Degree Programs and Minors

Aerospace Engineering ................................................................. 271
Astrophysics ................................................................................ 272
Biomedical Engineering ............................................................... 273
Biosystems and Agricultural Engineering ..................................... 274
Chemical Engineering ................................................................. 276
Chemistry ....................................................................................... 277
Civil Engineering ................................................................. 278
Computer Engineering .............................................................. 279
Computer Science ......................................................................... 281
Electrical Engineering ................................................................. 282
Geological Engineering ............................................................... 283
Geology ......................................................................................... 285
Geophysics ...................................................................................... 286
Information Technology .............................................................. 287
Management .................................................................................... 288
Materials Science and Engineering ............................................. 288
Mathematics ................................................................................... 289
Mechanical Engineering .............................................................. 290
Physics ............................................................................................ 292
Statistics .......................................................................................... 293
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, 1,700 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’s Academic and Distributed Computing, 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 tabl epid 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**
The Office of Admissions reviews all applications to determine applicants’ potential for academic success. This review process falls into two categories: guaranteed admission or admission by individual review in which freshman applicants whose records do not meet guaranteed admission requirements are evaluated through the Office of Admissions’ individual review process. Students who do not meet criteria for guaranteed admission should still apply.

**Guaranteed Admission**—Students are guaranteed admission to IT as freshmen if they
1. submit a complete application, including all test scores and transcripts, with a $35 application fee by the priority deadline (ACT preferred, SAT accepted; applying early in the senior year in high school strongly recommended).
2. complete high school course preparation requirements. See Freshman Admission in the General Information section of this catalog.
3. meet the ACT or SAT aptitude rating standards below. The following formulas show how to calculate ACT or SAT aptitude rating using high school rank percentile and ACT or SAT test scores. If the aptitude rating falls at or above the number indicated, students are admitted automatically, provided they also meet the other admission standards listed above.
   
   \[
   \text{AAR} = \text{High school rank percentile} + (2 \times \text{ACT composite score})
   \]
   \[
   \text{SAR} = \text{High school rank percentile} + (\text{SAT verbal} ÷ 10 + \text{SAT math} ÷ 10)
   \]

   An AAR of at least 135, or SAR of at least 200, guarantees admission. If a student’s AAR or SAR is below the automatic admission cutoffs, his or her application qualifies for the Office of Admissions’ individual review process.

**Note:** The AAR and SAR scores above were current for the fall 2002 application period. For official and up-to-date information about the University’s admissions policies, procedures, and deadlines, please see the latest edition of the *Undergraduate Application Booklet* available from the Office of Admissions (612-625-2008 or 800-752-1000) or online at <http://admissions.tc.umn.edu>.

**Admission by Individual Review**—Review considerations may be based on one or more of the following.

- A pattern of steady improvement in academic performance
- A strong college preparatory curriculum (including advanced placement) or a particularly challenging pattern of coursework
- The size of the applicant’s high school graduating class
- Extenuating circumstances that have adversely affected the applicant’s academic record or preadmission test scores
- Evidence of exceptional achievement or aptitude not reflected in the applicant’s academic record or preadmission test scores
- Evidence of exceptional talent or ability in artistic, scholarly, leadership, or athletic performance

**College Coursework Evaluation**—No college coursework is required for freshman admission. However, applicants who have completed any transferable college work should have at least a 2.70 grade point average (GPA) in transferable credits (in addition to meeting criteria 1-3 above) to qualify for automatic admission. Applications of students with GPAs below 2.70 are individually reviewed.

**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 their 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 “IT Undeclared” 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 in that office to learn about IT fields. Some of the services include 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, through which they can visit selected industries to talk and 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 Web 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 a year or more of college work 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 the overall GPA and grades in science and mathematics. 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.

Most courses transfer routinely. Equivalency for technical courses has been established between IT and most colleges and universities (see [www.it.umn.edu/admissions/transfer/credit.html](http://www.it.umn.edu/admissions/transfer/credit.html)). Technical courses in which a D has been earned do not transfer, unless the following course in the sequence was completed with at least a C.

**Dual Degree (3/2) Programs**—IT has cooperative agreements with a number of public and private colleges. These programs support those 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. At the private college, core college requirements and the pre-engineering core courses in math and science are completed. 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, Moorhead State University, 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; (outside Minnesota) Augustana College, SD; Carroll College, MT; Jackson State University, MS; Luther College, IA; North Central College, IL; North Park College, IL; University of Winnipeg, Manitoba, Canada; University of Wisconsin—La Crosse, WI; University of Wisconsin—River Falls, WI; 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 [www.catalogs.umn.edu/grad/index.html](http://www.catalogs.umn.edu/grad/index.html).

IT and the Graduate School jointly offer a program leading to the master of engineering (M.Eng. 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, manufacturing 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**—EngC 1011 and one literature

**Calculus**—Math 1271

**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.

Coursework in genetics and upper level statistics is strongly recommended.

Additional academic courses to complete degree requirements.

**Prerequisite 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/prospectivestudents.htm](http://penguin.d.umn.edu/Admissions/prospectivestudents.htm)
- Minneapolis: [www.meded.umn.edu](http://www.meded.umn.edu)
- Rochester: [www.mayo.edu/mms/admit.htm](http://www.mayo.edu/mms/admit.htm)

The CLA Career and Community Learning Center in 135 Johnston Hall has information on U. S. Medical Schools as well as career information about medical and paramedical fields.

For application procedures, students should consult the premedicine adviser in their IT departments.

**Minors**

**IT Management Minor Only**

This program is for IT undergraduates who wish to broaden their education by taking management courses. For more information, see the Degree Programs and Minors section.

**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.

This special lower division academic program continues into the sophomore year offering enough flexibility so students can take the courses they need to pursue any major. For the junior and senior years, each department offers its own upper division honors program consisting of courses, research projects, and honors opportunities leading to the *cum laude* degrees.

**Admission to Lower Division Program**—Most lower division honors students begin their participation in the honors program in the fall of the freshman year. These students apply and are admitted in their senior year of high school. Selection is based on academic accomplishments in high school, scores on standardized tests, an application essay, and a recommendation usually from a teacher or counselor. The priority application deadline for freshman admission is January 15.

Applications may be obtained by contacting the Office of Admissions, 240 Williamson Hall (612-625-2008).

Students with excellent grades in regular courses during the fall of their freshman year may apply to the honors program for spring semester. These students should have taken the appropriate first-semester mathematics and physics courses so they are prepared for the corresponding honors sequences.

**Admission to Upper Division Programs**—Students about to enter their junior year may apply to the upper division honors program administered through their major department. Admission requirements are set by the individual departments and may be obtained from the department or the IT Honors Office. Previous enrollment in the lower division honors program is not required for participation in upper division honors programs.

**Graduation With Honors**—Enrollment in the upper division honors program is required for graduation with the honors designations *cum laude*, *magna cum laude*, and *summa cum laude*. Other graduation criteria include at least two years of University of Minnesota coursework, quality of the grade record, participation in honors opportunities, fulfillment of requirements designated in the major field, and an honors thesis.

**IT Honors Office**—This office provides academic advising, procedural information, and other college office services to honors students. The address is IT Honors Office, University of Minnesota, 136 Lind Hall, 207 Church Street S.E., Minneapolis, MN 55455 (612-625-2800).

**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, 2101-2111
- Chem 2301, 2302, 2311
- EE 2001, 2011
- Math 1155, 1271-1272
- Math 1371-1372
- Math 1571-1572
- Phy 1301, 1302
- Phy 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 Phy 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.

General Information

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.
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, 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.

Conduct and Discipline
IT assumes that all students who enroll in its programs are serious about their education and expect 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.

The IT Student Conduct Committee, composed of faculty and students, hears cases of scholastic dishonesty. When charges are upheld, the student may be placed on disciplinary probation, failed in a course, suspended, or expelled.

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 in 105 Lind Hall upon request.

Disciplinary cases that are nonacademic in nature or that involve two or more colleges are referred to the Campus Committee on Student Behavior (612-624-6073).

Professional Registration
Registration as an engineer is a legal requirement for certain kinds of practice. 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. 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 50 Lind Hall or by writing to the Minnesota State Board of Architecture, Engineering, Land Surveying, Landscape Architecture 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). This office is responsible for admission, orientation, registration, 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, 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—This program supports women in their pursuit of science and engineering education and careers. Services are provided to women undergraduate and graduate students, transfer and nontraditional students, faculty, technical staff, fellows, and precollege girls.

The program recruits talented women in an attempt to increase the enrollment of women in IT degree programs to levels above national trends. It builds networks for IT women, provides skills and tools for success, and works to improve the climate for women in individual departments. Its outreach efforts focus on encouraging girls to explore and enjoy mathematics and science as well as educating parents, teachers, leaders, and the greater community on their critical roles in supporting girls and women in science and engineering. The program also provides student referral, scholarship and fellowship files, a resource library, networking information, MN-WISE electronic list server, and advocacy.

For more information, contact Program for Women, 107 Lind Hall, 207 Church Street S.E., Minneapolis, MN 55455 (612-624-1317).

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 60 students in Frontier Hall. The WISE House is a female first-year freshman community open to 20 students in Comstock Hall. Contact the IT Student Affairs Office for further information at 612-624-8010 or e-mail kubits001@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, kubits001@umn.edu.

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 Global Campus-Study Abroad office offers more than $150,000 in scholarships for study abroad. IT has also been supportive to students with financial need.

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 Global Campus-Study Abroad office 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, a two-credit 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.

**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 Chemical Society, American Institute of Chemical Engineers, Society of Physics Students, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society of Agricultural Engineers, 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, Tri Sigma, 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), 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* (newsletter) and *IT Technology* (technical magazine). The IT Board of Publications selects editors and business managers and directs the overall policy of the publications. Students are encouraged to participate as publication staff members.
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 4602 and AEM 4332, 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, 4441, or 4651
- AEM 4601—Instrumentation Lab
- AEM 4602—Aeromechanics Lab
- AEM 4331—Aerospace Vehicle Design I
- AEM 4332—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 2373 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
Phy 1301, 1302, 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.

Liberal education electives—15 credits

Campus liberal education requirements are to be met through the 15 credits of liberal education courses. 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 4602 and AEM 4332, 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, 4441, or 4651
- AEM 4601—Instrumentation Lab
- AEM 4602—Aeromechanics Lab
- AEM 4331—Aerospace Vehicle Design I
- AEM 4332—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 2373 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
Phy 1301, 1302, 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.
Institute of Technology

EE 3006—Fundamentals of Electrical Engineering Lab (1 cr)
EE 3005—Fundamentals of Electrical Engineering (4 cr)
AEM 4301—Spaceflight Dynamics (3 cr)
AEM 4201—Fluid Mechanics (4 cr)

Fall Semester (15 cr)
Liberal education elective (3 cr)
Math 2373—IT Linear Algebra and Differential Equations (4 cr)
AEM 2301—Mechanics of Flight (3 cr)
AEM 2012—Dynamics (3 cr)
Spring Semester (13 cr)
Liberal education elective (3 cr)
MatS 2001—Introduction to the Science of Engineering Materials (3 cr)
Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)
AEM 2011—Statics (3 cr)
Freshman Year

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 1301—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 1302—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 Sciences and Engineering III (4 cr)
Liberal education elective (3 cr)
Spring Semester (13 cr)
AEM 2012—Dynamics (3 cr)
AEM 2301—Mechanics of Flight (3 cr)
Math 2373—IT Linear Algebra and Differential Equations (4 cr)
Liberal education elective (3 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 4602—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 4332—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.

The areas of specialization are:

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

Required Courses

(Ast 1011—Exploring the Universe, Honors is recommended)
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 2373, 2374 or Math 2573H, 2574H
Math 2283, or any Math 3xxx
Phys 1301, 1302 or Phys 1401, 1402
Phys 2503 (or 2403), 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 elective (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)
Elective (4 cr)

Biomedical Engineering

Department of Biomedical Engineering
B.Bm.E.
The mission of the Department of Biomedical Engineering is to be a pre-eminent biomedical education and research department providing discoveries, inventions, and highly trained scientists and engineers to meet the needs of industry, health care providers, and the self-directed health care market in the community, the region, the nation, and the world.
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.

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 (612-626-8474, e-mail bmedus@umn.edu, <www.bme.umn.edu>).

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.
Institute of Technology

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 1371—Calculus I
Math 1271 or 1372—Calculus II
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)
Phys 1302—Introductory Physics II (4 cr)

Sophomore Year
Fall Semester (15 cr)
BME 2501—Cell and Molecular Biology for Biomedical Engineers (4 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 2263 or 2374—Multivariable Calculus (4 cr)
Spring Semester (17 cr)
BME 2602—Biomedical Engineering Undergraduate Seminar II (1 cr)
Chem 3501—Physical Chemistry I (3 cr)
or Biol 3021—Biochemistry (3 cr)
Math 2243 or 2373—Linear Algebra and Differential Equations (4 cr)
Stat 3021—Introduction to Probability and Statistics (3 cr)
Liberal education elective (3 cr)

Junior Year
Fall Semester (15 cr)
BME 3001—Biomechanics (4 cr)
BME 3101—Biomedical Transport Processes (4 cr)
Phsl 3061—Principles of Physiology (4 cr)
Liberal education elective (3 cr)

Spring Semester (16 cr)
BME 3201—Bioelectricity/Bioinstrumentation (4 cr)
BME 3301—Biomaterials (4 cr)
BME 3701—Biomedical Engineering Physiology Laboratory (2 cr)
Liberal education elective (6 cr)

Senior Year
Fall Semester (18 cr)
BME 4001W—Biomedical Engineering Design I (3 cr)
Engineering electives (12 cr)
Liberal education elective (3 cr)
Spring Semester (15 cr)
BME 4002W—Biomedical Engineering Design II (3 cr)
Engineering 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.

Biosystems and agricultural engineers integrate engineering and biology to design efficient, economical processes to improve the quality and safety of food products for consumers; protect and enhance the environment through design of sustainable practices to maintain and improve soil, water, and air quality; design efficient, profitable food production systems that protect the environment, humans, plants, and animals; and design safe, efficient machines and processes for biological systems.

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 biosystems and agricultural engineering curriculum emphasizes the physical, biological, and engineering sciences and engineering design. Students also study communications, social science, and humanities to provide a liberal education and prepare to work effectively with professionals in many disciplines. The program provides students with a background for continued professional growth and prepares them to contribute to an ever-changing society.

The curriculum includes emphases in environment, machinery systems, and bioprocessing and food. Students, with the assistance of an adviser, 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).

Liberal education requirements are the same for all students on the Twin Cities campus. Students must satisfy both the diversified core and designated theme requirements.

For additional information, contact Roger Ruan, Department of Biosystems and Agricultural Engineering, 213 Biosystems and Agricultural Engineering Building, 1390 Eckles Avenue, St. Paul, MN 55108. E-mail ruans001@umn.edu; 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 29 credits in the major. Non-BAE credits include 19 credits of engineering courses; 7 credits of composition; 48 credits of mathematics, chemistry, physics, biology, statistics, and computer programming; and credits needed to fulfill the University’s liberal education requirements.

### Required Courses From Other Programs

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEM 2021—Statics and Dynamics</td>
<td>4 cr</td>
</tr>
<tr>
<td>AEM 3031—Deformable Body Mechanics</td>
<td>3 cr</td>
</tr>
<tr>
<td>Biol 1009—General Biology</td>
<td>4 cr</td>
</tr>
<tr>
<td>CE 3502—Fluid Mechanics</td>
<td>4 cr</td>
</tr>
<tr>
<td>Chem 1021—Chemical Principles I</td>
<td>4 cr</td>
</tr>
<tr>
<td>Chem 1022—Chemical Principles II</td>
<td>4 cr</td>
</tr>
<tr>
<td>EE 3005—Fundamentals of Electrical Engineering</td>
<td>4 cr</td>
</tr>
<tr>
<td>EngC 1011—University Writing and Critical Reading</td>
<td>4 cr</td>
</tr>
<tr>
<td>Math 1271 or 1371 or 1571H—Calculus I</td>
<td>4 cr</td>
</tr>
<tr>
<td>Math 1272 or 1372 or 1572H—Calculus II</td>
<td>4 cr</td>
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<tr>
<td>Math 2273 or 2733 or 2694H—Linear Algebra and Differential Equations</td>
<td>4 cr</td>
</tr>
<tr>
<td>Math 2263 or 2735 or 274H—Multivariable Calculus</td>
<td>4 cr</td>
</tr>
<tr>
<td>ME 3324—Introduction to Thermal Science</td>
<td>4 cr</td>
</tr>
<tr>
<td>Phys 1301—Introductory Physics I</td>
<td>4 cr</td>
</tr>
<tr>
<td>Phys 1302—Introductory Physics II</td>
<td>4 cr</td>
</tr>
<tr>
<td>Rhet 1101—Writing to Inform, Convince, and Persuade</td>
<td>4 cr</td>
</tr>
<tr>
<td>or EngC 1011—University Writing and Critical Reading</td>
<td>4 cr</td>
</tr>
<tr>
<td>Math 1272—IIT Calculus II</td>
<td>4 cr</td>
</tr>
<tr>
<td>Phys 1302—IIT Calculus II</td>
<td>4 cr</td>
</tr>
<tr>
<td>Liberal education elective</td>
<td>3 cr</td>
</tr>
</tbody>
</table>

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

### Sample Biosystems and Agricultural Engineering Program

#### Freshman Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Fall</td>
<td>17 cr</td>
</tr>
<tr>
<td>BAE 1011—BAE Orientation</td>
<td>1 cr</td>
</tr>
<tr>
<td>BAE 2113—Introduction to Design</td>
<td>3 cr</td>
</tr>
<tr>
<td>BAE 3031—Engineering Principles of Molecular and Cellular Processes</td>
<td>3 cr</td>
</tr>
<tr>
<td>BAE 3023—Engineering Principles of Soil-Water-Plant Processes</td>
<td>3 cr</td>
</tr>
<tr>
<td>BAE 4013—Transport in Biological Systems</td>
<td>4 cr</td>
</tr>
<tr>
<td>BAE 4023—Instrumentation and Control for Biological Systems</td>
<td>3 cr</td>
</tr>
<tr>
<td>BAE 4112—Senior Design I-II</td>
<td>4 cr</td>
</tr>
<tr>
<td>Plus 9 credits of BAE in an emphasis</td>
<td></td>
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</table>

#### Sophomore Year

<table>
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<th>Semester</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Fall</td>
<td>15 cr</td>
</tr>
<tr>
<td>Chem 1022—Chemical Principles II</td>
<td>4 cr</td>
</tr>
<tr>
<td>Math 1372—IIT Calculus II</td>
<td>4 cr</td>
</tr>
<tr>
<td>Phys 1302—IIT Calculus II</td>
<td>4 cr</td>
</tr>
<tr>
<td>Liberal education elective</td>
<td>3 cr</td>
</tr>
</tbody>
</table>

#### Junior Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>16 cr</td>
</tr>
<tr>
<td>BAE 3023—Engineering Principles of Soil-Water-Plant Systems</td>
<td>3 cr</td>
</tr>
<tr>
<td>ME 3324—Introduction to Thermal Science</td>
<td>4 cr</td>
</tr>
<tr>
<td>Stat 3021—Introduction to Probability and Statistics</td>
<td>3 cr</td>
</tr>
<tr>
<td>Technical elective</td>
<td>3 cr</td>
</tr>
<tr>
<td>Biology elective</td>
<td>3 cr</td>
</tr>
</tbody>
</table>

### Senior Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>16 cr</td>
</tr>
<tr>
<td>BAE 4023—Instrumentation and Control for Biological Systems</td>
<td>3 cr</td>
</tr>
<tr>
<td>BAE emphasis (BAE 4313*/4523*, 4523*/4533, or 4713*/4723*)</td>
<td>3 cr</td>
</tr>
<tr>
<td>EE 3005—Fundamentals of Electrical Engineering</td>
<td>4 cr</td>
</tr>
<tr>
<td>Rhet 3562—Technical and Professional Writing</td>
<td>3 cr</td>
</tr>
<tr>
<td>Engineering elective or BAE emphasis</td>
<td>3 cr</td>
</tr>
</tbody>
</table>
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 semisworks 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, the chemical engineer is much in demand. He or she 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 (currently 2.70).

Degree Requirements

Students must complete at least 129 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.

The student, together with his or her adviser, plans 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
- Chem 4121—Process Analytical Chemistry
- Chem 4001—Material and Energy Balances
- Chem 4002—Transport Phenomena
- Chem 4003—Heat and Mass Transfer
- Chem 4004—Separation Processes
- Chem 4101—Chemical Engineering Thermodynamics
- Chem 4102—Reaction Kinetics and Reactor Engineering
- Chem 4401—Chemical Engineering Laboratory I
- Chem 4402—Chemical Engineering Laboratory II
- Chem 4501—Chemical Engineering Process Design I
- Chem 4502—Chemical Engineering Process Design II
- Chem 4601—Process Control

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, foreign language and culture, industrial engineering, interfacial engineering, management and economics, materials science, mathematics, paper science and engineering, polymer science, and process engineering.

Sample Chemical Engineering Program

Freshman Year

Fall Semester (15-17 cr)

- Chem 1021—General Principles of Chemistry I with Lab (4 cr)
- ChEn/Mats 1001—Advances in Chemical Engineering (1 cr) optional
- EngC 1011—University Writing and Critical Reading (4 cr)
- Math 1371—IT Calculus I (4 cr)

Liberal education elective (3-4 cr)

Spring Semester (18 cr)

- Biology elective (3 cr)
- Liberal education elective (3 cr)

Liberal education elective (3 cr)

Liberal education elective (3 cr)

* Offered alternating years
Chemistry

Department of Chemistry

B.S.Chem.

Mission—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.

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 (31 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 (15 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.

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 (3 cr)
Chem 3501—Physical Chemistry I (3 cr)
Chem 3502—Physical Chemistry II (3 cr)
Chem 4701—Inorganic Chemistry Lect (3 cr)
Advanced chemistry lecture elective (3 cr)
Advanced chemistry lab elective (6 cr)
Three courses selected from: Chem 4904—Directed Studies, 4111, 4311, 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 (3 cr)
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)

The chemical engineering program was ranked #1 in the nation in a National Research Council report.
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 (3 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)

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 elective courses.

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 57 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, geology, 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, engineering economics, and engineering design. Students are also required to select appropriate technical elective courses.
Required Courses
CE 3101—Computer Applications (3 cr)*
CE 3201—Transportation Engineering (3 cr)
CE 3202—Surveying and Mapping (2 cr)
CE 3301—Soil Mechanics I (3 cr)
CE 3401—Linear Structural Analysis (3 cr)
CE 3402—Construction Materials (3 cr)
CE 3501—Environmental Engineering (3 cr)
CE 3502—Fluid Mechanics (4 cr)
CE 4101—Project Management (3 cr)
CE 4102—Capstone Design (3 cr)
CE 4301—Soil Mechanics II (3 cr)
CE 4401—Steel and Concrete Design I (4 cr)
CE 4501—Hydrologic Design (4 cr)
CE 4502—Water and Wastewater Treatment (3 cr)
Technical electives (13 cr)**
A total of 71 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)
Geo 1001 (4 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)
Stat 3021—Applied Statistics (3 cr)
Biological writing requirement (EngC 1011 or Rhet 1152 recommended)
Liberal education electives (15 cr)

*Substitutions—Upon recommendation of an adviser, students may make the following substitutions:
A CSci programming course for CE 3101
A CE environmental course for AEM 2012

**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 (17 cr)
CE 1101—Civil Engineering Orientation (1 cr)
Chem 1021—Introduction to Chemistry (4 cr)
Geo 1001—The Dynamic Earth: An Introduction to Geology (4 cr)
Math 1372—IT Calculus II (4 cr)
Phys 1302—Introductory Physics II (4 cr)

Sophomore Year
Fall Semester (16 cr)
AEM 2011—Statics (3 cr)
CE 3202—Surveying (2 cr)
Chem 1022—Introduction to Chemistry II (4 cr)
Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)
Stat 3021—Probability and Statistics (3 cr)

Spring Semester (16 cr)
AEM 3031—Deformable Body Mechanics (3 cr)
CE 3101—Computer Applications in Civil Engineering I (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 (15-18 cr)
CE 4101W—Project Management (3 cr)
CE 4301—Soil Mechanics II (3 cr)
CE technical electives (6-8 cr)
Liberal education elective (3-4 cr)

Spring Semester (15-19 cr)
CE 4102W—Capstone Design (3 cr)
CE technical electives (6-8 cr)
Liberal education electives (6-8 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 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.
Institute of Technology

- 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; 32 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; 7 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. The average of all grades must be 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
- EE 2301—Introduction to Digital System Design
- EE 2361—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 3601—Transmission Lines
- EE 4951W—Senior Design Project
- CSci 4981H/4982V—Seniors Honors Project
- Math 1371 or 1271 or 1571H—Calculus I
- Math 1372 or 1272 or 1572H—Calculus II
- Math 2373 or 2243 or 2573H—Linear Algebra and Differential Equations
- Math 2374 or 2263 or 2574H—Multivariable Calculus
- EE 2301—Introduction to Digital System Design
- EE 2001—Introduction to Electronic and Electrical Circuits
- EE 2002—Introductory Circuits and Electronics Laboratory
- EE 2011—Linear Systems and Circuits
- EE 2301—Introduction to Digital System Design
- EE 2361—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 3601—Transmission Lines

**Final Project**
Students must take 7 credits of approved electives.

All students must take EE 4951W—Senior Design Project (2 cr) or the two-semester honors version 4981H/4982V. Students are organized into teams of approximately five members and design and construct a project under the direction of a faculty member.

**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)**
- CSci 1901—Structure of Computer Programming I (4 cr)
- Math 1372—IT Calculus II (4 cr)
- Phys 1302W—Introductory Physics for Science and Engineering II (4 cr)
- Biology with lab (4 cr)
- EE 1001—Introduction to Electrical Engineering (1 cr) (optional)

**Sophomore Year**

**Fall Semester (16 cr)**
- CSci 1902—Structure of Computer Programming II (4 cr)
- EE 2001—Introduction to Electronic and Electrical Circuits (3 cr)
- EE 2002—Introductory Circuits and Electronics Lab (1 cr)
- EE 2301—Introduction to Digital System Design (4 cr)
- Math 2373—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 (16 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 3601—Transmission Lines (3 cr)
Liberal education elective (4 cr)

Senior Year
Fall Semester (16 cr)
CSci 4061—Introduction to Operating Systems (4 cr)
Senior technical electives (12 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
B.S.Comp.Sc.

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 2.70).

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 courses, 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 4011—Formal Languages and Automata Theory
CSci 4041—Algorithms and Data Structures
CSci 4061—Introduction to Operating Systems
CSci 4081—Introduction to Software Engineering
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

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.

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)

Spring Semester (16 cr)
CSci 1901—Structure of Computer Programming I (4 cr)
Math 1372—IT Calculus 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 (14-19 cr)
CSci 4041—Algorithms and Data Structures (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 (14-16 cr)
CSci 4011—Formal Languages and Automata Theory (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)

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**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.
- 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 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 2361 and 361—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 2233 or 2373 or 2573H—Linear Algebra and Differential Equations  
Math 2263 or 2374 or 2574H—Multivariable Calculus and Vector Analysis  
Chem 1022—Chemical Principles II (4 cr)  
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 3102—Circuits and Electronics Lab 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 Lab 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:

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:

A. To produce graduates with a strong fundamental scientific and technical knowledge base and critical thinking skills required for engineering problem formulation and problem solving.

B. 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.

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

D. 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 three 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**

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

**Geoenvironmental Option**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>CE 3101</td>
<td>Computer Applications</td>
</tr>
<tr>
<td>CE 3501</td>
<td>Environmental Engineering</td>
</tr>
<tr>
<td>CE 3502</td>
<td>Fluid Mechanics</td>
</tr>
<tr>
<td>CE 4501</td>
<td>Hydrologic Design</td>
</tr>
<tr>
<td>CE 4531</td>
<td>Environmental Process Engineering</td>
</tr>
<tr>
<td>CE 4561</td>
<td>Solid and Hazardous Waste</td>
</tr>
<tr>
<td>GeoE 3301</td>
<td>Soil Mechanics I</td>
</tr>
<tr>
<td>GeoE 4102</td>
<td>Capstone Design</td>
</tr>
<tr>
<td>GeoE 4341</td>
<td>Engineering Geostatistics</td>
</tr>
<tr>
<td>GeoE 4351</td>
<td>Groundwater Mechanics</td>
</tr>
<tr>
<td>GeoE 4352</td>
<td>Groundwater Modeling</td>
</tr>
<tr>
<td>GeoE technical electives (6 cr)</td>
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</tbody>
</table>

**Geomechanics Option**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>CE 3101</td>
<td>Computer Applications I</td>
</tr>
<tr>
<td>CE 3502</td>
<td>Fluid Mechanics</td>
</tr>
<tr>
<td>CE 4212</td>
<td>Computer Applications II</td>
</tr>
<tr>
<td>CE 4351</td>
<td>Groundwater Mechanics</td>
</tr>
<tr>
<td>GeoE 3301</td>
<td>Soil Mechanics I</td>
</tr>
<tr>
<td>GeoE 3311</td>
<td>Rock Mechanics I</td>
</tr>
<tr>
<td>GeoE 4102</td>
<td>Capstone Design</td>
</tr>
<tr>
<td>GeoE 4301</td>
<td>Soil Mechanics II</td>
</tr>
<tr>
<td>GeoE 4311</td>
<td>Rock Mechanics II</td>
</tr>
<tr>
<td>GeoE 4341</td>
<td>Engineering Geostatistics</td>
</tr>
<tr>
<td>GeoE technical electives (7 cr)</td>
<td></td>
</tr>
</tbody>
</table>

**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 (17 cr)**

- Chem 1021—Chemical Principles I (4 cr)
- AEM 2011—Statics (3 cr)
- Geol 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)

**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)

- Geo 3301—Soil Mechanics I (4 cr)
- Geo 4102—Capstone Design (4 cr)
- Geo 4341—Engineering Geostatistics (3 cr)
- Liberal education elective (3 cr)

**Liberal education elective (3 cr)**

**Geomechanics Option**

**Fall Semester (16 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)
- Stat 3021—Probability and Statistics (3 cr)
- Liberal education elective (3 cr)

**Spring Semester (17 cr)**

- AEM 3311—Rock Mechanics I (4 cr)
- Geo 4102—Capstone Design (4 cr)
- Geo 4301—Soil Mechanics II (4 cr)
- Geo 4311—Rock Mechanics II (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)

**Liberal education elective (3 cr)**
### Degree Programs

#### 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 1012—Chemical Principles I (4 cr)
  - Math 2374—IT Multivariable Calculus and Vector Analysis (4 cr)
  - Stat 2021—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 2022—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—Petroleum (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 4311—Rock Mechanics II (3 cr)
  - Technical elective (GeoE) (4 cr)

- **Spring Semester (13 cr)**
  - Geo 4501—Structural Geology (3 cr)
  - Geo 4102—Senior Design (3 cr)
  - Geo 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: The Solid Earth
- Geo 2301—Mineralogy
- Geo 2302—Petroleum
- Geo 2303—Geochemical Principles
- Geo 3202—Geodynamics II: The Fluid Earth
- Geo 3301—Soil Mechanics I (3 cr)
- Geo 3311—Rock Mechanics I (3 cr)
- Geo 3911—Field Geology (3 cr)
- Geo 4203—Principles of Geophysical Exploration (3 cr)
- Geo 4703—Glacial Geology (3 cr)
- GeoE 4102—Senior Design (3 cr)
- GeoE 4301—Soil Mechanics II (3 cr)
- GeoE 4311—Rock Mechanics II (3 cr)
- GeoE technical elective (4 cr)
Institute of Technology

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

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

Required Courses From Other Programs
Math 1271, 1272 or Math 1371, 1372 or Math 1571H, 1572H—Calculus I and II
Math 2243 or 2373 or 2573H—Linear Algebra and Differential Equations
Phys 1301, 1302—Introductory Physics I and II
Chem 1021, 1022—Chemical Principles I and II

Electives
12 credits total of appropriate elective courses in physical and natural sciences, engineering, and mathematics, chosen in consultation with a faculty adviser

Geology or Environmental Science 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.

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)
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 (12 cr)
Geo 2302—Petroleum (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 3201—Geodynamics II: The Fluid Earth (3 cr)
Geo 3401—Geochronology and Earth History (3 cr)
Liberal education elective (3 cr)
Technical elective (3 cr)

Spring Semester (13 cr)
Geo 3890—Field Workshop (1 cr)
Geo 4501—Structural Geology (3 cr)
Geo 4602—Sedimentology and Stratigraphy (3 cr)
Liberal education elective (3 cr)

Senior Year
Fall Semester (15 cr)
Geo 4631—Earth Systems: Geosphere/Biosphere Interactions (3 cr)
Geology elective (3 cr)
Geology elective (3 cr)
Technical elective (3 cr)
Free elective (3 cr)

Spring Semester (14 cr)
Geo 3890—Field Workshop (1 cr)
Geology elective (3 cr)
Geology elective (3 cr)
Technical elective (3 cr)
Free elective (4 cr)

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, and this is reflected in the similarities between the two degree programs. Both programs 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.

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—Petroleum
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
Degree Programs

Institute of Technology

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 elective 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 or 2573H—Linear Algebra and Differential Equations
Math 2263 or 2374 or 2574H—Multivariable Calculus
Phys 1301, 1302, 2303—Introductory Physics I, II, and III

Electives
Nine credits total of 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)
Eng C 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—Petroleum (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)

Summer Session (4 cr)
Geo 3911—Introduction to Field Geology (4 cr)

Junior Year
Fall Semester (15 cr)
Geo 3202—Geodynamics II: The Fluid Earth (3 cr)
Geo 3401—Geoarcheology and Earth History (3 cr)
Geophysics elective (3 cr)
Liberal education elective (3 cr)
Technical elective (3 cr)

Spring Semester (14 cr)
Geo 3890—Field Workshop (1 cr)
Geo 4501—Structural Geology (3 cr)
Geophysics elective (3 cr)
Biology with lab (4 cr)
Liberal education elective (3 cr)

Summer Session (4 cr)
Geo 4921—Field Geophysics (4 cr)

Senior Year
Fall Semester (14 cr)
Geophysics elective (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 elective (3 cr)
Geo elective (3 cr)
Free elective (3 cr)
Liberal education elective (3 cr)

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, 4-198 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 1 (4 cr)
CSci 2121—Introduction to the Internet 2 (4 cr)

Breadth Courses
Three of the following courses:
Comm 3211—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)

Jour 3004—Information for Mass Communication (3 cr)
Jour 3614—History of Mass Communication Technology (3 cr)
Jour 3776—Mass Communication Law (3 cr)
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 2.80 or better and be admitted to an upper division IT major with at least 60 credits completed.

Prerequisites
Econ 1104 and 1105
or Econ 1101
and 1102

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)
Stat 3021—Introduction to Probability and Statistics (or equiv) (3 cr)
4 credits of upper division CSOM electives

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, semiconductors, 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 1272 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 3011—Introduction to Materials Science and Engineering (3 cr)
MatS 3012—Metals and Alloys (3 cr)
Mats 3801—Structural Characterization Lab (2 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)
Phys 1301—Introductory Physics I (4 cr)
Phys 1302—Introductory Physics II (4 cr)
Phys 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)
Math 1371—IT Calculus I (4 cr)
Phys 1301—Introductory Physics I (4 cr)
EngC 1011—University Writing and Critical Reading (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)
Phys 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)
Phys 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 3011—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)

Mathematics

School of Mathematics
B.S.Math.
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, 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 physics and computer science 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 computer science 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 and two technical elective courses (which can be mathematics courses)

To satisfy the algebra requirement, students must take two courses from the following:
Math 5705—Enumerative Combinatorics A
or Math 5707 Graph Theory and Non-Enumerative Combinatorics B
(but not both)
Math 4242—Applied Linear Algebra
Math 5248—Cryptology and Number Theory
Math 5251—Error-Correcting Codes, Finite Fields, Algebraic Curves
Math 5285—Honors: Fundamental Structures of Algebra I
Math 5286—Honors: Fundamental Structures of Algebra II
Math 5385—Introduction to Computational Algebraic Geometry
Math 5711—Linear Programming and Combinatorial Optimization

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
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 requirements, though it may be used as technical elective
Math 3113, 3118, 4113, and 4116—Topics in Elementary Mathematics, may not be used as upper division math courses or as technical electives.

**Required Courses From Other Programs**

Phys 1271, or equivalent;
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.

**Mathematics Minor**
A minor in mathematics is available through the College of Liberal Arts. Students must complete all lower division requirements for the major plus two adviser-approved upper division math courses, which are approved for the major (including Stat 5101-5102).

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**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)**
CSci 1107—Introduction to FORTRAN Programming for Scientists and Engineers (3 cr)
or CSci 1113—Introduction to C/C++ Programming for Scientists and Engineers (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)**
Math 2373—IT Linear Algebra and Differential Equations (4 cr)
Phys 2503—Introduction to Physics for Science and Engineering III (4 cr)
Liberal education elective (3 cr)
Biology with lab (4 cr)

**Spring Semester (16 cr)**
Math 2374—IT Multivariable Calculus and Vector Analysis (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)

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**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. The 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 emerging technologies through life-long learning.

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/uug>. 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-gradin@me.umn.edu). Program educational objectives and program outcomes can be seen at <www.me.umn.edu/info/uug/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.

Required Courses

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

Upper Division
ME 3031—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)
IE 4521—Statistics, Quality, and Reliability (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 2243 or 2273 or 2573H—Linear Algebra and Differential Calculus I, II (4 cr each)
Math 2263 2274 or 2574H—Multivariable Calculus (4 cr)
Physics 1301, 1302—Introductory Physics I, II (4 cr each)
MatS 2001 (4 cr)—Introduction to the Science of Engineering Materials (the lab associated with this class is required)
Liberal education electives (15 cr)

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 2243—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)
Chem 1021, 1022—Introductory Chemistry I, II (4 cr)

Junior Year
Fall Semester (16 cr)
EE 3005—Fundamentals of Electrical Engineering Lecture (4 cr)
EE 3006—Fundamentals of Electrical Engineering Lab (1 cr)
ME 3221—Design and Manufacturing I (4 cr)
ME 3321—Thermodynamics (4 cr)
Liberal education elective** (3 cr)

Spring Semester (16 cr)
ME 3031—Basic Mechanical Measurements Lab (4 cr)
ME 3222—Design and Manufacturing II (4 cr)
ME 3322—Heat Transfer and Fluid Flow (4 cr)
Technical elective (4 cr)

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

Fall Semester (16 cr)
IE 4521—Statistics, Quality, and Reliability (4 cr)
ME 3281—System Dynamics and Controls (4 cr)
ME 4054—Senior Design (4 cr)
Technical elective (4 cr)

Spring Semester (15 cr)
ME 4x3x—Senior Lab (4 cr)
Technical elective (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, 2303 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

Emphasis Requirements (choose one)

Physics Emphasis (30-33 cr)
The remaining two courses not already chosen from the list of Phys 4001, 4002, 4101, 4201 (7-8 cr)
Upper division or graduate physics elective (3-4 cr)
Upper division or graduate math elective (3-4 cr)
Technical electives (17 cr)

Engineering Emphasis (35-38 cr)
Chem 1021—Chemical Principles I (4 cr)
Two courses (or indicated substitutes) not already chosen from core program courses (7 cr):
Phys 4001 or AEM 2021 or AEM 2101-2102
Phys 4002 or EE 3601
Phys 4101, Chem 3502 or 4502
Phys 4201 or ME 3321 or ME 3324 or Chem 3501 or 4501
Technical electives (24 cr; 3xxx or higher; adviser approval required)

Biology Emphasis (34-36 cr)
BioC 3021—Biochemistry (3 cr)
Biol 1009—General Biology (counted in the liberal education requirement)
Chem 1021—Chemical Principles I (4 cr)
Chem 1022—Chemical Principles II (4 cr)
Chem 2301—Organic Chemistry I (3 cr)

Two courses (or indicated substitutes) not already chosen from core program courses (6-8 cr):
Phys 4001
Phys 4002
Phys 4101 or Chem 3502 or 4502
Phys 4201 or Chem 3501 or 4501
Technical electives in biology or related areas (14 cr; 3xxx or higher; adviser approval required)

Teaching Emphasis (30-34 cr)
Chem 1021—Chemical Principles I (4 cr)
Chem 1022—Chemical Principles II (4 cr)
One course from each of the following four groups (adviser approval required; the following are suggested courses):

History and Philosophy of Science
Phys 4111—History of Nineteenth-Century Physics (3 cr)
Phys 4121—History of Twentieth-Century Physics (3 cr)

Relativity, Astrophysics, and Cosmology
Ast 2001—Introduction to Astrophysics (4 cr)
Phy 4811—Introduction to Relativity and Cosmology (3 cr)

Earth Sciences
Geo 2201—Geodynamics I: The Solid Earth (4 cr)
Geo 3201—Geodynamics II: The Fluid Earth (4 cr)
Geo 2303—Geochemical Principles (3 cr)
Geo 3401—Geochronology and Earth History (3 cr)

Technology
AEM 4201—Fluid Mechanics
EE 5621—Physical Optics (4 cr, together with EE 5622—Physical Optics Lab)
Phys 4711—Introduction to Optics (3 cr)
Phys 5701—Solid State Physics (4 cr)

Technical electives in physics and related areas (10 cr; 3xxx or higher; adviser approval required)
Two courses in engineering, one of which has a substantial design component
Students must demonstrate knowledge of computer programming in at least one language through coursework or completion of project.

Students are strongly advised to participate in a program of voluntary secondary school teaching. Such experience is required for students wishing to enter the University’s College of Education and Human Development Secondary School Graduate Program leading to certification to teach. (For information, contact Student and Professional Services, 110 Wulling Hall.) Early admission into the program is possible in the junior year.
Physics Minor
A minor is available through the College of Liberal Arts (CLA); see the physics program in the CLA Degree Programs and Minors section.

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)
Phys 1905—Freshman Seminar: Physics Connections (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)
Phys 2503 or 2403V—Introductory Physics 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—Multivariable Calculus (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

School of Statistics

B.S.Stat.

Mission—To provide a logical framework for the collection, analysis, and interpretation of data. This data can be used to draw inferences in scientific studies and to make decisions and predictions in industrial, business, and governmental enterprises.

The School of Statistics offers a four-year curriculum leading to a bachelor of science degree. Statistics deals with methods and theories of data collection, tabulation, analysis, and interpretation, and with the use of data for inference and decision making in industrial, scientific, and government enterprises.

Degree Requirements
Students must complete at least 120 credits to graduate, including at least 38 credits in the major. Required are two years of math, a year of statistical theory, five courses in statistical methods, three courses with lab in the sciences, and three electives courses in statistics or related fields.

Required Courses
Stat 301I—Introduction to Statistical Analysis or Stat 302I—Introduction to Probability and Statistics
Stat 302I—Data Analysis
At least 10 credits of adviser-approved statistics electives chosen from
Stat 503I, 520I, 530I, 5302, 540I, 542I, 560I
Math 127I, 1272 or Math 137I, 1372 or Math 157I, 1572—Calculus I-II
Math 2263 or 2374 or 2574H—Multivariable Calculus
Math 2243—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 in statistics or related fields such as computer science, biostatistics, industrial engineering/operations research, mathematics

Statistics Minor

At least 14 credits from 3xxx-5xxx School of Statistics courses, including at least two 5xxx courses.