General Information

For more than a century, the Institute of Technology (IT) has provided education, research, and technology transfer in science and engineering. With 4,500 students enrolled in its undergraduate programs, 2,300 in graduate programs, and 400 faculty, IT’s 12 departments and schools and 15 research centers are committed to excellence in all they undertake.

Computer Facilities—IT, in cooperation with the Department of Computer Science and Engineering and the office of Academic and Distributed Computing Services, has established a number of computer laboratories for students. These laboratories provide interactive computing using either stand-alone computers and workstations or remote access to central computing facilities, including those of the Minnesota Supercomputer Institute. Laboratories are available to IT students any time during the work day and evening and weekend hours.

Students also have access through their departments to many special-purpose machines, ranging from small tabletop units for data reduction in laboratories to larger models reserved for special projects.

The Department of Computer Science offers a series of courses in Java, FORTRAN, and C++. Discipline-related computing courses are offered in some departments.

Admission

Freshman Admission

See Freshman Admission in the General Information section of this catalog and refer to the University of Minnesota, Twin Cities undergraduate application booklet for freshman admission requirements.

Appeals—Any student who believes that the circumstances concerning their application need further consideration may submit a written appeal to the Office of Admissions.

Upper Division Admission—Students entering as freshmen or sophomores must apply for admission to the upper division (junior and senior years). New freshmen and sophomores are told upon admission and at orientation what GPA might be required for entry into an IT's desired upper division major field. (For procedure, see Upper Division under Scholastic Policies in this college section.)

Admission Without a Designated Major—Students who want to keep their options open and learn about IT fields before selecting a specific major should indicate “Undecided” on the admission application. They receive advising from the Office of Lower Division Programs until they are admitted to upper division. During that period students can use the many resources available to learn about IT fields, including mentors; peer, faculty, industry, and alumni advisers; special courses; and written materials. These resources provide information about career opportunities in IT’s various fields and other colleges and help students avoid the mistake of selecting a major for the wrong reasons.

All students are urged to take advantage of the Industry Adviser and Mentor Programs, and visit selected industries to learn about engineering and science fields with an engineer and/or scientist of their choice. Currently, more than 200 engineers and scientists from Honeywell, 3M, NSP, and many other companies serve as advisers to IT students through this program. Arrangements to participate are made by online application.

IT undecided students follow the same first-year academic program as that followed by IT students with a specified major.

Advanced Standing Admission (Transfer)

Students who have completed any postsecondary classes after high school are considered for admission with advanced standing. Students planning to transfer to IT should be pursuing a lower division engineering, science, or math program. The mathematics, chemistry, physics, and computer science courses required for the preferred major should be mostly completed at the time of application. Admission decisions are based on an overall “technical” GPA using grades in science, calculus, computer science, and engineering. Because demand for some IT programs exceeds available places, applicants are asked to indicate three majors in order of preference. Applications must include recent transcripts from all colleges attended, reflecting all college work attempted (whether satisfactorily completed or not). Applications must also include a high school transcript to show whether the preparation requirements listed have been met.

IT's “cohort” program places new students into teams that take classes together—helping freshmen meet other students, form study groups, and establish friendships.

Most courses transfer routinely. Equivalency for technical courses has been established between IT and most colleges and universities (see www.it.umn.edu/prospective/equiv). Technical courses in which a D has been earned do not transfer.

Dual Degree (3/2) Programs—IT has cooperative agreements with a number of public and private colleges. These programs support students who want to combine a strong liberal arts background with study in engineering—and are willing to spend another year or two achieving this goal.

Under one plan a student can complete three years of study at a private college and then transfer to IT for two additional years. Core college requirements and the pre-engineering core courses in math and science are completed at the private college. A bachelor’s degree is awarded by both the private college and IT.

The second plan requires completion of a bachelor of arts degree in math or science before coming to the University to work toward a master of science degree in engineering. This typically involves completing some undergraduate engineering coursework. This plan minimizes the amount of undergraduate coursework required. The amount of such coursework will vary by department and area of study. Participating colleges include (in Minnesota) Augsburg College, Bethel College, Concordia College (Moorhead), Gustavus Adolphus College, Hamline University, Macalester College, MN State University–Moorhead, Northwestern College, the College of St. Catherine, Saint Mary’s College, St. Olaf College, St. John’s University-College of St. Benedict, St. Scholastica, University of St. Thomas, University of Minnesota, Morris; (outside Minnesota) Augustana College, SD; Carroll College, MT; Jackson State University, MS; Luther College, IA; North Central College, IL; North Park College, IL; Simpson College, IA; University of Mary, ND; University of Winnipeg, Manitoba, Canada; University of Wisconsin–Eau
Institute of Technology

Claire, WI; University of Wisconsin–La Crosse, WI; University of Wisconsin–River Falls, WI; Westmont College, CA; Wheaton College, IL; Whittier College, CA.

Degrees and Programs

Undergraduate Degrees—Each of IT’s undergraduate programs provides a rigorous and stimulating education enhanced by close interaction with distinguished research faculty and access to IT’s research facilities.

Eighteen degrees are offered:
- bachelor of aerospace engineering and mechanics*
- bachelor of science in astrophysics
- bachelor of biomedical engineering
- bachelor of biosystems and agricultural engineering*
- bachelor of chemical engineering*
- bachelor of science in chemistry
- bachelor of civil engineering*
- bachelor of computer engineering*
- bachelor of science in computer science
- bachelor of electrical engineering*
- bachelor of geological engineering*
- bachelor of science in geology
- bachelor of science in geophysics
- bachelor of materials science and engineering*
- bachelor of science in mathematics
- bachelor of mechanical engineering*
- bachelor of science in physics
- bachelor of science in statistics

* Program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET).

Graduate Degrees—The University of Minnesota is the only institution in the state that offers a full range of graduate programs in mathematics and computer science, the physical sciences, and engineering. Each IT department offers M.S. and Ph.D. degree programs in several areas within its discipline. For detailed information about the various graduate programs, consult the Graduate School Catalog at [www.catalogs.umn.edu/grad](http://www.catalogs.umn.edu/grad).

IT and the Graduate School jointly offer a program leading to the master of engineering (M.E.) degree in any of the engineering disciplines. This program provides advanced preparation in specialized design work for recent graduates in engineering as well as for working engineers who wish to improve their technical capabilities.

The management of technology program is an executive-format graduate program that prepares working engineers and scientists for careers in technology management. It is a part-time, two-year program leading to a master of science degree in the management of technology (M.S.-M.O.T.). Similar professional masters programs are offered in infrastructure systems, and software engineering. For more information, contact the Center for the Development of Technological Leadership, 510 West Bank Office Building, 1300 S. Second Street, Minneapolis, MN 55455 (612-624-5747).

Interdisciplinary Programs—IT students can plan interdisciplinary programs tailored to their specific interests. Although a degree is approved by a single department, students can combine coursework from several departments.

Many interdisciplinary programs are possible. A few examples include acoustics, bioengineering, environmental engineering, nuclear engineering, and transportation. Students should contact their department office or visit 105 Lind Hall for more information.

Premedical Programs—Because there is no prescribed premedical major, some students plan their IT programs as preparation for medical school. The Minnesota medical schools in Duluth, Minneapolis, and Rochester give strong preference to applicants who are state residents.

The Minneapolis campus Medical School has approved the following courses to fulfill its premedical requirements.

Biology—Biol 1009 and 3211 and 2005. This sequence is most parallel to MCAT.

Biochemistry—BioC 3021, BioC 4025 (optional lab)

Chemistry—Chem 1021–1022, 2301–2302 and 2311

English and Literature—One English Composition course and one literature course

Calculus—Math 1271 or equivalent

Physics—Physics 1201 and 1202 or 1301 and 1302

Social and Behavioral Sciences and Humanities—Four courses: one course in psychology with the remaining coursework in at least two of the following areas—history, sociology, anthropology, philosophy, comparative studies, music, or art.

All math/science courses must be taken A-F. A-F grading is preferred for all coursework.

Pre-requisite courses do change occasionally. The Medical School Web sites have the most up-to-date information and can be found at:

Duluth: [http://penguin.d.umn.edu/Admissions](http://penguin.d.umn.edu/Admissions)

Minneapolis: [www.meded.umn.edu](http://www.meded.umn.edu)

Rochester: [www.mayo.edu/mms/md-admissions.html](http://www.mayo.edu/mms/md-admissions.html)

For more information, contact the Health Careers Center in 2-571/585 Moos Tower (612-624-6767) or visit the Web site at [www.healthcareers.umn.edu](http://www.healthcareers.umn.edu).

Minors

Information Technology Minor Only

This interdisciplinary minor provides opportunities to students in nontechnical disciplines to supplement their major with courses focused on information technology. For more information, see the Degree Programs and Minors section.

Honors Program

The IT honors program provides special educational experiences to those students who have the ability and motivation to accept an extra challenge. Honors opportunities include a specially designed academic curriculum during the freshman and sophomore years, upper division programs leading to the cum laude degrees, close contact with instructors, opportunities for research, and a variety of elective honors courses, seminars, and colloquia offered in IT and the College of Liberal Arts.

During the freshman year, most lower division honors students take enriched mathematics, physics, and chemistry courses that provide excellent preparation for any IT major. Students also participate in the many social and cocurricular activities initiated by the IT Student Honors Group and may live in honors housing.
Scholastic Policies

Continuation in Sequences—IT students taking the following lower division sequence courses must earn at least a C- each semester to continue in the sequence.

Chem 1021-1022, 2011-2111
Chem 2301, 2302, 2311
EE 2001, 2011
Math 1155, 1271-1272*
Math 1371-1372
Math 1571-1572
Phys 1301, 1302
Phys 2303, ** 2601

* To continue in additional mathematics courses (in particular Math 2243 or Math 2263) or sequences, IT students must earn at least a C- in Math 1272, 1372, or 1572.

** To continue in physics sequences, IT students must earn at least a C- in Phys 2303.

IT students must earn at least a C- in all 1xxx and 3xxx math, physics, and chemistry courses, and all courses required by the major. All courses required by the major must be taken A-F.

Upper Division—The upper division corresponds to the junior and senior years.

Freshmen and sophomores must apply for entry and are told at orientation what minimum GPA might be required. Students should file an application in 105 Lind Hall before completing their sophomore year.

Changing Majors—To change majors within IT, upper division students must petition. Forms are available in 105 Lind Hall. A transcript must accompany the petition.

Students who graduate from IT but continue to register for courses will automatically have their status changed to nondegree unless they had previously been admitted to a second (double) major.

To change majors from IT to another college unit or campus within the University, students must apply for transfer through the One Stop Student Services Center, 200 Fraser Hall, as far as possible in advance of the projected transfer. Some units have transfer application deadlines. Students must meet admission requirements of the unit they plan to enter.

The University ranks tenth nationally among all U.S. colleges and Universities, public and private, in the number of patents issued to faculty over the past five years.

Conduct and Discipline

IT assumes that all students who enroll in its programs are serious about their education and expects them to be responsible individuals who demand of themselves high standards of honesty and good personal conduct.

IT expects the highest standards of honesty and integrity in the academic performance of its students. Any act of scholastic dishonesty is regarded as a serious offense, which may result in expulsion. IT defines scholastic dishonesty as submission of false records of academic achievement; cheating on assignments or examinations; plagiarizing; altering, forging, or misusing a University academic record; taking, acquiring, or using test materials without faculty permission; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement. Aiding and abetting a student in an act of scholastic dishonesty is also considered a serious offense.

All students at the University have the right to a calm, productive, and stimulating learning environment. Students who engage in behavior that disrupts the learning environment for others may be subject to disciplinary action under the Student Conduct Code, which prohibits disruptive conduct. In addition, students responsible for such behavior may be required to cancel their registration (or have their registration canceled).

All disciplinary cases that are academic and nonacademic in nature or that involve two or more colleges are referred to the Office for Student Academic Integrity, 2221 University Avenue S.E., Minneapolis, MN 55414 (612-624-0073). A student has the right to a hearing and to appeal any disciplinary action. Copies of the procedures for cases of scholastic dishonesty are available at the Office for Student Academic Integrity.

Professional Registration

Registration is a legal requirement for certain kinds of practice in engineering and in geoscience. A professional license is required before an individual may use the designation of engineer in any legal connection. Many engineers obtain a license to show their support for legal recognition of the professional standing of the engineer or geologist. Many also obtain a license because professional registration may be useful or required in future employment.
The license is awarded in most states to those graduates of an accredited engineering curriculum who have passed examinations in the fundamentals, principles, and practice of engineering and demonstrated their competence by a specified number of years of appropriate experience. The fundamentals of engineering examination covers materials studied in undergraduate curricula. This examination is given in the spring and fall each year and may be taken by students in their senior year. More information and applications may be obtained from IT Career Services in 50 Lind Hall or by writing to the Minnesota State Board of Architecture, Engineering, Land Surveying, Landscape Architecture, Geoscience, and Interior Design, 133 7th Street E., St. Paul, MN 55101-2333 (651-296-2388).

Advising

Advising for freshmen is coordinated by the Office of Lower Division Programs, 128 Lind Hall (612-624-2890). Every IT freshman is assigned to a team of approximately 100 students. During orientation, freshmen meet with their team adviser and plan their fall schedule. Students on each team take one or more courses together; this encourages the formation of study and support groups. Freshmen must meet with their team adviser at least once each term to discuss their progress and plan their schedule for the following semester.

All lower division students obtain advising through the Office of Lower Division Programs until admission to upper division.

Special Learning Opportunities and Resources

Student Affairs Office—Prospective and current students can discuss any questions or problems with an advising staff member in the Student Affairs Office, 105 Lind Hall (612-624-8504) or e-mail studentaff@it.umn.edu. This office is responsible for admission, orientation, scholastic conduct, institute-wide scholarships, degree requirements and procedures, and related functions. Appointments are encouraged.

Tutors—IT provides peer tutors for students in chemistry, mathematics, physics, and other IT courses. These teaching assistants, selected from junior and senior IT students, are trained, qualified, and willing to assist students one-on-one with problems in IT lower division courses. Tutoring is provided in various locations—in 150 Lind Hall, by appointment in 128 Lind Hall, and in all residence halls.

Mathematics graduate teaching assistants are available in 150 Lind Hall with the undergraduate teaching assistants. In addition, graduate teaching assistants provide tutoring for computer science courses in 4-205 Electrical Engineering/Computer Science.

For more information about tutors, contact the Office of Lower Division Programs, 128 Lind Hall (612-624-2890).

Paid Learning Opportunities—IT Career Services (ITCS) provides information about off-campus employment related to major or career interests. Many options are available for part-time, summer internship, and cooperative education employment. Students may be eligible for part-time or summer internship opportunities as early as the end of their freshman year. Students entering upper division may be eligible to participate in cooperative education programs offered through their major department. For more information, visit the ITCS Web site at www.it.umn.edu/career or contact ITCS, 50 Lind Hall (612-624-4090).

IDEAS (Integrated Degrees in Engineering, Arts, and Sciences)—This scholarship program is for undergraduates who integrate degrees from IT and the College of Liberal Arts. IDEAS enriches students’ education by exploring how technology and society influence each other and promotes leadership in technology by providing students with educational opportunities for increased breadth and depth in liberal arts, business, and technical management. For more information, contact the IT Student Affairs Office, 105 Lind Hall, (612-624-8504).

Academic Program for Excellence in Engineering and Science (APEXES)—APEXES promotes academic excellence and the increased presence of underrepresented groups (African American, Chicano/Latino, Native American) in engineering and the physical sciences. Through its precollege, undergraduate, and graduate/faculty programs, it promotes diversity in the classroom, laboratory, and workplace to prepare IT students for careers in an ethnically diverse work force.

Working with other IT and University offices, the program offers a variety of academic enrichment programs such as tutoring, learning assessment, career assessment, and study groups. Through collaboration with IT departments and corporate sponsors, APEXES identifies experiences outside the classroom such as internships, cooperative programs, and work teams to expose students to applications in science and engineering. These collaborations also provide merit scholarships for underrepresented students in engineering and the physical sciences who excel academically.

For more information, contact APEXES, 107 Lind Hall, 207 Church Street S.E., Minneapolis, MN 55455 (612-626-0219; e-mail APEXES@umn.edu).

Program for Women—The mission of this program is to encourage, recruit, and retain women faculty and students in the physical sciences, mathematics, and engineering. Since its establishment in 1990, the program has been responsible for numerous activities and events for undergraduate and graduate women, women faculty, and pre-college outreach programs. The program supports a female graduate student in each academic department to encourage networking within the department and assist in recruiting more women into the program. Retention strategies focus on networking within and across the academic departments in IT both for faculty and students.

For more information visit the IT Program for Women Web site at www.it.umn.edu/women or contact Associate Dean Roberta M. Humphreys, 105 Walter Library, 612-624-2006.

UNITE Instructional Television—About 50 credit courses each semester are offered through UNITE (UNiversity-Industry Television for Education), an instructional television system for continuing education at the employee’s workplace. In addition, 25 of these courses are offered by streaming video—live as they happen on campus—or by video-on-demand. These include both upper division and graduate courses as well as specially developed courses and seminars. Classes are held in TV studio classrooms with on-campus students in attendance. The system is interactive, enabling students at all sites to talk with the instructor and take part in class discussions. Participating companies help support the system by paying a fee based on the number of credits for which its employees are enrolled. This fee is separate from tuition, which is paid either by the student or the company, depending on company policy.

For more information, contact the Director, UNITE Instructional Television, 114 Lind Hall, 207 Church Street S.E., Minneapolis, MN 55455 (612-624-2332).
On-campus Living Experiences for Freshmen in IT—
The Explorations in Engineering and Sciences House (IT Explorations) and the Women in Science and Engineering House (WISE) are new IT residential learning environments. These houses create a smaller living-learning environment in which students can benefit from others who have similar academic and career interests in science and/or engineering. Participating students find support from their peers that can enhance their success in the classroom and on campus. Faculty and staff advisers from IT provide guidance during students’ first year on campus, on-site academic advising, access to information on career options, and coordinate various social activities such as dinner with professionals, faculty members, and student organizations.

All participants are strongly encouraged to register for IoT 1312—Exploring Careers in Science and Engineering (2 cr). This course can be used as a freshman seminar.

IT Explorations is a co-ed community open to 80 students in Frontier Hall. The WISE House is a female first-year freshman community open to 30 students in Comstock Hall. Contact the IT Student Affairs Office for further information at 612-624-8010, e-mail kubit001@umn.edu, or visit the Housing and Residential Life Web site at www.housing.umn.edu.

International Programs

IT students have hundreds of study abroad programs to choose from. Students can study in or outside their major, study a second language, or study the history and culture of a region. Study in English is possible at various sites including Hong Kong, Sweden, Norway, England, Denmark, Australia and many others. Students may spend a semester, academic year, or May session enhancing their cross-cultural skills, language ability, or professional experience. Each IT department has a list of recommended locations for study abroad. Students can learn more about these options by contacting Susan Kubitschek, 106 Lind Hall, kubit001@umn.edu, 612-624-8010.

Opportunities in Science and Engineering—Students have access to science and engineering courses through student exchanges at universities in many countries. Many of these opportunities are very affordable and the Learning Abroad Center offers more than $150,000 in scholarships for study abroad. IT has also been supportive to students with financial need. Students interested in doing an international internship in a technical field should contact IAESTE at IAESTE@umn.edu or call 612-624-2413.

Other Information—For information about opportunities through the International Student Exchange Program (ISEP), International Association for the Exchanges of Students for Technical Experience (IAESTE), and Institute for Study Abroad (Butler University, IN), visit the Learning Abroad Center in 230 Heller Hall. Advisers there can assist you with study and credit options, financial aid, and orientations. For a full listing of study abroad opportunities, see www.UMabroad.umn.edu.

Career Information

IT Career Services (ITCS), 50 Lind Hall (612-624-4090), www.it.umn.edu/career provides comprehensive career planning and job search assistance for IT students and alumni.

ITCS helps students explore major and career options. Each semester the office offers IoT 1312—Exploring Careers in Science and Engineering (2 cr), a career exploration course that identifies how interests, skills, and abilities align with career possibilities, and provides the opportunity to meet professionals working in engineering and science fields.

ITCS provides a variety of services to students seeking part-time jobs, summer internship and cooperative program positions, or permanent jobs after graduation. ITCS hosts on-campus interviewing, posts job opportunities, and helps students learn all aspects of the job search process, including writing résumés and job search correspondence, developing interviewing skills, and learning how to access job and employer information.

The office also supplies information about and applications for the Engineer In Training (EIT) examinations.

Students are encouraged to register with ITCS as early as their sophomore year.

Institute of Technology graduates and faculty have founded more than 1,000 companies that employ at least 153,000 people worldwide and have more than $20 billion in annual sales.

Student Organizations and Activities

Scientists and engineers find that membership in technical or professional societies usually helps their career development. Many of these societies have student chapters at the University. Through them students have the opportunity to participate in activities of the parent society, gain experience in conducting technical meetings, and meet senior members of the societies. In addition, regular membership in the society is facilitated upon graduation and any entrance fee is reduced or waived for former student members.

Professional Societies—Branches of the following national professional societies are maintained at the University of Minnesota by students and faculty: American Institute of Chemical Engineers, Society of Physics Students, American Society of Civil Engineers, American Society of Mechanical Engineers, Society for Engineering in Agricultural, Food, and Biological Systems, American Institute of Aeronautics and Astronautics, American Institute of Industrial Engineers, and Institute of Electrical and Electronic Engineers. Additional professional societies include the Society of Women Engineers, National Society of Black Engineers, Triangle, Theta Tau, and Alpha Sigma Kappa.

Honorary Scholastic Societies—These IT societies promote the high standards of the engineering profession by conferring memberships, awards, and other honors on undergraduates distinguished for scholastic achievement and for character. The societies normally elect members from the junior and senior classes on the basis of scholarship (as measured by class rank) and character (as judged by peers and faculty). Of these honorary societies, only Tau Beta Pi selects its members from students in all IT undergraduate departments. The others confine their membership to students from a single department: Alpha Epsilon (biosystems and agricultural engineering), Chi Epsilon (civil engineering), Eta Kappa Nu and Kappa Eta Kappa (electrical engineering), Pi Tau Sigma (mechanical engineering), and Sigma Gamma Tau (aerospace engineering and mechanics).

Plumb Bob—A senior honorary leadership and service society, Plumb Bob works to create and maintain a spirit of fellowship and cooperation among IT students and further the interests of IT and the University. Its members are chosen for their character, leadership, and service.
IT Student Board
This board is the executive body of IT students, representing them in matters affecting the general interests of IT and the University.

Student Publications
Two publications are produced by IT students. IT Connection is IT’s bi-weekly newsletter for students, staff, and faculty and includes meetings notices and information on scholarships and programs of interest. For more information contact connection@itdean.umn.edu. Minnesota Technolog is IT’s official student magazine. Published three times a year, this 83-year-old publication features pieces written by students on science and engineering issues. For more information contact technolog@itdean.umn.edu.

The IT Student Publications selects editors and business managers and directs the overall policy of the publications. Students are encouraged to participate as publication staff members.

Directory
(area code 612)

Office of the Dean
105 Walter Library
624-2006
E-mail: info@it.umn.edu

Office of the Associate Dean for Student Affairs
106 Lind Hall
624-5091
E-mail: studentaff@itdean.umn.edu

Office of Lower Division Programs
128 Lind Hall
624-2890
E-mail: itld@umn.edu

Student Affairs Office (Admissions)
105 Lind Hall
624-8504
E-mail: studentaff@itdean.umn.edu

Center for the Development of Technological Leadership
510 West Bank Office Building
624-5747
E-mail: general@cdtl.umn.edu

IT Honors Office
136 Lind Hall
625-2800
E-mail: honors@itdean.umn.edu

IT Career Services
50 Lind Hall
624-4090
E-mail: itcs@umn.edu

Academic Program for Excellence in Engineering and Science (APEXES)
107 Lind Hall
626-0219
E-mail: apexes@umn.edu

Departments
Aerospace Engineering and Mechanics
107 Akerman Hall
625-8000
E-mail: dept@aem.umn.edu

Astronomy
356 Tate Laboratory of Physics
624-0211
E-mail: tij@astro.umn.edu

Bio-based Products
203 Kaufert Laboratory
625-5200
E-mail: shri@umn.edu

Biomedical Engineering
7-105 Basic Sciences and Biomedical Engineering Building
624-4507
E-mail: bmedus@umn.edu

Biosystems and Agricultural Engineering
213 Biosystems and Agricultural Engineering Building, St. Paul
625-7733
E-mail: bac@umn.edu

Chemical Engineering and Materials Science
151 Amundson Hall
625-1313
E-mail: dwilliams@chem.umn.edu

Chemistry
135 Smith Hall
624-8008
E-mail: stathopo@chem.umn.edu

Civil Engineering
122 Civil Engineering Building
625-5522
E-mail: civ@umn.edu

Computer Science and Engineering
4-192 Electrical Engineering/Computer Science
625-4002
E-mail: ugrad_info@cs.umn.edu

Electrical and Computer Engineering
4-174 Electrical Engineering/Computer Science
625-3300
E-mail: undergraduate_studies@ece.umn.edu

Geology and Geophysics (Earth Sciences)
108 Pillsbury Hall
624-1333
E-mail: geology@umn.edu

Mathematics
115 Vincent Hall
625-4848
E-mail: dept@math.umn.edu

Mechanical Engineering
1100 Mechanical Engineering
625-5842
E-mail: jeanne@me.umn.edu

Physics
148 Tate Laboratory of Physics
624-7375
E-mail: ugrad@physics.spa.umn.edu

Statistics
313 Ford Hall
625-8046
E-mail: info@stat.umn.edu

IT Web Site
www.it.umn.edu
Aerospace Engineering

Department of Aerospace Engineering and Mechanics

B.A.E.M.

The mission of the bachelor of aerospace engineering and mechanics (B.A.E.M.) program is to produce graduates who are prepared to enter and sustain the practice of aerospace engineering and related fields, or to pursue advanced studies. This mission is consistent with the mission of the University of Minnesota in learning and teaching; and with the mission of the Institute of Technology to provide a rigorous and stimulating education for its undergraduate majors and to provide programs of instruction in engineering that meet nationally accepted standards for practice of the profession of engineering.

Aerospace engineering is a multidisciplinary field that encompasses many areas of science and engineering and plays a major role in the technological advancement of society. As a constantly changing profession, aerospace engineering is concerned with a wide range of problems and the latest technologies. For this reason an aerospace engineer must have a comprehensive fundamental education in mathematics, physical sciences, and engineering sciences. The four-year program leading to the B.A.E.M. provides this broad background.

The program is accredited by the Engineering Accreditation Commission of ABET.

Educational objectives of the B.A.E.M. program are to produce graduates:

- with a broad background in aerospace engineering and mechanics, including fluid mechanics, structural mechanics, and aerospace systems.
- who can apply their knowledge of aerospace engineering and mechanics to achieve success in the aerospace industry, related government agencies, and other engineering industries.
- with skills in the essential tools used in aerospace and other industries. These tools include experimental methods, problem-solving techniques, computational methods and engineering design.
- with the ability to both seek out assistance when needed and to learn new skills throughout their careers.
- with the oral and written communication skills needed to successfully work in a modern multidisciplinary environment.
- who can be successful in graduate-level work in engineering, as well as in other professional schools.

The courses required for the B.A.E.M. include significant laboratory and design experiences.

The department offers an optional engineering intern program in the upper division. The program allows students to obtain industrial work experience by alternating semesters (including the summer) of industrial employment with academic studies during their junior and senior years. Prospective participants should contact the intern program director for information in the fall of their sophomore year.

Admission Requirements—Complete specific lower division courses and meet GPA requirement set by IT (currently 2.00).

Degree Requirements

Students must complete at least 127 credits to graduate, including at least 56 credits in the major. The courses required for the degree are listed below. These include two technical electives selected from IT upper division courses in an area of interest to the student. One additional technical elective must be taken from the list of five courses in the area of solid mechanics and materials. Campus liberal education requirements are to be met through the 15 credits of liberal education courses. The campus writing requirements are met by B.A.E.M. majors by taking two additional writing intensive courses. These courses may also count as liberal education electives. Two required courses, AEM 4602W and AEM 4332W, are writing intensive courses, and these complete the requirements for four writing intensive courses where one course is the upper division and one course is in the major.

Required Courses

Lower Division

- AEM 2011—Statics
- AEM 2012—Dynamics
- AEM 2301—Mechanics of Flight

Upper Division

- AEM 3031—Deformable Body Mechanics
- AEM 4201—Fluid Mechanics
- AEM 4202—Aerodynamics
- AEM 4203—Aerospace Propulsion
- AEM 4301—Spaceflight Dynamics
- AEM 4303—Flight Dynamics and Control
- AEM 4501—Aerospace Structures
- One of AEM 4502, 4511, 4581, 5441, 5651
- AEM 4601—Instrumentation Lab
- AEM 4602W—Aeromechanics Lab
- AEM 4331—Aerospace Vehicle Design I
- AEM 4332W—Aerospace Vehicle Design II

Two technical electives

Required Courses From Other Programs

- Chem 1021—Chemical Principles I
- CSci 1113—Programming for Scientists and Engineers
- EE 3005, 3006—Fundamentals of Electrical Engineering and Lab
- Math 1271, 1272 or Math 1371, 1372 or Math 1571H, 1572H—Calculus I, II
- Math 2243 or 2273 or 2573H—Linear Algebra and Differential Equations
- Math 2263 or 2374 or 2574H—Multivariable Calculus
- MatS 2001—Introduction to Science of Engineering Materials
- ME 3324—Introduction to Thermal Science
- Phys 1301W, 1302W, 2503—Introductory Physics I, II, III

Liberal education electives—15 credits

Electives

Restrictions on Upper Division Technical Electives

Three courses (9 credits) of upper division technical electives are required. Generally the elective requirement is met by selecting non-required 3xxx, 4xxx, and 5xxx courses offered by engineering departments. Some courses from mathematics or science departments are also acceptable. Exceptions and additions to this rule are the subject of this section.

No course equivalent to a course required in the B.A.E.M. program may be used as an elective; no 1xxx science or mathematics course may be used; and no 1xxx engineering course may be used except for one in the special category described below in (b).
a) Elective in the solid mechanics, engineering materials, and composites area: One of five courses, AEM 4502, 4511, 4581, 5441, and 5651 must be taken.

b) Restrictions on use of some courses as technical electives: One of the three technical electives other than the “solids” elective of part (a) above may be replaced by one of the following (if more than one is taken, the extra credits are not counted toward the degree requirements):

- The second semester of chemistry, Chem 1022
- A 2xxx mathematics, science, or engineering course (e.g., Ast 2001)
- A 3xxx computation course (e.g., CE 3101)
- A 3xxx statistics course (e.g., Stat 3021)

c) Other general restrictions on technical electives:

- No 1xxx mathematics or natural science course (e.g., Ast 1001) is acceptable.
- Only one programming course may be used; therefore an AEM student will not be given credit toward the degree for more than one course of FORTRAN, Pascal, or C/C++.
- The following 3xxx engineering courses contain material already covered in required courses and so are not acceptable as technical electives: CE 3502, ME 3322. These are essentially contained in the required course AEM 4201. CE 3202 (surveying) is not suitable.
- No courses from the Carlson School of Management may be used as technical electives.

Sample Aerospace Engineering Program

Freshman Year

Fall Semester (16 cr)
Chem 1021—Chemical Principles I (4 cr)
EngC 1011—University Writing and Critical Reading (4 cr)
Math 1371—IT Calculus I (4 cr)
Phys 1301W—Introductory Physics I (4 cr)

Spring Semester (16 cr)
Biol 1001—Introductory Biology I (4 cr)
CSci 1113—Introduction to C/C++ Programming for Scientists and Engineers (4 cr)
Math 1372—IT Calculus II (4 cr)
Phys 1302W—Introductory Physics II (4 cr)

Sophomore Year

Fall Semester (17 cr)
AEM 2011—Statics (3 cr)
Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)
MatS 2001—Introduction to the Science of Engineering Materials (3 cr)
Phys 2503—Introductory Physics for Scientists and Engineers (4 cr)

Spring Semester (17 cr)
AEM 2301—Mechanics of Flight (3 cr)
Math 2373—IT Calculus III (4 cr)

Junior Year

Fall Semester (15 cr)
AEM 3031—Deformable Body Mechanics (3 cr)
AEM 4201—Fluid Mechanics (4 cr)
AEM 4301—Spaceflight Dynamics (3 cr)
EE 3005—Fundamentals of Electrical Engineering (4 cr)
EE 3006—Fundamentals of Electrical Engineering Lab (1 cr)

Spring Semester (16 cr)
AEM 4202—Aerodynamics (4 cr)
AEM 4303—Flight Dynamics and Control (3 cr)
AEM 4501—Aerospace Structures (3 cr)
AEM 4601—Instrumentation Laboratory (3 cr)

Liberal education elective (3 cr)

Senior Year

Fall Semester (17 cr)
AEM 4331—Aerospace Vehicle Design I (3 cr)
AEM 4602W—Aeromechanics Laboratory (4 cr)
ME 3324—Introduction to Thermal Science (4 cr)
Technical elective (3 cr)
Liberal education elective (3 cr)

Spring Semester (17 cr)
AEM 4203—Aerospace Propulsion (4 cr)
AEM 4332W—Aerospace Vehicle Design II (4 cr)
Technical elective (3 cr)
Solids technical elective (3 cr)
Liberal education elective (3 cr)

Astrophysics

Department of Astronomy

B.S.Astro.P.

An undergraduate program is offered leading to a B.S. in astrophysics. The astrophysics program enables students to develop the skills necessary to tackle complex and ill-defined problems within the physical sciences. The program prepares students for careers in professional astronomy, computational astrophysics, secondary education in the physical sciences, ROTC programs in the Air Force or Navy, data analysis, or laboratory science.

Admission Requirements—Complete specific lower division courses and meet GPA requirement set by IT (currently 2.00).

Degree Requirements

Students must complete at least 120 credits to graduate, including at least 19 credits in the major.

The astrophysics degree has several different tracks, depending on the area of specialization a student wishes to pursue. Each track has the same core math, physics, and astrophysics requirements. In addition to these core courses, each track requires 16 credits specific to the area of specialization.

Areas of specialization

- Professional astronomer
- Computational astrophysics
- Secondary education
- Data analysis specialist
- Laboratory scientist

Required Courses

(Ast 1011—Exploring the Universe, Honors is recommended but not required)
Ast 2001—Astrophysics
Two 4xxx or 5xxx astronomy courses
Ast 4994—Senior Thesis (3 cr minimum)
Math 1271, 1272 or Math 1371, 1372 or Math 1571H, 1572H
Math 2243, 2263 or Math 2371, 2372 or Math 2573H, 2574H
Math 2283, or any Math 3xxx or Math 4xxx
Phys 1301, 1302 or Phys 1401, 1402
Phys 2503, 2601, 2605
Phys 4001, 4002

Electives—16 credits from the area of specialization or any 3xxx, 4xxx, or 5xxx astronomy, math, chemistry, or physics course

Final Project

A minimum of 3 credits of Ast 4994—Senior Thesis is required for the degree.
Astrophysics Minor
A minor in astrophysics can be earned through the College of Liberal Arts by taking:
Ast 1001 or 1011 (recommended, not required)
Ast 2001 and its prerequisites

Sample Astrophysics Program
Freshman Year
Fall Semester (16 cr)
Ast 1011—Exploring the Universe (4 cr)
Math 1371—IT Calculus I (4 cr)
Phys 1301—Introductory Physics I (4 cr)
Liberal education elective (4 cr)

Spring Semester (16 cr)
EngC 1011—University Writing and Critical Reading (4 cr)
Math 1372—IT Calculus II (4 cr)
Phys 1302—Introductory Physics II (4 cr)
Liberal education elective (4 cr)

Sophomore Year
Fall Semester (16 cr)
Math 2373—IT Linear Algebra and Differential Equations (4 cr)
Phys 2503—Introductory Physics for Sciences and Engineering III (4 cr)
Liberal education electives (8 cr)

Spring Semester (14 cr)
Ast 2001—Introduction to Astrophysics (4 cr)
Math 2374—IT Multivariable Calculus (4 cr)
Phys 2601—Quantum Physics (4 cr)
Phys 2605—Quantum Physics Lab (2 cr)

Junior Year
Fall Semester (16 cr)
Ast 4xxx or 5xxx (4 cr)
Math 2283—Sequences, Series, and Foundations (4 cr)
Phys 4001—Analytical Mechanics (4 cr)
Degree elective (4 cr)

Spring Semester (12 cr)
Ast 4xxx or 5xxx (4 cr)
Phys 4002—Electricity and Magnetism (4 cr)
Degree elective (4 cr)

Senior Year
Fall Semester (15-16 cr)
Ast 4994—Directed Research (3-4 cr)
Degree elective (4 cr)
Liberal education elective (4 cr)
Elective (4 cr)

Spring Semester (16 cr)
Degree elective (4 cr)
Liberal education elective (4 cr)
Elective (4 cr)

Bio-based Products Engineering
Department of Bio-based Products
Bio-based products are materials, chemicals, and energy derived from renewable, bio-resources including forestry, agriculture and other biomass. Many of the commercial products and forms of energy that we use today and come from depleting fossil fuels can be derived from renewable, bio-resources. The molecular building blocks and components of biomass can be harnessed to heat our homes, run our cars, light our buildings, and provide industrial and consumer products. These products include fibers and fiber-based products, paper, board, engineered wood, structural panels, wood-based composites, renewable plastics, and bio-derived chemicals and fuels.

Biomedical Engineering
Department of Biomedical Engineering
B.Bm.E.
The Department of Biomedical Engineering at the University of Minnesota seeks to:
• deliver innovative educational programs of the highest quality at all degree levels;
• conduct pioneering high-impact research spanning basic science to clinical and technological application; and
• serve the local biomedical engineering community at the University, in Medical Alley, and beyond via these pursuits.
The program aims to provide educational experiences that enable students to:
• learn the scientific and engineering principles underlying the six major elements of biomedical engineering (BME): cellular and molecular biology, physiology, biomechanics, bioelectricity/instrumentation, biomedical transport processes, and biomaterials.
• gain technical depth and expertise in one particular area within BME.
• learn experimental, statistical, and computational techniques in the context of BME.
• apply and integrate knowledge of several of the six major elements of BME to solve biomedical design problems.
• prepare for a career in biomedical engineering or professional health practice by developing communication and teamwork skills, and by developing an understanding of the importance of lifelong learning, professionalism, social and legal issues, and ethical responsibility.

Biomedical engineers apply the fundamentals of mathematics, physics, chemistry, and biology to solve medically-relevant problems. Areas of interest may include medical device design, fabrication, and testing; prosthesis fabrication; ergonomics and human factors; physiological function monitoring; home health care technology development; biomedical informatics; functional imaging and tomography; biomaterial development and biocompatibility; artificial tissue and organ fabrication; cell- and biomodule-based sensors and therapeutics; gene therapy development; and biomedical microsystems.

While these examples represent current areas, biomedical engineering continues to change with the rapid advances in biology, medicine, and technology. Therefore, it is a goal of the program to ensure that students have sufficient breadth in their studies to be able to adapt and develop new opportunities and areas of application during their professional career. At the same time the program seeks to promote sufficient depth in one area of biomedical engineering so that students can develop particular expertise in an area of their choosing.

The Program for Women in IT supports women in their pursuit of education and careers in science and engineering.
For additional information, contact Director of Undergraduate Studies, Department of Biomedical Engineering, University of Minnesota, 7-105 Basic Sciences and Biomedical Engineering Building, 312 Church Street SE, Minneapolis, MN 55455 (612-624-4507, e-mail bmedus@umn.edu, www.umn.edu/bme.

Admission Requirements—Complete specific lower division courses and meet GPA requirement set by IT.

Degree Requirements
Students must complete at least 125 credits to graduate, including 30 credits in the major. The credit total includes the lower division program of mathematics, physics, chemistry, biology, and liberal education, as well as the upper division program of biomedical engineering, statistics, physiology, and engineering electives.

Required Courses
BME 2501—Cell and Molecular Biology of Biomedical Engineers
BME 2601—Biomedical Engineering Undergraduate Seminar I
BME 2602—Biomedical Engineering Undergraduate Seminar II
BME 3001—Biomechanics
BME 3101—Biomedical Transport Processes
BME 3201—Bioelectricity and BioInstrumentation
BME 3301—Biomaterials
BME 3701—Biomedical Engineering Physiology Laboratory
BME 4001W—Biomedical Engineering Design I
BME 4002W—Biomedical Engineering Design II
Chem 1021—Chemical Principles I
Chem 1022—Chemical Principles II
Chem 2301—Organic Chemistry I
Chem 3501—Physical Chemistry I
or Biol 3021—Biochemistry
Biol 1009—General Biology
CSci 1107—Introduction to FORTRAN Programming for Scientists and Engineers
Math 1271 or 1372—Calculus II
Math 1271 or 1371—Calculus I
Math 2243 or 2373—Linear Algebra and Differential Equations
Math 2263 or 2374—Multivariable Calculus
Phys 1301W—Introductory Physics I
Phys 1302W—Introductory Physics II
Phsl 3061—Principles of Physiology
Stat 3021—Introduction to Probability and Statistics
Electives—24 credits of engineering electives (requires department approval) and 23 credits of liberal education electives (includes Biol 1009)

Sample Biomedical Engineering Program

Freshman Year
Fall Semester (16 cr)
Chem 1021—Chemical Principles I (4 cr)
EngC 1011—University Writing and Critical Reading (4 cr)
Math 1371 or 1271—Calculus I (4 cr)
Phys 1301—Introductory Physics I (4 cr)

Spring Semester (16 cr)
Biol 1009—General Biology (4 cr)
Chem 1022—Chemical Principles II (4 cr)
Math 1372 or 1272—Calculus II (4 cr)

Sophomore Year
Fall Semester (14 cr)
BME 2601—Biomedical Engineering Undergraduate Seminar I (1 cr)
Chem 2301—Organic Chemistry I (3 cr)
CSci 1107—Introduction to FORTRAN Programming for Scientists and Engineers (3 cr)
Math 2374—Multivariable Calculus (4 cr)
Stat 3021—Introduction to Probability and Statistics (3 cr)

Spring Semester (18 cr)
BME 2501—Cell and Molecular Biology for Biomedical Engineers (4 cr)
BME 2602—Biomedical Engineering Undergraduate Seminar II (1 cr)
Chem 3501—Physical Chemistry I (3 cr)
or Biol 3021—Biochemistry (3 cr)
Math 2373—Linear Algebra and Differential Equations (4 cr)
Liberal education elective (3 cr)

Junior Year
Fall Semester (14 cr)
BME 3001—Biomechanics (4 cr)
BME 3201—Bioelectricity and Bioinstrumentation (4 cr)
BME 3701—Physiology Laboratory (2 cr)
Phsl 3061—Principles of Physiology (4 cr)

Spring Semester (17 cr)
BME 3101—Biomedical Transport Processes (4 cr)
BME 3301—Biomaterials (4 cr)
Liberal education elective (9 cr)

Senior Year
Fall Semester (18 cr)
BME 4001W—Biomedical Engineering Design I (3 cr)
Engineering and science electives (12 cr)
Liberal education elective (3 cr)

Spring Semester (15 cr)
BME 4002W—Biomedical Engineering Design II (3 cr)
Engineering and science electives (12 cr)

Biosystems and Agricultural Engineering

Department of Biosystems and Agricultural Engineering

B.B.A.E.
The mission of the Department of Biosystems and Agricultural Engineering is to conduct research and educate people to solve engineering problems in agricultural and biological environments.

Educational objectives for the program are to produce graduates:

- with a broad fundamental engineering background including mathematics, physical science, biological science, engineering science, and computational skills needed for their future practice of biosystems and agricultural engineering.
- with the skills necessary to carry out an effective design process including the ability to think creatively, work cooperatively, formulate problems, synthesize information, develop and evaluate alternatives, implement solutions, and communicate effectively at all stages of the process.
- with the ability to address issues of ethics, safety, professionalism, and social and economic impacts in engineering practice and design.
- with specific abilities to pursue careers that integrate engineering and biology to design efficient, economical systems to produce and deliver high quality, safe food to consumers; to design sustainable systems that protect the environment, humans, plants, and animals; and to design safe and efficient machines, processes, and practices for biological systems.
- who have opportunities to develop in-depth background in one of the following areas of emphasis:
  Bioprocessing and Food—design and develop systems for processing agricultural and biological materials to produce important products such as foods or pharmaceuticals.
  Environment—design and develop systems to preserve and protect agricultural and natural resources including soil, water, and air.
Machinery Systems—design and develop systems for production and processing of food and other biological materials.

The curriculum includes emphases in bioprocessing and food, environment, and machinery systems. Students, with the assistance of an advisor, plan a curriculum tailored to their individual interests in one of these three emphases.

Engineering internships are available to supplement classroom instruction by providing practical education and experience with an employer. Students may begin their internships in the summer following their first year.

The biosystems and agricultural engineering program is accredited by the Accreditation Board for Engineering and Technology (ABET).

For additional information, contact Director of Undergraduate Studies, Department of Biosystems and Agricultural Engineering, 213 Biosystems and Agricultural Engineering Building, 1390 Eckles Avenue, St. Paul, MN 55108. E-mail bae@umn.edu; phone 612-625-7733, fax 612-624-3005.

Admission Requirements—Complete specific lower division courses and meet GPA requirement set by IT (currently 2.00).

Degree Requirements

Students must complete at least 128 credits to graduate, including 30 credits in the major. Non-BAE credits include 27–30 credits of engineering courses; 7 credits of composition; 45 credits of mathematics, chemistry, physics, biology, statistics, and computer science; and credits needed to fulfill the University's liberal education requirements.

Required Courses

BAE 1011—BAE Orientation (1 cr)
BAE 2113—Introduction to Design (3 cr)
BAE 3013—Engineering Principles of Molecular and Cellular Processes (3 cr)
BAE 3023—Engineering Principles of Soil-Water-Plant Processes (3 cr)
BAE 4013—Transport in Biological Systems (4 cr)
BAE 4023—Instrumentation and Control for Biological Systems (3 cr)
BAE 4114—Capstone Design Project (4 cr)

Plus 9 credits (three courses) of BAE in an emphasis (For a designated emphasis, at least two courses must be in that emphasis.)

Environment

BAE 4523—Water Management Engineering (3 cr)
BAE 4533—Agricultural Waste Management Engineering (3 cr)
BAE 5513—Watershed Engineering (3 cr)

Machinery Systems

BAE 4313—Design of Machine Systems (3 cr)
BAE 4323—Machinery Elements (3 cr)

Bioprocessing and Food

BAE 4713—Bioprocessing Engineering (3 cr)
BAE 4723—Food Process Engineering (3 cr)

Required Courses From Other Programs

AEM 2021—Statics and Dynamics (4 cr)
AEM 3031—Deformable Body Mechanics (3 cr)
Biol 1009—General Biology (4 cr)
CE 3502—Fluid Mechanics (4 cr)
Chem 1021—Chemical Principles I (4 cr)
Chem 1022—Chemical Principles II (4 cr)
EE 3005—Fundamentals of Electrical Engineering (4 cr)
EngC 1011—University Writing and Critical Reading
or Rhet 1101—Writing to Inform and Persuade (4 cr)
Math 1271 or 1371 or 1571H—Calculus I (4 cr)
Math 1272 or 1372 or 1572H—Calculus II (4 cr)
Math 2243 or 2573 or 2573H—Linear Algebra and Differential Equations (4 cr)
Math 2263 or 2573 or 2574H—Multivariable Calculus (4 cr)

ME 3324—Introduction to Thermal Science (4 cr)
Phys 1301—Introductory Physics I (4 cr)
Phys 1302—Introductory Physics II (4 cr)
Rhet 3562—Technical Writing (3 cr)
Stat 3021—Introduction to Probability and Statistics (3 cr)

Electives—8 credits of engineering electives, 6 credits of biology electives, at least 3 credits of technical electives (computer science or 3 additional credits of engineering or biology electives), plus liberal education requirements.

Sample Biosystems and Agricultural Engineering Program

Freshman Year

Fall Semester (17 cr)
BAE 1011—BAE Orientation (1 cr)
Chem 1021—Chemical Principles I (4 cr)
Math 1371—IT Calculus I (4 cr)
Phys 1301—Introductory Physics I (4 cr)
Rhet 1101—Writing to Inform, Convince, and Persuade (4 cr)
or EngC 1011—University Writing and Critical Reading (4 cr)

Spring Semester (15 cr)
Chem 1022—Chemical Principles II (4 cr)
Math 1372—IT Calculus II (4 cr)
Phys 1302—Introductory Physics II (4 cr)
Liberal education elective (3 cr)

Sophomore Year

Fall Semester (15 cr)
AEM 2021—Statics and Dynamics (4 cr)
BAE 2113—Introduction to Design (3 cr)
Biol 1009—General Biology (4 cr)
Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)

Spring Semester (16 cr)
AEM 3031—Deformable Body Mechanics (3 cr)
BAE 3013—Engineering Principles of Molecular and Cellular Processes (3 cr)
Math 2373—IT Linear Algebra and Differential Equations (4 cr)
Biology elective (3 cr)
Liberal education elective (3 cr)

Junior Year

Fall Semester (16 cr)
BAE 3023—Engineering Principles of Soil-Water-Plant Systems (3 cr)
CE 3502—Fluid Mechanics (4 cr)
ME 3324—Introduction to Thermal Science (4 cr)
Stat 3021—Introduction to Probability and Statistics (3 cr)
Technical elective (3 cr)
Biology elective (3 cr)

Spring Semester (17 cr)
BAE 4023—Instrumentation and Control for Biological Systems (3 cr)
BAE emphasis (BAE 4313*/4323*, 4523*/4533*, or 4713*/4723*) (3 cr)
EE 3005—Fundamentals of Electrical Engineering (4 cr)
Rhet 3562—Technical and Professional Writing (4 cr)
Engineering elective or BAE emphasis (3 cr)

Senior Year

Fall Semester (16 cr)
BAE 4013—Transport in Biological Systems (4 cr)
BAE 4114—Capstone Design Project (4 cr)
BAE emphasis (BAE 5513) or engineering elective (3 cr)
Engineering elective (2 cr)
Liberal education elective (3 cr)

Spring Semester (15 cr)
BAE emphasis (BAE 4313*/4323*, 4523*/4533*, or 4713*/4723*) (3 cr)
Engineering elective or BAE emphasis (3 cr)
Liberal education elective (3 cr)
Liberal education elective (3 cr)
Biology elective (3 cr)

* Offered alternating years
Chemical Engineering

Department of Chemical Engineering and Materials Science

B.Ch.E.

The mission of the Department of Chemical Engineering and Materials Science is to perform the nation’s highest quality education and research, at the undergraduate and graduate levels, in the behavior and structure of chemical processes and materials.

The educational objective of the chemical engineering program is to provide experiences that challenge students to:

- learn the scientific and engineering principles underlying the six major elements of chemical engineering: balances of material and energy; thermodynamics of physical and chemical equilibria; transport of heat, mass, and momentum; reaction kinetics and reactor analysis; separation operations; and process dynamics and control.
- apply and integrate knowledge of the elements of chemical engineering to identify, formulate, and solve chemical process design problems.
- learn to use and apply modern experimental and computational techniques in chemical engineering.
- conduct experiments, including design of experiment, execution and recording, analysis and interpretation of results, and professional reporting of results.
- prepare for a career in chemical engineering and related fields by developing communication skills and coming to understand the importance of lifelong learning, professionalism, and ethical responsibility.

The chemical engineer is primarily a producer whose special province is to develop a process from its laboratory beginning through semiworks equipment to full-scale production. Chemical engineering is based on applications of chemistry, biology, physics, materials science, mathematics, and economics. The chemical engineering curriculum (third and fourth years) includes the study of applied mathematics; material and energy balances; properties and physics of gases, liquids, and solids; fluid mechanics; heat and mass transfer; thermodynamics; chemical and biological reaction kinetics and reactor design; and the integrating subjects of process design, control, and economic optimization. Because of this broad-based foundation, which emphasizes basic and engineering science, the chemical engineer is considered the universal engineer.

Chemical engineering deals with operations such as materials handling, mixing, fluid flow and metering, extrusion, coating, heat exchange, filtration, drying, evaporation, distillation, absorption, extraction, ion exchange, combustion, catalysis, and processing in chemical and biochemical reactors.

Because many industries are based on some chemical or physical transformation of matter, chemical engineers are much in demand. They may work in the manufacture of inorganic products (fertilizers, paints, ceramics, electronic materials); in the manufacture of organic products (polymers, films, papers, petrochemicals); in the manufacture of batteries and fuel cells; in the processing of minerals and materials; in food processing and fermentation, or in the production of antibiotics and biochemical products.

**Admission Requirements**—Complete specific lower division courses and meet GPA requirement set by IT.

**Degree Requirements**

Students must complete at least 128 credits to graduate, including at least 30 credits in the major. The credit total includes the lower division program of chemistry, mathematics, physics, biology, and liberal education, as well as the upper division program of chemical engineering, chemistry, materials science, electives, and liberal education requirements.

Students, together with their adviser, plan the degree program in stages. A course plan is submitted every semester for the first two years, and once a year after that.

**Required Courses**

- Chem 1021—Chemical Principles I
- Chem 1022—Chemical Principles II
- Chem 2301—Organic Chemistry I
- Chem 2302—Organic Chemistry II
- Chem 2311—Organic Lab
- Chem 3501—Physical Chemistry I
- Chem 3502—Physical Chemistry II
- ChEn 3701—Introduction to Biomolecular Engineering
- Chem 4121—Process Analytical Chemistry
- ChEn 4001—Material and Energy Balances
- ChEn 4005—Momentum and Heat Transport
- ChEn 4006—Mass Transfer and Separations
- ChEn 4101—Chemical Engineering Thermodynamics
- ChEn 4102—Reaction Kinetics and Reactor Engineering
- ChEn 4201—Computational Methods in ChEn
- ChEn 4401—Chemical Engineering Laboratory I
- ChEn 4402—Chemical Engineering Laboratory II
- ChEn 4501—Chemical Engineering Process Design I
- ChEn 4502—Chemical Engineering Process Design II
- ChEn 4601—Process Control
- Math 1271 or 1371 or 1571H—Calculus I
- Math 1272 or 1372 or 1572H—Calculus II
- Math 2243 or 2373 or 2573H—Linear Algebra and Differential Equations
- Math 2263 or 2374 or 2574H—Multivariable Calculus
- MatS 3011—Introduction to Materials Science and Engineering
- Phys 1301—Introductory Physics I
- Phys 1302—Introductory Physics II

**Electives**

Elective emphasis courses chosen with adviser assistance from chemical engineering and related areas such as biochemical engineering, biotechnology, biomedical engineering, chemistry, computer science and engineering, food science, industrial engineering, interfacial engineering, management and economics (if completing the management minor), materials science, mathematics, paper science and engineering, polymer science, and process engineering.
Sample Chemical Engineering Program

Freshman Year

Fall Semester (16-17 cr)
ChEn 1001—Advances in Chemical Engineering and Materials Science (1 cr) (optional)
Chem 1021—Chemical Principles I (4 cr)
EngC 1011—University Writing and Critical Reading (4 cr)
Math 1271 or 1371—Calculus I (4 cr)
Phys 1301—Physics I (4 cr)

Spring Semester (16 cr)
Chem 1022—Chemical Principles II (4 cr)
Math 1272 or 1372—Calculus II (4 cr)
Phys 1302—Physics II (4 cr)
Liberal education elective (4 cr)

Sophomore Year

Fall Semester (16 cr)
Chem 2301—Organic Chemistry I (3 cr)
Chem 3502—Physical Chemistry II (3 cr)
Math 2263 Multivariable Calculus or 2374—Multivariable Calculus and Vector Analysis (4 cr)
MatS 3011—Introduction to the Science and Engineering (3 cr)
*Liberal education elective (3 cr)

Spring Semester (17 cr)
Chem 2302—Organic Chemistry II (3 cr)
Chem 3501—Physical Chemistry I (3 cr)
ChEn 4001—Material and Energy Balances (4 cr)
Math 2243 or 2373—Linear Algebra and Differential Equations (4 cr)
*Liberal education elective (3 cr)

Junior Year

Fall Semester (15 cr)
Chem 2311—Organic Lab (4 cr)
ChEn 3701—Introduction to Biomolecular Engineering (3 cr)
ChEn 4101—Chemical Engineering Thermodynamics (4 cr)

Spring Semester (17 cr)
Chem 4121—Process Analytical Chemistry (3 cr)
ChEn 4006—Mass Transfer and Separations (4 cr)
ChEn 4201—Computational Methods in Chemical Engineering (3 cr)
ChEn 4102—Reaction Kinetics and Reactor Engineering (4 cr)
Liberal education elective (3 cr)

Senior Year

Fall Semester (15 cr)
ChEn 4401—Chemical Engineering Lab I (3 cr)
ChEn 4501—Chemical Engineering Process Design I (3 cr)
ChEn 4214—Polymers (3 cr)
Technical elective (3 cr)
Liberal education elective (3 cr)

Spring Semester (16 cr)
ChEn 4402—Chemical Engineering Lab II (2 cr)
ChEn 4502—Chemical Engineering Design II (2 cr)
ChEn 4601—Process Control (3 cr)
Technical electives (6 cr)
Liberal education elective (3 cr)

Chemistry

Department of Chemistry
B.S.Chem.

The mission of the Department of chemistry is to enrich the science of chemistry through the education of students from all disciplines, the training of future professional chemists, and the pursuit of knowledge.

Chemistry probes the fundamental concepts of nature and helps us understand the world around us. It deals with all substances at the molecular level: their composition, their properties, and how they are transformed into new substances.

Chemistry is a central science of great importance to society. It provides a broad range of opportunities in many specialized fields, including biotechnology, polymer chemistry, environmental chemistry, materials chemistry, and medicine.

The chemical engineering program was ranked #1 in the nation in a National Research Council report.

After graduating with a bachelor’s degree, many chemistry majors go on to graduate or professional schools to pursue advanced degrees. Other graduates find employment in industry, education, or government.

Admission Requirements—Complete specific lower division courses and meet GPA requirement set by IT (currently 2.00)

Degree Requirements

Students must complete at least 120 credits to graduate, including 40 credits in the major. The chemistry curriculum includes courses in chemistry, physics, mathematics, and the liberal arts distributed as follows:

- Chemistry lecture/lab (32 cr)
- Mathematics (12 cr)
- Calculus-based physics (8 cr)
- Advanced chemistry lecture elective (3 cr)
- Advanced chemistry lab electives (6 cr)
- Advanced technical electives (6 cr)
- Math or physics elective (4 cr)
- Liberal education electives (3 cr)
- Free electives (27 cr)

All required courses must be taken A-F. A grade of C- or better is required in all technical courses.

By selecting appropriate electives, students can construct a program with emphasis in special interest areas such as bioscience, chemical physics, education, environmental chemistry, and materials chemistry. Other special interest areas are also possible, and chemistry advisers can be helpful in designing such programs. Students can do dual degrees, but this option requires careful course planning and should be discussed as early as possible with an adviser.

All chemistry majors are advised by faculty and staff in the chemistry advising office. After consulting with an adviser, students submit a one-year plan in their degree program.
Institute of Technology

**Required Courses**

- Chem 1021—Chemical Principles I (4 cr)
- Chem 1022—Chemical Principles II (4 cr)
- Chem 2101—Analytical Chemistry (3 cr)
- Chem 2111—Analytical Chemistry Lab (2 cr)
- Chem 2301—Organic Chemistry I (3 cr)
- Chem 2302—Organic Chemistry II (3 cr)
- Chem 2311—Organic Chemistry Lab (4 cr)
- Chem 3501—Physical Chemistry I (3 cr)
- Chem 3502—Physical Chemistry II (3 cr)
- Chem 4701—Inorganic Chemistry Lecture (3 cr)
- Advanced chemistry lecture elective (3 cr)
- Advanced chemistry lab elective (6 cr)
- Three courses selected from: Chem 4094—Directed Studies, 4111, 4511, 4711, 5223
- Advanced technical electives—Two 3xxx or higher courses of 3 credits or more in any field of science (6 cr)
- Math 1271 or 1371 or 1571H—Calculus I (4 cr)
- Math 1272 or 1372 or 1572H—Calculus II (4 cr)
- Math 2243 or 2373 or 2573H—Linear Algebra and Differential Equations or Phys 2303—Physics III (4 cr)
- Math 2263 or 2374 or 2574H—Multivariable Calculus (4 cr)
- Phys 1301—Physics I (4 cr)
- Phys 1302—Physics II (4 cr)

**Sample Chemistry Program**

**Freshman Year**

**Fall Semester (15 cr)**
- Chem 1021—Chemical Principles I (4 cr)
- EngC 1011—University Writing and Critical Reading (4 cr)
- Math 1371—IT Calculus I (4 cr)
- Liberal education elective (3 cr)

**Spring Semester (16 cr)**
- Biol 1009—Biology (4 cr)
- Chem 1022—Chemical Principles II (4 cr)
- Math 1372—IT Calculus II (4 cr)
- Phys 1301—Physics I (4 cr)

**Sophomore Year**

**Fall Semester (16 cr)**
- Chem 2101—Analytical Chemistry (3 cr)
- Chem 2111—Analytical Chemistry Lab (2 cr)
- Chem 2301—Organic Chemistry I (3 cr)
- Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)
- Phys 1302—Physics II (4 cr)

**Spring Semester (16 cr)**
- Chem 2302—Organic Chemistry II (3 cr)
- Chem 2311—Organic Chemistry Lab (4 cr)
- Math 2373—IT Linear Algebra and Differential Equations or Phys 2303—Physics III (4 cr)
- Liberal education electives (6 cr)

**Junior Year**

**Fall Semester (14 cr)**
- Chem 3501—Physical Chemistry I (3 cr)
- Advanced lab elective (2 cr)
- Advanced technical elective (3 cr)
- Liberal education elective (3 cr)
- Free elective (3 cr)

**Spring Semester (15 cr)**
- Chem 3502—Physical Chemistry II (3 cr)
- Advanced technical elective (3 cr)
- Liberal education elective (3 cr)
- Free electives (6 cr)

**Senior Year**

**Fall Semester (14 cr)**
- Chem 4701—Inorganic Chemistry Lecture (3 cr)
- Advanced chemistry lecture elective (3 cr)
- Advanced lab elective (2 cr)
- Free electives (6 cr)

**Spring Semester (14 cr)**
- Advanced lab elective (2 cr)
- Free electives (12 cr)

**Chemistry Minor**

A minor is available through the College of Liberal Arts (CLA); see the chemistry program in the CLA Degree Program and Minors section.

**Civil Engineering**

**Department of Civil Engineering**

**B.C.E.**

The mission of the civil engineering program is comprised of three overlapping and mutually supportive components:

1. Prepare students to become productive engineers and contributing members of their professional community.
2. Prepare students for continual learning and professional development.
3. Prepare students for formal advanced education.

The program has four core objectives:

- To produce graduates with a strong fundamental scientific and technical knowledge base and critical thinking skills required for engineering problem formulation and problem solving.
To produce graduates with the ability to work as a professional team member. This includes the ability to communicate effectively through both oral and written language.

To produce graduates with an understanding of their obligations as professional civil engineers to protect human health, welfare, and the environment.

To ensure that graduates have opportunities to complement their academic studies with scholarly (research) investigations, co-ops, and internships.

Civil engineering deals with the science and art of engineering applied to solving problems and designing systems related to infrastructure and the environment. Principal fields within civil engineering are structural engineering, environmental engineering, water resources engineering, transportation engineering, and geotechnical engineering. The upper division civil engineering program requires students to take introductory courses in all of the above areas. In addition, students may emphasize a special interest in one of the areas by selecting appropriate technical electives in consultation with their adviser.

**Admission Requirements**—Complete specific lower division courses and meet GPA requirement set by IT (currently 2.00).

**Degree Requirements**

Students must complete at least 128 credits to graduate, including 64 credits in the major. In addition to the liberal education requirements for all Twin Cities campus students, the lower division program requires coursework in basic and engineering science, math, physics, chemistry, statistics, computer science, statics, and deformable body mechanics. The upper division program requires courses in surveying, transportation, soil mechanics, fluid mechanics, water resources, environmental sciences, structures, project management, and engineering design. Students are also required to select appropriate technical elective courses.

**Required Courses**

<table>
<thead>
<tr>
<th>Course ID</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CE 3101</td>
<td>Computer Applications</td>
<td>3 cr</td>
</tr>
<tr>
<td>CE 3102</td>
<td>Uncertainty and Decision Analysis in Civil Engineering</td>
<td>3 cr</td>
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<tr>
<td>CE 3201</td>
<td>Transportation Engineering</td>
<td>3 cr</td>
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<tr>
<td>CE 3202</td>
<td>Surveying and Mapping</td>
<td>2 cr</td>
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<tr>
<td>CE 3301</td>
<td>Soil Mechanics I</td>
<td>3 cr</td>
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<tr>
<td>CE 3401</td>
<td>Linear Structural Analysis</td>
<td>3 cr</td>
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<tr>
<td>CE 3402</td>
<td>Construction Materials</td>
<td>3 cr</td>
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<tr>
<td>CE 3501</td>
<td>Environmental Engineering</td>
<td>3 cr</td>
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<tr>
<td>CE 3502</td>
<td>Fluid Mechanics</td>
<td>4 cr</td>
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<tr>
<td>CE 4101</td>
<td>Project Management</td>
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<td>CE 4102</td>
<td>Capstone Design</td>
<td>3 cr</td>
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<tr>
<td>CE 4301</td>
<td>Soil Mechanics II</td>
<td>3 cr</td>
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<tr>
<td>CE 4401</td>
<td>Steel and Concrete Design</td>
<td>4 cr</td>
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<tr>
<td>CE 4501</td>
<td>Hydrologic Design</td>
<td>4 cr</td>
</tr>
<tr>
<td>CE 4502</td>
<td>Water and Wastewater Treatment</td>
<td>3 cr</td>
</tr>
</tbody>
</table>

Technical electives (17 cr)**

A total of 64 credits are required from other departments, distributed as follows:

- AEM 2011—Statics (3 cr)
- AEM 2012—Dynamics (3 cr)*
- AEM 3031—Deformable Body Mechanics (3 cr)
- Chem 1021, 1022 (8 cr)
- Math 1371, 1372, 2373, 2374
- or Math 1271, 1272, 2243, 2263
- or Math 1571H, 1572H, 2573H, 2574H (16 cr)
- Phys 1301, 1302 (8 cr)
- Biology with lab (4 cr)

Freshman writing requirement (EngC 1011 or Rhet 1152 recommended)

Liberal education electives (15 cr)

**Substitutions**—Upon approval of the director of undergraduate studies, students may make the following substitutions:

- A CSci programming course for CE 3101
- A CE environmental or transportation course for AEM 2012
- Stat 3021 for CE 3102
- A CE technical elective for AEM2012

**Electives**—Students may obtain guidelines for meeting the technical elective requirement in 122 Civil Engineering.

**Final Project**

All civil engineering students must complete CE 4102—Capstone Design.

**Sample Civil Engineering Program**

**Freshman Year**

**Fall Semester (16 cr)**
- Math 1371—IT Calculus I (4 cr)
- Phys 1301—Introductory Physics I (4 cr)
- Biology with lab (4 cr)
- Freshman writing requirement (EngC 1011 or Rhet 1152 recommended) (4 cr)

**Spring Semester (16-17 cr)**
- CE 1101—Civil Engineering Orientation (1 cr)
- Chem 1021—Introduction to Chemistry (4 cr)
- Math 1372—IT Calculus II (4 cr)
- Phys 1302—Introductory Physics II (4 cr)
- Liberal education elective (3-4 cr)

**Sophomore Year**

**Fall Semester (16 cr)**
- AEM 2011—Statics (3 cr)
- CE 3202—Surveying (2 cr)
- CE 3102—Uncertainty and Decision Analysis in Civil Engineering (3 cr)
- Chem 1022—Introduction to Chemistry II (4 cr)
- Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)

**Spring Semester (16 cr)**
- AEM 3031—Deformable Body Mechanics (3 cr)
- CE 3101—Computer Applications in Civil Engineering (3 cr)
- CE 3201—Transportation Engineering (3 cr)
- CE 3501—Environmental Engineering (3 cr)
- Math 2373—IT Linear Algebra and Differential Equations (4 cr)

**Junior Year**

**Fall Semester (16-17 cr)**
- AEM 2012—Dynamics (3 cr)
- CE 3401—Linear Structural Analysis (3 cr)
- CE 3402—Construction Materials (3 cr)
- CE 3502—Fluid Mechanics (4 cr)
- Liberal education elective (3-4 cr)

**Spring Semester (17-18 cr)**
- CE 3301—Soil Mechanics I (3 cr)
- CE 4401—Steel and Concrete Reinforced Design (4 cr)
- CE 4501—Hydrologic Design (4 cr)
- CE 4502—Water and Wastewater Treatment (3 cr)
- Liberal education elective (3-4 cr)

**Senior Year**

**Fall Semester (17-19 cr)**
- CE 4101W—Project Management (3 cr)
- CE 4301—Soil Mechanics II (3 cr)
- CE technical electives (8-9 cr)
- Liberal education electives (3-4 cr)

**Spring Semester (12-15 cr)**
- CE 4102W—Capstone Design (3 cr)
- CE technical electives (6-8 cr)
- Liberal education electives (3-4 cr)
Computer Engineering
Department of Electrical and Computer Engineering
B.Comp.Eng.

The mission of the computer engineering program is to educate students in the core topics as well as in a broad set of specialties of computer engineering, to impart students with professional attributes that characterize a well-schooled engineer and citizen, and to provide students with opportunities for research experience in one of the leading computer engineering centers of scholarship.

The field of computer engineering resulted from the tremendous development of computers and, in particular, the evolution of microprocessors. The design process for almost every electronic system includes the specification and development of the control program for the system’s microprocessor. A particular computer engineering job can be more closely related to hardware or software, to functional design or detailed design. The B.Comp.Eng. degree provides the background necessary for persons, with continuing study, to work in any of the many computer engineering subfields. The bachelor’s degree itself does not, however, provide highly specialized knowledge in any particular subfield.

The program in computer engineering is built on a foundation of mathematics and sciences. It educates students in the core topics as well as in a broad set of specialties. It imparts the professional attributes that characterize a well-schooled engineer and citizen. It aims to provide its graduates with:

- knowledge of fundamentals. Students are educated in the mathematical, physical, and computer sciences which underpin modern computer engineering.
- experimental skills and technological awareness. The curriculum instills the skills and mindsets necessary to acquire, analyze, and interpret data and to remain aware of relevant current and future technologies.
- social and professional attributes. Students are introduced to the liberal arts and engineering ethics. Opportunities are provided to acquire communication skills and to experience the application of engineering design skills in the team mode. The necessity of lifelong learning to a successful engineering career is emphasized.
- creative thinking and problem-solving skills. Students are familiarized with the essential tools of modern computer engineering and are imbued with the attitude necessary for their efficient application.
- technical breadth and depth. Students are educated in the broad spectrum of computer engineering subdisciplines and are given the opportunity for in-depth study in several specialties.

The computer engineering curriculum, offered jointly by the Department of Electrical and Computer Engineering (ECE) and the Department of Computer Science and Engineering (CSE), gives graduates a strong theoretical and practical background. It requires students to learn to work in teams and to develop good oral and written communication skills. It offers students an opportunity to concentrate in one of several areas, such as computer design, computer architecture and networks, and very large integrated circuit design and computer-aided circuit design. Elective courses may be selected from ECE, CSE, or other departments to tailor a program to fit particular interests.

An honors program and an engineering co-op program are available to qualified upper division students. The honors program offers students an opportunity to do a two-semester individual project under the guidance of a faculty member. The co-op program offers industrial experience and some financial support through alternate on-campus study and off-campus industrial assignment.

**Admission Requirements**—Complete specific lower division courses and meet GPA requirement set by IT.

**Degree Requirements**

Students must complete at least 126 credits to graduate, including 78 credits in the major. The curriculum includes 16 credits of calculus from mathematics; 8 credits of calculus-based physics; 33 credits of required electrical engineering courses; 20 credits of required computer science courses; 20 credits of senior-level technical electives from computer science or electrical engineering; 6 credits of approved electives; and liberal education requirements. Honors students may substitute their senior design project credits for senior technical electives and the general senior project design course. Co-op students who complete both industrial assignments may use their 3 industrial assignment credits as non-major senior technical electives.

Transfer students must satisfy IT’s residency requirements, and all senior technical electives must be taken from the University. All technical courses must be taken A-F. Student must complete all required technical courses with a grade of C- or better, and the average grade in all electrical engineering and computer science courses must be C or better.

**Required Courses**

- CSci 1901—Structure of Computer Programming I
- CSci 1902—Structure of Computer Programming II
- CSci 2011—Discrete Structures of Computer Science
- CSci 4041—Algorithms and Data Structures
- CSci 4061—Introduction to Operating Systems
- EE 2001—Introduction to Electronic and Electrical Circuits
- EE 2002—Introductory Circuits and Electronics Laboratory
- EE 2011—Linear Systems and Circuits
## Sample Computer Engineering Program

### Freshman Year

**Fall Semester (15 cr)**
- EngC 1011—University Writing and Critical Reading (4 cr)
- Math 1371—IT Calculus I (4 cr)
- Phys 1301W—Introductory Physics for Science and Engineering I (4 cr)
- Liberal education elective (3 cr)

**Spring Semester (16-17 cr)**
- Math 1372—IT Calculus II (4 cr)
- Phys 1302W—Introductory Physics for Science and Engineering II (4 cr)
- Lib lab with lab (4 cr)
- EE 1001—Introduction to Electrical Engineering (1 cr) (optional)

### Sophomore Year

**Fall Semester (16 cr)**
- CSci 1901—Structure of Computer Programming I (4 cr)
- EE 2001—Introduction to Electronic and Electrical Circuits (3 cr)
- EE 2002—Introductory Circuits and Electronics Lab (1 cr)
- Math 2371—IT Linear Algebra and Differential Equations (4 cr)

**Spring Semester (18 cr)**
- CSci 2011—Discrete Structures of Computer Science (4 cr)
- EE 2011—Linear Systems and Circuits (3 cr)
- EE 2361—Introduction to Microcontrollers (4 cr)
- Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)
- Liberal education elective (3 cr)

### Junior Year

**Fall Semester (16 cr)**
- EE 3015—Signals and Systems (3 cr)
- EE 3101—Circuits and Electronics Lab I (2 cr)
- EE 3115—Analog and Digital Electronics (4 cr)
- Technical elective (3 cr)
- Liberal education elective (4 cr)

**Spring Semester (17 cr)**
- CSci 4041—Algorithms and Data Structures (4 cr)
- EE 3025—Statistical Methods (3 cr)
- EE 3102—Circuits and Electronics Lab II (2 cr)
- EE 4363—Computer Architecture and Machine Organization (4 cr)
- Liberal education elective (4 cr)

### Senior Year

**Fall Semester (15 cr)**
- CSci 4061—Introduction to Operating Systems (4 cr)
- Senior technical electives (11 cr)

**Spring Semester (15 cr)**
- EE 4951W—Senior Design Project (2 cr)
- Senior technical electives (10 cr)
- Liberal education elective (3 cr)

### Computer Science

#### Department of Computer Science and Engineering

**B.S.Comp.Sc.**

**Mission**—To create a top-quality research and teaching computer science program where teaching, research, and service are interwoven seamlessly; and inform the academic world about the successes through a variety of innovative means.

Computer science is concerned with the study of the hardware, software, and theoretical aspects of high-speed computing devices and with the application of these devices to scientific, technological, and business problems.

A bachelor’s degree gives students a basic understanding of computer science. After completing a required set of fundamental courses, students arrange their subsequent work around one of several upper division emphases within either computer science or an interdisciplinary area involving computer applications. The degree prepares students for graduate work or for various industrial, governmental, and business positions involving the use of computers.

**Admission Requirements**—Complete Math 1271 (1371) and 1272 (1372), Math 2243, CSci 1901, 1902, 2011, and meet GPA requirement set by IT (currently 2.40 technical GPA).

**Degree Requirements**

Students must complete at least 124 credits to graduate, including at least 45 credits in the major. The bachelor of science degree requires, in addition to University requirements, four mathematics courses, two physics courses, and one statistics course. The degree also requires 36 credits of required CSci classes, plus an upper division emphasis. The upper division emphasis is any program that

- forms a coherent academic program in an area of computer science or its applications;
- consists of at least 17 credits of 4xxx (or higher) courses with at least nine of these being CSci courses;
- consists primarily of regular classes; in particular, the upper division option should contain no more than 3 credits of classes numbered CSci 59xx or CSci 4970, or any non-CSci independent study classes.

All courses listed here must be taken A-F and passed with a C- or better.

#### Required Courses

- CSci 1901—Structure of Computer Programming I
- CSci 1902—Structure of Computer Programming II
- CSci 2011—Discrete Structures of Computer Science
- CSci 2021—Machine Architecture and Organization
- CSci 2031—Introduction to Numerical Computing
- CSci 3081W—Program Design and Development
- CSci 4011—Formal Languages and Automata Theory
- CSci 4041—Algorithms and Data Structures
- CSci 4061—Introduction to Operating Systems
- Math 1271 or 1371 or 1571H—Calculus I
- Math 1272 or 1372 or 1572H—Calculus II
- Math 2243 or 2373 or 2573H—Linear Algebra and Differential Equations
One additional 3 or 4 credit course with advanced math or logic content
Phys 1301—Introductory Physics I
Phys 1302—Introductory Physics II
Stat 3021—Introduction to Probability and Statistics

Sample Computer Science Program

Freshman Year

**Fall Semester (15 cr)**
Math 1371—IT Calculus I (4 cr)
Phys 1301—Introductory Physics I (4 cr)
Liberal education elective (3 cr)
and EngC 1011—University Writing and Critical Reading (4 cr)

**Spring Semester (16 cr)**
CSci 1901—Structure of Computer Programming I (4 cr)
Math 1372—IT Calculus II (4 cr)
Phys 1302—Introductory Physics II (4 cr)
Liberal education elective (4 cr)

Sophomore Year

**Fall Semester (15 cr)**
CSci 1902—Structure of Computer Programming II (4 cr)
CSci 2011—Discrete Structures (4 cr)
Math 2373—IT Linear Algebra and Differential Equations (4 cr)
Stat 3021—Introduction to Probability and Statistics (3 cr)

**Spring Semester (14-16 cr)**
CSci 2021—Machine Architecture and Organization (4 cr)
CSci 2031—Introduction to Numerical Computing (4 cr)
Other math elective (3-4 cr)
Liberal education elective (3-4 cr)

Junior Year

**Fall Semester (17-19 cr)**
CSci 3081W—Program Design and Development (4 cr)
CSci 4061—Introduction to Operating Systems (4 cr)
Liberal education elective (3-4 cr)
Elective (3-4 cr)
Elective (3 cr) (if needed)

**Spring Semester (18-20 cr)**
CSci 4011—Formal Languages and Automata Theory (4 cr)
CSci 4041—Algorithms and Data Structures (4 cr)
CSci 4081W—Introduction to Software Engineering (4 cr)
Liberal education elective (3-4 cr)
Elective (3-4 cr)

Senior Year

**Fall Semester (15-18 cr)**
Upper division CSci (3 cr)
Upper division CSci (3 cr)
Upper division (3-4 cr)
Elective (3-4 cr)
Liberal education elective (3-4 cr)
or Elective (3-4 cr)

**Spring Semester (15-19 cr)**
Upper division CSci (3 cr)
Upper division (3-4 cr)
Upper division or elective (3-4 cr)
Elective (3-4 cr)
Liberal education elective (3-4 cr)
or Elective (3-4 cr)

Computer Science Minor

A minor is available through the College of Liberal Arts (CLA); see the computer science program in the CLA Degree Programs and Minors section.

**Electrical Engineering**

**Department of Electrical and Computer Engineering**

B.E.E.

The mission of the electrical engineering program is to educate students in the core topics as well as in a broad set of specialties of electrical engineering, to impart students with professional attributes that characterize a well-schooled engineer and citizen, and to provide students with opportunities for research experience in one of the leading electrical engineering centers of scholarship.

Electrical engineers work in highly diverse areas such as computers, telecommunications, semiconductors, electric energy, consumer and entertainment electronics, biomedical technology, defense and aerospace systems, and automotive electronics. They design and develop components, software, and systems; carry out analysis; and work in research, management, and sales. The bachelor of electrical engineering prepares students for immediate entry into professional work, for graduate study and further specialization in engineering, for advanced work in business and management, or for study in a different direction such as medicine.

The program in electrical engineering is built on a foundation of mathematics and sciences. It educates students in the core topics as well as in a broad set of specialties. It imparts the professional attributes that characterize a well-schooled engineer and citizen. It aims to provide its graduates with:

- knowledge of fundamentals. Students are educated in the mathematical, physical, and computer sciences which underpin modern computer engineering.
- experimental skills and technological awareness. The curriculum instills the skills and mindsets necessary to acquire, analyze, and interpret data and to remain aware of relevant current and future technologies.
- social and professional attributes. Students are introduced to the liberal arts and engineering ethics. Opportunities are provided to acquire communication skills and to experience the application of engineering design skills in the team mode. The necessity of lifelong learning to a successful engineering career is emphasized.
- creative thinking and problem-solving skills. Students are familiarized with the essential tools of modern computer engineering and are imbued with the attitude necessary for their efficient application.
• technical breadth and depth. Students are educated in the broad spectrum of computer engineering subdisciplines and are given the opportunity for in-depth study in several specialties.

The curriculum administered by the Department of Electrical and Computer Engineering gives graduates a strong theoretical and practical background based on design experiences. It requires students to work in teams and develop good oral and written communication skills. It offers an opportunity to concentrate in one of several specialized areas, including biomedical engineering, communications, computers, control systems, electric energy systems and power electronics, microelectronic devices and circuit design, optics and magnetic recording, and signal processing.

An honors program and an engineering co-op program are available to qualified upper division students. The honors program offers an opportunity to do a two-semester individual project under the guidance of a faculty member. The co-op program offers industrial experience and some financial support through alternate on-campus study and off-campus industrial assignment.

Admission Requirements—Complete specific lower division courses and meet GPA requirement set by IT.

Degree Requirements
Students must complete at least 126 credits to graduate, including 65 credits in the major. The requirement includes 16 credits of calculus from mathematics; 8 credits of calculus-based physics; 4 credits of chemistry; 4 additional credits from chemistry or physics; 4 credits of computer science; 35 credits of required electrical engineering courses; 20 credits of senior-level technical electives from electrical engineering; 12 credits approved electives; and liberal education courses. Honors students may substitute their senior design project credits for senior technical electives and the general senior project design course. Co-op students may use their 3 industrial assignment credits as non-major technical electives if they complete both industrial assignments.

Transfer students must satisfy IT’s residency requirements, and all senior technical electives must be taken from the University. All technical courses must be taken A-F. Students must complete all required technical courses with a grade of C- or better and the average grades in all electrical engineering courses must be C or better.

Required Courses
Chem 1021—Chemical Principles I
Chem 1022—Chemical Principles II
or
Phys 2303—Introductory Physics for Sciences and Engineering III
CSci 1113—Introduction to C/C++ Programming for Scientists and Engineers
EE 2001—Introduction to Electronic and Electrical Circuits
EE 2002—Introduction to Circuits and Electronics Laboratory
EE 2011—Linear Systems and Circuits
EE 2301 and 0301—Introduction to Digital System Design
EE 2361 and 0361—Introduction to Microcontrollers
EE 3015—Signals and Systems
EE 3025—Statistical Methods in Electrical and Computer Engineering
EE 3101—Circuits and Electronics Laboratory I
EE 3102—Circuits and Electronics Laboratory II
EE 3115—Analog and Digital Electronics
EE 3161—Semiconductor Devices
EE 3601—Transmission Lines
EE 4951W—Senior Design Project
Math 1271 or 1371 or 1571H—Calculus I
Math 1272 or 1372 or 1572H—Calculus II
Math 2243 or 2373 or 2573H—Linear Algebra and Differential Equations
Math 2263 or 2374 or 2574H—Multivariable Calculus
Phys 1301W—Introductory Physics for Sciences and Engineering I
Phys 1302W—Introductory Physics for Sciences and Engineering II

Electives
20 credits of EE senior (4xxx or 5xxx) technical electives and 12 credits of electives from an approved list of courses

Final Project
All students must take EE 4951W—Senior Design Project (2 cr). Students are organized into teams of approximately five members and design and construct a project under the direction of a faculty member.

Sample Electrical Engineering Program (with second semester of chemistry)

Freshman Year
Fall Semester (16-17 cr)
EngC 1011—University Writing and Critical Reading (4 cr)
Math 1371—IT Calculus I (4 cr)
Phys 1301W—Introductory Physics I (4 cr)
Biology with lab (4 cr)
EE 1001—Introduction to Electrical Engineering (1 cr) (optional)

Spring Semester (15 cr)
CSci 1113—Introduction to C/C++ Programming (4 cr)
Math 1372—IT Calculus II (4 cr)
Phys 1302W—Introductory Physics II (4 cr)
Liberal education elective (3 cr)

Sophomore Year
Fall Semester (16 cr)
Chem 1021—Chemical Principles I (4 cr)
EE 2001—Introduction to Electronic and Electrical Circuits (3 cr)
EE 2002—Introduction to Circuits and Electronics Laboratory (1 cr)
EE 2301 and 0301—Introduction to Digital System Design (4 cr)
Math 2373—IT Linear Algebra and Differential Equations (4 cr)

Spring Semester (18 cr)
Chem 1022—Chemical Principles II (4 cr)
or
Phys 2303—Physics of Matter (4 cr)
EE 2361 and 361—Introduction to Microcontrollers (4 cr)
EE 2011—Linear Systems and Circuits (3 cr)
Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)
Liberal education elective (3 cr)

Junior Year
Fall Semester (16 cr)
EE 3015—Signals and Systems (3 cr)
EE 3101—Circuits and Electronics Laboratory I (2 cr)
EE 3115—Analog and Digital Electronics (4 cr)
Technical elective (4 cr)
Liberal education elective (3 cr)

Spring Semester (14 cr)
EE 3025—Statistical Methods (3 cr)
EE 3102—Circuits and Electronics Laboratory II (2 cr)
EE 3161—Semiconductor Devices (3 cr)
EE 3601—Transmission Lines (3 cr)
Liberal education elective (3 cr)

Senior Year
Fall Semester (16 cr)
Senior technical electives (16 cr)

Spring Semester (15 cr)
EE 4951—Senior Design Project (2 cr)
Senior technical electives (10 cr)
Liberal education elective (3 cr)
Geological Engineering
Department of Civil Engineering

B.Geo.E.
The mission of the geological engineering program is comprised of three overlapping and mutually supportive components:

- Prepare students to become productive engineers and contributing members of their professional community.
- Prepare students for continual learning and professional development.
- Prepare students for formal advanced education.

The program has four core objectives:

1. To produce graduates with a strong fundamental scientific and technical knowledge base and critical thinking skills required for engineering problem formulation and problem solving.
2. To produce graduates with the ability to work as a professional team member. This includes the ability to communicate effectively through both oral and written language.
3. To produce graduates with an understanding of their obligations as professional geological engineers to protect human health, welfare, and the environment.
4. To ensure that graduates have had opportunities to complement their academic studies with scholarly (research) investigations, co-ops, and internships.

A geological engineer applies the principles of engineering and science to the problems of planning, analysis, design, construction, and operation of facilities on and under the surface of the Earth. Geological engineering is based on applications of geology, physics, chemistry, mathematics, and engineering mechanics. A geological engineer requires many of the skills required of a civil engineer, an environmental engineer, and geologist. The geological engineer, however, is uniquely qualified to work at the interfaces of these disciplines.

Within the geological engineering program are two degree paths:

The geoenvironmental option focuses on 1) soil and groundwater contamination, modeling, and remediation; 2) solid and hazardous waste characterization, management, and disposal; 3) groundwater resources management and exploitation.

The geomechanics option focuses on 1) foundations for buildings, bridges, roads, and dams; 2) analysis and design of surface and subsurface excavations; 3) evaluation of natural geologic hazards.

The most common professional employment for graduates is within the private sector as consulting engineers. Graduates also work at international, national, state, and local agencies involved with environmental protection, energy conservation and generation, and natural-resources conservation and exploitation.

After completing approximately four semesters, students may enter an engineering educational cooperative. Participants alternate study semesters with a six-month work period, for which they earn 3 credits.

With less than one year of additional study beyond the requirements for the geological engineering degree, students can now obtain a double degree: a B. Geological Engineering and B.S. Geology.

The geological engineering program is accredited by the Engineering Accreditation Commission of ABET.

Admission Requirements—Complete specific lower division courses and meet GPA requirement set by IT (currently 2.30).

Degree Requirements
Students must complete at least 128 credits to graduate, including 40 credits in the major. The first two years of the curriculum are almost identical with the first years of the civil engineering program and are similar to those in other IT engineering programs. Students may transfer to geological engineering from another IT engineering program, another University college or campus, or another academic institution.

By choosing one of the two curricular paths within geological engineering, and by selecting appropriate technical electives (in consultation with their academic adviser), students can emphasize various special interest areas in their upper division curriculum.

With few exceptions, all upper division courses in geological engineering, civil engineering, and geology may be used to fulfill the technical elective requirements. Many courses from other IT departments may be used as technical electives in the geological engineering program. However, each student’s final program must satisfy the detailed curricular requirements specified by ABET for a geological engineering degree.

Required Courses
AEM 2011—Statics
AEM 2012—Dynamics (geomechanics option only)
AEM 3031—Deformable Body Mechanics
Chem 1021—Chemical Principles I
Chem 1022—Chemical Principles II
Geo 1001—the Dynamic Earth
Geo 2301—Mineralogy
Geo 2302—Petrology
Geo 4203—Principles of Geophysical Exploration
or Geo 4211—Solid Earth Geophysics I
Geo 3911—Introduction to Field Geology
Geo 4501—Structural Geology
Geo 4602 or 4701 or 4703
Math 1271 or 1371 or 1571H—Calculus I
Math 1272 or 1372 or 1572H—Calculus II
Math 2243 or 2373 or 2573H—Linear Algebra and Differential Equations
Math 2263 or 2374 or 2574H—Multivariable Calculus
Phys 1301—Introductory Physics I
Phys 1302—Introductory Physics II
Stat 3021—Probability and Statistics

Geoenvironmental Option
CE 3101—Computer Applications
CE 3501—Environmental Engineering
CE 3502—Fluid Mechanics
CE 4501—Hydrologic Design
CE 4531—Environmental Process Engineering
CE 4561—Solid and Hazardous Waste
Geol 3301—Soil Mechanics I
Geol 4102—Capstone Design
GeoE 4341—Engineering Geostatistics
GeoE 4351—Groundwater Mechanics
GeoE 4352—Groundwater Modeling
GeoE technical electives (6 cr)

Geomechanics Option
CE 3101—Computer Applications I
CE 3502—Fluid Mechanics
CE 4121—Computer Applications II
CE 4351—Groundwater Mechanics
GeoE 3301—Soil Mechanics I
GeoE 3311—Rock Mechanics I
GeoE 4102—Capstone Design
GeoE 4301—Soil Mechanics II
GeoE 4311—Rock Mechanics II
GeoE 4341—Engineering Geostatistics
GeoE technical electives (7 cr)
Final Project
All students must take GeoE 4102—Capstone Design. This course is an extensive capstone design project and requires written and oral presentations of project results.

Geoenvironmental Option

Sample Program

Freshman Year
Fall Semester (16 cr)
Biol 1009—General Biology (4 cr)
EngC 1011—University Writing and Critical Reading (4 cr)
Math 1371—IT Calculus I (4 cr)
Phys 1301—Introductory Physics I (4 cr)

Spring Semester (15 cr)
Geo 1001—Introduction to Geology (4 cr)
Math 1372—IT Calculus II (4 cr)
Phys 1302—Introductory Physics II (4 cr)
Liberal education elective (3 cr)

Sophomore Year
Fall Semester (17 cr)
AEM 2011—Statics (3 cr)
Chem 1021—Chemical Principles I (4 cr)
Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)
Stat 3021—Probability and Statistics (3 cr)
Liberal education elective (3 cr)

Spring Semester (17 cr)
AEM 3031—Deformable Body Mechanics (3 cr)
Chem 1022—Chemical Principles II (4 cr)
Math 2373—IT Linear Algebra and Differential Equations (4 cr)
Liberal education elective (3 cr)
Liberal education elective (3 cr)

Junior Year
Fall Semester (16 cr)
CE 3101—Computer Applications I (3 cr)
CE 3501—Environmental Engineering (3 cr)
CE 3502—Fluid Mechanics (4 cr)
Geo 2301—Mineralogy (3 cr)
Liberal education elective (3 cr)

Spring Semester (13 cr)
CE 4501—Hydrologic Design (4 cr)
Geo 2302—Petrology (3 cr)
GeoE 3301—Soil Mechanics I (3 cr)
GeoE 4341—Engineering Geostatistics (3 cr)

Summer Session (3 cr)
Geo 3911—Field Geology (3 cr)

Senior Year
Fall Semester (16 cr)
CE 4203—Principles of Geophysical Exploration (3 cr)
Geo 4703—Glacial Geology (3 cr)
GeoE 4301—Soil Mechanics II (3 cr)
GeoE 4351—Groundwater Mechanics (3 cr)
Technical elective (GeoE) (4 cr)

Spring Semester (13 cr)
Geo 4501—Structural Geology (3 cr)
GeoE 4102—Senior Design (3 cr)
GeoE 4311—Rock Mechanics II (3 cr)
GeoE technical elective (4 cr)

Geomechanics Option

Sample Program

Freshman Year
Fall Semester (16 cr)
Biol 1009—General Biology (4 cr)
EngC 1011—University Writing and Critical Reading (4 cr)
Math 1371—IT Calculus I (4 cr)
Phys 1301—Introductory Physics I (4 cr)

Spring Semester (15 cr)
Geo 1001—Introduction to Geology (4 cr)
Math 1372—IT Calculus II (4 cr)
Phys 1302—Introductory Physics II (4 cr)
Liberal education elective (3 cr)

Sophomore Year
Fall Semester (17 cr)
AEM 2011—Statics (3 cr)
Chem 1021—Chemical Principles I (4 cr)
Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)
Stat 3021—Probability and Statistics (3 cr)
Liberal education elective (3 cr)

Spring Semester (17 cr)
AEM 2012—Dynamics (3 cr)
AEM 3031—Deformable Body Mechanics (3 cr)
Chem 1022—Chemical Principles II (4 cr)
Math 2373—IT Linear Algebra and Differential Equations (4 cr)
Liberal education elective (3 cr)

Junior Year
Fall Semester (16 cr)
CE 3101—Computer Applications I (3 cr)
CE 3502—Fluid Mechanics (4 cr)
Geo 2301—Mineralogy (3 cr)
GeoE 3301—Soil Mechanics I (3 cr)
Liberal education elective (3 cr)

Spring Semester (15 cr)
CE 4121—Computer Applications II (3 cr)
Geo 2302—Petrology (3 cr)
GeoE 3311—Rock Mechanics I (3 cr)
GeoE 4341—Engineering Geostatistics (3 cr)
Liberal education elective (3 cr)

Summer Session (3 cr)
Geo 3911—Field Geology (3 cr)

Senior Year
Fall Semester (16 cr)
Geo 4203—Principles of Geophysical Exploration (3 cr)
Geo 4703—Glacial Geology (3 cr)
GeoE 4301—Soil Mechanics II (3 cr)
GeoE 4351—Groundwater Mechanics (3 cr)
Technical elective (GeoE) (4 cr)

Spring Semester (13 cr)
Geo 4501—Structural Geology (3 cr)
GeoE 4102—Senior Design (3 cr)
GeoE 4311—Rock Mechanics II (3 cr)
GeoE technical elective (4 cr)
## Geology

### Department of Geology and Geophysics

**B.S. Geol.**

**Mission**—To generate and develop knowledge and understanding of the geology of earth processes, and to share the knowledge and understanding by providing a broad range of educational programs to a diverse community within the university, the state, and society as a whole.

Geology is the study of the composition, structure, and history of the Earth and of the processes that operate on and within it, with emphasis on the crust, oceans, and atmosphere. The department’s programs emphasize applications of physics, chemistry, and biology to understanding the Earth.

Geologists and geophysicists are employed in a wide range of fields, including exploration for and development of natural resources (hydrocarbons, minerals, groundwater); environmental science; urban planning; education; and oceanography. Potential employers include the oil, gas, and minerals industries; environmental consultants; federal and private research institutions; universities; schools; and government agencies. An advanced degree is usually required for a career in research or teaching.

**Admission Requirements**—Complete specific lower division courses and meet GPA requirement set by IT (currently 2.00).

**Degree Requirements**

Students must complete at least 120 credits to graduate, including 52 credits in the major. Geology and geophysics are closely related fields, and this is reflected in the similarities between the two degree programs. Both are built around a core of basic Earth-science courses taken mainly in the sophomore and junior years. Both programs provide a strong foundation in mathematics, physics, and chemistry.

Selection of a degree program should be made during the second year, though a later decision is possible. Both degree programs offer a good foundation for students preparing either for graduate work or for professional work with the baccalaureate degree.

Specific tracks within the B.S. Geology degree program are completed by selecting appropriate geology and related science courses in consultation with a faculty adviser. Students must pass all core courses with a grade of C- or better.

### Required Courses

- Geo 2201—Geodynamics I: The Solid Earth
- Geo 2301—Mineralogy
- Geo 2302—Petrology
- Geo 2303—Geochemical Principles
- Geo 3202—Geodynamics II: The Fluid Earth
- Geo 3401—Geochronology and Earth History
- Geo 3911—Introduction to Field Geology
- Geo 4501—Structural Geology
- Geo 4602—Sedimentology and Stratigraphy
- Geo 4631—Earth Systems: Geosphere/Biosphere Interactions

**Any two of:**

- Geo 3870—Modeling Workshop
- Geo 3880—Laboratory Workshop
- Geo 3890—Field Workshop

**Any one of:**

- Geo 4911—Advanced Field Geology
- Geo 4971—Field Hydrogeology

12 credits of elective geology, with no more than 4 credits of 1xxx courses and 3 credits of 2xxx courses

### Required Courses From Other Programs

- Chem 1021, 1022 or Math 1371, 1372 or Math 1571H, 1572H—Calculus I and II
- Phys 1301, 1302—Introductory Physics I and II

**One of the following:**

- Math 2243 or 2373—Linear Algebra and Differential Equations, or Math 2573H—Honors Calculus III
- Math 2263 or 2374—Multivariable Calculus

**Electives**

8 credits of additional appropriate elective courses in physical and natural sciences, engineering, and mathematics, chosen in consultation with a faculty adviser.

### Sample Geology Program

#### Freshman Year

**Fall Semester (15 cr)**

- Chem 1021—Principles of Chemistry I (4 cr)
- Math 1371—IT Calculus I (4 cr)
- Biology with lab (4 cr)
- Liberal education elective (3 cr)

**Spring Semester (16 cr)**

- Chem 1022—Principles of Chemistry II (4 cr)
- Math 1372—IT Calculus II (4 cr)
- Phys 1301—Introductory Physics I (4 cr)

#### Sophomore Year

**Fall Semester (14 cr)**

- Geo 2201—Geodynamics I: The Solid Earth (3 cr)
- Geo 2301—Mineralogy (3 cr)
- Math 2373—IT Linear Algebra and Differential Equations (4 cr)
- Phys 1302—Introductory Physics II (4 cr)

**Spring Semester (12 cr)**

- Geo 2302—Petrology (3 cr)
- Geo 2303—Geochemical Principles (3 cr)
- Liberal education elective (3 cr)
- Technical elective (3 cr)

**Summer Session (4 cr)**

- Geo 3911—Introduction to Field Geology (4 cr)

#### Junior Year

**Fall Semester (15 cr)**

- Geo 2301—Mineralogy (3 cr)
- Liberal education elective (3 cr)
- Liberal education elective (3 cr)
- Technical elective (3 cr)

**Spring Semester (13 cr)**

- Geo 3890—Field Workshop (1 cr)
- Geo 3401—Geochronology and Earth History (3 cr)
- Geo 4602—Sedimentology and Stratigraphy (3 cr)
- Liberal education elective (3 cr)
- Liberal education elective (3 cr)
- Technical elective (3 cr)

**Summer Session (4 cr)**

- Geo 4911—Advanced Field Geology (4 cr)

#### Senior Year

**Fall Semester (15 cr)**

- Geo 4631—Earth Systems: Geosphere/Biosphere Interactions (3 cr)
- Geo 4761—Advanced Field Geology (3 cr)
- Liberal education elective (3 cr)
- Liberal education elective (3 cr)
- Technical elective (3 cr)
- Free elective (3 cr)

**Spring Semester (14 cr)**

- Geo 3890—Field Workshop (1 cr)
- Geo 4971—Field Hydrogeology (3 cr)
- Liberal education elective (3 cr)
- Technical elective (3 cr)
- Free elective (4 cr)

### Geology or Environmental Geoscience Minor

Minors in geology or environmental science are available through the College of Liberal Arts (CLA); see the geology program in the CLA Degree Programs and Minors section.
Geophysics

Department of Geology and Geophysics

B.S. Geophys.

Mission—To generate and develop knowledge and understanding of the geophysics of earth processes, and to share the knowledge and understanding by providing a broad range of educational programs to a diverse community within the university, the state, and society as a whole.

Geophysics is the study of the physical structure and properties of the Earth through application of the principles and techniques of classical physics. Major topics include the physical properties of rocks and minerals, the origin and dynamics of the Earth’s gravity and magnetic fields, earthquakes and the propagation of waves in the Earth (seismology), and the dynamics of the Earth’s crust, mantle, and deep interior.

Geologists and geophysicists are employed in a wide range of fields, including exploration for and development of natural resources (hydrocarbons, minerals, groundwater); environmental science; urban planning; education; and oceanography. Potential employers include the oil, gas, and minerals industries; environmental consultants; federal and private research institutions; universities; schools; and government agencies. An advanced degree is usually required for a career in research or teaching.

Admission Requirements—Complete specific lower division courses and meet GPA requirement set by IT (currently 2.00).

Degree Requirements

Students must complete at least 120 credits to graduate, including 52 credits in the major. Geology and geophysics are closely related fields, which is reflected in the similarities between the two degree programs. Both programs are built around a core of basic Earth science courses taken mainly during the sophomore and junior years. Both programs provide a strong foundation in mathematics, physics, and chemistry.

Selection of a degree program should be made during the second year, though a later decision is possible. Both degree programs offer a good foundation for students preparing either for graduate work or for professional work with the baccalaureate degree. Students must pass all core courses with a grade of C- or better.

Required Courses

Geo 2201—Geodynamics I: The Solid Earth
Geo 2301—Mineralogy
Geo 2302—Petrology
Geo 2303—Geochemical Principles
Geo 3202—Geodynamics II: The Fluid Earth
Geo 3401—Geochronology and Earth History
Geo 3911—Introduction to Field Geology
Geo 4501—Structural Geology

Any two of:
Geo 3870—Modeling Workshop
Geo 3880—Laboratory Workshop
Geo 3890—Field Workshop

Any one of:
Geo 4911—Advanced Field Geology
Geo 4971—Field Hydrogeology
9 cr of 4xxx geophysics courses
9 cr of elective geology courses (no more than 4 cr being 1xxx courses and no more than 3 cr being 2xxx courses)

Required Courses From Other Programs

Chem 1021, 1022—Chemical Principles I and II
Math 1271, 1272 or Math 1371, 1372, or Math 1571H, 1572H—Calculus I and II
Math 2243 or 2373—Linear Algebra and Differential Equations
Math 2263 or 2374—Multivariable Calculus and Vector Analysis or Math 2573H—Honors Calculus III
Phys 1301, 1302, 2303—Introductory Physics I, II, and III

Electives

Nine credits of additional appropriate elective courses in physical and natural sciences, engineering, and mathematics, chosen in consultation with a faculty adviser.

Sample Geophysics Program

Freshman Year

Fall Semester (11 cr)
Chem 1021—Principles of Chemistry I (4 cr)
Math 1371—IT Calculus I (4 cr)
Liberal education elective (3 cr)

Spring Semester (16 cr)
Chem 1022—Principles of Chemistry II (4 cr)
EngC 1011—University Writing and Critical Reading (4 cr)
Math 1372—IT Calculus II (4 cr)
Phys 1301—Introductory Physics I (4 cr)

Sophomore Year

Fall Semester (14 cr)
Geo 2201—Geodynamics I: The Solid Earth (3 cr)
Geo 2301—Mineralogy (3 cr)
Math 2373—IT Linear Algebra and Differential Equations (4 cr)
Phys 1302—Introductory Physics II (4 cr)

Spring Semester (17 cr)
Geo 2302—Petrology (3 cr)
Geo 2303—Geochemical Principles (3 cr)
Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)
Phys 2303—Introductory Physics III (4 cr)
Liberal education elective (3 cr)

Junior Year

Fall Semester (15 cr)
Geo 3202—Geodynamics II: The Fluid Earth (3 cr)
Geo 4501—Structural Geology (3 cr)
Geo 4203—Principles of Geophysical Exploration (3 cr)
Liberal education elective (3 cr)
Technical elective (3 cr)

Spring Semester (14 cr)
Geo 3890—Field Workshop (1 cr)
Geo 3401—Geochronology and Earth History (3 cr)
Geo elective (3 cr)
Biology with lab (4 cr)
Liberal education elective (3 cr)

Senior Year

Fall Semester (14 cr)
Geo 4211—Solid Earth Geophysics I (3 cr)
Geo elective (3 cr)
Technical elective (3 cr)
Technical elective (3 cr)
Free elective (2 cr)

Spring Semester (13 cr)
Geo 3890—Workshop (1 cr)
Geo 4212—Solid Earth Geophysics II (3 cr)
Geo elective (3 cr)
Free elective (3 cr)
Liberal education elective (3 cr)

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Information Technology

Interdisciplinary

Minor Only
This interdisciplinary minor requires a minimum of 14 credits, including two core courses from the Institute of Technology, and three breadth courses selected from the Colleges of Human Ecology, Liberal Arts, or Architecture and Landscape Architecture. It is intended to provide opportunities to students in nontechnical disciplines to supplement their major with a practical set of courses focused on information technology. Courses furnish basic knowledge and skills in Internet and Web technology and explore application of these skills. A GPA of 2.00 or above is required in the minor courses. Students interested in the minor should contact Ahmed Naumaan in the Department of Computer Science and Engineering, 4-192 Electrical Engineering/Computer Science, 200 Union Street S.E., Minneapolis, MN 55455 (612-625-4002).

Requirements

Minor Core Courses
Two of the following three courses:
CSci 1103—Introduction to Computer Programming in Java (3 cr)
CSci 1121—Introduction to the Internet (4 cr)
CSci 2121—Introduction to the Internet (2 cr)

Breadth Courses
Three of the following courses:
Comm 3201—Introduction to Electronic Media Production (3 cr)
Comm 3211—Introduction to US Electronic Media (3 cr)
Comm 4231—Comparing Electronic Media Systems (3 cr)
Comm 4235—Electronic Media and Ethnic Minorities, A World View (3 cr)
Comm 4291—New Telecommunication Media (3 cr)
Comm 5233—Electronic Media and National Development (3 cr)
DHA 2334—Computer Applications I: Digital Composition for Design (3 cr)*
DHA 4334—Computer Applications II: Design for the Digital Environment (3 cr)
DHA 4384—Interactive Media (3 cr)
DHA 5381—Digital Illustration (3 cr)
DHA 5382—Digital Sound and Video (3 cr)
DHA 5383—Modeling and Animation (3 cr)
DHA 5385—Internet-based Media (3 cr)
DHA 5399—Theory of Electronic Design (3 cr)
EngC 3632—Electronic Texts (3 cr)
Geog 3561—Principles of Geographic Information Science (3 cr)
Geog 5563—Advanced Geographic Information Science (3 cr)
Geog 5564—Urban Geographic Information Science and Analysis (3 cr)
Jour 3004—Information for Mass Communication (3 cr)
Jour 3614—History of Mass Communication Technology (3 cr)
Jour 3776—Mass Communication Law (3 cr)

*DHA 2334 is a prerequisite for the more advanced courses. The courses are limited to graphic design majors, however technology minors may gain access via instructor permission by showing a degree program form that includes the minor courses.

Management

Minor Only
This program trains future engineers and scientists in accounting, operations and management sciences, finance, and marketing. Courses are taught by Carlson School of Management (CSOM) faculty. For applications, contact IT Student Affairs, 105 Lind Hall, 207 Church Street S.E., Minneapolis, MN 55455 (612-624-8504).

To enroll in the management minor, students must have an overall GPA of 3.00 or higher and 30 semester hours completed.

Prerequisites
Econ 1104
or Econ 1101
Econ 1105 or 1102 are recommended but not required
Stat 3021—Introduction to Probability and Statistics (or equivalent) (3 cr)

Required Courses
Acct 2050—Principles of Accounting (4 cr)
Acct 3001—Introduction to Management Accounting (3 cr)
Fina 3001—Finance Fundamentals (3 cr)
Mgmt 3001—Fundamentals of Management (3 cr)
Mktg 3001—Principles of Marketing (3 cr)

Materials Science and Engineering

Department of Chemical Engineering and Materials Science

B.Mat.S.E.
The mission of the Department of Chemical Engineering and Materials Science is to perform the nation’s highest quality education and research, at the undergraduate and graduate levels, in the behavior and structure of chemical processes and materials.

The materials science and engineering (MSE) program provides educational experiences that challenge students to:

1. learn the scientific and engineering principles underlying the four major elements of materials engineering: structure, properties, processing, and performance of engineering materials (including metals and alloys, ceramics, polymers, and composites).
2. apply and integrate knowledge of the above four elements to identify, formulate and solve materials selection problems and design problems.
3. learn experimental, statistical and computational techniques in the context of MSE.
4. design and conduct experiments, as well as analyze and interpret data.
5. prepare for an engineering career by developing communication and teamwork skills, and an understanding of the importance of lifelong learning, professionalism, and ethical responsibility.

The four-year program in materials science and engineering leads to a bachelor’s degree that enables students to immediately enter the profession. The program develops an understanding of the properties and the origin of these properties in a broad range of materials, including metals, ceramics, semiconductors, polymers, and composites. Because the program is broadly based, graduates find employment across a broad range of industries, including the automotive, chemical, electronics, energy, and medical technology industries. Graduates also find positions in consulting, research, technical management, and teaching.

The materials science and engineering program is accredited by the Engineering Accreditation Commission of ABET.

Admission Requirements—Complete specific lower division courses and meet GPA requirement set by IT (currently 2.30).

Degree Requirements
Students must complete at least 128 credits to graduate, including 38 credits in the major. Credits include the specific required courses listed below. In addition, the University’s liberal education requirements must be met.
Required Courses
AEM 2011—Statics (3 cr)
AEM 3031—Deformable Body Mechanics (3 cr)
AEM 4511—Mechanics of Composite Materials (3 cr)
CE 3101—Computer Applications I (3 cr)
Chem 1021—Chemical Principles I (4 cr)
Chem 1022—Chemical Principles II (4 cr)
Chem 2301—Organic Chemistry I (3 cr)
Math 1271 or 1371 or 1571H—Calculus I (4 cr)
Math 2272 or 1372 or 1572H—Calculus II (4 cr)
Math 2243 or 2373 or 2573H—Linear Algebra and Differential Equations (4 cr)
Math 2263 or 2374 or 2574H—Multivariable Calculus (4 cr)
MatS 301I—Introduction to Materials Science and Engineering (3 cr)
MatS 3012—Metals and Alloys (3 cr)
MatS 3801—Structural Characterization Lab (2 cr)
MatS 3011—Introduction to Materials Science and Engineering (3 cr)
MatS 3851W—Materials Properties Lab (2 cr)
MatS 4001—Thermodynamics of Materials (4 cr)
MatS 4002—Mass Transport and Kinetics (4 cr)
MatS 4013—Electrical and Magnetic Properties of Materials (3 cr)
MatS 4212—Ceramics (3 cr)
MatS 4214—Polymers (3 cr)
MatS 4221—Materials Design and Performance (4 cr) (includes lab)
MatS 4301W—Materials Processing (4 cr) (includes lab)
MatS 4400—Senior Design Project (3 cr)
Phy 1301—Introductory Physics I (4 cr)
Phy 1302—Introductory Physics II (4 cr)
Phy 2303—Physics of Matter (4 cr)

Technical Electives
See the director of undergraduate studies for a list of technical electives.

Final Project
The senior design project, MatS 4400, requires a written final report and an oral presentation.

Sample Materials Science and Engineering Program

Freshman Year
Fall Semester (16 cr)
EngC 1011—University Writing and Critical Reading (4 cr)
Math 1371—IT Calculus I (4 cr)
Phy 1301—Introductory Physics I (4 cr)
Biology with lab (4 cr)

Spring Semester (16 cr)
Chem 1021—General Principles I with Lab (4 cr)
Math 1372—IT Calculus II (4 cr)
Phy 1302—Introductory Physics II (4 cr)
Liberal education elective (4 cr)

Sophomore Year
Fall Semester (15 cr)
CE 3101—Computer Applications I (3 cr)
Chem 1022—General Principles II with Lab (4 cr)
Math 2274—Multivariable Calculus and Vector Analysis (4 cr)
Phy 2303—Physics of Matter (4 cr)

Spring Semester (17 cr)
AEM 2011—Statics (3 cr)
Chem 2301—Organic Chemistry I (3 cr)
Math 2273—Linear Algebra and Differential Equations (4 cr)
MatS 301I—Introduction to Materials Science and Engineering (no lab) (3 cr)
Liberal education elective (4 cr)

Junior Year
Fall Semester (16 cr)
AEM 3031—Deformable Body Mechanics (3 cr)
MatS 3012—Metals and Alloys (3 cr)
MatS 3801—Structural Characterization Lab (2 cr)
MatS 4001—Thermodynamics of Materials (4 cr)
Liberal education elective (4 cr)

Spring Semester (15 cr)
MatS 3851W—Materials Properties Lab (2 cr)
MatS 4002—Kinetics and Mass Transport (4 cr)
MatS 4013—Electrical and Magnetic Properties of Materials (3 cr)
Technical elective (3 cr)
Liberal education elective (3 cr)

Senior Year
Fall Semester (17 cr)
MatS 4212—Ceramics (3 cr)
MatS 4214—Polymers (3 cr)
MatS 4221—Materials Design and Performance and Lab (4 cr)
Technical elective (4 cr)
Technical elective (3 cr)

Spring Semester (16 cr)
AEM 4511—Composite Materials (3 cr)
MatS 4301W—Materials Processing (4 cr)
MatS 4400—Senior Design (3 cr)
Technical elective (3 cr)
Liberal education elective (3 cr)

The National Research Council ranked the mathematics program #14 in the nation.

Mathematics

School of Mathematics

B.S. Math.
The mission of the program is to provide high-quality mathematics instruction in a stimulating intellectual atmosphere. The goal is to educate students at all levels to provide cultural enrichment, to give them the analytic tools they need to become responsible citizens, and to prepare them for careers involving mathematics.

The School of Mathematics offers a program leading to the bachelor of science degree. The course of study is flexible and may be adapted to satisfy a wide variety of interests and needs. Students may prepare for graduate study in mathematics or emphasize various fields of interest, such as preparation for secondary school teaching, actuarial science, or programs in applied mathematics, including industrial mathematics, biology, mathematics applicable to computer science, and numerical analysis. Programs for specializations in actuarial science, preparation for teaching in the secondary school, and mathematics applicable to computer science earn a designation that appears on the diploma.

Admission Requirements—Complete the lower division courses described below and meet GPA requirement set by IT (currently 2.00).

Degree Requirements
Students must complete at least 120 credits to graduate. This includes one of the lower division sequences described below, eight mathematics adviser-approved upper division courses (including two satisfying the algebra requirement and two satisfying the analysis requirement), and two semesters of technical electives. Students must also complete three semesters of physics and one semester of computer science. Students must take all required technical courses A-F and complete them with a grade of C- or better.

The School of Mathematics offers a program leading to the bachelor of science degree. The course of study is flexible and may be adapted to satisfy a wide variety of interests and needs. Students may prepare for graduate study in mathematics or emphasize various fields of interest, such as preparation for secondary school teaching, actuarial science, or programs in applied mathematics, including industrial mathematics, biology, mathematics applicable to computer science, and numerical analysis. Programs for specializations in actuarial science, preparation for teaching in the secondary school, and mathematics applicable to computer science earn a designation that appears on the diploma.

Admission Requirements—Complete the lower division courses described below and meet GPA requirement set by IT (currently 2.00).

Degree Requirements
Students must complete at least 120 credits to graduate. This includes one of the lower division sequences described below, eight mathematics adviser-approved upper division courses (including two satisfying the algebra requirement and two satisfying the analysis requirement), and two semesters of technical electives. Students must also complete three semesters of physics and one semester of computer science. Students must take all required technical courses A-F and complete them with a grade of C- or better.
For details about what courses are appropriate for the actuarial science, secondary teaching, or other specializations, see the publication Mathematics Major Requirements (available in the Undergraduate Math Office, 115 Vincent Hall or on the Web at www.math.umn.edu) or consult your adviser. For courses appropriate for other interests, consult your mathematics adviser.

**Required Courses**

### Lower Division Requirements

*One of the following sequences:*
- Math 1271-1272-2243-2263
- Math 1371-1372-2373-2374
- Math 1571H-1572H-2573H-2574H

Students who have not taken all four semesters of honors calculus must take Math 2283 or Math 3283. Math 3283 satisfies the writing-intensive course in the major requirement.

### Upper Division Requirements

Eight upper division math courses at 4xxx or above and two technical elective courses (which can be mathematics courses)

To satisfy the algebra requirement, students must take two courses from the following, with at least one of the courses chosen from Group A:

**Group A**
- Math 4281—Introduction to Modern Algebra
- Math 5248—Cryptography and Number Theory
- Math 5251—Error-Correcting Codes, Finite Fields, Algebraic Curves
- Math 5285H—Honors: Fundamental Structures of Algebra, I
- Math 5286H—Honors: Fundamental Structures of Algebra, II
- Math 5385—Introduction to Computational Algebraic Geometry

**Group B**
- Math 4242—Applied Linear Algebra
- Math 5705—Enumerative Combinatorics
- Math 5707—Graph Theory and Non-enumerative Combinatorics
- Math 5711—Linear Programming and Combinatorial Optimization
- Math 5485—Introduction to Numerical Methods, I

To satisfy the analysis requirement, students must take two courses from the following:
- Math 4606—Advanced Calculus
- Math 5486—Introduction to Numerical Methods II
- Math 5525—Introduction to Ordinary Differential Equations
- Math 5535—Dynamical Systems and Chaos
- Math 5583—Complex Variables
- Math 5587—Elementary Partial Differential Equations I
- Math 5588—Elementary Partial Differential Equations II
- Math 5615—Honors: Introduction to Analysis I
- Math 5616—Honors: Introduction to Analysis II
- Math 5651—Basic Theory of Probability and Statistics (or the equivalent Stat 5101)
- Math 5652—Introduction to Stochastic Processes
- Math 5654—Prediction and Filtering

The School of Mathematics will accept the following statistics courses as part of the eight-course upper division mathematics requirement:
- Stat 5101—Theory of Statistics I
- Stat 5102—Theory of Statistics II

Note that the content of Stat 5101 is the same as Math 5651—Basic Theory of Probability and Statistics.

No other courses from other departments may be used as part of the eight-course math requirement, though other courses may be used as technical electives.

Math 4512—Differential Equations With Applications may not be used to satisfy part of the eight-course upper division math requirement, though it may be used as technical elective.

Math 3113, 3116, 3118, 4113, 4116, and 4118—Topics in Elementary Mathematics, may not be used as upper division math courses as technical electives.

Math 3283W—Sequences, Series and Foundations and Math 4005—Calculus Refresher may not be used to satisfy part of the eight-course upper division math requirement or as technical electives.

**Required Courses From Other Programs**

Phys 1301-1302 plus one of the following: 2303, 2311, or 2503 (or the equivalent honors sequence).

*One course in computer programming, usually one of the following:*
- CSci 1103—Introduction to Computer Programming in Java (3 cr)
- CSci 1107—Introduction to FORTRAN Programming for Scientists and Engineers (3 cr)
- CSci 1113—Introduction to C/C++ Programming for Scientists and Engineers (4 cr)
- CSci 1901—Structure of Computer Programming I (4 cr)

**Liberal education electives (15 cr)**

**Electives**

Technical elective (two courses, not necessarily in mathematics, of at least 3 credits each that satisfy three requirements):
- The courses have Math 1271—Calculus I or equivalent as prerequisite;
- The courses are 3xxx or higher;
- The courses form a coherent part of the student’s program, as determined in consultation with the student’s adviser.

**Sample Mathematics Program**

### Freshman Year

#### Fall Semester (15 cr)
- EngC 1011—University Writing and Critical Reading (4 cr)
- Math 1371—IT Calculus I (4 cr)
- Phys 1301—Introductory Physics I (4 cr)
- Liberal education elective (3 cr)

#### Spring Semester (14-15 cr)
- Phys 1302—Introductory Physics II (4 cr)
- Liberal education elective (3 cr)

### Sophomore Year

#### Fall Semester (15 cr)
- CSci 1103—Introduction to Computer Programming in Java (3 cr)
- Phys 2371—IT Linear Algebra and Differential Equations (4 cr)
- Liberal education elective (3 cr)
- Biology with lab (4 cr)

#### Spring Semester (16 cr)
- Math 2373—Linear Algebra and Differential Equations (4 cr)
- Math 3283W—Sequences, Series, and Foundations: Writing Intensive (4 cr)
- Liberal education elective (4 cr)
- Free elective (4 cr)

### Junior Year

#### Fall Semester (15-16 cr)
- Upper division math (3-4 cr)
- Upper division math (4 cr)
- Technical elective (4 cr)
- Upper division composition (4 cr)

#### Spring Semester (16 cr)
- Upper division math (4 cr)
- Upper division math (4 cr)
- Technical elective (4 cr)
- Liberal education elective (4 cr)

### Senior Year

#### Fall Semester (15 cr)
- Upper division math (4 cr)
- Upper division math (4 cr)
- Free elective (7 cr)

#### Spring Semester (15 cr)
- Upper division math (4 cr)
- Upper division math (4 cr)
- Free elective (7 cr)
Mathematics Minor
A minor in mathematics is available through the College of Liberal Arts. Students must complete all lower division requirements for the major (including 2283 or 3283) plus two adviser-approved upper division math courses. Usually, the adviser approves any course that counts toward the math major. This includes Stat 5101-5102 but does not include math courses that are approved only as technical electives.

Mechanical Engineering
Department of Mechanical Engineering
B.M.E.
The Department of Mechanical Engineering is committed to offering undergraduate and graduate education of the highest quality in mechanical and industrial engineering, to conducting significant basic and applied research in selected areas, and to providing professional service to the appropriate constituencies of a major land grant university.

Mechanical engineering is involved in most technological activities of society and dominates many—including automotive, transportation and materials handling, environmental and pollution control systems, refrigeration and cryogenics, power systems design, automation, system dynamics and control, computer-aided design and manufacturing, and machinery/consumer products production. A mechanical engineer may be engaged in design, development, research, testing, manufacturing, administration, marketing, consulting, or education.

Objectives for the mechanical engineering program are:
1. to provide for study in the basic sciences, the liberal arts, engineering analysis and design in accordance with national standards and thereby provide the necessary tools for students to pursue successful careers as mechanical engineers or to seek continued graduate education.
2. to provide strong training in experimental and computational techniques and to give students the ability to work in multidisciplinary design teams to meet the needs of the modern work place. The program benefits by enrichment from research activities and strong ties to industry.
3. to give students with the ability to communicate technical information effectively, understand professional and ethical responsibilities of a mechanical engineer, and to adapt to modern work place. The program benefits by enrichment from research activities and strong ties to industry.

The program prepares students for an industrial career in mechanical engineering or for graduate work. A strong background in the basic sciences of mathematics, physics, and chemistry is balanced with courses in engineering science and engineering design. Through electives, each student has an opportunity to develop a program of study that reflects his or her particular area of interest.

A co-op program is available during the last two years of study. Upper division status and a satisfactory GPA are required for admission. The co-op program provides applied engineering training in selected established industries during semesters of supervised assignments that alternate with semesters of University studies.

Professional training in industrial engineering is offered through an industrial engineering option. Students selecting this option complete the same set of required courses as other mechanical engineering students, but their technical electives must be selected from an approved list and in consultation with a faculty adviser. Students selecting the option may also apply to the co-op program.

The program is accredited by the Engineering Accreditation Commission of ABET.

Information is available on the Web at www.me.umn.edu/info/ug. Further details and information about alternative course selections, elective programs, areas of specialization, and changes in course or credit requirements are available in 1120 Mechanical Engineering (612-625-5842, e-mail u-gradinfo@me.umn.edu). Program educational objectives and program outcomes can be seen at www.me.umn.edu/info/ug/objectives_and_outcomes.

Admission Requirements—Complete specific lower division courses and meet GPA requirement set by IT (currently 2.50).

Degree Requirements
Students must complete at least 127 credits to graduate, including 48 credits in the major. The courses required for the degree are listed below. These include four technical electives totaling 16 credits.

The mechanical engineering program was ranked #8 in the nation in a report by the National Research Council.

Required Courses

Lower Division
ME 2011—Introduction to Mechanical Engineering (4 cr)

Upper Division
IE 4521—Statistics, Quality, and Reliability (4 cr)
ME 4031W—Basic Mechanical Measurements Laboratory (4 cr)
ME 3221—Design and Manufacturing I: Engineering Materials and Manufacturing Processes (4 cr)
ME 3222—Design and Manufacturing II (4 cr)
ME 3281—Systems, Dynamics, and Controls (4 cr)
ME 3321—Thermodynamics (4 cr)
ME 3322—Heat Transfer and Fluid Flow (4 cr)
ME 4054—Senior Design (4 cr)
ME 4x3x—Senior Laboratory (4 credits to be selected from those offered; senior lab courses are numbered ME 4x3x) (4 cr)

Technical electives: four 4-credit, upper division IT courses, a minimum of two courses must be ME or IE courses.

Required Courses From Other Programs
AEM 2021—Statics and Dynamics (4 cr)
AEM 3031—Deformable Body Mechanics (3 cr)
Chem 1021—Chemical Principles I (4 cr)
CSci 1113—Introduction to C/C++ Programming for Scientists and Engineers (4 cr)
EE 3005—Fundamentals of Electrical Engineering (4 cr) and EE 3006—Lab (1 cr)
Math 1271, 1272 or Math 1371, 1372 or Math 1571H, 1572H—Calculus I, II (4 cr each)
Math 2233 or 2373 or 2573H—Linear Algebra and Differential Equations (4 cr)
Math 2263 2374 or 2574H—Multivariable Calculus (4 cr)
Math 291—Introduction to the Science of Engineering Materials (the lab associated with this class is required)

Sample Mechanical Engineering Program
Freshman Year
Fall Semester (16 cr)
EngC 1011—University Writing and Critical Reading (4 cr)
Math 1371—IT Calculus I (4 cr)
Phys 1301—Introductory Physics I (4 cr)
Biology with lab (4 cr)

Spring Semester (15 cr)
Chem 1021—General Principles of Chemistry I (4 cr)
Math 1372—IT Calculus II (4 cr)
Phys 1302—Introductory Physics II (4 cr)
Liberal education elective** (3 cr)
Sophomore Year

Fall Semester (16 cr)
- AEM 2021—Statics and Dynamics (4 cr)
- Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)
- MatS 2001—Introduction to Mechanical Properties* (4 cr)
- ME 2011—Introduction to Mechanical Engineering (4 cr)

Spring Semester (17 cr)
- AEM 3031—Deformable Body Mechanics (3 cr)
- CSci 1113—Introduction to C/C++ Programming for Scientists and Engineers (4 cr)
- Math 2373—IT Linear Algebra and Differential Equations (4 cr)
- Liberal education elective** (3 cr)
- Liberal education elective** (3 cr)

Junior Year

Fall Semester (15 cr)
- ME 3281—System Dynamics and Control (4 cr)
- ME 3221—Design and Manufacturing I (4 cr)
- ME 3321—Thermodynamics (4 cr)
- Liberal education elective** (3 cr)

Spring Semester (17 cr)
- EE 3005—Fundamentals of Electrical Engineering (4 cr)
- EE 3006—Fundamentals of Electrical Engineering Laboratory (1 cr)
- IE 4521—Statistics, Quality, and Reliability (4 cr)
- ME 3222—Design and Manufacturing II (4 cr)
- ME 3322—Heat Transfer and Fluid Flow (4 cr)

Senior Year

Fall Semester (16 cr)
- ME 4031W—Basic Mechanical Measurements Laboratory (4 cr)
- Technical elective (4 cr)
- Technical elective (4 cr)
- Technical elective (4 cr)

Spring Semester (15 cr)
- ME 4x3x—Senior Lab (4 cr)
- ME 4054W—Senior Design Projects (4 cr)
- Technical elective (4 cr)
- Liberal education elective** (3 cr)

* The 4-credit course has a 3-credit lecture and 1-credit lab.
** The assumption is that liberal education courses will each be 3 credits.

Physics

School of Physics and Astronomy

B.S. Phys.

Mission—To add to our understanding of the physical principles governing our observable universe, to teach these principles to students at the University of Minnesota, and to use our knowledge of these principles in the service of the citizens of the state of Minnesota.

Physics is concerned with the fundamental properties and interactions of all forms of matter. Experimental and theoretical investigations are combined to formulate mathematical relationships that describe and predict the behavior of nature.

The undergraduate physics program prepares students for employment, often in industrial or governmental laboratories, or for further study at graduate or professional schools in physics, engineering, biophysics, medicine, education, law, or business.

The program integrates a broad foundation in physics that can be flexibly combined with coursework in other technical disciplines or used to specialize in physics. Students should consult a physics adviser to help formulate objectives for undergraduate study.

Technical electives are 3xxx courses and above, usually taken from courses in IT or the College of Biological Sciences, which further these objectives.

Admission Requirements—Complete specific lower division courses and meet GPA requirement set by IT (currently 2.00).

Degree Requirements

Students must complete at least 120 credits to graduate, including 30-38 credits in the major.

Physics majors must take all required physics and mathematics courses A-F and must earn a grade of C- or better in all physics, mathematics, and technical elective courses (except those offered S-N only). Only students with grades of B or better in the introductory physics courses can generally expect to succeed in the major. Students also choose one emphasis within the program and must complete the University’s liberal education requirements.

Required Courses

Core Program
- Phys 1301W, 1302W, 2503 or Phys 1401V, 1402V, 2403V (12 cr)
- Phys 2201—Introduction to Thermal and Statistical Physics (2 cr)
- Phys 2601—Quantum Physics (4 cr)
- Phys 2605—Quantum Physics Laboratory (3 cr)
- Phys 4051—Methods of Experimental Physics I (5 cr)
- Phys 4052W—Methods of Experimental Physics II (5 cr)

At least two of the following four courses:
- Phys 4001—Analytical Mechanics (4 cr)
- Phys 4002—Electricity and Magnetism (4 cr)
- Phys 4101—Quantum Mechanics (4 cr)
- Phys 4201—Statistical and Thermal Physics (3 cr)

One of the following four sequences:
- Math 1271, 1272, 2243, 2263 or Math 1371, 1372, 2373, 2374 or Math 1571H, 1572H, 2573H (15-16 cr)
- Liberal education requirements
### Emphases (choose one)
- Professional Physics Emphasis (30-33 cr)
- Engineering Emphasis (35-38 cr)
- Biology Emphasis (34-36 cr)
- Teaching Emphasis (30-34 cr)
  - History and Philosophy of Science
  - Relativity, Astrophysics, and Cosmology
  - Earth Sciences
  - Technology

### Sample Physics Program (Physics Emphasis)
#### Freshman Year
**Fall Semester (15 cr)**
- EngC 1011—University Writing and Critical Reading (4 cr)
- Math 1271 or 1371 or 1571H—Calculus I (4 cr)
- Phys 1301W or 1401V—Introductory Physics I (4 cr)
- Freshman Seminar (1-3 cr)

**Spring Semester (15-16 cr)**
- Math 1272 or 1372 or 1572H—Calculus II (4 cr)
- Phys 1302W or 1402V—Introductory Physics II (4 cr)
- Technical elective (chemistry) (4 cr)
- Liberal education elective (arts and humanities) (3-4 cr)

#### Sophomore Year
**Fall Semester (15 cr)**
- Math 2243 or 2373 or 2573H—Linear Algebra/Differential Equations (4 cr)
- Math 2263 or 2374 or 2574H—Multivariable Calculus and Vector Analysis, or Honors Calculus III (4 cr)
- Liberal education elective (history and social sciences) (3 cr)
- Liberal education elective (for example, biology) (4 cr)

**Spring Semester (15 cr)**
- Math 2263 or 2374 or 2574H (4 cr)
- Phys 2601—Quantum Physics (4 cr)
- Phys 2605—Quantum Physics Lab (3 cr)
- Technical elective (CSci C/C++ programming) (4 cr)

#### Junior Year
**Fall Semester (16 cr)**
- Phys 4001—Analytical Mechanics (4 cr)
- Phys 4051—Methods of Experimental Physics I (5 cr)
- Math elective (4 cr)
- Open elective (3 cr)

**Spring Semester (16 cr)**
- Phys 4002—Electricity and Magnetism (4 cr)
- Phys 4052W—Methods of Experimental Physics II (5 cr)
- Technical elective (4 cr)
- Liberal education elective (3 cr)

#### Senior Year
**Fall Semester (14 cr)**
- Phys 4101—Quantum Mechanics (4 cr)
- Phys 4201—Statistical and Thermal Physics (3 cr)
- Technical elective (3 cr)
- Liberal education elective (4 cr)

**Spring Semester (15 cr)**
- Physics or astrophysics elective (4 cr)
- Technical elective (for example, lab project) (4 cr)
- Liberal education elective (4 cr)
- Open elective (3 cr)

### Statistics Minor
A minor is available through the College of Liberal Arts (CLA); see the physics program in the CLA Degree Programs and Minors section.

### Statistics
#### School of Statistics

**B.S.Stat.**

**Mission**—To explore the principles underlying sound statistical analysis; to develop improved ways to draw inferences in scientific studies and make decisions and predictions in industrial, business, and governmental enterprises; and to use our knowledge of these principles in the service of the citizens of the state of Minnesota.

Statistics is concerned with theories and methods of data collection, tabulation, analysis, and interpretation, and their use in learning from data and making decisions.

A bachelor’s degree gives students an understanding of the theory of statistics and trains them in basic use of the most important types of statistical methods. The degree prepares students for graduate work or for jobs in such diverse areas as marketing analysis, quality management, and support for scientific research.

The program provides a broad foundation in statistics that can be combined with coursework in other technical disciplines or as a basis for further specialization in statistics.

Technical electives are 3xxx courses and above, often courses in mathematics, computer science, industrial engineering, or biostatistics.

#### Degree Requirements
Students must complete at least 120 credits to graduate, including at least 38 credits in statistics and technical electives.

Required are two years of math, one year of statistical theory, five courses in statistical methods, three courses with lab in the sciences, and three elective courses in statistics or related fields.

#### Required Courses
- Stat 3011—Introduction to Statistical Analysis
- or Stat 3021—Introduction to Probability and Statistics
- Stat 3022—Data Analysis
- Stat 4101-4102—Theory of Statistics I-II
- or Stat 5101-5102—Theory of Statistics I-II

At least 10 credits of adviser-approved statistics electives chosen from Stat 5031, 5101, 5102, 5103, 5200, 5201, 5302, 5303, 5401, 5402, 5421, 5601

Math 1271, 1272 or Math 1371, 1372 or Math 1571H, 1572H—Calculus I-II

Math 2263 or 2374—Multivariable Calculus and Vector Analysis, or 2573H—Honors Calculus III

Math 2243 or 2373—Linear Algebra and Differential Equations (4 cr)

Math 4242—Applied Linear Algebra

**One course among the following three:**
- CSci 1103—Introduction to Computer Programming in Java
- CSci 1107—Introduction to FORTRAN Programming for Scientists and Engineers
- CSci 1113—Introduction to C/C++ Programming for Scientists and Engineers

Three courses with lab, chosen from at least two of the fields of physics, chemistry, biology

Three adviser-approved courses totaling at least 10 credits in statistics or related fields such as computer science, biostatistics, industrial engineering/operations research, mathematics

### Statistics Minor
A minor is available through the College of Liberal Arts. The minor requires at least 14 credits from 3xxx-5xxx School of Statistics courses, including at least two 4xxx or 5xxx courses.