College of Engineering

Jerry E. Stonaker, Dean
Fred T. Gilliam, Associate Dean, Academic Affairs
Fred D. Tampkins, Associate Dean, Administration
Walter N. Odum, Director, Cooperative Engineering Program
James T. Pipkin, Director, Minority Engineering Programs

Engineers solve problems. To do so, they apply science, mathematics, and creativity to invent, design, test, build, and operate engineering systems that will meet the needs of society. In the latter half of the 20th century, engineers developed the personal computer, the space shuttle, artificial hearts and many other "high-tech" products. The opportunities to use technology for the benefit of 21st century society will be even greater.

Engineers use the same problem solving strategies whether designing a bridge, trouble shooting a computer chip problem or developing a more efficient automobile engine. This commonality of approach makes it easy for an engineer to move from one specialization to another, and it happens frequently. The engineer's can-do, problem solving outlook is also good preparation for management, and many engineers follow this career path.

"High-tech" products. The opportunities to use technology for the benefit of 21st century society will be even greater.

Increasingly, engineers must also have good interpersonal skills to work effectively in the interdisciplinary groups required to tackle modern engineering projects. They must understand the ethical, environmental, political and business implications of their work. Engineers must work comfortably among the cultures, customs and languages of multi-national enterprises.

In light of modern society's ever-increasing dependence on technology, there is a continuing and urgent need for engineering graduates who possess the high levels of technical competence and social understanding that will enable them to fulfill their responsibilities as professional engineers. The College of Engineering prepares men and women to face these challenges and to seize the opportunities to become the technologists of the 21st century.

Graduates of the B.S. curricula offered by the college may enter directly into a position in industry, government, or private practice, or may pursue advanced study in graduate school. Their professional activities include research, development, design, operations analysis, construction, production supervision, and technical sales. Many practice their profession in Tennessee, but engineering knows no geographical bounds, and graduates of the college serve throughout the nation and in other countries as well.

The College of Engineering prepares engineers to become the technologists of the 21st century. The college, in cooperation with industrial sponsors, established the Minority Engineering Scholarship Program in 1973. The program goal is to increase significantly the number of qualified minority engineering graduates.

The College of Engineering offers an opportunity to apply engineering coursework in a real-world setting, and enables the student to define more clearly educational and career interests and objectives. All positions are paid positions, and most students are able to offset a substantial amount of their college expenses with Co-op savings. Candidates must be able to project a minimum of 52 weeks of Co-op work term experience toward the senior year, within the regular alternating sequence, to qualify for an assignment. Further details may be obtained from the Cooperative Engineering Program Office via e-mail at coop@engr.utk.edu or via the program homepage at http://www.engr.utk.edu/COOP/
Graduate programs leading to the degree of Master of Science are offered in all areas of study, and the degree of Doctor of Philosophy is offered in nine major subject areas: aerospace engineering, chemical engineering, civil engineering, computer engineering, electrical engineering, engineering management, materials science, nuclear engineering, and polymer engineering. Information concerning graduate programs is given in the Graduate Catalog.

TAU BETA Pi NATIONAL HEADQUARTERS

The college is honored to have the national headquarters of Tau Beta Pi, the National Honor Society, located on our campus. This honor was earned in part through the outstanding efforts of R.G. "Red" Matthews, who served as secretary-treasurer for the organization from 1930 to 1947. The suite of offices, located in Dougherty Hall, is occupied by Mr. J.D. Froula, secretary-treasurer, Roger Hawes, Assistant Secretary-Treasurer, and his staff.

CURRICULA IN ENGINEERING

NATIONAL ACCREDITATION

Since 1936, engineering programs at institutions of higher learning have been accredited by an organization formed by many engineering societies and known as the Accreditation Board for Engineering and Technology (ABET). ABET accreditation ensures that graduates of UTK engineering programs are adequately prepared by individual degree programs to follow. Additional program outcomes specified by ABET accreditation criteria also require an assessment process to ensure that program outcomes critical to successful engineering practice are being achieved. Assessment of proven programs boundaries concern to all engineering disciplines are required by ABET. Specifically, each engineering program must demonstrate that its graduates have: 1. an ability to apply knowledge of mathematics, science, and engineering; 2. an ability to design and conduct experiments as well as to analyze and interpret data; 3. an ability to design a system, component, or process to meet desired needs; 4. an ability to function on multidisciplinary teams; 5. an ability to identify, formulate, and solve engineering problems; 6. an understanding of professional and ethical responsibility; 7. an ability to communicate effectively; 8. the broad education necessary to understand the impact of engineering solutions in a global/social context; 9. a recognition of the need for and an ability to engage in life-long learning; 10. a knowledge of contemporary issues; 11. an ability to use the techniques, skills, and modern engineering tools necessary to practice engineering. The College of Engineering has embraced these program outcomes as valid and valuable objectives of educational and professional effectiveness. Thus, the College proposes students to demonstrate sufficiency and a subject for excellence in these areas. This goal is achieved by ensuring that instruction and other learning experiences are provided that will produce each program outcome. Engineering courses, mathematics, and natural science courses, and the humanities and social sciences provide essential contributions to the achievement of these goals. Program outcomes that are critically dependent on humanistic and social science courses are included in the General Education Requirements section to follow. Additional program outcomes specified by ABET accreditation criteria are also discussed in subsequent sections.

DESIGNATION OF A MINOR

An engineering undergraduate may declare a minor in a non-engineering related area and have the minor listed on the permanent record under the following conditions: 1. Minors must be officially approved and described in the UT Knoxville catalog. No unofficial minors will be recorded. Minors exist in Aerospace Engineering, Environmental Engineering, Materials Science and Engineering, Architecture and Business Administration, and in numerous departments in Agriculture and Arts and Sciences. 2. Course work for a minor may also be used to satisfy engineering degree requirements, provided that the courses would be a part of engineering degree requirements even if no minor was declared. Completion of a minor often involves the taking of some courses which cannot be used to satisfy the minimum requirement for an engineering degree. 3. A student must notify his or her advisor and major department office when beginning work on a minor. The intention to complete a minor must be declared at the time of application for a degree if the minor is to appear on the final transcript. Degree applications are handled by the UT Knoxville Records Office.

COU course load

The maximum number of hours which can be taken by an undergraduate engineering student without special permission is 19. The Associate Dean for Academic Affairs must give permission to take 20 hours or more. In general, this decision is based on the student's previous performance at UT Knoxville.

LATE DROP REQUESTS

Late drop requests, which may be approved for reasons other than academic difficulties, are handled by the Office of Records. For other procedures refer to "Changes in Registration" in the general section of this catalog.

GENERAL REQUIREMENTS

Students are advised to consult the University Catalog for a detailed listing of policies and procedures. All students, including internal UTK transfers, must meet the minimum requirements stated below in order to be considered for admission into the College. The College has maintained a 2.0 cumulative average over these specific courses, or their equivalent. English 101, 102, Chemistry 120, 130, and Math 141, 142. 1. Must be taken at the accredited for quality and seriousness of purpose. An excess may be approved for reasons other than academic difficulties, or repeated courses, or failure may result in dismissal. Any UT Knoxville student desiring association with one of the departments of the College of Engineering should go to the department office for the desired major. An interview with the department head or his designee is held, with the major items of consideration being the same as for external transfer students. An interview with the Associate Dean or Major Advisor Change form is processed by the department to officially change the student's academic home.
Outcomes are shown below. The first two outcomes and a cluster of courses relevant to that era are led to educational components in engineering curricula to the practice of engineering. Developing skills and providing experiences critical and support engineering courses in an engineering domain more than ensure adequate breadth in these courses. Thus, in the College of Engineering, humanities and social science courses are critically dependent on contributions from graduate. In fact, certain program outcomes are not part of the minimum degree requirements, and to fully utilize the SNC grading option for such coursework.

**General Education Electives**

Engineering programs are significant to the educational objectives of each engineering program, and the program outcomes desired of every engineering graduate. In fact, certain program outcomes are critically dependent on contributions from these courses. Thus, in the College of Engineering, humanities and social science courses do more than ensure adequacy breadth in the educational experience. They also complement the support engineering courses in developing skills and providing experiences critical to the practice of engineering. Program outcomes supported by the general education courses in the humanities and social science cluster and a cluster of courses relevant to that outcome are shown below. The first two outcomes, (1) the broad education necessary to understand the impact of engineering solutions in a global/social context and (2) a knowledge of the human-in-the-loop concept and understanding of the personal, social, ethical, international, and cultural implications of engineering solutions require the student to matriculate, but only after receiving the evaluation of transfer credits by the Admissions Office.

Program for Second B.S. Degree. Upon approval by the Dean of Engineering and the Committee on Degrees of a program of study recommended by the major engineering department, a student who already holds a bachelor's degree may obtain a degree in engineering upon meeting all of the course requirements of the selected engineering program. In no case will the minimum requirements exceed 30 semester credits. The providing University regulations shall apply.

SATISFACtORY/No Credit Courses. Engineering majors may take half of the minimum hours required (9) of humanities/social science electives in a Satisfactory/No Credit (S/NC) grading basis. No other courses specified as part of the minimum degree requirements may utilize S/NC grading, unless utilized on only that grading basis. Students are encouraged to take courses of interest which are not part of the minimum degree requirements, and to fully utilize the SNC grading option for such coursework.

**Correspondence Courses.** A student should check with his or her major department to see what restrictions there are, if any, on the use of correspondence courses to meet the minimum degree requirements.

**General Education Electives.** Elective programs are significant to the educational objectives of each engineering program, and the program outcomes desired of every engineering graduate. In fact, certain program outcomes are critically dependent on contributions from these courses. Thus, in the College of Engineering, humanities and social science courses do more than ensure adequacy breadth in the educational experience. They also complement the support engineering courses in developing skills and providing experiences critical to the practice of engineering. Program outcomes supported by the general education courses in the humanities and social science cluster and a cluster of courses relevant to that outcome are shown below. The first two outcomes, (1) the broad education necessary to understand the impact of engineering solutions in a global/social context and (2) a knowledge of the human-in-the-loop concept and understanding of the personal, social, ethical, international, and cultural implications of engineering solutions require the student to matriculate, but only after receiving the evaluation of transfer credits by the Admissions Office.

Program for Second B.S. Degree. Upon approval by the Dean of Engineering and the Committee on Degrees of a program of study recommended by the major engineering department, a student who already holds a bachelor's degree may obtain a degree in engineering upon meeting all of the course requirements of the selected engineering program. In no case will the minimum requirements exceed 30 semester credits. The providing University regulations shall apply.

SATISFACtORY/No Credit Courses. Engineering majors may take half of the minimum hours required (9) of humanities/social science electives in a Satisfactory/No Credit (S/NC) grading basis. No other courses specified as part of the minimum degree requirements may utilize S/NC grading, unless utilized on only that grading basis. Students are encouraged to take courses of interest which are not part of the minimum degree requirements, and to fully utilize the SNC grading option for such coursework.

**Correspondence Courses.** A student should check with his or her major department to see what restrictions there are, if any, on the use of correspondence courses to meet the minimum degree requirements.

**General Education Electives.** Elective programs are significant to the educational objectives of each engineering program, and the program outcomes desired of every engineering graduate. In fact, certain program outcomes are critically dependent on contributions from these courses. Thus, in the College of Engineering, humanities and social science courses do more than ensure adequacy breadth in the educational experience. They also complement the support engineering courses in developing skills and providing experiences critical to the practice of engineering. Program outcomes supported by the general education courses in the humanities and social science cluster and a cluster of courses relevant to that outcome are shown below. The first two outcomes, (1) the broad education necessary to understand the impact of engineering solutions in a global/social context and (2) a knowledge of the human-in-the-loop concept and understanding of the personal, social, ethical, international, and cultural implications of engineering solutions require the student to matriculate, but only after receiving the evaluation of transfer credits by the Admissions Office.

Program for Second B.S. Degree. Upon approval by the Dean of Engineering and the Committee on Degrees of a program of study recommended by the major engineering department, a student who already holds a bachelor's degree may obtain a degree in engineering upon meeting all of the course requirements of the selected engineering program. In no case will the minimum requirements exceed 30 semester credits. The providing University regulations shall apply.

SATISFACtORY/No Credit Courses. Engineering majors may take half of the minimum hours required (9) of humanities/social science electives in a Satisfactory/No Credit (S/NC) grading basis. No other courses specified as part of the minimum degree requirements may utilize S/NC grading, unless utilized on only that grading basis. Students are encouraged to take courses of interest which are not part of the minimum degree requirements, and to fully utilize the SNC grading option for such coursework.

**Correspondence Courses.** A student should check with his or her major department to see what restrictions there are, if any, on the use of correspondence courses to meet the minimum degree requirements.
BACHELOR OF SCIENCE PROGRAM

Chemical engineering deals with the development, design, operation, and management of plants and processes for economical, safe conversion of chemical raw materials to useful products. It is a broadly based discipline with heavy emphasis on chemistry and mathematics, with supporting study in areas such as physics, materials, and humanities.

Chemical engineering graduates of The University of Tennessee, Knoxville (UTK) possess the knowledge base, intellectual skills, and professional commitment that prepare them for innovative technical leadership, graduate study, productive service to society, and continued professional growth through lifelong learning. Preparation is based on the learning objectives identified below, regular evaluation of the achievement of these objectives, and use of evaluation results to improve the educational process.

Technical Knowledge (I): Graduates of the UTK chemical engineering program demonstrate the ability to apply knowledge of mathematics, chemistry, science, and engineering to identify and solve problems dealing with material and energy balances applied to chemical processes; thermodynamics of physical and chemical equilibria; heat, mass, and momentum transfer; continuous and staged separations; chemical kinetics and reactions; and process dynamics and control.

Analytical Skills: Graduates of the UTK chemical engineering program demonstrate the ability to apply the following analytical skills in the solution of engineering problems: differential and integral calculus, ordinary differential equations, linear algebra, statistics methods, and numerical methods.

Problem Formulation and Solution Skills: Graduates of the UTK chemical engineering program demonstrate the ability to function as effective team members and leaders. This includes the ability to work effectively with other team members; employ appropriate team facilitation procedures as needed; organize and lead a team effort; and contribute individual expertise in achieving team goals.

Lifelong Learning Skills: Graduates of the UTK chemical engineering program recognize the need for and are able to engage in lifelong learning. Students will have the ability to obtain needed information from libraries and electronic data bases; the ability to use the Internet as an effective communication and research tool; the ability to use distance learning media to independently complete required assignments; and flexibly with lifelong learning resources available through professional societies.

Professional Commitment: Graduates of the UTK chemical engineering program demonstrate acceptable levels of dedication and professional ethical responsibility. Students are required to take a course preparing them for the Fundamentals of Engineering Examination, reciting a grade based on their performance on a "mock Fundamentals of Engineering Examination," and are strongly encouraged to pursue professional registration as Professional Engineers.

Safety, Health, and Environmental Protection: Graduates of the UTK chemical engineering program demonstrate the ability to plan and operate chemical process safety, including occupational safety and health and minimization of adverse environmental impact.

Understanding of the Global and Social Impact of Engineering: Graduates of the UTK chemical engineering program demonstrate an appreciation for the global and societal impact of engineering decisions.

Technical Knowledge (II): Graduates of the UTK chemical engineering program demonstrate an understanding of safety, environment, operability, and analysis and interpretation of technical material presented in lectures and seminars.

Teamwork Skills: Graduates of the UTK chemical engineering program demonstrate the ability to function as effective team members and leaders. This includes the ability to work effectively with other team members; employ appropriate team facilitation procedures as needed; organize and lead a team effort; and contribute individual expertise in achieving team goals.

Communication Skills: Graduates of the UTK chemical engineering program demonstrate the ability to communicate effectively in writing, speaking, and listening in a variety of contexts. Specific skills include the ability to write effective reports, experimental procedures, memos, and similar documents; make effective oral presentations and critique presentations by others; prepare appropriate visual representations effectively in both written and oral presentations; and critically evaluate technical material presented in lectures and seminars.

HONORS PROGRAM

The honors program encourages highly motivated students to develop a minor specialization preparation in chemical engineering. Admission is selective. Application to the honors program is made when the student applies for upper division status. Honors requirements are: credit for 3 of the 4 honors seminars, CHE 307, 308, 407 and 408, CHE 447, one of CHE 467, 477, 478 or 488 as a technical elective and CHE 483 as a chemistry option. Students interested in this honors program should consult the department's honors coordinator.

PROGRESSION TO UPPER DIVISION

Progress of chemical engineering students to departmental upper division courses is competitive and is based on a variety of factors. Factors considered include overall grade point average, performance in selected lower division courses and evidence of satisfactory and orderly progress through the prescribed curriculum.

Upper-Division Status: A lower-division student may apply for progression to Upper-Division Status after completing CHE 200, 230 and 240 with a grade of C or better in each course and an overall GPA of 2.5 or better.

Provisional Status: Students who have completed CHE 200, 230, and 240 with an overall GPA of at least 2.1 may apply for provisional status. The granting of Provisional Upper-Division Status is based on the availability of space in the departmental programs after Upper-Division Status students have been accommodated. Provisional students are required to demonstrate the ability to perform satisfactorily in at least a minimum of seven departmental courses with a grade of C or better in each course (including the final three courses completed) and to continue with upper-division studies depends on their ability to do so.

Any student with an overall GPA below 2.1 will be advised to upper division Chemical Engineering courses. Students who have not been admitted to Upper-Division or Provisional Status will be dropped from upper-division departmental class rolls.

Transfer students at the upper-level division are admitted on a Provisionals Status basis only.

GRADUATE STUDY PROGRAM

The chemical engineering program is designed to prepare students for professional and research careers in chemical engineering. In addition, students may pursue a Master of Science and Doctor of Philosophy degree at the University of Tennessee.

The Graduate Catalog contains detailed information.

CIVIL AND ENVIRONMENTAL ENGINEERING

Professors: G.D. Reed (Condra Professor and Head), Ph.D., P.E., M.B.C.A.; R.M. Bennett, Ph.D., P.E., Illinois; E.D. Gunderson (Fred N. Peabody Professor), Ph.D., P.E., Illinois; A. Chatfjelda, Ph.D., M.B.T., Virginia Tech; W.T. Davis, Ph.D., M.B.T., Tennessee; J.H. DeShenger, Ph.D., Ph.D.; P.E., Arkansas; R.M. Bennet, Ph.D., P.E., Illinois; E.D. Gunderson (Fred N. Peabody Professor), Ph.D., P.E., Illinois; A. Chatfjelda, Ph.D., M.B.T., Virginia Tech; W.T. Davis, Ph.D., M.B.T., Tennessee; J.H. DeShenger, Ph.D.,
The curriculum in Civil Engineering provides training in fundamental engineering sciences and in basic techniques that are essential. Technical electives are available in construction, environmental engineering, geotechnical, material, structural, transportation, or water resources. Students are required to maintain a cumulative grade point of at least 2.00 in all Civil Engineering and Environmental Engineering courses taken at the University of Tennessee, Knoxville, and to satisfy the graduation requirements. No more than six hours of Civil and Environmental Engineering courses in which a D is the highest grade earned may be counted toward graduation.

ELECTIVES
Electives are chosen to meet student career objectives and program accreditation requirements. Students must consult with their advisor and have their selections pre-approved. A student must have a GPA of 2.75 or higher or approval of the instructor to take 500-level courses for undergraduate credit.

ENVIRONMENTAL ENGINEERING MINOR
The College of Engineering offers a minor in Environmental Engineering to those undergraduate students whose academic history provides the prerequisites for the courses required by the minor. The minor requires the completion of a minimum of 21 credits in coursework which builds on the foundational knowledge of students interested in environmental engineering. Some of the courses used in the minor may also satisfy a requirement for a major. Students are advised to take the first professional degree in Environmental Engineering at The University of Tennessee, Knoxville as the M.S. in Environmental Engineering which builds on the minor.

COURSE REQUIREMENTS
Choose One:
- CHEM 200 Inorganic Chemistry
- CHEM 510 Analytical Chemistry
- CHEM 350 Organic Chemistry

Required:
- MGR 210 General Microbiology
- CHE 200 Chemical Engineering Fundamentals
- CHE 202 Chemical Engineering Fundamentals
- CHE 380 Water and Wastewater Treatment
- CE 395 Hydrology or EIE 315 Soil & Water Conservation

Choose One:
- GEDL 460 or GEDL 485 Environmental Ethics
- GEDL 485 or CE 465 Hydrology
- GIS 415 Soil Hydrology
- GEOG 546 Air & Waste Management

ADVISING
Students are asked to fill in their interest to enroll the minor with the complete office of the Department of Civil and Environmental Engineering, 223 Perkins Hall. The student's home department advisor will then be supplied with the information about the Minor requirements to assist with prerequisite sequencing. A copy will be made with undergraduate records so the Minor, once completed, will be shown on the student's transcript.
The laboratories are devoted specifically to support the undergraduate teaching program. The faculty seeks to keep and develop professionals with a strong interest in enhancing the cultural growth of the students. Electrical Engineering. The program also has basicsciences and the specialized areas of ElectricalEngineering. The Electrical Engineering program is to: prepare its students for entry into the profession of Electrical Engineering; and(b) instill in its students the capabilities required by the discipline, the recognition of the need to enhance the first of Electrical Engineering, and the desire for the long learning; and (c) equip its students with a general knowledge of technical and non-technical disciplines as they are prepared for further study in other fields including professional and graduate education.

**PROGRAM EDUCATIONAL OBJECTIVES**

The educational objectives of the Electrical Engineering program include: (1) an understanding of the phenomena necessary to analyze and design complex devices and systems containing hardware and software components; (2) an understanding of mathematics through differential and integral calculus and differential equations; (3) an understanding of probability and statistics, including applications; (4) an understanding of linear algebra, numerical analysis, and advanced calculus; (5) an understanding of the basic sciences including chemistry and physics; (6) a progression of design projects and tasks throughout the program; (7) an early student progression through the program; and (8) achievement of all six program Outcomes common to all engineering disciplines and the two additional department specified outcomes. See Program Outcomes below.

**PROGRAM OUTCOMES**

In addition to the eleven program outcomes listed in the College of Engineering section on National Accreditation (listed on page 117), Electrical Engineering educational outcomes include: (a) experience in using organizational skills and system management and problem-solving skills in analyzing problem solving in Electrical Engineering and other engineering related fields. The Electrical Engineering program is under continuous assessment and improvement based on Engineering Criteria 2000. The Advisory Committee to the department, which is made up of persons from industry, government, and the College of Engineering, is composed of college administrators and faculty, provides consultant input in planning the curriculum and evaluates curricular outcomes and establishes the requisite assessment requirements for the program.

**PROGRAM**

The course of study for the degree of Bachelor of Science in Electrical Engineering is structured to provide a foundation in both the basic sciences and the specialized areas of Electrical Engineering. The program also has sufficient humanities and social science electives among the basic science and the technical program to provide a well-rounded education. The faculty meets to keep classes small enough to allow effective interaction with students.

The Electrical Engineering Department maintains a number of laboratories to support the undergraduate teaching program. The laboratories are devoted specifically to electrical, communications, digital systems, electronics, image processing, machinery, micro-
program, equipping the student for entry into a variety of work in industry and research. The program also leads to graduate work in other physics or engineering.

ENVIRONMENTAL ENGINEERING
(See Civil Engineering)

INDUSTRIAL ENGINEERING

Professors: T.E. Starnes (Acting Head), Ph.D., P.E.; W.W. Claycombe, Ph.D., Virginia Polytechnic Institute; F.E. H. Devine, P.E., Ph.D. Texas; G.W. Garrison (UTSIB), Ph.D., North Carolina State; H.L. Cowles (Emeritus); M.S. North Carolina State; P.E.; J.A. Bordiulli, Ph.D. Ohio State; P.E.


The undergraduate curriculum in industrial engineering provides a strong background in both fundamental engineering principles and the analytic methods necessary for solving the multi-faceted problems associated with the production, maintenance, and delivery of goods and services. In particular, this curriculum emphasizes the knowledge and skills necessary to design integrated systems of people, material, equipment, and energy whenever they are found, such that the overall system functions at an optimal level and such that the needs of human components of the system are adequately met.

GOALS
The goals of the Industrial Engineering undergraduate program are to prepare students to contribute to the profession of Industrial Engineering and to prepare them for further study, independent professional, and graduate education.

OBJECTIVES
The objectives of the Industrial Engineering Program include enabling the students to:

(1) Understand and be able to apply the following concepts to multifaceted problems associated with the production, maintenance, and delivery of goods and services:

a) Fundamental human factors which influence engineering design, the economic analysis of alternative design choices, introductory economics and accounting, quality control techniques, manufacturing processes and materials, production and inventory system design and control, the mathematical modeling and simulation of complex systems, and the design and installation of information acquisition and control systems.

b) An ability to communicate effectively, both orally and in writing, to function on multidisciplinary teams, to have a knowledge of pertinent, contemporary issues, and to recognize the need for a commitment to life-long learning.

(2) This curriculum emphasizes the knowledge and skills necessary to design integrated systems of people, material, equipment, and energy whenever they are found, such that the overall system functions at an optimal level and such that the needs of human components of the system are met. The field, broad base in engineering, combined with education in applying engineering methodology to traditionally non-engineering problem areas as provided through the Industrial Engineering curriculum, leads to participation by Industrial Engineers in an unlimited range of fields; including, among others, retail distribution, banking, health care delivery, corporate management, municipal management, food industry, as well as traditional areas of manufacturing.

OUTCOMES
The eleven program outcomes listed in the College of Engineering section on National Accreditation are the accepted outcomes of the Industrial Engineering Department.

UNIVERSITY OF TENNESSEE GENERAL EDUCATION REQUIREMENTS
Industrial Engineering students are required to take Economics 201 and two English electives. They must select the remainder of their humanities/social sciences elective courses to satisfy the University of Tennessee General Education Requirements in accordance with the established College of Engineering Policy. An Industrial Engineering advisor will assist the student in selecting courses to meet these requirements.

GRADUATE STUDY PROGRAMS
The Department of Industrial Engineering offers a graduate program leading to the Master of Science degree in industrial engineering, concentrations in traditional industrial engineering, engineering management, and manufacturing systems engineering. The Ph.D. with a major in Engineering Science is available through the Department of Engineering Science and Mechanics with a specialization in industrial engineering. Students who enroll in the Master of Science degree may select a concentration in either Industrial Engineering, Engineering Management, or Manufacturing Systems Engineering. Admission is open to graduates of ABET-accredited undergraduate programs in Industrial Engineering, or to graduates of other technical curricula who satisfy prerequisites depending on their academic background and industrial experience. Policies concerning prerequisites require

Note: Any 400-level course required in the Baccalaureate Science in Industrial Engineering program at UT Knoxville may not be used for graduate credit in the M.S. degree program.

INDUSTRIAL ENGINEERING AND MANUFACTURING SYSTEMS ENGINEERING

Under the Industrial Engineering and Manufacturing Systems Engineering Concentration, students may select either the thesis or non-thesis option. The thesis option requires 24 hours of coursework plus 6 hours thesis. The non-thesis option requires 30 hours of coursework plus a 3-hour industrial design project. Depending upon a student's background, and career objectives, graduate work in Industrial Engineering enables the student to select an area of specialization from operations research, human factors engineering, quality engineering, maintenance and reliability engineering, or general industrial engineering. In addition to the concentration in manufacturing systems engineering, a dual degree program, requiring a total of 67 semester hours of coursework, is available in manufacturing, and leads to an MBA and an MS degree.

It is also possible in either concentration for a student to select minors in engineering, mathematics, psychology, business, computer science, statistics, or economics.

ENGINEERING MANAGEMENT
The Engineering Management Concentration has an additional admission requirement of at least two years' industrial experience as a practicing engineer or scientist, or current full-time employment in an appropriate engineering or applied science position. The program is non-thesis and requires 30 hours of course work plus a 3-hour capstone project.

MATERIALS SCIENCE AND ENGINEERING

Professors: J.E. Brown, Ph.D., B.S. Tennessee; C.R. Brzozej, Ph.D., Tennessee; R.A. Buchanan, Ph.D. Vanderbilt; E. C. Clark (Emeritus), Ph.D. California (Berkeley); F. G. Fellers, Ph.D. Akron; P.K. Law, Ph.D. Northwestern, J. E. Le (Adjunct Status), Thomas Jefferson, Ph.D. North Carolina (Emeritus); H. Lowandies (Part-time), Ph.D. Colorado; C.D. Lundin, Ph.D.; D. Remesale (Polytechnic Institute); C.J. Mortaga (Part-time), Ph.D. Kentucky; B.F. Diver (Adjunct Status), Ph.D. Massachusetts; T.M. Podraza, Ph.D. National University (Argentina); J.P. Phillips, Ph.D. Liverpool (England); E.E. Stenstrom (Emeritus); Ph.D. Cincinnati.

Associate Professors: W.T. Becker, Ph.D., Illinois; Roberto S. Benson, Ph.D. Florida State University; C.T. Lu (Adjunct Status), Ph.D.; R. Brown University; T.Y. Maek, Ph.D. Ohio State University.

Assistant Professor: K.M. Kil. Ph.D. Delaware.

BACHELOR OF SCIENCE PROGRAM

Materials Science and Engineering is concerned with the science and technology needed to develop and apply materials for the benefit of society. The undergraduate program is designed to prepare students to undertake materials science and engineering courses or to enter graduate programs in this or related disciplines. In order to accomplish this overall goal, the program is divided into the core courses for the program for the degree of B.S. in Materials Science and Engineering.
MINOR IN MATERIALS SCIENCE AND ENGINEERING

A minor in Materials Science and Engineering (MSE) is offered through the College of Engineering to those undergraduate students who have met the prerequisites for the courses required by the minor. The minor requires completion of a minimum of 18 semester hours in course work which develops a foundation in MSE and allows concentration in MSE areas to be selected by the student (e.g., metallurgy, polymers, ceramics, composites, or electronic materials). Some of the courses used for the MSE minor may also satisfy requirements for the student's major.

Students may enter the minor program by completing a form at the office of the Department of Materials Science and Engineering, 434 Dougherty Engineering Building. A copy of the completed enrollment form and information on the minor requirements will be forwarded to the student's home department advisor. A copy of the form also will be filed with the Office of Records and Certification so that upon completion, the minor will be shown on the student's transcript.

Required courses:

Students may enroll in the minor program by completing a form the office of the Graduate Program Assistant (GPA) of at least 2.0 in all materials types with flexibility in the upper division courses to permit concentration and in-depth coverage of specific materials categories. By judicious choices of electives the student may meet a broad perspective or develop special interests as discussed above. The major in Materials Science and Engineering specifically requires that Economics 201 and one course from the Redline Distinguished Clarke be included as a part of this group.

Graduate materials science and engineering requires a minimum grade point average of 3.0 for all departmental courses.

PROGRESSION TO UPPER-DIVISION PROGRAMS

Progression of students to departmental Upper-Division courses is competitive. Factors considered include overall grade point average, performance in selected lower-division courses and the ability of the student to progress through the prescribed curriculum.

Upper-Division Status: A Lower-Division student formally applies for Upper-Division Status after completing 50 semester hours of Upper-Division engineering curriculum course work with an overall GPA of at least 2.4. This must include Materials Science and Engineering 201 and 302.

 Provisional Status: Students who have completed 50 semester hours of Lower-Division engineering curriculum course work with an overall GPA of at least 2.4 may apply for Provisional Status. The granting of Provisional Status is based on the availability of space in the departmental program and the competitiveness of the applicant. Provisional students are not eligible to apply for Upper-Division Status.

 Transfer Students: At the Upper-Division level students are admitted on a Provisional Status basis only. Any student presenting more than 28 hours of Lower-Division engineering curriculum course work to transfer credit is considered for a transfer student.

 TRANSFER STUDE NTS

Students at the Upper-Division level are admitted on a Provisional Status basis only. Any student presenting more than 28 hours of Lower-Division engineering curriculum course work to transfer credit is considered for a transfer student.

MINOR IN MATERIALS SCIENCE AND ENGINEERING

A minor in Materials Science and Engineering (MSE) is offered through the College of Engineering to those undergraduate students who have met the prerequisites for the courses required by the minor. The minor requires completion of a minimum of 18 semester hours in course work which develops a foundation in MSE and allows concentration in MSE areas to be selected by the student (e.g., metallurgy, polymers, ceramics, composites, or electronic materials). Some of the courses used for the MSE minor may also satisfy requirements for the student's major.

Students may enter the minor program by completing a form at the office of the Department of Materials Science and Engineering, 434 Dougherty Engineering Building. A copy of the completed enrollment form and information on the minor requirements will be forwarded to the student's home department advisor. A copy of the form also will be filed with the Office of Records and Certification so that upon completion, the minor will be shown on the student's transcript.

Required courses:

Students may enroll in the minor program by completing a form the office of the Graduate Program Assistant (GPA) of at least 2.0 in all materials types with flexibility in the upper division courses to permit concentration and in-depth coverage of specific materials categories. By judicious choices of electives the student may meet a broad perspective or develop special interests as discussed above. The major in Materials Science and Engineering specifically requires that Economics 201 and one course from the Redline Distinguished Clarke be included as a part of this group.

Graduate materials science and engineering requires a minimum grade point average of 3.0 for all departmental courses.

PROGRESSION TO UPPER-DIVISION PROGRAMS

Progression of students to departmental Upper-Division courses is competitive. Factors considered include overall grade point average, performance in selected lower-division courses and the ability of the student to progress through the prescribed curriculum.

Upper-Division Status: A Lower-Division student formally applies for Upper-Division Status after completing 50 semester hours of Upper-Division engineering curriculum course work with an overall GPA of at least 2.4. This must include Materials Science and Engineering 201 and 302.

 Provisional Status: Students who have completed 50 semester hours of Lower-Division engineering curriculum course work with an overall GPA of at least 2.4 may apply for Provisional Status. The granting of Provisional Status is based on the availability of space in the departmental program and the competitiveness of the applicant. Provisional students are not eligible to apply for Upper-Division Status.

 Transfer Students: At the Upper-Division level students are admitted on a Provisional Status basis only. Any student presenting more than 28 hours of Lower-Division engineering curriculum course work to transfer credit is considered for a transfer student.

 TRANSFER STUDE NTS

Students at the Upper-Division level are admitted on a Provisional Status basis only. Any student presenting more than 28 hours of Lower-Division engineering curriculum course work to transfer credit is considered for a transfer student.

MINOR IN MATERIALS SCIENCE AND ENGINEERING

A minor in Materials Science and Engineering (MSE) is offered through the College of Engineering to those undergraduate students who have met the prerequisites for the courses required by the minor. The minor requires completion of a minimum of 18 semester hours in course work which develops a foundation in MSE and allows concentration in MSE areas to be selected by the student (e.g., metallurgy, polymers, ceramics, composites, or electronic materials). Some of the courses used for the MSE minor may also satisfy requirements for the student's major.

Students may enter the minor program by completing a form at the office of the Department of Materials Science and Engineering, 434 Dougherty Engineering Building. A copy of the completed enrollment form and information on the minor requirements will be forwarded to the student's home department advisor. A copy of the form also will be filed with the Office of Records and Certification so that upon completion, the minor will be shown on the student's transcript.

Required courses:

Students may enroll in the minor program by completing a form the office of the Graduate Program Assistant (GPA) of at least 2.0 in all materials types with flexibility in the upper division courses to permit concentration and in-depth coverage of specific materials categories. By judicious choices of electives the student may meet a broad perspective or develop special interests as discussed above. The major in Materials Science and Engineering specifically requires that Economics 201 and one course from the Redline Distinguished Clarke be included as a part of this group.

Graduate materials science and engineering requires a minimum grade point average of 3.0 for all departmental courses.

PROGRESSION TO UPPER-DIVISION PROGRAMS

Progression of students to departmental Upper-Division courses is competitive. Factors considered include overall grade point average, performance in selected lower-division courses and the ability of the student to progress through the prescribed curriculum.

Upper-Division Status: A Lower-Division student formally applies for Upper-Division Status after completing 50 semester hours of Upper-Division engineering curriculum course work with an overall GPA of at least 2.4. This must include Materials Science and Engineering 201 and 302.

 Provisional Status: Students who have completed 50 semester hours of Lower-Division engineering curriculum course work with an overall GPA of at least 2.4 may apply for Provisional Status. The granting of Provisional Status is based on the availability of space in the departmental program and the competitiveness of the applicant. Provisional students are not eligible to apply for Upper-Division Status.

 Transfer Students: At the Upper-Division level students are admitted on a Provisional Status basis only. Any student presenting more than 28 hours of Lower-Division engineering curriculum course work to transfer credit is considered for a transfer student.

 TRANSFER STUDE NTS

Students at the Upper-Division level are admitted on a Provisional Status basis only. Any student presenting more than 28 hours of Lower-Division engineering curriculum course work to transfer credit is considered for a transfer student.

MINOR IN MATERIALS SCIENCE AND ENGINEERING

A minor in Materials Science and Engineering (MSE) is offered through the College of Engineering to those undergraduate students who have met the prerequisites for the courses required by the minor. The minor requires completion of a minimum of 18 semester hours in course work which develops a foundation in MSE and allows concentration in MSE areas to be selected by the student (e.g., metallurgy, polymers, ceramics, composites, or electronic materials). Some of the courses used for the MSE minor may also satisfy requirements for the student's major.

Students may enter the minor program by completing a form at the office of the Department of Materials Science and Engineering, 434 Dougherty Engineering Building. A copy of the completed enrollment form and information on the minor requirements will be forwarded to the student's home department advisor. A copy of the form also will be filed with the Office of Records and Certification so that upon completion, the minor will be shown on the student's transcript.

Required courses:

Students may enroll in the minor program by completing a form the office of the Graduate Program Assistant (GPA) of at least 2.0 in all materials types with flexibility in the upper division courses to permit concentration and in-depth coverage of specific materials categories. By judicious choices of electives the student may meet a broad perspective or develop special interests as discussed above. The major in Materials Science and Engineering specifically requires that Economics 201 and one course from the Redline Distinguished Clarke be included as a part of this group.

Graduate materials science and engineering requires a minimum grade point average of 3.0 for all departmental courses.

PROGRESSION TO UPPER-DIVISION PROGRAMS

Progression of students to departmental Upper-Division courses is competitive. Factors considered include overall grade point average, performance in selected lower-division courses and the ability of the student to progress through the prescribed curriculum.

Upper-Division Status: A Lower-Division student formally applies for Upper-Division Status after completing 50 semester hours of Upper-Division engineering curriculum course work with an overall GPA of at least 2.4. This must include Materials Science and Engineering 201 and 302.

 Provisional Status: Students who have completed 50 semester hours of Lower-Division engineering curriculum course work with an overall GPA of at least 2.4 may apply for Provisional Status. The granting of Provisional Status is based on the availability of space in the departmental program and the competitiveness of the applicant. Provisional students are not eligible to apply for Upper-Division Status.

 Transfer Students: At the Upper-Division level students are admitted on a Provisional Status basis only. Any student presenting more than 28 hours of Lower-Division engineering curriculum course work to transfer credit is considered for a transfer student.

 TRANSFER STUDE NTS

Students at the Upper-Division level are admitted on a Provisional Status basis only. Any student presenting more than 28 hours of Lower-Division engineering curriculum course work to transfer credit is considered for a transfer student.
The program culminates in a major aerospace education. These include guidance, control, environmental, ramjet, rocket, turbojet, testing, and applied research associated with space engineering. An agreement among southern states for Aerospace Engineering uses the basic sciences and mathematics to develop the foundation for the discipline. Production, testing, and applied research associated with aerospace vehicles. These vehicles include aircraft, spacecraft, and missiles. Auxiliary and propulsion systems are also an integral part of the education. These include guidance, control, environmental, ramjet, rocket, turbojet, and airplane systems. Emphasis in the senior year is directed toward these topics, and the program culminates in a major aerospace design project.

An agreement among states for allowing academic programs allows legal residents of states to enroll in certain programs at UT, Knoxville on an in-state tuition basis. The undergraduate program in Aerospace Engineering is available on an in-state basis to students from Alabama, Arkansas, Kentucky, Louisiana, and South Carolina. 

A coursework program leading to a major in Aerospace Engineering for students in other engineering degrees program is also offered. The academic objectives of the Aerospace Engineering program are:

- To provide students with a comprehensive education that includes in-depth instruction in aerodynamics, structures, flight mechanics, orbital mechanics, flight propulsion, and the behavior of spacecraft.
- To provide students for professional careers in Aerospace Engineering by developing the skills pertinent to problem solving, analyzing, design, and those personal skills required for teamwork and effective communication.
- To provide adequate opportunities to develop and cultivate lifelong learning skills, individual professionalism and ethics, and to nourish creative talents.

The Engineering Science degree program is a flexible course of study with elective options available to satisfy individual interests and career objectives. The program prepares students for an education with breadth in engineering science, mathematics, and physical or biological science. The curriculum is rigorous, non-traditional, and designed to nourish creative talents. Selected groups of technical electives provide an opportunity to develop special interests that cannot be accommodated in other traditional engineering disciplines. Examples of special interest elective group available are biomedical engineering, engineering mechanics, computational mechanics, and the mechanics of engineering materials. This program can include coursework required for entrance into most medical schools. The undergraduate program in Engineering Material gives the student a mechanics oriented program in the area of materials for the design of engineering structures. The student can learn to analyze structures for such phenomena as fracture, fatigue, and stability of systems. By choosing the technical electives to focus in an area of special emphasis, the student can emphasize metals, polymers, or composites. The education objectives of the Engineering Science program are:

- To provide students with a solid foundation in mathematics, the sciences, and engineering sciences, and engineering design suitable for a variety of interdisciplinary fields.
- To provide students education and problem-solving experience in computational methods.
- To prepare students for professional careers in interdisciplinary fields that require strong teaming abilities and communication skills.
- To provide multifaceted opportunities for the development and cultivation of lifelong learning skills, professionalism, ethics, and the nourishment of creative talents.

ACADEMIC COMMON MARKET

An agreement among states for allowing academic programs allows legal residents of states to enroll in certain programs at UT, Knoxville on an in-state tuition basis. The undergraduate program in Aerospace Engineering is available on an in-state basis to students from Alaska, Arkansas, Kentucky, Louisiana, Mississippi, and West Virginia.

PROGRESSION TOWARD GRADUATION

The freshman year curriculum is common to all engineering majors. The sophomore curriculum for Aerospace Engineering is available on an in-state basis to students from Alabama, Arkansas, Kentucky, Louisiana, Mississippi, and West Virginia.

GRADUATE STUDY

Graduate programs leading to the degrees of Master of Science and Doctor of Philosophy (Ph.D.) in Mechanical Engineering are available to graduate students who have completed a bachelor's degree in the appropriate subject. The graduate programs are designed to provide advanced training in the subject matter, to foster independent research, and to prepare students for careers in teaching and industry. The requirements for admission to the graduate programs are as follows:

- A bachelor's degree in mechanical engineering or a closely related field.
- A minimum GPA of 3.0 in the last 60 hours of undergraduate coursework.
- Two letters of recommendation from undergraduate instructors.
- An acceptable GRE score (minimum of 150 in each section for all programs except those in engineering management).
- A statement of purpose outlining the student's academic and professional goals.

Graduate programs are offered in the following areas:

- Mechanical Engineering
- Aerospace Engineering
- Materials Science and Engineering
- Biomedical Engineering
- Environmental Engineering
- Civil Engineering
- Electrical and Computer Engineering
- Industrial and Systems Engineering
- Nuclear Engineering
- Chemical Engineering
- Marine and Ocean Engineering

Graduate students are encouraged to consult with the Graduate Program Coordinator regarding their specific area of interest and to plan their course of study accordingly. Graduate students are expected to maintain a minimum GPA of 3.0 in all graduate coursework.

The College of Engineering at the University of Tennessee, Knoxville, is committed to excellence in teaching, research, and service. The College offers undergraduate and graduate programs in a wide range of engineering disciplines, as well as interdisciplinary programs that combine engineering with other fields such as business, computer science, and environmental science. The College has a strong focus on interdisciplinary research and collaboration, and is home to several research centers and institutes that support cutting-edge research and innovation. The College is also committed to preparing students for successful careers in engineering and related fields, and offers a variety of resources and support services to help students achieve their goals.
phy with a major in Engineering Science are available to graduates of recognized curricula in engineering. Graduates of recognized curricula in mathematics, computer science or one of the physical or biological sciences may also qualify for admission depending upon their background. Each applicant is advised as to any prerequisite courses needed to enter a program. Program options include solid and fluid mechanics (with emphasis toward computational techniques), biomedical engineering, artificial intelligence applications, composite materials and fracture mechanics. Interdisciplinary programs are arranged to meet individual needs or interests. The student's study must be approved by his or her advisory committee, and must comply with the requirements of the Graduate School.

NUCLEAR ENGINEERING

Professors: P.H. Datti (Head), Ph.D. Tennessee; P.F. Hannum (Part-time), Ph.D. Tennessee.

Associate Professors: P.H. Datti; J.K. Franklin; P.D. Tennessee; A.E. Cardon; Ph.D. Tennessee; P.G. Groe; Ph.D. Virginia (A.E. Cardon); I.H. Gann; Ph.D. Tennessee; R.E. Pevey; Ph.D. Tennessee.

Research Professor: W.H. Henry, Ph.D. Tennessee.

Research Associate Professor: H.J. Lee, Ph.D. Tennessee.

Research Associate Professor: J.S. Poon, Ph.D. Tennessee.

Associate Professor: A.E. Cardon; Ph.D. Tennessee; W.J. West, Ph.D. Tennessee.


Research Associate Professor: J.S. Poon, Ph.D. Tennessee.

Research Professor: W.H. Henry, Ph.D. Tennessee.

Research Associate Professor: H.J. Lee, Ph.D. Tennessee.

Research Associate Professor: J.S. Poon, Ph.D. Tennessee.

Associate Professor: A.E. Cardon; Ph.D. Tennessee; W.J. West, Ph.D. Tennessee.


Research Associate Professor: J.S. Poon, Ph.D. Tennessee.

Research Associate Professor: J.S. Poon, Ph.D. Tennessee.

BACHELOR OF SCIENCE PROGRAM

The program for the B.S. degree in Nuclear Engineering is nationally accredited by the Accreditation Board for Engineering and Technology (ABET) which is described earlier in this catalog. The educational objectives of the B.S. program are to:

1. Provide students with fundamental knowledge in mathematics, computer science, the basic sciences, and the engineering sciences that is necessary to solve state-of-the-art problems in nuclear and radiological engineering.

2. Provide students with a real-world design and analysis experience in nuclear and radiological engineering that shall include environmental, societal, safety, and economic considerations.

3. Provide students with appropriate skills in oral and written communication, teamwork, laboratory work, problem solving and the use of modern engineering tools that will prepare them to work productively in a contemporary and global environment.

4. Provide students with a diverse general education in the humanities, ethics, and social sciences to complement their technological education in order to understand and appreciate the importance of ethics in society and in personal development.

5. Foster a genuine desire for lifelong learning in students.

Students majoring in Nuclear Engineering take courses in the basic sciences, engineering fundamentals, mathematics, computer science, humanities, and special areas of nuclear engineering including fusion system design and safety, radiation transport and shielding, heat transfer and fluid flow, reactor safety, reactor control, fuel cycle and waste management, and nuclear physics. Nuclear engineering students may concentrate in Radiological Engineering by substitution of three courses. The Radiological Engineering concentration stresses most of the requirements of pre-med, pre-vet, and pre-dentistry programs.

MASTER OF SCIENCE PROGRAM

A graduate program leading to a degree of Master of Science is available to graduates of recognized undergraduate curricula in engineering, physics, chemistry, or mathematics. Each applicant will be advised as to the necessary prerequisites before entering the program. The general requirements of the master's degree are summarized in the Graduate Catalog.

DOCTORAL PROGRAM

A program leading to the Ph.D. degree is available in nuclear engineering. For details, see the Graduate Catalog.

ACADEMIC COMMON

A requirement for all students sharing academic programs is the availability of legal residents of the United States to enroll in nuclear engineering courses. This requirement is to ensure that all incoming students are current on nuclear physics. Nuclear engineering students may complete the requirements of the nuclear engineering program at their college of origin by substitution of three courses. The Radiological Engineering concentration stresses most of the requirements of pre-med, pre-vet, and pre-dentistry programs.

CURRICULA

Table 134: Total 134 hours

General Education Electives: Minimum of 14 hours required. (See College of Engineering/Social Requirements.)
CHEMICAL ENGINEERING

Sophomores
- Chemical Engineering 200, 230, 240, 340, 360, 380: 14
- Mathematics 210, 211, 212: 9

Junior
- Materials Science & Engineering 201: 3
- Mathematics 330, 331, 332, 342: 15

Senior
- General Education Electives: 6
- Chemical Engineering 301, 310, 314, 360, 380, 385: 14
- Physics 223: 3
- Chemistry 210: 3
- Chemistry 220, 320, 420, 430: 3

Electives
- Chemical Engineering 401, 410, 415, 447, 450: 17
- Technical Electives: 9

General Education Electives: Total: 134 hours

CIVIL ENGINEERING

Sophomores
- Mathematics 205, 231, 241: 8
- Physics 231: 3
- Statistics 205: 3

Junior
- Nuclear Engineering 200, 230, 240: 9
- General Education Electives: 6
- Civil Engineering 301, 351, 361, 380: 15
- Civil Engineering 220, 222, 230, 380, 390: 14
- "General Education Electives: 6
- Senior
- Civil Engineering 435, 445, 471, 480: 12
- Civil Engineering 420, 421, 449: 4
- Civil Engineering 322, 310, 311, 312: 3
- Technical Electives: 3
- "General Education Electives: 6

Total: 134 hours

ELECTRICAL ENGINEERING

Sophomores
- Electrical Engineering 201, 209: 8
- Mathematics 231, 232: 6
- Physics 231: 3
- Electrical Engineering 220, 230, 240: 10
- Mathematics 241: 4

Junior
- Electrical Engineering 310, 311, 331, 341, 351, 361: 15
- General Education Electives: 6
- Electrical Engineering 312, 321, 332, 342, 352, 362: 13
- "General Education Electives: 5
- Electrical Engineering 400: 6
- Electrical Engineering 331, 332: 6
- Mechanical Engineering 231: 3
- Nuclear Engineering 245, Engineering 310, 332, 345: 3

Total: 134 hours

Students must meet the design, depth, and breadth requirements of the department in their selection of electives. The design requirement is met by taking EE 450, Senior Design. The depth requirement is met by taking two more units selected in one of the core areas: EE 411, 412, power (EE 413, 420), electronics (EE 421, 432), communications (EE 441, 442), and computation (EE 451, 452). The breadth requirement is met by taking courses in other core areas, or courses in areas such as electrical, control, mechanical, civil, and environmental engineering, power electronics, and emerging technologies. Electives are approved by the student's faculty advisor.

- At least one of the technical electives is required to be a digital logic course, as a General Education elective.
- Philosophy 442: Birkhoff's Ethics, Philosophy 444: Professional Responsibility, Philosophy 345: Medical Ethics, or Philosophy 246: Environmental Ethics.

ENGINEERING PHYSICS

Freshmen

Hours Credit

- English 101, 102: 6
- Mathematics 241, 251: 8
- Physics 137, 138: 10

Sophomores

- "Engineering Fundamentals 101, 102: 12
- Mathematics 261: 3
- Physics 237, 238, 239: 10

Junior

- Mathematics 291, 241: 7
- Physics 142: 3
- "Physics 240, 251: 5

Total: 134 hours

- "Transfer students from other engineering departments may substitute General Education Electives Fundamentals 102 for Physics 137, Physics 251 for Physics 138, and Physics 141, 142 for Physics 237, 238.
- A total of 12 hours of engineering electives plus 3 hours of General Education Electives must be taken.
- "Technical Electives must be approved by the student's faculty advisor.

ENGINEERING SCIENCE

Sophomores
- Mathematics 231, 232, 200: 9
- Physics 231, 232: 6
- Electrical Engineering 220, 230: 10
- "General Education Electives: 6
- Mathematics 241: 4

Junior
- Electrical Engineering 310, 311, 331, 341, 351, 361: 15
- "General Education Electives: 6
- Electrical Engineering 312, 321, 332, 342, 352, 362: 13
- "General Education Electives: 4
- Electrical Engineering 400: 6
- Electrical Engineering 331, 332: 6
- Mechanical Engineering 231: 3
- Nuclear Engineering 245, Engineering 310, 332, 345: 3

Total: 134 hours

- At least six electives must be approved by the student's faculty advisor and the department head.
- Technical electives include courses in mathematics, statistics, computer science, and natural science, as well as course in engineering.

ENGINEERING SCIENCE: BIOMEDICAL ENGINEERING CONCENTRATION

Sophomores
- Mathematics 241, 231, 200: 8
- Physics 231, 232: 6
- Engineering Science 231, 271, 291: 12
- "General Education Electives: 6

Junior
- Electrical Engineering 200: 3
- "Engineering Science 331, 343: 9
- Engineering Science 301, 341: 4
- "Materials Science and Engineering 201: 3
- Mechanical Engineering 231: 3
- "Industry Engineering 401, 405: 6
- "Nuclear Engineering 243, 245: 4
- "Technical Electives: 6
- "General Education Electives: 6

Total: 135 hours

All electives must be approved by the student's faculty advisor and the department head. Technical electives (including biomedical engineering courses) are chosen to form a biomedical engineering program, which must include biological engineering and organic chemistry courses as well as part of the technical electives.

INDUSTRIAL ENGINEERING

Sophomores
- "General Education Electives: 6
- Mathematics 231, 232, 241: 8
- Physics 231: 3
- Engineering Science 201: 3
- Industrial Engineering 200: 3
- Accounting 201: 3
- General Education Electives: 6
- "General Education Electives: 6

Junior
- "Engineering Science 301, 302, 304, 306: 18
- "Industrial Engineering 401, 405: 6
- "Nuclear Engineering 243, 245: 4
- "Technical Electives: 6
- "General Education Electives: 6

Total: 150 hours

The technical elective must be taken from within the Industrial Engineering Department or be approved by the student's faculty advisor and department head.

MATERIALS SCIENCE AND ENGINEERING

Sophomores
- Materials Science and Engineering 201, 202, 203, 204, 205: 4
- Physics 231, 232: 6
- Nuclear Engineering 205, 209, 214: 6
- Chemical Engineering 200, 240: 6
- "General Education Electives: 6

Total: 132 hours

Hours Credit

- "General Education Electives: 6
### College of Engineering

**Junior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry 475</td>
<td>4</td>
</tr>
<tr>
<td>Electrical Engineering 390</td>
<td>3</td>
</tr>
<tr>
<td>Engineering Science 321</td>
<td>3</td>
</tr>
<tr>
<td>General Education Electives</td>
<td>9</td>
</tr>
<tr>
<td>Materials Science and Engineering Elective</td>
<td>3</td>
</tr>
<tr>
<td>Technical Elective</td>
<td>9</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>133</strong></td>
</tr>
</tbody>
</table>

*General Education courses must include Economics 201 and one course from the Effective Communications Cluster in addition to the requirements described under Approved General Education Electives.

**MECHANICAL ENGINEERING**

**Sophomore**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics 241, 231, 200</td>
<td>8</td>
</tr>
<tr>
<td>Physics 231, 232</td>
<td>7</td>
</tr>
<tr>
<td>Engineering Science 231, 321</td>
<td>6</td>
</tr>
<tr>
<td>Mechanical Engineering 301</td>
<td>3</td>
</tr>
<tr>
<td>Economics 201</td>
<td>4</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>4</td>
</tr>
<tr>
<td>Mechanical Engineering 391, 341, 363, 366, 345</td>
<td>21</td>
</tr>
<tr>
<td>Electrical Engineering 301, 302</td>
<td>9</td>
</tr>
<tr>
<td>Engineering Science 341</td>
<td>3</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>138</strong></td>
</tr>
</tbody>
</table>

*General Education Electives must include one course from the Effective Communications Cluster.

**Senior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Engineering 481, 485, 475, 455, 431</td>
<td>13</td>
</tr>
<tr>
<td>Mechanical Engineering 465 and 469 or 456</td>
<td>6</td>
</tr>
<tr>
<td>Technical Elective</td>
<td>3</td>
</tr>
<tr>
<td>Technical Elective (to be selected from EES 452, AE 361, SE 369)</td>
<td>6</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>134</strong></td>
</tr>
</tbody>
</table>

**NUCLEAR ENGINEERING**

**Sophomore**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 300, 304, 241</td>
<td>6</td>
</tr>
<tr>
<td>Physics 231</td>
<td>4</td>
</tr>
<tr>
<td>Nuclear Engineering 200, 203</td>
<td>4</td>
</tr>
<tr>
<td>Computer Science 332</td>
<td>3</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>4</td>
</tr>
<tr>
<td>Industrial Engineering 490</td>
<td>3</td>
</tr>
<tr>
<td>Nuclear Engineering 400, 403, 404, 405, 431, 472</td>
<td>17</td>
</tr>
<tr>
<td><em>Technical Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>131</strong></td>
</tr>
</tbody>
</table>

*General Education electives must include one course from the Effective Communications Cluster.

**Junior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 231</td>
<td>4</td>
</tr>
<tr>
<td>Nuclear Engineering 301, 304, 342, 381, 470</td>
<td>15</td>
</tr>
<tr>
<td>Biology 102</td>
<td>4</td>
</tr>
<tr>
<td>Biochemistry and Cell Biology (BCMB) 230</td>
<td>5</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>6</td>
</tr>
<tr>
<td>Mechanical Engineering 405</td>
<td>3</td>
</tr>
<tr>
<td>Nuclear Engineering 400, 403, 405, 431, 472</td>
<td>17</td>
</tr>
<tr>
<td><em>Technical Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>131</strong></td>
</tr>
</tbody>
</table>

*General Education electives must include one course from the Effective Communications Cluster.

**Senior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Engineering 400, 403, 405, 431, 472</td>
<td>17</td>
</tr>
<tr>
<td><em>Technical Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>131</strong></td>
</tr>
</tbody>
</table>

**NUCLEAR ENGINEERING: RADIOTHERAPEUTIC CONCENTRATION**

**Sophomore**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 200, 221, 241</td>
<td>8</td>
</tr>
<tr>
<td>Physics 231, 106</td>
<td>7</td>
</tr>
<tr>
<td>Nuclear Engineering 200, 203</td>
<td>4</td>
</tr>
<tr>
<td>Electrical Engineering 390</td>
<td>3</td>
</tr>
<tr>
<td>Computer Science 332</td>
<td>3</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>4</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>9</td>
</tr>
<tr>
<td>Physics 241</td>
<td>3</td>
</tr>
<tr>
<td>Nuclear Engineering 200, 203, 304, 381, 470</td>
<td>15</td>
</tr>
<tr>
<td>Biology 102</td>
<td>4</td>
</tr>
<tr>
<td>Biochemistry and Cell Biology (BCMB) 230</td>
<td>5</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>6</td>
</tr>
<tr>
<td>Nuclear Engineering 400</td>
<td>3</td>
</tr>
<tr>
<td>Nuclear Engineering 400, 403, 405, 431, 472</td>
<td>17</td>
</tr>
<tr>
<td><em>Technical Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>131</strong></td>
</tr>
</tbody>
</table>

*General Education electives must include one course from the Effective Communications Cluster.

**Junior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 231</td>
<td>4</td>
</tr>
<tr>
<td>Nuclear Engineering 301, 304, 342, 381, 470</td>
<td>15</td>
</tr>
<tr>
<td>Biology 102</td>
<td>4</td>
</tr>
<tr>
<td>Biochemistry and Cell Biology (BCMB) 230</td>
<td>5</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>6</td>
</tr>
<tr>
<td>Mechanical Engineering 400, 403, 405, 431, 472</td>
<td>17</td>
</tr>
<tr>
<td><em>Technical Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>131</strong></td>
</tr>
</tbody>
</table>

*General Education electives must include one course from the Effective Communications Cluster.

**Senior**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 241</td>
<td>3</td>
</tr>
<tr>
<td>Nuclear Engineering 200, 203, 304, 381, 470</td>
<td>15</td>
</tr>
<tr>
<td>Mechanical Engineering 400, 403, 405, 431, 472</td>
<td>17</td>
</tr>
<tr>
<td><em>Technical Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><em>General Education Electives</em></td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>131</strong></td>
</tr>
</tbody>
</table>

*General Education electives must include one course from the Effective Communications Cluster.

**Technical Electives are selected from upper division mathematics, chemistry, and engineering courses and must be pre-approved by the department. Pre-Med, pre-vet and pre-dentistry students must take Chemistry 360 and also Chemistry 369.