.E. program have the opportunity to put their design and entrepreneurial skills to use in ASCE design competitions, projects sponsored by regional companies, and research projects in the Undergraduate Research Opportunities Program.

Honors Requirements—To graduate with department honors, a student must have a 3.40 GPA, be an active member of Tau Beta Pi or a professional engineering society (ASCE) and be nominated by a department faculty member.

Admission Requirements

Students must complete 9 courses before admission to the program.

Freshmen and transfer students are usually admitted to pre-major status before admission to this major.

A GPA above 2.00 is preferred for the following:

• 2.50 for students already admitted to the degree-granting college.
• 2.50 for students transferring from another University of Minnesota college.
• 2.50 for students transferring from outside the University.

Students need to apply to the B.S.C.E. upper division program during the second semester of their sophomore year. Those who meet the GPA requirements for admission at the end of their third semester (first semester of sophomore year) will be granted provisional admission to the upper division program pending their successful completion of all courses remaining listed below with a cumulative GPA that meets the required level (2.50).

For information about UMD admission requirements, visit the UMD Admissions website.

Course Admission Requirements (35 cr)

Admission to the upper division B.S.C.E. program is competitive and based on performance in lower division courses and space availability. A C- or better is required in all program courses.

CE 1025—Introduction to Civil Engineering (1 cr)
CHEM 1153—General Chemistry I (4 cr)
CHEM 1154—General Chemistry Lab I (1 cr)
CS 1121—Introduction to Programming in Visual BASIC.NET, LE CAT3 (3 cr)
MATH 1296—Calculus I, LE CAT2 (5 cr)
MATH 1297—Calculus II (5 cr)
PHYS 2011—General Physics I, LE CAT4 (4 cr)
WRIT 1120—College Writing, LE CAT1 (3 cr)
MATH 3280—Differential Equations with Linear Algebra (4 cr)
or MATH 3298—Calculus III (4 cr)

Program Requirements

• Liberal education program requirements.
• Each graduate must complete a minimum of 2 elective courses in their focus area: structural engineering, water resources engineering, transportation engineering, geotechnical engineering.
B.S.C.E. Major Requirements (40 cr)
CE 3015—CAD and Engineering Drawing (3 cr)
CE 3016—Surveying (2 cr)
CE 3026—Project Management (3 cr)
CE 3027—Infrastructure Materials (4 cr)
CE 3115—Structural Analysis (3 cr)
CE 3225—Hydraulics and Hydrology (4 cr)
CE 336—Transportation Engineering (4 cr)
CE 3425—Engineering Geology (3 cr)
CE 3426—Soil Mechanics (4 cr)
CE 4155—Senior Design I (3 cr)
CE 4255—Senior Design II (3 cr)
PHYS 2012—General Physics II (4 cr)

Additional B.S.C.E. Requirements (25 cr)
MATH 3280 and MATH 3298 must be completed, whichever course was not taken for admission to the civil engineering program must be taken for the B.S.C.E.
CE 3221—Fluid Mechanics (3 cr)
COMM 1112—Public Speaking, LE CAT6 (3 cr)
STAT 3411—Engineering Statistics (3 cr)
SW 1210—Global Issues, LEIP CAT8 (3 cr)
WRIT 31xx
ECON 1022—Principles of Economics: Macro, LE CAT6 (3 cr)
or ECON 1023—Principles of Economics: Micro, LE CAT6 (3 cr)
CE 3025—Environmental Engineering (3 cr)
or CHE 2001—Introduction to Environmental Engineering (3 cr)
MATH 3280—Differential Equations with Linear Algebra (4 cr)
or MATH 3298—Calculus III (4 cr)

Civil Engineering Technical Electives
Choose 5 courses for 15 credits from the focus groups listed below. At least 2 courses must be taken from the same focus group. An additional 6 credits of general technical electives must be taken and can be chosen from any course in the Swenson College of Science and Engineering at 2xxx or above (including CE courses not already counted toward the degree). CHEM 1152 can also be used to fulfill a portion of the general technical elective requirement.

Students are required to complete one of the following course groups.

Structures Focus Group
Take 0 or more course(s) from the following:
CE 4115—Design of Steel Structures (3 cr)
CE 4126—Design of Concrete Structures (3 cr)
CE 4137—Advanced Structural Analysis and Design (3 cr)
CE 5115—Structural Dynamics (3 cr)
CE 5126—Prestressed Concrete Structures (3 cr)
CE 5127—Bridge Analysis and Design (3 cr)
CE 5410—Finite Element Methods for Civil Engineering Applications (3 cr)
CE 5515—Sustainable Design and Construction (3 cr)

Water Resources Focus Group
Take 0 or more course(s) from the following:
CE 4215—Coastal and Marine Engineering (3 cr)
CE 4226—Water Resources (3 cr)

Transportation Engineering Focus Group
Take 0 or more course(s) from the following:
CE 4315—Traffic Systems Operations and Safety (3 cr)
CE 4326—Highway Planning and Design (3 cr)
CE 5315—Traffic Flow Theory and Modeling (3 cr)

Geotechnical Engineering Focus Group
Take 0 or more course(s) from the following:
CE 4415—Geotechnical Design (3 cr)
CE 4426—Rock Mechanics (3 cr)
CE 4436—Design of Underground and Surface Excavations in Rock (3 cr)

Computer Information Systems B.S.

Computer Science
Required credits to graduate with this degree: 120.
Required credits within the major: 78.
Professionals in the field of information systems work with information technology and must have sound technical knowledge of computers, software, and communications. Since they operate within an organizational framework, they must also understand business and business functions. The B.S. in computer information systems is a four-year program that includes formal courses in information technology (including system architecture, operating systems, interactive multimedia computing, and networking), management information systems, project organization and management, and business organizational functions. The program also includes supporting courses in communications, mathematics and statistics, and the economic, social, and ethical implications of computing. Goals of the learning process include the development of good software development and communication skills and the ability to work effectively in team environments. This program provides both the necessary foundational studies for students seeking entry-level positions in information systems and a strong basis for continued career growth.

This program is appropriate for students seeking a professional career in the computer information systems field. It is a multidisciplinary program that emphasizes the study of systems development methodology and technology for our rapidly changing information society.

Graduates are prepared for positions in the design and development of information systems as project managers, information systems center specialists, network administrators, and database administrators. This major is also appropriate preparation for information systems graduate programs or MBA professional programs.

Admission Requirements
For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements
Requirements for the B.S. in computer information systems include:

• Liberal education requirements.
• Advanced writing requirement: WRIT 3121—Advanced Writing: Business and Organization or WRIT 3130—Advanced Writing: Engineering or WRIT 3150—Advanced Writing: Science (3).
• Minor in business administration.
• Exit interview before graduation.

Computer Information Systems Core Courses
CS 1521—Computer Science II (5 cr)
CS 2511—Software Analysis and Design (4 cr)
CS 3011—Information Technology Hardware and Software (4 cr)
FMIS 2201—Information Technology in Business (3 cr)
CS 1511—Computer Science I, LE CAT3 (5 cr)
or CS 1581—Honors: Computer Science I, LE CAT3, H (5 cr)

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Advanced Courses
- CS 3111—Computer Ethics (4 cr)
- CS 3121—Interactive Multimedia Technology (4 cr)
- CS 3211—Database System Concepts (4 cr)
- CS 3221—Operating Systems Practicum (4 cr)
- CS 4411—Data Communications and Network Technology (4 cr)
- CS 4531—Software Engineering (4 cr)

Additional Requirements
Additional requirements also include completing a business administration minor for non-LSBE students.
- COMM 1112—Public Speaking, LE CAT3 (3 cr)
- MATH 1296—Calculus I, LE CAT2 (5 cr)
- STAT 3611—Introduction to Probability and Statistics (4 cr)
- 21 credits of electives in the humanities, social sciences, and the arts

Computer Information Systems Minor

Computer Science
Minor Related to a Major
Required credits in this minor: 29.
The computer information systems minor is not available to computer science majors.

Minor Requirements
Core Courses
- CS 1511—Computer Science I, LE CAT3 (5 cr)
- CS 1521—Computer Science II (5 cr)
- CS 2511—Software Analysis and Design (4 cr)
- CS 3011—Information Technology Hardware and Software (4 cr)
- FMIS 2201—Information Technology in Business (3 cr)

Electives
Take 2 or more course(s) totaling no more than 8 credit(s) from the following:
- CS 3121—Interactive Multimedia Technology (4 cr)
- CS 3211—Database System Concepts (4 cr)
- CS 3221—Operating Systems Practicum (4 cr)
- CS 4411—Data Communications and Network Technology (4 cr)
- CS 4531—Software Engineering (4 cr)

Computer Science B.S.

Computer Science
Required credits to graduate with this degree: 120.
Required credits within the major: 89 to 94.

Computer science is a discipline that requires understanding the design of computers and computational processes. The B.S. in computer science is an accredited, four-year program that provides a solid foundation in mathematics and statistics, computational problem solving, software design and analysis, programming languages, algorithms, data structures, and computer organization and architecture. The program also requires that students acquire significant knowledge in several subdisciplines of computer science, thus enabling them to apply and situate their knowledge of computer science fundamentals. Goals of the learning process include highly developed programming skills, an understanding of the context in which computing activities occur, and an ability to communicate effectively. The program provides the necessary foundational studies for students preparing for graduate school as well as those seeking careers in industry.

The program is accredited by the Computing Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone: 410-347-7700.

Honors Requirements—Program candidates submit an application to the department honors committee. Participants must maintain a 3.00 cumulative GPA and a 3.30 GPA in the major and complete an honors research project supervised by a faculty member; credit for the project can be earned in CS 4994—Honors Project.

Admission Requirements
For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements
Requirements for the B.S. in computer science include:
• Liberal education requirements.
• Senior survey, contact the computer science office for details.
• A minor or a second major from another department.

Core Courses (22 cr)
- CS 1511—Computer Science I, LE CAT3 (5 cr)
- CS 2511—Software Analysis and Design (4 cr)
- CS 2521—Computer Organization and Architecture (4 cr)
- ECE 1315—Digital System Design (4 cr)
- CS 1511—Computer Science I, LE CAT3 (5 cr)

Advanced Courses (20 cr)
- CS 3111—Computer Ethics (4 cr)
- CS 3512—Computer Science Theory (4 cr)
- CS 4531—Software Engineering (4 cr)
- CS 5631—Operating Systems (4 cr)
- CS 5621—Computer Architecture (4 cr)
- CS 5651—Computer Networks (4 cr)

Advanced Course Electives (12 cr)
Either CS 5621 or CS 5651 must be taken (under Advanced Courses); if both courses are taken, the second course fulfills the requirement of one Advanced Course Elective.

Take 3 or more course(s) from the following:
- CS 4511—Computability and Complexity (4 cr)
- CS 4521—Algorithms and Data Structures (4 cr)
- CS 4611—Database Management Systems (4 cr)
- CS 4821—Computer Security (4 cr)
- CS 5541—Artificial Intelligence (4 cr)
- CS 5551—User Interface Design (4 cr)
- CS 5641—Compiler Design (4 cr)
- CS 5721—Computer Graphics (4 cr)
- CS 5741—Object-Oriented Design (4 cr)
- CS 5751—Introduction to Machine Learning (4 cr)
- CS 5761—Introduction to Natural Language Processing (4 cr)

Courses From Other Programs (23 cr)
- COMM 1112—Public Speaking, LE CAT3 (3 cr)
- MATH 1296—Calculus I, LE CAT2 (5 cr)
- MATH 1297—Calculus II (5 cr)
- MATH 2326—Introduction to Linear Algebra and Mathematical Reasoning (3 cr)
- STAT 3611—Introduction to Probability and Statistics (4 cr)
- WRIT 3130—Advanced Writing: Engineering (3 cr)
- WRIT 3150—Advanced Writing: Science (3 cr)
The B.S.E.C.E. program combines traditional electrical engineering topics with current computer design and analysis topics. The program is concerned with the theory, design, and application of electrical phenomena and digital computers, including electronic circuits, signal analysis, system design, and computer architecture. The department displays strengths in such diverse areas as electronics, signal processing, electromagnetics, digital computer systems, communications, and controls. Faculty specialize in areas such as VLSI design, microprocessor systems, image processing, robust control, solid state devices, optoelectronics, nanostuctures, robotics, instrumentation, neural networks, and fuzzy logic. The program balances theoretical and practical experience in electrical and computer engineering through analysis, synthesis, and experimentation, using facilities that include major instructional and research laboratories.

Electrical and computer engineering program educational objectives:
1. Develop a productive career.
2. Advance knowledge in their field through technical innovations and scholarly research.
3. Integrate the impact ethical foundation, creative purpose, and technical knowledge into responsible citizenship.
4. Contribute to the well-being of their community.
5. Pursue lifelong learning.

Honors Requirements—To receive department honors upon graduation, students must finish the program with an overall GPA of at least 3.50, satisfactorily complete a research project under the guidance of a faculty member, and convey the results in an oral and written presentation to the department.

Admission Requirements
Students who enter the electrical and computer engineering program as freshmen must follow the lower division program.

Students should complete the lower division ECE program before applying to the upper division program. Admission is competitive and on a space-available basis. A minimum GPA of 2.00 is required for admission to the upper division program. See department for details.

For information about UMD admission requirements, visit the UMD Admissions website.

Lower Division (22 cr)
ECE 1001—Introduction to Electrical and Computer Engineering (2 cr)
ECE 1315—Digital System Design (4 cr)
ECE 2006—Electrical Circuit Analysis (4 cr)
ECE 2111—Linear Systems and Signal Analysis (4 cr)
ECE 2212—Electronics I (4 cr)
ECE 2325—Microcomputer System Design (4 cr)

Lower Division From Other Programs (37 cr)
First math course is determined by math ACT score. This schedule presupposes placement into MATH 1296.
CS 1511—Computer Science I, LE CAT3 (5 cr)
CS 1521—Computer Science I, LE CAT3 (5 cr)
MATH 1296—Calculus I, LE CAT2 (5 cr)
MATH 1297—Calculus II (5 cr)
MATH 3280—Differential Equations with Linear Algebra (4 cr)
Electrical and Computer Engineering Minor

Electrical and Computer Engineering

Minor Related to a Major

Required credits in this minor: 42.

The electrical and computer engineering minor provides a complete introduction to both analog circuit design and digital computer circuit design and analysis.

Minor Requirements

Lower Division

For computer science majors: CS 2521 may be substituted for ECE 2325
ECE 1315—Digital System Design (4 cr)
ECE 2006—Electrical Circuit Analysis (4 cr)
ECE 2111—Linear Systems and Signal Analysis (4 cr)
ECE 2212—Electronics I (4 cr)
ECE 2325—Microcomputer System Design (4 cr)
MATH 1296—Calculus I, LE CAT2 (5 cr)
MATH 1297—Calculus II (5 cr)
PHYS 2011—General Physics I, LE CAT4 (4 cr)
PHYS 2012—General Physics II (4 cr)

Upper Division

MATH 3280—Differential Equations with Linear Algebra (4 cr)

Environmental Science B.S.

Swenson College of Science and Engineering

Required credits to graduate with this degree: 120.

Required credits within the major: 101 to 105.

The B.S. in environmental science is designed for students that want a multidisciplinary science education focusing on aspects of the environment. This environmental science program requires a broad base of knowledge in the basic sciences and mathematics, physics, chemistry, biology, Earth sciences, and statistics. In addition, prudent study of environmental science requires understanding of economic, political, and ethical considerations. Environmental science features an intense grounding in resource issues (including courses in renewable and non-renewable resources) and builds on the strength of UMD in freshwater issues. In addition, the capstone course deals with sources, distribution, and ultimate fate of air, water, and solid waste pollution. Elective courses from areas, such as habitats, climate processes, environmental chemistry, quantitative methods, and global resources are also required.

The program is predicated on the belief that a student graduating with a B.S. in environmental science should have a firm background in physical and life sciences and a basic understanding of 1) existing environmental policies and regulations and the legislative process of their formation; 2) the major environmental issues including water, global climate, energy, pollution, and population; 3) techniques of environmental monitoring and prediction; and 4) economics and business organization.
Environmental Science B.S.

Admission Requirements

For entering freshmen, the only admission requirement is acceptance into the College of Science and Engineering. Transfer students must meet campus and college requirements and are accepted into the program at the level corresponding to credits completed, based on existing transfer manuals and on faculty judgment when courses are not in existing manuals.

For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements

Requirements for the B.S. in environmental science include:

- Liberal education requirements.
- A minor is not required.
- A 2.00 minimum GPA in the major, including supporting courses.
- A 2.00 minimum GPA in all work attempted at UMD. A 2.00 minimum GPA in all work including transfer credits.

Required Environmental Science Core (20 cr)

ESCI 2210—Science and Management of Environmental Systems (4 cr)
ESCI 3101—Nonrenewable Resources (4 cr)
ESCI 3102—Renewable Resources (4 cr)
ESCI 4102—Environmental Assessment (4 cr)
CHE 4615—Pollution Control Technologies (4 cr)
or ESCI 4101—Pollution and Technology (4 cr)

Required Courses From Other Programs (63-64 cr)

BIOL 1011—General Biology I, LE CAT4 (5 cr)
BIOL 1012—General Biology II (5 cr)
BIOL 2801—General Ecology (3 cr)
BIOL 2802—Ecology Laboratory (2 cr)
GEOL 1110—Geology and Earth Systems, LE CAT4 (4 cr)
MATH 1297—Calculus II (5 cr)
MATH 2011—General Physics I, LE CAT4 (4 cr)
PHYS 2012—General Physics II (4 cr)
PHYS 2011—General Physics I, LE CAT4 (4 cr)
WRIT 3150—Advanced Writing: Science (3 cr)

Concentration Electives (10 cr)

Courses can be distributed among the groups in any combination. Discuss with adviser the benefits of breadth (credits in several concentrations) versus depth (credits in a particular concentration).

Take no more than 10 credit(s) from the following:

Environmental Chemistry

take 0–10 credit(s) from the following:

Biol 5868—Ecotoxicology (3 cr)
CHEM 2541—Organic Chemistry I (3 cr)
CHEM 2542—Organic Chemistry II (3 cr)
CHEM 2543—Organic Chemistry I Laboratory (1 cr)
CHEM 2544—Organic Chemistry II Laboratory (1 cr)
CHEM 3100—Earth’s Climate and Environment: Past and Future (3 cr)
or GEOG 3401—Weather and Climate (3 cr)
MATH 1290—Calculus for the Natural Sciences, LE CAT2 (5 cr)
or MATH 1296—Calculus I, LE CAT2 (5 cr)
STAT 2411—Statistical Methods, LE CAT2 (3 cr)
or STAT 3411—Engineering Statistics (3 cr)
or STAT 3611—Introduction to Probability and Statistics (4 cr)

Climate Processes

Take 0–10 credit(s) from the following:

GEOL 3401—Weather and Climate (3 cr)
GEOG 3422—Natural Hazards (3 cr)
GEOG 3446—Water Processes and Management (3 cr)
LIM 5004—Field Limnology (2 cr)
LIM 5101—Physical Limnology (3 cr)
LIM 5102—Chemical Limnology (3 cr)
LIM 5103—Geological Limnology (3 cr)
CHEM 589—Coral Reef Field Studies (3 cr)
or GEOG 5839—Coral Reef Geology (3 cr)

Global Resources

Take 0–10 credit(s) from the following:

ECON 3721—Natural Resource and Energy Economics (3 cr)
ECON 3777—Environmental Economics (3 cr)
GEOG 3461—Geography of Global Resources (3 cr)
GEOG 4451—The Geography of Soils (4 cr)
GEOL 4240—Physical Hydrogeology (4 cr)
GEOL 4250—Environmental Hydrogeology (4 cr)
GEOL 4350—Economic Geology (4 cr)

Water Science Electives (8–11 cr)

Must include three courses, at least one course each from Group A and B. Courses used to satisfy a water science elective may not be used to satisfy a concentration elective. At least one course used to fill the water science electives or the concentration electives must have a laboratory or field component.

Take 3 or more course(s) totaling 8–11 credit(s) from the following:

Group A Groundwater

Take 1–2 course(s) from the following:

GEOL 4240—Physical Hydrogeology (4 cr)
GEOL 4250—Environmental Hydrogeology (4 cr)
GEOL 4710—Aqueous Geochemistry/Chemical Hydrogeology (4 cr)

Group B Surface Water

Take 1–2 course(s) from the following:

BIOL 5805—Fisheries Ecology (3 cr)
BIOL 5833—Stream Ecology (4 cr)
BIOL 5861—Lake Ecology (3 cr)
GEOG 5446—Water Processes and Management (3 cr)
LIM 5004—Field Limnology (2 cr)
LIM 5101—Physical Limnology (3 cr)
LIM 5102—Chemical Limnology (3 cr)
LIM 5103—Geological Limnology (3 cr)
CHEM 5859—Coral Reef Field Studies (3 cr)
or GEOG 5839—Coral Reef Geology (3 cr)

Concentration Electives (10 cr)

Courses can be distributed among the groups in any combination. Discuss with adviser the benefits of breadth (credits in several concentrations) versus depth (credits in a particular concentration).

Take no more than 10 credit(s) from the following:

Environmental Chemistry

Take 0–10 credit(s) from the following:

Biol 5868—Ecotoxicology (3 cr)
CHEM 2541—Organic Chemistry I (3 cr)
CHEM 2542—Organic Chemistry II (3 cr)
CHEM 2543—Organic Chemistry I Laboratory (1 cr)
CHEM 2544—Organic Chemistry II Laboratory (1 cr)
CHEM 3100—Earth’s Climate and Environment: Past and Future (3 cr)
or GEOG 3401—Weather and Climate (3 cr)
MATH 1290—Calculus for the Natural Sciences, LE CAT2 (5 cr)
or MATH 1296—Calculus I, LE CAT2 (5 cr)
STAT 2411—Statistical Methods, LE CAT2 (3 cr)
or STAT 3411—Engineering Statistics (3 cr)
or STAT 3611—Introduction to Probability and Statistics (4 cr)

Climate Processes

Take 0–10 credit(s) from the following:

GEOL 3401—Weather and Climate (3 cr)
GEOG 3422—Natural Hazards (3 cr)
GEOG 3446—Water Processes and Management (3 cr)
GEOG 3120—Geomorphology (4 cr)
GEOG 4210—Glacial and Quaternary Geology (4 cr)
GEOG 5220—Advances in Paleoclimatology (3 cr)
LIM 5103—Geological Limnology (3 cr)

Global Resources

Take 0–10 credit(s) from the following:

ECON 3721—Natural Resource and Energy Economics (3 cr)
ECON 3777—Environmental Economics (3 cr)
GEOG 3461—Geography of Global Resources (3 cr)
GEOG 4451—The Geography of Soils (4 cr)
GEOL 4240—Physical Hydrogeology (4 cr)
GEOL 4250—Environmental Hydrogeology (4 cr)
GEOL 4350—Economic Geology (4 cr)
Habits
Take 0–10 credit(s) from the following:
- BIOL 4905—Ecological Invasions (2 cr)
- BIOL 5777—Plankton Biology (2 cr)
- BIOL 5801—Microbial Ecology (2 cr)
- BIOL 5802—Microbial Ecology Laboratory (2 cr)
- BIOL 5805—Fisheries Ecology (3 cr)
- BIOL 5808—Landscape Ecology: Theory and Application (3 cr)
- BIOL 5833—Stream Ecology (4 cr)
- BIOL 5861—Lake Ecology (3 cr)
- BIOL 5863—Ecosystems Ecology (3 cr)
- BIOL 5865—Conservation Biology (2 cr)
- BIOL 5870—Wetland Ecology (3 cr)
- BIOL 5839—Coral Reef Field Studies (3 cr)
- CHEM 5151—Honors: General Chemistry I, LE CAT4, H (5 cr)

Quantitative Methods
Take 0–10 credit(s) from the following:
- BIOL 5807—Mathematical Ecology (3 cr)
- CHE 2111—Material and Energy Balances (3 cr)
- CHE 2121—Chemical Engineering Thermodynamics (3 cr)
- CHE 3111—Fluid Mechanics (3 cr)
- CHE 5022—Transport Processes in Wells and Pipelines (3 cr)
- GEOG 5563—Environmental Application of GIS (4 cr)
- GEOG 5581—Digital Image Processing and Analysis (4 cr)
- GEOL 5215—Glaciology (3 cr)
- LIM 5004—Field Limnology (2 cr)
- LIM 5011—Physical Limnology (3 cr)
- MATH 3280—Differential Equations with Linear Algebra (4 cr)
- PHYS 5043—Environmental Optics (3 cr)
- PHYS 5053—Data Analysis Methods in Physics (3 cr)
- PHYS 5541—Fluid Dynamics (3 cr)
- STAT 5411—Analysis of Variance (3 cr)

Environmental Science Minor
Swenson College of Science and Engineering

Minor Related to a Major
Required credits in this minor: 30 to 34.

The environmental science minor enhances a student’s understanding of the scope of environmental problems, the biochemical and physical processes of environmental degradation, the sciences of non-renewable and renewable resources, and economic and political issues surrounding environmental problems. The minor provides valuable background for many environmental careers and applications.

Minor Requirements
ES Minor Core
- GEOL 1110—Geology and Earth Systems, LE CAT4 (4 cr)
- ESCI 2210—Science and Management of Environmental Systems (4 cr)
- ESCI 3101—Nonrenewable Resources (4 cr)
- ESCI 3102—Renewable Resources (4 cr)

Take one of the following course pairs:
- CHEM 1151—General Chemistry I, LE CAT4 (5 cr)
- CHEM 1152—General Chemistry II (5 cr)
- CHEM 1161—Honors: General Chemistry I, LE CAT4, H (5 cr)
- CHEM 1162—Honors: General Chemistry II, H (5 cr)

Minor Electives
Two additional courses for at least four credits from the following:
- ESCI 4101—Pollution and Technology (4 cr)
- ESCI 4102—Environmental Assessment (4 cr)

Geological Sciences B.S.

Geological Sciences
Required credits to graduate with this degree: 120.
Required credits within the major: 77 to 78.

This program requires summer terms.

The B.S. degree in geological sciences is designed for students interested in a career in geoscience. The study of geology requires a broad base of knowledge in related sciences (chemistry and physics) and mathematics. In addition, the program includes a solid core of geology courses, including a course in field mapping.

Honors Requirements—To attain departmental honors, students must undertake an independent research project (typically two semesters) and maintain a cumulative overall GPA of 3.00. The research can be part of a UROP, directed research, independent study, or an internship with a faculty member. Students must make a brief oral presentation to the department summarizing their results and produce a research paper (maximum 10 pages) OR give an oral or poster presentation of their research results at a regional or national meeting (e.g., GSA, AGU, SEPM, or similar campus event).

Admission Requirements
For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements
Requirements for the B.S. in geological sciences include:

- Liberal education requirements.
- Advanced writing requirement: WRIT 3150—Advanced Writing: Science (3 cr).
- Minor or double major.

Geology Core Courses (34–35 cr)
- GEOL 2110—Earth History (4 cr)
- GEOL 4110—Earth History Laboratory (1 cr)
- GEOL 2120—The Earth’s Dynamic Interior (3 cr)
- GEOL 2311—Mineralogy (4 cr)
- GEOL 2312—Petrology (5 cr)
- GEOL 3210—Sedimentology and Stratigraphy (4 cr)
- GEOL 4450—Structural Geology (5 cr)
- GEOL 4500—Field Geology (6 cr)
- GEOL 4910—Geology and Earth Systems, LE CAT4 (4 cr)
- GEOL 1110—Geology and Earth Systems, LE CAT4 (4 cr)
- GEOL 1130—Introduction to Environmental Science, LEIP CAT4 (4 cr)
- GEOL 1610—Oceanography, LE CAT5 (3 cr)
- GEOL 1414—Physical Geography, LE CAT4 (4 cr)

Advanced Electives
With the exception of GEOL 4110, electives (3xxx and above) are selected from yearly geological sciences offerings. Six credits of limnology courses may be substituted for geological sciences courses. GEOL 4563 and 4564 (5 credit total) may be substituted for geological sciences courses.

Take 15 or more credit(s) from the following:
- AST 4110—Observational Astronomy (3 cr)
- GEOL 4451—The Geography of Soils (4 cr)
- GEOL 3000—Geologic Maps (3 cr)
Industrial Engineering B.S.I.E.

Electives
Take exactly 1 course(s) from the following:
- GEOI 2312—Petroleum (5 cr)
- GEOI 3420—Sedimentology and Stratigraphy (4 cr)
- GEOI 4240—Physical Hydrogeology (4 cr)
- GEOI 4250—Environmental Hydrogeology (4 cr)
- GEOI 4450—Structural Geology (5 cr)

Industrial Engineering B.S.I.E.
Mechanical/Industrial Engineering
Required credits to graduate with this degree: 127.

The mission of the bachelor of science in industrial engineering program is to deliver a hands-on, laboratory-intensive undergraduate education that provides students with the tools and skills to excel in the profession, as they pursue lifelong learning and make positive contributions to society. With an emphasis on integrated systems and a strategic partnership with Luleå University of Technology in Sweden, the B.S.I.E. program offers unique opportunities for study abroad, undergraduate research, and technical electives to develop an enhanced global perspective.

The educational objectives of the industrial engineering program are to produce graduates who are able to:

1. Solve industrial engineering problems by applying contemporary engineering tools to propose and implement effective solutions.
2. Design, develop, implement, and improve integrated systems that include people, materials, information, equipment, and energy.
3. Contribute as informed, ethical, and responsible members of the engineering profession and society as a whole.
4. Continue lifelong professional development throughout their career.
5. Collaborate and communicate effectively with others as a member or leader of an engineering or multidisciplinary team in an international setting.

Geological Sciences Minor

Minor Related to a Major

Required credits in this minor: 25 to 27.

The geological sciences minor enhances the student’s understanding of and familiarity with earth materials and processes, and provides valuable background for many environmental careers and applications.

Minor Requirements

Minor Courses
- GEOI 3091—Independent Study (1–2 cr)
- GEOI 3100—Earth’s Climate and Environment: Past and Future (3 cr)
- GEOI 3210—Geomorphology (4 cr)
- GEOI 3710—Introduction to Geochemistry (3 cr)
- GEOI 4210—Glacial and Quaternary Geology (4 cr)
- GEOI 4240—Physical Hydrogeology (4 cr)
- GEOI 4250—Environmental Hydrogeology (4 cr)
- GEOI 4320—Precambrian Geology (3 cr)
- GEOI 4335—Physical Volcanology (3 cr)
- GEOI 4350—Economic Geology (4 cr)
- GEOI 4480—Tectonics (3 cr)
- GEOI 4815—Exploration Geophysics (4 cr)
- GEOI 4820—Global Geophysics (3 cr)
- GEOI 5091—Geologic Problems (1–2 cr)
- GEOI 5095—Special Topics: (Various Titles to be Assigned) (1–3 cr)
- GEOI 5100—Seminar (1–2 cr)
- GEOI 5200—Geological Field Studies (2–3 cr)
- GEOI 5215—Glaciology (3 cr)
- GEOI 5220—Advances in Paleoclimatology (3 cr)
- GEOI 5260—Fluvial Geomorphology (4 cr)
- GEOI 5310—Advanced Petrology (3 cr)
- GEOI 5430—Stratigraphy and Basin Analysis (3 cr)
- GEOI 5450—Advanced Structure (3 cr)
- GEOI 4710—Aqueous Geochemistry/Chemical Hydrogeology (4 cr)
- GEOI 5730—Geochronology (3 cr)
- GEOI 5839—Coral Reef Geology (3 cr)

Courses Required From Other Programs (28 cr)

MATH 1290—Calculus for the Natural Sciences, LE CAT2 (5 cr)
MATH 1296 may be substituted for MATH 1290
MATH 1297—Calculus II (5 cr)
PHYS 2011—General Physics I, LE CAT4 (4 cr)
PHYS 2012—General Physics II (4 cr)

Take one of the following course sequences
- CHEM 1151—General Chemistry I, LE CAT4 (5 cr)
- CHEM 1161—Honors: General Chemistry I, LE CAT4, H (5 cr)
  and CHEM 1153—Honors: General Chemistry II, H (5 cr)
  and CHEM 1161—Honors: General Chemistry I, LE CAT4, H (5 cr)

Geological Sciences Minor

Geological Sciences

Minor Related to a Major

Required credits in this minor: 25 to 27.

The geological sciences minor enhances the student’s understanding of and familiarity with earth materials and processes, and provides valuable background for many environmental careers and applications.

Minor Requirements

Minor Courses
- GEOI 3100—Earth’s Climate and Environment: Past and Future (3 cr)
- GEOI 3111—Earth History Laboratory (1 cr)
- GEOI 3210—The Earth’s Dynamic Interior (3 cr)
- GEOI 3211—Mineralogy (4 cr)
- GEOI 3210—Geomorphology (4 cr)
- GEOI 4100—Geology and Earth Systems, LE CAT4 (4 cr)
  or GEOI 1130—Introduction to Environmental Science, LEIP CAT4 (4 cr)
  or GEOI 1610—Oceanography, LE CAT5 (3 cr)
  or GEOI 1414—Physical Geography, LE CAT4 (4 cr)
- CHEM 1151—General Chemistry I, LE CAT4 (5 cr)
  or CHEM 1113—Introduction to General, Organic, and Biological Chemistry I, LE CAT4 (5 cr)

Electives
Take exactly 1 course(s) from the following:
- GEOI 2312—Petroleum (5 cr)
- GEOI 3420—Sedimentology and Stratigraphy (4 cr)
- GEOI 4240—Physical Hydrogeology (4 cr)
- GEOI 4250—Environmental Hydrogeology (4 cr)
- GEOI 4450—Structural Geology (5 cr)
The industrial and systems engineering concentration emphasizes the overall perspective of people and productivity, in any type of system, including manufacturing, service, health care, transportation, communication, and agriculture. The international engineering concentration offers a unique opportunity to study engineering in another culture; space is limited. Courses are taught in English and opportunities for travel and externally-focused projects abound.

**Honors Requirements** — To graduate with department honors, a student must graduate with a 3.40 GPA, be an active member of Tau Beta Pi or a professional engineering society (ASME, ASSE, IIE, or MSPE), and be nominated by a department faculty member.

**Admission Requirements**
Freshmen and transfer students are usually admitted to pre-major status before admission to this major.

Freshman, sophomores, and transfer students may declare an IE major and admitted to lower division status. Admission to upper division B.S.I.E. program is competitive and based on performance in lower division courses and space availability. To be considered students must complete the MIE Application to Upper Division. The following requirements must be met:

- Completion of the following courses or their transfer equivalents:
  - WRIT 1120
  - CS 1121 or 1511 or 2121
  - IE 1225
  - CE 2017
  - ME 2105
  - MATH 3280

- A cumulative UMD GPA of 2.50 or above

- Successful completion with grades of C- or better of all required program course taken at UMD or within the University of Minnesota system.

- Successful completion with grades of C or better of all required program courses transferred from outside the University of Minnesota system.

Applicants not meeting these requirements may be admitted to the upper division B.S.I.E. program on a space-available basis.

For information about UMD admission requirements, visit the UMD Admissions website.

**Program Requirements**
Requirements for the B.S.I.E. include:

- Successful completion with grades of C- or better, or S, of all required program courses taken at UMD or within the University of Minnesota system

- Successful completion with grades of C or better of all required program course transferred from outside the University of Minnesota system

- Acceptance to the upper division BSIE program and either the Industrial and System Engineering or International Engineering sub-plan.

- A minimum GPA of 2.00 in all courses taken in the major, including required courses in related fields.

**Maintenance Standards:** Continuation of upper division status requires students to be in good academic standing. BSIE upper division students placed on academic probation or who have been academically dismissed by the Swenson College of Science and Engineering will also be removed from upper division BSIE status.

**Program Sub-plans**
Students are required to complete one of the following sub-plans.

**International Engineering Sub-plan**
This sub-plan is optional and does not fulfill the sub-plan requirement for this program.

The international engineering concentration offers a unique opportunity to study engineering in another culture; space is limited. Courses are taught in English and opportunities for travel and externally-focused projects abound.

**International Engineering Core Courses (33 cr)**
Required courses include fundamental material in engineering science, industrial engineering, and mechanical engineering. Courses in Sweden build on these fundamentals, frequently in the context of significant projects.

- IE 1225—Introduction to Design and Manufacturing Engineering (4 cr)
- IE 3115—Operations Research (4 cr)
- IE 3122—Materials Engineering Laboratory (2 cr)
- IE 3125—Engineering Economic Analysis (3 cr)
- IE 3130—Materials Processing Engineering (3 cr)
- IE 3140—Human Factors and Ergonomic Design (3 cr)
- IE 3222—Occupational Systems Laboratory (2 cr)
- IE 4010—Six Sigma Quality Control (3 cr)
- IE 4020—Lean Enterprises Management (3 cr)
- ME 2105—Introduction to Material Science for Engineers (3 cr)
- ME 2226—Dynamics (3 cr)

**Courses From Other Programs (45 cr)**
These courses help engineers develop a foundation of mathematics, sciences, economics, statistics, and communication skills. International engineering emphasizes the culture, historical perspective, and current events and issues in a foreign setting.

- CHEM 1153—General Chemistry I (4 cr)
- CHEM 1154—General Chemistry Lab I (1 cr)
- ECE 2006—Electrical Circuit Analysis (4 cr)
- MATH 1297—Calculus II (5 cr)
- MATH 1298—Calculus III (5 cr)
- MATH 3280—Differential Equations with Linear Algebra (4 cr)
- PHYS 2111—General Physics I, LE CAT 4 (4 cr)
- PHYS 2122—General Physics II (4 cr)
- STAT 3411—Engineering Statistics (3 cr)
- WRIT 1120—College Writing, LE CAT I (3 cr)
- ECON 1022—Principles of Economics: Macro, LE CAT 6 (3 cr)

or
- ECON 1023—Principles of Economics: Micro, LE CAT 6 (3 cr)
### Advanced Writing Requirement (3 cr)

**WRIT 3130** is preferred

Take exactly 1 course(s) from the following:
- **WRIT 3130**—Advanced Writing: Engineering (3 cr)
- **WRIT 3150**—Advanced Writing: Science (3 cr)
- **WRIT 3180**—Honors: Advanced Writing, H (3 cr)

### Computer Science Elective (3 cr)

Take 1 or more course(s) from the following:
- **CS 1121**—Introduction to Programming in Visual BASIC.NET, LE CAT3 (3 cr)
- **CS 1511**—Computer Science I, LE CAT3 (5 cr)
- **CS 2121**—Introduction to Programming in Java, LE CAT3 (3 cr)

### Industrial Engineering Elective (3 cr)

Take 1 or more course(s) totaling 3 or more credit(s) from the following:
- **IE 4495**—Special Topics: (Various Titles to be Assigned) (1–4 cr)
- **IE 5305**—Supply Chain Management (3 cr)
- **IE 5315**—Organizational Control Methods (3 cr)
- **IE 5325**—Advanced Engineering Economics (3 cr)
- **IE 5335**—Engineered Products and Services (3 cr)
- **ME 3111**—Fluid Mechanics (3 cr)

### Courses Taken in Luleå, Sweden (31 cr)

- **FST 1816**—Introduction to Scandinavia (LE-8) (3 cr)
  - Simulation of production systems (4 cr)
  - Automation (4 cr)
  - CAD (4 cr)
  - Integrated manufacturing systems (8 cr)
  - Approved technical, manufacturing, or business electives (8 cr)

### Industrial and Systems Engineering Program Sub-plan

The industrial and systems engineering concentration emphasizes the overall perspective of people and productivity in any type of system, including manufacturing, service, health care, transportation, communication, and agriculture. Concentration electives allow students to study systems of interest to them.

### Industrial and Systems Engineering Core Courses (49 cr)

Required courses include fundamental material in engineering science, engineering management, industrial engineering, and mechanical engineering. Concepts are delivered in lecture and reinforced in lab experiences.
- **EMGT 4110**—Engineering Professionalism and Practice (2 cr)
- **IE 1225**—Introduction to Design and Manufacturing Engineering (4 cr)
- **IE 3115**—Operations Research (4 cr)
- **IE 3122**—Materials Engineering Laboratory (2 cr)
- **IE 3125**—Engineering Economic Analysis (3 cr)
- **IE 3130**—Materials Processing Engineering (3 cr)
- **IE 3140**—Human Factors and Ergonomic Design (3 cr)
- **IE 3222**—Occupational Systems Laboratory (2 cr)
- **IE 4010**—Six Sigma Quality Control (3 cr)
- **IE 4020**—Lean Enterprises Management (3 cr)
- **IE 4035**—Facility Planning and Simulation (4 cr)
- **IE 4222**—Systems Integration Laboratory (2 cr)
- **IE 4230**—Systems Integration (3 cr)
- **IE 4255**—Multidisciplinary Senior Design (4 cr)
- **IE 4993**—Industrial Engineering Seminar (1 cr)
- **ME 2105**—Introduction to Material Science for Engineers (3 cr)
- **ME 2226**—Dynamics (3 cr)

### Courses From Other Programs (51 cr)

These courses help engineers develop a foundation of mathematics, sciences, economics, statistics, and communication skills.
- **CHEM 1153**—General Chemistry I (4 cr)
- **CHEM 1154**—General Chemistry Lab I (1 cr)
- **ECE 2006**—Electrical Circuit Analysis (4 cr)
- **MATH 1296**—Calculus I, LE CAT2 (5 cr)
- **MATH 1297**—Calculus II (5 cr)
- **MATH 3280**—Differential Equations with Linear Algebra (4 cr)
- **PHYS 1111**—General Physics I, LE CAT4 (4 cr)
- **PHYS 2111**—General Physics II (4 cr)
- **STAT 3411**—Engineering Statistics (3 cr)
- **WRIT 3120**—College Writing, LE CAT1 (3 cr)
- **ECON 1022**—Principles of Economics: Macro, LE CAT6 (3 cr)
- **ECON 1023**—Principles of Economics: Micro, LE CAT6 (3 cr)
- **ACCT 2001**—Survey of Accounting, LE CAT8 (3 cr)
- **COMM 1121**—Public Speaking, LE CAT3 (3 cr)
- **PSY 1003**—General Psychology, LE CAT6 (4 cr)
- **INTB 3201**—International Business (3 cr)

### Advanced Writing Requirement

**WRIT 3130** is preferred

Take no more than 1 course(s) totaling 3 or more credit(s) from the following:
- **WRIT 3130**—Advanced Writing: Engineering (3 cr)
- **WRIT 3150**—Advanced Writing: Science (3 cr)
- **WRIT 3180**—Honors: Advanced Writing, H (3 cr)

### Computer Science Elective (3 cr)

Take 3 or more credit(s) from the following:
- **CS 1121**—Introduction to Programming in Visual BASIC.NET, LE CAT3 (3 cr)
- **CS 1511**—Computer Science I, LE CAT3 (5 cr)
- **CS 2121**—Introduction to Programming in Java, LE CAT3 (3 cr)

### Industrial and Systems Engineering Electives (6 cr)

These courses help an industrial engineer develop systems skills in technical areas. (Cannot count credits from other requirement categories.)

Take 6 or more credit(s) from the following:
- **IE 4495**—Special Topics: (Various Titles to be Assigned) (1–4 cr)
- **IE 5305**—Supply Chain Management (3 cr)
- **IE 5315**—Organizational Control Methods (3 cr)
- **IE 5325**—Advanced Engineering Economics (3 cr)
- **IE 5335**—Engineered Products and Services (3 cr)
- **ME 3111**—Fluid Mechanics (3 cr)
- **CHE 3111**—Fluid Mechanics (3 cr)

### Additional Electives (6 cr)

(Cannot count credits from other requirement categories.)

Take 2 or more course(s) totaling 6 or more credit(s) from the following:
- **CHE 2111**—Material and Energy Balances (3 cr)
- **CS 1521**—Computer Science II (5 cr)
- **ECE 1315**—Digital System Design (4 cr)
- **ECE 2111**—Linear Systems and Signal Analysis (4 cr)
- **ECE 2212**—Electronics I (4 cr)
- **ECE 2325**—Microcomputer System Design (4 cr)
- **ECE 3151**—Control Systems (3 cr)
- **ECE 5335**—Engineered Products and Services (3 cr)
- **ME 3111**—Fluid Mechanics (3 cr)
- **CHE 3111**—Fluid Mechanics (3 cr)
Swenson College of Science and Engineering

IE 5305—Supply Chain Management (3 cr)
IE 5315—Organizational Control Methods (3 cr)
IE 5325—Advanced Engineering Economics (3 cr)
IE 5335—Engineered Products and Services (3 cr)
IE 5991—Independent Study in Industrial Engineering (1–4 cr)
MATH 3298—Calculus III (4 cr)
MATH 3355—Discrete Mathematics (4 cr)
ME 3140—System Dynamics and Control (3 cr)
ME 3211—Thermodynamics (3 cr)
ME 4135—Robotics and Controls (4 cr)
ME 4145—CAD/CAM (4 cr)
ME 4175—Machine Design (3 cr)
ME 4245—Machining and Machine Tools (4 cr)
ME 4495—Special Topics: (Various Titles to be Assigned) (1–4 cr)
ME 5315—Nondestructive Evaluation of Engineering Materials (3 cr)
ME 5325—Sustainable Energy System (3 cr)
MGTS 4472—Entrepreneurship (3 cr)
STAT 5411—Analysis of Variance (3 cr)
STAT 5511—Regression Analysis (3 cr)
ME 3111—Fluid Mechanics (3 cr)
or
CHE 3111—Fluid Mechanics (3 cr)

Mathematics B.S.

Mathematics and Statistics

Required credits to graduate with this degree: 120.
Required credits within the major: 51.
The program in mathematics develops competence in mathematical techniques and sharpens mathematical insight. Mathematics is fundamental to solving problems in physics, chemistry, biology, medicine, business, engineering, and technology. The mathematics major prepares students for careers in business, industry, and government and for further graduate studies.

Note: the B.S. in statistics and actuarial science is listed separately.

Honors Requirements—To graduate with department honors, a student must complete the program with an overall and department GPA of 3.50, satisfactorily complete a research project under the guidance of a department faculty member, and convey research results in a public presentation.

Admission Requirements

For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements

Requirements for the B.S. in mathematics include:

• Liberal education requirements.
• Minor or second major from another area of study.
• Advanced writing requirement: WRIT 31xx.

Introduction to Calculus Courses (10 cr)

Calculus I

Take one of the following three Calculus I courses:
MATH 1290—Calculus for the Natural Sciences, LE CAT2 (5 cr)
or
MATH 1296—Calculus I, LE CAT2 (5 cr)
or
MATH 1596—Honors: Calculus I, LE CAT2, H (5 cr)

Take one of the following two Calculus II courses:
MATH 1297—Calculus II (5 cr)
or
MATH 1597—Honors: Calculus II, H (5 cr)

Electives (16 cr)

Core courses cannot count as electives.
MATH elective courses must be at least 3100.
STAT elective courses must be at least 5000.
At least 10 credits of MATH and/or STAT electives must be 4xxx or above.
At least 6 credits of electives must have MATH prefix and be 4xxx or above.
Only one credit of MATH 3120 may count toward the math major.
MATH 4371 cannot be counted toward the major.

MATH

Take 0–6 credit(s) from the following:
MATH 3xxx

MATH/STAT 4xxx-5xxx

Take 10–16 credit(s) from the following:
MATH 4xxx
MATH 5xxx
STAT 5xxx

Double Majors ONLY

• A student pursuing a second major in statistics and actuarial science cannot apply STAT courses as electives.
• A student with a second major other than statistics and actuarial science may substitute courses from the approved nondepartmental list (below) on a one elective MATH credit for two outside credits exchange basis for up to seven MATH elective credits.

Approved Nondepartmental List:

Take 0–14 credit(s) from the following:
BIOL 5807—Mathematical Ecology (3 cr)
CHE 4301—Chemical Reaction Engineering (3 cr)
CHE 4402—Process Dynamics and Control (3 cr)
CHEM 4641—Physical Chemistry I (3 cr)
CHEM 4642—Physical Chemistry II (3 cr)
CS 4511—Computability and Complexity (4 cr)
CS 4521—Algorithms and Data Structures (4 cr)
CS 3541—Artificial Intelligence (4 cr)
CS 5721—Computer Graphics (4 cr)
CS 5751—Introduction to Machine Learning (4 cr)
ECE 5151—Digital Control System Design (3 cr)
ECE 5741—Digital Signal Processing (3 cr)
ECE 5831—Fuzzy Set Theory and Its Application (3 cr)
GEOL 4240—Physical Hydrogeology (4 cr)
ME 4112—Heat and Mass Transfer (3 cr)
ME 4135—Robotics and Controls (4 cr)
PHYS 4001—Classical Mechanics (4 cr)
PHYS 4011—Electromagnetic Theory (4 cr)
PHYS 4021—Quantum Physics II (4 cr)
PHYS 4031—Thermal and Statistical Physics (4 cr)
PHYS 5702—Computational Methods in Physics (3 cr)
PHYS 5501—Advanced Classical Mechanics (3 cr)
PHYS 5541—Fluid Dynamics (3 cr)

Mathematics Core Courses (20 cr)

Core courses cannot count as electives.

Take the following six courses:
MATH 3280—Differential Equations with Linear Algebra (4 cr)
MATH 3355—Discrete Mathematics (4 cr)
MATH 3941—Elementary Real Analysis (4 cr)
MATH 4326—Linear Algebra (3 cr)
STAT 3611—Introduction to Probability and Statistics (4 cr)

Required From Other Departments (5 cr)

CS 1511—Computer Science I, LE CAT3 (5 cr)

Approved Nondepartmental List:

Take 0–14 credit(s) from the following:
BIOL 5807—Mathematical Ecology (3 cr)
CHE 4301—Chemical Reaction Engineering (3 cr)
CHE 4402—Process Dynamics and Control (3 cr)
CHEM 4641—Physical Chemistry I (3 cr)
CHEM 4642—Physical Chemistry II (3 cr)
CS 4511—Computability and Complexity (4 cr)
CS 4521—Algorithms and Data Structures (4 cr)
CS 3541—Artificial Intelligence (4 cr)
CS 5721—Computer Graphics (4 cr)
CS 5751—Introduction to Machine Learning (4 cr)
ECE 5151—Digital Control System Design (3 cr)
ECE 5741—Digital Signal Processing (3 cr)
ECE 5831—Fuzzy Set Theory and Its Application (3 cr)
GEOL 4240—Physical Hydrogeology (4 cr)
ME 4112—Heat and Mass Transfer (3 cr)
ME 4135—Robotics and Controls (4 cr)
PHYS 4001—Classical Mechanics (4 cr)
PHYS 4011—Electromagnetic Theory (4 cr)
PHYS 4021—Quantum Physics II (4 cr)
PHYS 4031—Thermal and Statistical Physics (4 cr)
PHYS 5702—Computational Methods in Physics (3 cr)
PHYS 5501—Advanced Classical Mechanics (3 cr)
PHYS 5541—Fluid Dynamics (3 cr)
Program Areas of Emphasis

Mathematics includes a wide variety of areas in which students can specialize: traditional mathematics (preparation for Graduate School), applied analysis, computational mathematics, discrete mathematics, and mathematics education. Although no area is required for the MATH major, students are encouraged to work with their advisers to develop a coherent major plan. See the Department of Mathematics and Statistics web page: http://www.d.umn.edu/math for descriptions of elective course groups.

Mathematics Minor

Mathematics and Statistics

Minor Related to a Major

Required credits in this minor: 24.

The minor in mathematics is based on the completion of the traditional core of calculus, differential equations, and elementary linear algebra commonly required of undergraduate physical science, engineering, and mathematics degrees. Additional, more advanced, elective classes are required, as well. The minor in mathematics certifies a student’s quantitative, problem-solving, and critical thinking skills.

Minor Requirements

Core Courses (14 cr)

Calculus I

MATH 1296—Calculus I, LE CAT2 (5 cr)

or MATH 1596—Honors: Calculus I, LE CAT2, H (5 cr)

Calculus II

MATH 1297—Calculus II (5 cr)

or MATH 1597—Honors: Calculus II, H (5 cr)

Core Course

MATH 3280—Differential Equations with Linear Algebra (4 cr)

Electives (10 cr)

Elective credits must be from MATH and/or STAT courses above 3xxx. Only one of STAT 3411 and STAT 3611 may count toward the math minor.

Mechanical Engineering B.S.M.E.

Mechanical/Industrial Engineering

Required credits to graduate with this degree: 127.

Required credits within the major: 112.

The mission of the bachelor of science in mechanical engineering program is to deliver a laboratory-intensive, undergraduate mechanical engineering education that provides students with the tools and skills to excel in the engineering profession, as they pursue lifelong learning and make positive contributions to society. The student learning experience offers unique opportunities for study abroad, undergraduate research, and electives outside of mechanical engineering to develop an enhanced global perspective.

Mechanical engineering program educational objectives:

B.S.M.E. graduates will

1. Solve mechanical engineering problems by applying contemporary engineering tools to propose and implement effective solutions.

2. Design, develop, implement and improve thermal and mechanical systems.

3. Contribute as informed, ethical, and responsible members of the engineering profession and society as a whole.

4. Continue lifelong professional development throughout their career.

5. Collaborate and communicate effectively with others as a member or leader of an engineering or multidisciplinary team in an international setting.

The B.S.M.E. program integrates topics from chemistry, physics, advanced mathematics and statistics, and core engineering science to prepare graduates to work professionally in both thermal and mechanical systems, from design, development, manufacture, and use of products involving mechanical and thermal elements.

The program emphasizes the production engineering approach to mechanical and thermal systems design and development. Upper division courses provide students with a strong understanding of mechanical and thermal systems, and the skills to design, develop, and implement these systems. The mechanical engineering program is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone: 410-347-7700.

Mechanical engineering graduates are qualified for employment in a wide variety of industries including design, manufacturing, materials, aerospace, transportation, natural resources, and energy. Graduates may pursue assignments in design, development, manufacturing, operations, project engineering, or sales, and frequently move into engineering management. They are also well qualified to continue with graduate education.

Students in the B.S.M.E. program have the opportunity to put their design and entrepreneurial skills to use in ASME design competitions, projects sponsored by regional companies, and research projects in the Undergraduate Research Opportunities Program.

Honors Requirements—To graduate with department honors, a student must have a 3.40 GPA, be an active member of Tau Beta Pi or a professional engineering society (ASME, ASSE, IIE, or MSPE), and be nominated by a department faculty member.

Admission Requirements

Freshmen and transfer students are usually admitted to pre-major status before admission to this major.

Freshman, sophomores, and transfer students may declare a ME major and be admitted to lower division status. Admission to the upper division B.S.M.E. program is competitive and based on performance in lower division courses and space availability. To be considered students must complete the MIE Application to Upper Division. The following requirements must be met:

- Completion of the following courses or their transfer equivalents:
  - WRIT 1120
  - CS 1121 or 1511 or 2121
  - IE 1225
Courses From Other Programs (49 cr)
These courses help engineers develop a foundation of mathematics, sciences, economics, statistics, and communication skills.

ME 4135—Robotics and Controls (4 cr)
ME 4245—Machining and Machine Tools (4 cr)
ME 4495—Special Topics: (Various Titles to be Assigned) (1–4 cr)
ME 5305—Computational Fluid Dynamics (3 cr)
ME 5315—Nondestructive Evaluation of Engineering Materials (3 cr)
ME 5325—Sustainable Energy System (3 cr)
ME 5335—Introduction to Finite Element Analysis (3 cr)
ME 5345—Smart Materials and Structures (3 cr)
ME 5355—Gas Turbines (3 cr)

Mechanical Engineering Technical Electives (6 cr)
Take 2 or more course(s) totaling 6 or more credit(s) from the following:
CHE 4621—Particle Technology (3 cr)
CHE 5022—Transport Processes in Wells and Pipelines (3 cr)
ECE 4501—Power Systems (4 cr)
ECE 5995—Special Topics: (Various Titles to be Assigned) (1–3 cr)
IE 3115—Operations Research (4 cr)
IE 4010—Six Sigma Quality Control (3 cr)
IE 4020—Lean Enterprises Management (3 cr)
IE 4495—Special Topics: (Various Titles to be Assigned) (1–4 cr)
IE 4993—Industrial Engineering Seminar (1 cr)
IE 5315—Organizational Control Methods (3 cr)
Physics B.S.

Physics

Required credits to graduate with this degree: 120.

Required credits within the major: 71 to 73.

The B.S. in physics is primarily for students planning to work toward an advanced degree in physics or a related area. The physics courses emphasize conceptual foundations, problem-solving skills, and experimental techniques.

Students are encouraged to participate in research, with emphasis in experimental high-energy physics and particle astrophysics; limnological research, including observational studies and modeling of lakes; and computational physics. Additional faculty interests include optics and condensed matter physics. The department also offers courses required for other science and engineering programs.

Honors Requirements—To graduate with honors, students must participate in the department honors program, complete and present a research project, and maintain a GPA above 3.00 overall and in the major. They are also expected to attend department colloquia. Interested students should contact the physics honors program coordinator.

Admission Requirements

For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements

Requirements for the B.S. in physics include:

- Liberal education requirements.
- A minor or a second major in a different program.

The first math course is determined by math placement exam. The sample plan presupposes placement into MATH 1296.

Courses numbered above 3xxx will be offered in alternate years only. Some courses suggested in the sample plans in the junior and senior years may need to be switched to match the course offerings.

Students interested in teaching 9-12 physics may enroll concurrently in the Department of Education and apply for admission to the Secondary Teacher Education Program.

Core Courses (42 cr)

The department also recommends the supplementary courses PHYS 2111 and PHYS 2112.

PHYS 1021—Exploring Current Topics in Physics (1 cr)
PHYS 2011—General Physics I, LE CAT4 (4 cr)
PHYS 2012—General Physics II (4 cr)
PHYS 2021—Relativity and Quantum Physics (4 cr)
PHYS 2022—Classical Physics (4 cr)
PHYS 2033—Classical and Quantum Physics Lab (2 cr)
PHYS 3061—Instrumentation (3 cr)
PHYS 4001—Classical Mechanics (4 cr)
PHYS 4011—Electromagnetic Theory (4 cr)
PHYS 4021—Quantum Physics II (4 cr)
PHYS 4031—Thermal and Statistical Physics (4 cr)
PHYS 5061—Experimental Methods (3 cr)
PHYS 5090—Physics Seminar (1 cr)

Required Courses From Other Programs (29–31 cr)

Two semesters of chemistry are recommended.

MATH 1296—Calculus I, LE CAT2 (5 cr)
MATH 1297—Calculus II (5 cr)
MATH 3280—Differential Equations with Linear Algebra (4 cr)
MATH 3298—Calculus III (4 cr)
WRIT 3150—Advanced Writing: Science (3 cr)
CHEM 1161—Honors: General Chemistry I, LE CAT4, H (5 cr)
CHEM 1153—General Chemistry I (4 cr)
CHEM 1154—General Chemistry Lab I (1 cr)
CS 1511—Computer Science I, LE CAT3 (5 cr)
CS 1131—Introduction to Programming in FORTRAN, LE CAT3 (3 cr)

Physics Minor

Physics

Minor Related to a Major

Required credits in this minor: 32.

The physics minor provides an introduction to classical and quantum physics.

Minor Requirements

Physics Minor Courses (32 cr)

MATH 1296—Calculus I, LE CAT2 (5 cr)
MATH 1297—Calculus II (5 cr)
PHYS 1021—Exploring Current Topics in Physics (1 cr)
PHYS 2011—General Physics I, LE CAT4 (4 cr)
PHYS 2012—General Physics II (4 cr)
PHYS 2021—Relativity and Quantum Physics (4 cr)
PHYS 2022—Classical Physics (4 cr)
PHYS 2033—Classical and Quantum Physics Lab (2 cr)

PHYS 3xxx–5xxx

Take 3 or more credit(s) from the following:

PHYS 3xxx
PHYS 4xxx
PHYS 5xxx
Statistics and Actuarial Science
B.S.

Mathematics and Statistics
Required credits to graduate with this degree: 120.

Required credits within the major: 50 to 51.

The science of statistics is concerned with generating and analyzing data. Actuarial science applies statistical methods to assess risk in the insurance and financial industries. The statistics and actuarial science major trains students for careers in a wide variety of fields from banking and government to health care. Advisers have information on the national actuarial examinations.

Honors Requirements—To graduate with department honors, a student must complete the program with an overall and department GPA of 3.50, satisfactorily complete a research project under the guidance of a faculty member, and convey research results in a public presentation.

Admission Requirements
For information about UMD admission requirements, visit the UMD Admissions website.

Program Requirements
Requirements for the B.S. in statistics and actuarial science include:

- Liberal education requirements.
- Advanced writing requirement: WRIT 31xx.
- A minor in an area other than mathematics or a second major.

Introduction to Calculus Courses (10 cr)

Calculus I
Take one of the following Calculus I courses:
MATH 1290—Calculus for the Natural Sciences, LE CAT2 (5 cr)
or MATH 1296—Calculus I, LE CAT2 (5 cr)
or MATH 1596—Honors: Calculus I, LE CAT2, H (5 cr)

Calculus II
Take one of the following Calculus II courses:
MATH 1297—Calculus II (5 cr)
or MATH 1597—Honors: Calculus II, H (5 cr)

Statistics and Actuarial Science Core Courses (40–41 cr)
CS 1511—Computer Science I, LE CAT3 (5 cr)
MATH 3298—Calculus III (4 cr)
MATH 3355—Discrete Mathematics (4 cr)
MATH 3280—Differential Equations with Linear Algebra (4 cr)
MATH 3941—Undergraduate Colloquium (1 cr)
STAT 3611—Introduction to Probability and Statistics (4 cr)
STAT 5511—Regression Analysis (3 cr)
STAT 5531—Probability Models (4 cr)
STAT 5571—Probability (4 cr)
STAT 5572—Statistical Inference (4 cr)
Take one of the following two courses:
MATH 4201—Elementary Real Analysis (4 cr)
or MATH 4326—Linear Algebra (3 cr)