College of Engineering

William T. Snyder, Dean
William L. Grecco, Associate Dean

The engineer applies mathematical and scientific knowledge in planning economical ways of providing materials and energy in forms that are useful to humankind. In today's technology-based society, everyone feels the effects of the engineer's plans and decisions. Hence, there is a continuing and urgent need for engineering graduates who possess a thorough understanding of mathematical and scientific principles, who apply these principles to the solution of practical and high technology problems, and who can view the solutions in their overall social perspective so that the actions that they recommend will have long-term benefits. It is the purpose of the College of Engineering to educate men and women to the high levels of technical competence and social understanding that will enable them to fulfill their responsibilities as professional engineers.

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 Cooperative Engineering Program was established in 1928. The University of Tennessee was one of the early pioneers in this valuable type of education, which originated at the University of Cincinnati in 1905.

The College of Engineering is housed in Ferris, Estabrook, Perkins, Dougherty, and Berry Halls, and in the Pasqua Engineering Building and East Stadium, all located on the southeastern end of the campus, and the Alumni Memorial Auditorium-Gymnasium.

TAU BETA PI NATIONAL HEADQUARTERS

The college is honored to have the National Headquarters of Tau Beta Pi, the National Engineering Honor Society, housed on our campus. This honor was earned in part through the untiring efforts of R. C. "Red" Matthews, who served as secretary-treasurer for the organization from 1905 to 1947. The suite of offices, located in Dougherty Hall, is occupied by Mr. J. D. Froula, secretary-treasurer, and his staff.

COOPERATIVE ENGINEERING PROGRAM

The five-year Cooperative Engineering Program is offered in order to provide an augmented engineering education that includes significant experience in industry as well as superior academic preparation.

Cooperative work assignments differ from part-time or summer employment in that they involve regularly scheduled cycles of full-time academic terms alternating with full-time work periods, normally resulting in fifteen to nineteen months planned, career-related assignments of progressive complexity and responsibility. In introducing the student in this manner to engineering employment, the College and the facilities of industry join together to offer a broader and richer preparation for postgraduate employment than can be provided by a conventional academic program. This experience in an industrial and professional environment contributes to the student's maturity, increases the scope of acquaintances and concepts, offers an opportunity to apply theory and skills in a real-world setting, and enables the student to define more clearly educational and career interests and objectives. Some of the experience is at a subprofessional level not available to an engineer after graduation, yet is of great significance in achieving a complete education and early effectiveness.

Participation in the Cooperative Engineering Program usually begins with application during the freshman year, and placement with a co-op employer during the sophomore year, after the student has met academic progress and grade qualifications required by employers and the Co-op Program. A single application period is held each academic year, and students interested in co-oping should apply at the first opportunity open to them in order to receive full benefit of counseling available before placement and to establish priority in placement activities. Each class of applicants takes priority over succeeding classes for all positions for which the earlier applicants are qualified. Students undecided about participating should nevertheless apply during their freshman year if possible, and then request that their applications be held until they withdraw or are ready to make a definite commitment.

In general, students begin work after the first or second sophomore semester, although an exceptionally well-qualified can-
candidates might begin a field assignment at the end of the freshman year. A schedule of courses is taught by each engineering department specifically to meet the needs of co-op students, and applicants must be able to fit into that schedule in order to participate. Candidates must be able to project a minimum of fifteen months of co-op experience prior to the senior year, within the regular alternating sequence, to qualify for placement. With very few exceptions, transfer students must complete a minimum of two academic terms at UTK before beginning co-op assignments, the first establishing qualifications, and the second while placement is secured.

Students in the Cooperative Engineering Program are classified for salary purposes as freshmen, sophomores, or juniors according to their progress in meeting bachelor's degree requirements in their major department. Second degree students, those transferring from other colleges within UTK or from other universities, and those who choose to coordinate co-op courses consistent with the minimum engineering schedule, are assigned "equivalent semesters completed" - a rating that indicates actual progress toward their UTK engineering degree. The number of terms in school or hours completed, are frequently not accurate indications of academic progress in engineering in such cases.

Students who wish to co-op must plan carefully in order to fit into the established schedules of courses offered for co-ops. Those planning to transfer to the College of Engineering from other disciplines or schools should begin working as early as possible with an advisor in the department they plan to enter in order to enter the co-op schedule at an optimum time. Brochures with further details, sample calendars showing school and work schedules, and current employment lists may be obtained from the Cooperative Engineering Program, University of Tennessee, Knoxville, TN 37996-2350. Because of heavy appointment and travel schedules of the co-op coordinators, prospective students wishing to discuss the program with a coordinator in advance of the annual information and orientation meeting should telephone the Co-op Office, 615/974-4323, in advance for an appointment.

GRADUATE PROGRAM

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 subjects: aerospace engineering, civil engineering, civil engineering as a discipline, electrical and computer engineering, engineering science, mechanical engineering, metallurgical engineering, nuclear engineering, and polymer engineering. A Master of Engineering degree focusing on engineering design professional practice is offered in all of these areas in order to participate.

CURRICULA IN ENGINEERING

NATIONAL ACCREDITATION

Since 1936, engineering programs at institutions of higher learning have been accredited by organizations formed by many engineering societies and as the Accreditation Board for Engineering and Technology (ABET). Currently accredited engineering programs at UTK include aerospace, agricultural, chemical, civil, electrical, engineering science and mechanics, industrial, mechanical, metallurgical, and nuclear. Co-op programs in the above areas are presently ABET accredited.

DESIGNATION OF A MINOR

An engineering undergraduate may declare a minor in a non-engineering subject area and have the minor listed on the permanent record under the following conditions:

1. Only one minor may be declared and officially designated.
2. The minor must be one officially approved and described in the UTK catalog.
3. No unofficial minors will be recognized. Minors exist in Architecture and Business Administration, and in numerous departments in Agriculture and Liberal Arts. Presently no engineering student can minor in another engineering discipline, nor can a non-engineering student declare an engineering minor.
4. Courses taken to satisfy the 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.
5. A student should 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 UTK Records Office.

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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 past academic performance at UTK.

DROPOUT DEADLINE

The drop and add deadline for all undergraduate courses administered by any department in the College of Engineering is the end of the tenth calendar day of each semester counted from the beginning day of classes. Any drop action after this date on the part of any student (regardless of major) is subject to late drop regulations. Late drop requests which may be approved for reasons other than academic difficulties, are handled by the Office of Academic Affairs, 118 Perkins Hall. For other procedures refer to "Changes in Registration" in the general section of this catalog.

GENERAL REQUIREMENTS

Students are advised to consult the University's degree requirements as stated in the front section of this catalog as well as departmental requirements.

Inspection Trip. Each candidate for graduation majoring in aerospace, mechanical, chemical, or metallurgical engineering must participate in inspection trips scheduled by the major department.

Transfer Students. All transfer students - Tennessee resident, out-of-state students and international students - are reviewed by a College Association Committee prior to an Association decision, regardless of transfer GPA. Applications for Association are submitted to the Associate Dean for Academic Affairs of the College and the Dean of the Department with which Association is desired.

Factors considered in the decision include:
1. Overall academic performance in previous college work;
2. Incidence of withdrawals, incompletes, or other evidence of problems interfering with orderly academic progress;
3. The level of the student's interest in engineering, as evidenced by the kinds of courses taken and institutions attended;
4. A statement of educational goals, which all transfer students are encouraged to submit as part of their admission to UTK; and
5. The restrictions on space and staff in the department applied for.

Transfer Credit. Every attempt will be made to give maximum credit for courses taken elsewhere and transferred to the college. Discussions concerning the evaluation of transfer credits should be conducted with the head of the department (or designee) into which the student proposed to transfer 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 already holding a bachelor's degree may obtain the appropriate first degree in engineering upon meeting all of the course requirements of the selected engineering program. In no case will the minimum requirement be less than 30 semester credits. The prevailing University regulations shall apply.

Satisfactory/No Credit Courses. An undergraduate engineering student may count towards a degree up to 9 semester
hours obtained by Satisfactory/No Credit (S/NC) grading. Such hours must be used for humanities-social sciences elective credit in engineering. Certain engineering courses carry only S/NC grading do not count in this limit.

**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 course credit to meet the minimum degree requirements.

**Humanities and Social Science Electives.** The college assumes an obligation to include in each of the engineering curricula a means whereby students gain greater insight into their interaction with society, both personally and professionally. For this purpose, a part of each engineering curriculum is devoted to humanities and social science electives. These electives serve a three-fold need: to provide an expanded sensitivity to the human aspects of the practice of engineering; to enrich the student’s knowledge of the world in which he or she lives - its culture, behavior patterns, history, and governance; and to provide a basis for the appreciation of and the ability to deal with complex interactions between technology and society in the contemporary world. Engineers are now working with new constraints that demand a consciousness of the social and political implications of their work. They are interacting with the public in explaining their work as the public demands greater participation in the decision-making process concerning the utilization of technology. Because of the significance of this technology-society interaction, engineering students are encouraged to seriously consider the selection of required electives in this area.

Students are urged to plan their Humanities/Social Science elective program in consultation with their advisor. Requirements:

1. Courses must be from this approved list
2. 18 hours minimum
3. 45 hours maximum in social sciences (12 hours maximum)
4. 6 hours minimum in humanities (12 hours maximum)
5. At least 8 hours must be in a single department
6. 6 hours maximum introductory courses (italicized)
7. Foreign languages (a) a foreign language will not be approved if it is the student’s native language, (b) 6 hours minimum (if only 3 hours taken, that 3 hours may not be used as a H/SS elective, and (c) other foreign languages may be approved Introduction courses are in Italics below (6 hours maximum) HUMANITIES

Afro-American Studies 201, 202, 322, 352
American Studies 310
Anthropology 110, 130, 410, 419
Asian Studies 101, 102
Foreign Languages: French 111, 112, 211, 212; German 101, 102, 201, 202; Greek 121, 122, 261, 262; Italian 111, 112, 211, 212; Portuguese 111, 112, 211, 212; Russian 101, 102, 201, 202; Spanish 111, 112, 211, 212

Medieval Studies 201, 261, 262
Music General 110, 120
Philosophy 110, 111, 120, 121, 322, 324, 326
Religious Studies 101, 102, 212, 232, 235, 301, 302, 305, 309, 311, 312, 313, 315, 322, 326
University Honors 237, 337, 437 SOCIAL SCIENCE
Economics 201, 321, 323, 324, 325
Geography 141, 320, 330, 361, 421, 441, 443
Political Science 301, 310, 311, 320, 321, 330, 331, 340, 350, 355, 361, 365, 368, 370, 374
Psychology 110, 210, 220, 360
Sociology 110, 200, 310, 311, 321, 340, 343, 344, 345, 363
University Honors 247, 347, 447
University Studies 310, 320, 410, 420
American History Requirement. Engineering students, regardless of natural origin, must fulfill the American history requirement described elsewhere in this catalog. Those students who have not had the required year of American history in high school may choose the required six semester hours from History 251 and 252, or other courses deemed suitable by the Department of History. These hours may be counted as part of the required block of humanities and social science electives.

**Technical Electives.** Technical electives are to be selected with the advice and approval of the student’s major department. In some of the curricula tabulation a choice of such electives is indicated, and regulations in regard to their selection are stated.

**The Voluntary ROTC Program.** Engineering students may participate in the ROTC Program. Advanced ROTC courses (300 and 400 series) may be counted as technical elective credit toward an engineering degree up to a total of six (6) semester hours. Normally, Military Science courses cannot be used as humanities/social science electives. Individual departments determine the appropriate substitutions.

**Approval of Electives and Substitutions.** Each student shall discuss with an advisor the status of the program of study no later than the beginning of the second semester prior to anticipated graduation. Any necessary additions to or substitutions in the program, or electives requiring special approval, must be cleared in writing at that time, and it is each student’s responsibility to see that all necessary approvals are secured. Inattention to such matters will most likely delay graduation.

**AGRICULTURAL ENGINEERING**

(See College of Agriculture)

**CHEMICAL ENGINEERING**

Professors:

J. P. Parone (Head), Ph. D. Northwestern, PE;
D. C. Bogue, Ph. D. Delaware, E. S. Clark;
Ph. D. California (Berkeley), L. W. Crawford
(Space Institute, Tullahoma), Ph. D.
Cincinnati; O. L. Culberson (Emeritus), Ph. D.
Texas; J. F. Fellers, Ph. D. Akron;
G. C. Frazier, Jr., Eng. Johns Hopkins;
J. M. Holmes (Emeritus), Ph. D. Tennessee;
H. W. Hsu, Ph. D. Wisconsin; H. F. Johnson
(Emeritus), Ph. D. Yale; C. F. Moore, Ph. D.
Louisiana State; J. W. Prados, Ph. D.
Tennessee, P. E.; C. D. Scott (Adjunct Status), Ph. D.
Tennessee, P. E.;
C. O. Thomas, Ph. D. Tennessee,
J. S. Watson (Part-time), Ph. D. Tennessee.

Associate Professors:

P. R. Blenkowsky, Ph. D. Purdue;
J. W. Blackburn (Research), Ph. D. Tennessee;
D. D. Bruns, Ph. D. Houston;
C. H. Byers (Adjunct Status), Ph. D. California
(Berkeley); R. M. Cowce, Ph. D. Tennessee;
T. L. Donaldson (Adjunct Status), Ph. D.
Pennsylvania, M. G. Hansen, Ph. D.
Wisconsin; A. C. Sheth (Space Institute,
Tullahoma), Ph. D. Northwestern;
F. E. Weber, Ph. D. Minnesota.

Assistant Professor:

T. W. Wang, Ph. D. Massachusetts Institute of Technology.

**BACHELOR OF SCIENCE PROGRAM**

Chemical engineering is a discipline dedicated to the development, design, operation and management of plants and processes for economical conversion of chemical raw materials to useful products. It is a broadly based discipline, with heavy emphasis on chemistry and mathematics, and also including physics, mathematics and the humanities. Graduates of the program are quite versatile, with careers in fields such as food and pharmaceutical processing, biochemical engineering, fuels production and conversion, polymers and plastics, process control and instrumentation.

The curriculum provides a central core of required courses with flexibility in the upper-division years to permit emphasis on preparation for graduate school or professional employment. A minimum grade point average of 2.0 for all departmental courses is required for graduation.

A minimum of 18 semester hours of humanities-social science courses are required, which are to be selected from the list under “Curricula in Engineering”.

**PROGRESSION TO UPPER-DIVISION**

Progression of chemical engineering students to departmental Upper-Division courses is competitive and is based on capacity. 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 50 semester hours of Lower-Division engineering curriculum course work with an overall GPA of at least 2.4. This must include Chemical Engineering 200.

PROVISIONAL STATUS: Students who have completed 50 semester hours of Lower-Division engineering curriculum course work with an overall GPA between 2.0 and 2.4 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 their abilities to perform satisfactorily in upper-division courses by attaining a minimum GPA of 2.0 in at least 9 hours of 200 and 300 level required courses specified by the department. Further progression to upper-division courses is dependent upon this minimum level of performance.

Any student with an overall GPA below 2.0 will not be admitted to upper-division Chemical Engineering courses. Students who have not been admitted to an Upper-Division Status will be dropped from departmental class rolls.

Transfer students at the Upper-Division level are admitted on a Provisional Status basis only.

GRADUATE STUDY PROGRAM

Graduate programs leading to the degrees of Master of Science and Doctor of Philosophy in Chemical Engineering are offered. The University’s Graduate School operates a Resident Graduate Program at Oak Ridge and Kingsport. See the Graduate Catalog for detailed information.

CIVIL ENGINEERING

Including Environmental Engineering

Professors:
- G. D. Reed (Head), Ph. D. Arkansas, P. E.; E. G. Burdette (Fred N. Peabody Professor), Ph. D. Illinois, P. E.; A. Chattejee, Ph. D. North Carolina State, P. E.; W. T. Davis (Associate Dean - Graduate School), Ph. D. Tennessee; D. W. Goodpasture (Tenneco Professor), Ph. D. Illinois, P. E.; W. L. Grecco (Associate Dean - Engineering), Ph. D. Michigan State, P. E.; K. W. Heathington (Associate Vice President - Research), Ph. D. Northwestern, P. E.; J. B. Humphreys, Ph. D. Texas A&M, P. E.; H. L. Johnson, M. S. Tennessee, P. E.; W. A. Miller (Director - SAMS), Ph. D. Georgia Institute of Technology, P. E.; B. A. Tschantz (Condra Professor), ScD New Mexico State, P. E.; C. R. Walker (Emeritus) M. S. Massachusetts Institute of Technology, P. E.; D. W. Weeter, Ph. D. Purdue, P. E.; J. Wegmann (IBM Professor), Ph. D. Northwestern.

Associate Professors:
- B. J. Frederick, B. C. E. Clarkson University, P. E.; J. H. Hansen (Space Institute, Tullahoma), Ph. D. Missouri; G. D. Kressin, J. D. Tennessee; A. B. Moore, M. S. Tennessee; R. B. Robinson (Fisher Professor), Ph. D. Iowa State, P. E.; R. F. Tiry (Emeritus), B. S. Marquette, P. E.

Assistant Professors:
- R. M. Bennett, Ph. D. Illinois, P. E.; E. C. Drumm, Ph. D. Arizona, P. E.; W. F. Kane, Ph. D. Virginia Polytechnic Institute and State University.

BACHELOR OF SCIENCE PROGRAM

The curriculum in civil engineering is designed to provide training in fundamental engineering sciences and in certain basic subjects in various civil engineering fields to serve as a basis for entrance into civil engineering practice and/or for graduate study. By use of technical electives a student can emphasize areas of study in construction, environmental engineering, geotechnical/materials, structures, transportation, or water resources.

Students are required to maintain a cumulative grade point average of at least 2.0 in all civil engineering and environmental engineering courses taken at the University of Tennessee, Knoxville, and used to satisfy the graduation requirements.

ELECTIVES

The department maintains lists of acceptable technical electives at the departmental office. Students must consult this list prior to registering for elective courses.

MASTER OF SCIENCE PROGRAM

Graduate programs in civil engineering and environmental engineering leading to the degree of Master of Science are offered to graduates of recognized undergraduate curricula.

The general requirements for the masters’ degrees are stated in the Graduate Catalog.

DOCTORAL PROGRAM

Graduate work leading to the degree of Doctor of Philosophy with a major in civil engineering is offered. Major fields of study include environmental engineering, geotechnical/materials, structural engineering, transportation, and water resources.

The general requirements for the doctoral degree are stated in the Graduate Catalog.

ELECTRICAL AND COMPUTER ENGINEERING

Professors:
- J. M. Googe (Acting Head), Ph. D. Georgia Institute of Technology, P. E.; A. Alexeff, Ph. D. Wisconsin, P. E.; J. M. Bailey, Ph. D.
- Georgia Institute of Technology; J. D. Birdwell, (John Fisher Young Professorship), Ph. D. Massachusetts Institute of Technology; A. O. Bishop, Ph. D. Clemson; T. V. Blaizek (Haliburton Professor), Ph. D. Pennsylvania; R. E. Bockrath (IBM Professorship), Ph. D. Northwestern; B. K. Bose (Condra Chair of Excellence), Ph. D. Calcutta; D. W. Bouldin (IBM Professorship), Ph. D. Vanderbilt, P. E.; R. C. Gonzales (IBM Professorship, Distinguished Professor), Ph. D. Florida; J. M. Googe, Ph. D. Georgia Institute of Technology, P. E.; G. W. Hoffman, Ph. D. Harvard; J. C. Hung (Distinguished Professor), Ph. D. New York, P. E.; E. J. Kennedy (Weston Fulton Professorship), Ph. D. Tennessee, P. E.; J. S. Lawier (Tenneco, Inc. Professor), Ph. D. Michigan State; W. O. Leffell (Emeritus), M. S. Tennessee; H. P. Neff, Ph. D. Auburn, P. E.; M. O. Pace, Ph. D. Georgia Institute of Technology, P. E.; J. F. Pierce (Distinguished Professor), Ph. D. Pittsburgh, P. E.; R. W. Rochelle, Ph. D. Maryland; J. R. Roth, Ph. D. Cornell; B. Smith, Jr. (Emeritus), M. S. Illinois, P. E.; F. W. Symonds, Ph. D. Nottingham (UK); J. D. Tillman (Emeritus), Ph. D. Auburn; C. H. Weaver (Emeritus), Ph. D. Wisconsin, P. E.

Associate Professors:
- R. D. Joseph (Space Institute, Tullahoma), Ph. D. Case Institute of Technology; A. Pujol (Space Institute, Tullahoma), Ph. D. Vanderbilt; M. J. Roberts, Ph. D. Tennessee; D. Rosenberg, Ph. D. New York; J. M. Rochelle, Ph. D. Tennessee; M. M. Trivedi, Ph. D. Utah State; J. W. Waller, Ph. D. Tennessee.

Assistant Professors:
- B. W. Bomar (Space Institute, Tullahoma), Ph. D. Tennessee; M. Abidi, Ph. D. Tennessee; D. Brzakovic, Ph. D. Florida.

Lecturers:

Courses required in the Electrical and Computer Engineering undergraduate curriculum cannot be used in either the M. S. or the Ph. D. programs.

BACHELOR OF SCIENCE PROGRAM

The Bachelor of Science in Electrical Engineering is planned to provide a foundation in both the basic sciences and specialized areas of modern engineering. The curriculum contains a suitable amount of cultural work to enhance the growth of the student toward the goal of becoming a professional person with strong social awareness. In the senior year, the student may elect to take courses focused in any one of the areas of electrical engineering; computer engineering, electromagnetic fields and communications, electronics and instrumentation, energy conversion and power systems, plasma and electro-optics engineering, and systems and networks. All of these areas are continued through the M. S. and Ph. D. programs. The senior curriculum
is sufficiently flexible to allow a student to take several courses outside the chosen area of focus. A student must take at least one senior elective that is a designated design course.

Generally, all sophomore and junior course work is offered each semester. Senior work is scheduled so that the student may enter at the beginning of the Fall Semester. This arrangement allows maximum flexibility, since the student may elect the normal four-year schedule, may choose an accelerated schedule, or may participate in the Cooperative Engineering Program. In addition to the usual research and teaching facilities in machinery, electronics, microwaves, solid state devices, and control equipment, the department has microcomputer, minicomputer and personal computer facilities.

PROGRESSION TO UPPER-DIVISION STATUS
Progression of electrical engineering majors to the upper-division programs of the department is based on the completion of all freshman courses prior to entering the sophomore level. Students applying for ECE 201 must have completed all courses listed in the freshman year of the ECE curriculum. Students must complete ECE 201, 202, Mathematics 200, 231, 241 and Physics 231, 232 before enrolling in junior level (300) courses in ECE. Prerequisites and corequisites as stated in the catalog are strictly enforced.

Students are evaluated during the second semester of the freshman year for enrollment in ECE 201, during the first semester of the sophomore year for ECE 202, and during the second semester of the sophomore year for enrollment in the junior level courses. Students must pre-register in the Department the previous semester to be evaluated for 201.

Passing grades in ECE 201, 202 and all of their corequisites and prerequisites are required for enrollment in all upper division electrical engineering courses.

Those not supplied into the junior level courses of the department will not be permitted to register for any upper division courses within the department. Students failing to meet the departmental requirements for course enrollment will be counseled and advised of educational alternatives. In the junior year, students may select any 4 of 6 electives during the second semester. These elective courses include electronics, energy, communications, computers, systems and plasma. Students must maintain an overall GPA of 2.00 on all ECE courses before obtaining a Bachelor of Science Degree.

GRADUATE

Comprehensive course and research programs for the degrees of Master of Science, Master of Engineering, and Doctor of Philosophy in Electrical Engineering are offered for students with career goals such as advanced design, research and teaching. Students admitted to the graduate program are expected to have a minimum point average of 3.0 for both all undergraduate study and for the senior year. Students with a B.S. or B.A. degree in a field other than Electrical Engineering are required to take certain ECE undergraduate courses before beginning the graduate program. See the Graduate Catalog for complete details on the graduate program.

ENGINEERING PHYSICS
Professor W. M. Bugg (Head): Physics staff as listed in the College of Liberal Arts.

The curriculum in engineering physics is designed to fulfill the educational requirements for professional work in various fields of applied science which are based upon a thorough knowledge of physics. The first two years are concerned with fundamental courses in engineering, science, and mathematics. In the upper division, the curriculum allows some choice of courses in engineering and in physics depending upon the interest of the student. The undergraduate program is a complete, professional program, equipping the student for entry into a variety of work in industry and research. The program also leads to graduate work in either physics or engineering.

ENGINEERING SCIENCE AND MECHANICS

Professors:

J. E. Stoneking (Head), Ph. D. Illinois, P. E.;
B. Antar (Space Institute, Tullahoma), Ph. D. Texas; A. J. Baker, Ph. D. New York, P. E.;
T. G. Carley, Ph. D. Illinois, P. E.;
J. H. Forrestor, Ph. D. Iowa State, P. E.;
W. Frost (Space Institute, Tullahoma), Ph. D. Washington, R. J. Jendrucko, Ph. D. Virginia, P. E.;
D. R. Keefe (Space Institute, Tullahoma), Ph. D. Florida; K. H. Kim, Ph. D. North Carolina State; J. D. Landes, Ph. D. Lehigh, P. E.; C. W. Lee, Ph. D. Illinois Institute of Technology;
T. D. McInay (Space Institute, Tullahoma), Ph. D. Auburn;
C. A. Newton (Emeritus), M. S. Syracuse;
H. Ph. Ph. D. Illinois Institute of Technology;
C. J. Remenyik, Ph. D. Johns Hopkins;
R. M. Robers (Associate Dean and Space Institute, Tullahoma), Ph. D. Air Force Institute of Technology;
R. L. Shobe (Emeritus), M. S. Kansa State;
W. T. Snyder (Dean), Ph. D. Northwestern;
W. W. Thomas, Jr. (Emeritus), B. S. Tennessee; J. Wassertman, Ph. D. Cincinnati, P. E.

Research Professor:

T. F. Moriarty, Ph. D. Illinois, P. E.

Associate Professors:

E. K. Boyce, M. S. Tennessee;
J. E. Caruthers (Space Institute, Tullahoma), Ph. D. Georgia Institute of Technology;
C. R. Engels (Space Institute, Tullahoma), Ph. D. Virginia Polytechnic Institute;
W. A. Lyday, Jr., M. S. Tennessee;
A. Mathews, Ph. D. Illinois, P. E.;
M. H. McInay (Space Institute, Tullahoma), Ph. D. Florida; C. J. Myers (Space Institute, Tullahoma), Ph. D. Indiana University;
G. H. Parham, Jr. (Emeritus), B. S. Cincinnati; W. E. Scott, Ph. D. Johns Hopkins;
M. O. Soliman, Ph. D. Tennessee, P. E.;
J. S. Steinhoff (Space Institute, Tullahoma), Ph. D. University of Chicago.

Assistant Professor:

J. A. M. Boulet, Ph. D. Stanford.

BACHELOR OF SCIENCE PROGRAM

The curriculum in engineering science provides students an opportunity for education with breadth in engineering science, mathematics, and physical or biological science. The program prepares students for a career in engineering development, research or additional graduate study leading to the master's or the doctoral degrees. The curriculum provides students a broad engineering education which permits a strong emphasis on engineering principles and basic science.

In the first two years students in the engineering science program study engineering, science, and mathematics. The engineering science program in the upper-division years contains a sufficient number of electives to provide for those special interests of students that cannot be accommodated in other programs. Examples of special interest elective groups available are engineering mechanics, biomedical engineering, environmental sciences, engineering materials, and non-destructive evaluation. Other elective groups are currently being developed and will be available in the future.

The engineering mechanics elective group focuses on analytical, computational and experimental methods used in investigating practical engineering problems. It is designed especially to develop engineers capable of engaging in research and development in industrial and governmental research laboratories. Because such preparation involves emphasis on the link between the basic sciences and engineering fundamentals, the engineering mechanics elective group provides a good background for students wishing to pursue engineering graduate studies.

The biomedical engineering elective group provides the basic background for an engineer to contribute to the fields of biology and medicine in technical areas as the design of research and diagnostic equipment, the development of artificial organs, and the application of the engineering sciences to further the basic understanding of biological systems. With some modifications, the program can emphasize other areas such as the use of computer systems to automate hospital operations, analyze medical data, and contribute to the broad area of health care delivery systems. Interested and qualified students may choose to use this program as a background for graduate study in engineering or the life sciences. The program includes the courses required for entrance into most medical schools, including The University of Tennessee Center for the Health Science in Memphis.

The environmental sciences elective group provides the opportunity for the student to apply engineering principles to the solution of environmental problems. This program gives the necessary background to achieve a high level of competence in professional practice or graduate study.
The engineering materials elective group provides background in the use of materials for various engineering applications including the selection of the proper materials to support the anticipated loads during the design life of the industrial need for individuals with a combined background in both structural analysis and materials properties.

The non-destructive evaluation elective group provides background in the application of techniques for evaluation material properties and determining material flaws. Demand for this background is increasing in high technology industries. Techniques studied include ultrasonics, X-rays, dye penetration, photelasticity.

The basic engineering sciences curriculum provides an opportunity to study those engineering science areas recognized by the American Society for Engineering Education as (1) mechanics; (2) electrical science, electric and magnetic fields, circuits, and electronics; (3) thermodynamics and statistical mechanics; (4) materials and momentum, and motion transfer; and (5) information science; (6) transfer and rate processes such as heat, mass, and momentum transfer; and (7) environmental sciences. No student will study all the engineering sciences but must structure a course plan to provide depth in some of the engineering sciences.

Because of the large number of elective courses to be selected in the engineering science degree program, faculty advising plays an essential role in the process of developing the student's course of study. Before the end of the sophomore year, students in the engineering science program are required to develop, in concert with a faculty advisor, a statement of objective and a course plan for the upper-division years.

For students with more than 70 semester hours, this course plan must be filed with the office of Admissions and Records before they can register for additional courses, and before a senior standing sheet can be prepared.

**MASTER OF SCIENCE AND DOCTORAL PROGRAMS**

Graduate programs leading to the degrees of Master of Science and Doctor of Philosophy in engineering with a major in engineering sciences are available to graduates of recognized curricula in engineering, mathematics, or one of the physical or biological sciences. Program options include solid mechanics, fluid mechanics, biomedical engineering, and other engineering sciences. In the biomedical and engineering science option, interdisciplinary programs are arranged to meet individual needs or interests. Each applicant is advised as to any prerequisite courses before entering a program; the student's program of study must be approved by his or her advisory committee, and must comply with the requirements of the Graduate School. The student's major professor may be selected from a department other than the Department of Engineering Science and Mechanics.

The flexibility and interdisciplinary aspects of the program options are intended to be of particular interest to prospective students currently employed in research, development, or design activities and whose interests in continuing education (either full-time or part-time) lie at one of the interfaces between science and engineering, or can best be met by interdisciplinary study in engineering. The department's course offerings and research activities are also intended to meet the needs of students who seek preparation for employment in engineering areas requiring specialization in mechanics, or in related interdisciplinary studies.

General policies of the Graduate School relating to admission, residence, examinations, and research are described in the Graduate Catalog.

**INDUSTRIAL ENGINEERING**

Professors:


Associate Professors:

D. H. Hutchinson, Ph. D. Georgia Institute of Technology, K. E. Kirby, Ph. D. Tennessee.

Assistant Professors:


Instructor:

D. F. Jackson, M. S. Tennessee.

Lecturers:

J. A. Bontadelli (Part-time), Ph. D. Ohio State; S. Douglass (Part-time), Ph. D. Tennessee, J. C. Mitchell (Part-time), Space Institute, Tullahoma, Ph. D. Vanderbilt.

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, materials, equipment, and energy with which they are found, such that the overall system functions at an optimal level and such that the needs of the human components of the system are adequately met.

This curriculum, which is built upon a strong background in mathematics and statistics, includes fundamental course work in all of the engineering sciences, introductory economics and accounting, training in fundamental human factors which influence engineering design, the economic analysis of alternative design choices, quality control techniques, manufacturing processes and materials, production and inventory system design and control, material handling systems and facilities design, the mathematical modeling and simulation of complex systems, and the design and installation of information acquisition and control systems. The technical and non-technical electives further allow the students to specialize in an area(s) which meets particular needs.

The solid, broad base in engineering, combined with training 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, aerospace systems, research groups, and government as well as in the traditional area of manufacturing.

**MASTER OF SCIENCE PROGRAM**

A graduate program leading to the degree of Master of Science is open to graduates of A.B. E. T.-accredited undergraduate curricula in Industrial Engineering or to graduates of other technical curricula who have an approved list of prerequisite course work. A non-thesis option of 30 semester hours of course work plus a 3-hour project is available.

Graduate work in Industrial Engineering provides for concentrations in operations research, engineering management, manufacturing and production systems, human factors engineering, information systems, reliability and quality control and traditional industrial engineering. Either one or two minors can be elected in Engineering, Mathematics, Psychology, Business, Computer Science, Statistics or Economics.

**MASTER OF ENGINEERING PROGRAM**

This professional degree program is intended as a culminating year in a five-year baccalaureate-master program which emphasized engineering design and professional practice. Admission requirements include those presented above plus the requirement of a Bachelor's degree from an A.B. E. T.-accredited Industrial Engineering program. This 30-semester hour program requires 12 hours of course work in an industrial engineering core, 6 hours of technical methods electives, 6 hours of Industrial engineering design electives and 6-hour thesis or design project.

**MATERIALS SCIENCE AND ENGINEERING**

Professors:

J. E. Spruiell (Head), Ph. D. Tennessee; K. H. G. Ashbee, Ph. D. Birmingham (England); D. C. Bogue, Ph. D. Delaware; B. S. Bovis (Part-time), Ph. D. Massachusetts Institute of Technology, C. R. Brooks, Ph. D.
Tennessee; R. A. Buchanan, Ph. D.; D. Vanderbilt; E. S. Clark, Ph. D. California (Berkeley); D. A. Canonico (Adjunct Status), Ph. D. Lehig; J. F. Fellers, Ph. D. Akron; J. S. Lin (Adjunct Status), Ph. D. Kansas; D. H. Louden (Research Professor, Part-time), Ph. D. Colorado; C. D. Lundin, Ph. D. Rensselaer Polytechnic Institute; C. J. McHargue (Part-time), Ph. D. Kentucky; B. F. Oliver, Ph. D. Pennsylvania State; P. J. Phillips, Ph. D. Liverpool (England); E. E. Stansbury (Emeritus), Ph. D. Cincinnati.

Associate Professors: W. T. Becker, Ph. D.Illinois; C. T. Liu (Adjunct Status), Ph. D. Brown University; T. T. Meek, Ph. D. Ohio State; A. J. Pedraza, Ph. D. National University (Argentina).

Assistant Professor: Roberto S. Benson, Ph. D. Florida State University.

### 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 provide education and training in the fundamental and engineering sciences with special attention given to the production, development and utilization of materials. Emphasis is placed on developing the expertise needed to participate in selection, development and production of materials for major engineering systems. The program strives to develop in its students the ability to specify materials requirements, select from existing materials, conceive and characterize new materials and applications, develop the data base required for use of materials (including an understanding of failure modes and phenomena), and develop processes for improvement of materials and/or materials systems. It is anticipated that some of the program’s graduates will continue their education in graduate school; hence it is important that the program prepare those students for advanced studies.

The field of materials science and engineering is quite broad, encompassing metallic, ceramic, and polymeric materials as well as composites made from combinations of materials. Consequently, the curriculum contains a central core of courses that are applicable to all materials types with flexibility in the upper division years to permit concentration and in-depth coverage of specific materials categories. Students have the opportunity to select from three concentrations: metallurgical engineering, polymer engineering or materials engineering. By judicious choice of electives the student may get a broad education or may develop a specialty area such as materials processing, mechanical behavior of materials, failure analysis, materials for electronic devices, or materials characterization. A minimum of 19 semester-hours of humanities-social science courses must be taken from the approved list of courses. Graduation in materials science and engineering requires a minimum grade point average of 2.00 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 evidence of satisfactory and orderly progress through the prescribed curriculum.

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

**PROVISIONAL STATUS:** Students who have completed 50 semester hours of Lower-Division engineering curriculum course work with an overall GPA between 2.0 and 2.4 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 their ability to perform satisfactorily in upper-division courses by attaining a minimum GPA of 2.0 in at least 8 hours of 300-level required courses specified by the department. Further progression to upper-division courses is dependent upon this minimum level of performance.

**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 by transfer credit is considered to be a transfer student.

### GRADUATE STUDY PROGRAMS

Graduate programs leading to the degrees of Master of Science and Doctor of Philosophy with a major in metallurgical engineering or polymer engineering are offered. Detailed information about graduate programs in materials science and engineering and the requirements for either M. S. or Ph. D. degrees are given in the Graduate Catalog.

### MECHANICAL AND AEROSPACE ENGINEERING

Professors:

D. R. Pitts (Head), Ph. D. Georgia Institute of Technology; R. V. Arimilli, Ph. D. Virginia Polytechnic Institute and State University; J. F. Bailey (Emeritus), Ph. D. Lehig, P. E.; G. W. Braun (Emeritus, Space Institute, Tallahoma), Ph. D. G. Totten; F. G. Collins (Space Institute, Tallahoma), Ph. D. California (Berkeley), P. E.; A. J. Edmondson, (Associate Head), Ph. D. Texas A&M; J. A. Eular, Ph. D. Purdue, P. E.; W. Frost (Space Institute, Tallahoma), Ph. D. Washington; G. W. Garrison (Space Institute, Tallahoma), Ph. D. North Carolina State; K. E. Harwell (Space Institute, Tallahoma), Ph. D. California Institute of Technology, P. E.; W. H. Heiser (Space Institute, Tallahoma), Ph. D. Massachusetts Institute of Technology; J. W. Hodging, Ph. D. Georgia Institute of Technology, P. E.; R. W. Holland, M. S. Tennessee, P. E.; W. S. Johnson, Ph. D. Clemson, Ph. D. Oklahoma State, P. E.; E. J. Krane, Ph. D. Oklahoma; H. Liston, Jr. (Vice Provost), M. E. A. George Washington; C. F. Lo (Space Institute, Tallahoma, Research Professor), Ph. D. Cornelt; R. L. Maxwell (Emeritus), M. S. Case Western Reserve, P. E.; M. W. Milligan, Ph. D. Tennessee, P. E.; M. K. Newman (Emeritus, Space Institute, Tallahoma), Ph. D. Columbia, P. E.; M. Parang, Ph. D. Oklahoma, P. E.; J. R. Parsons, Jr., Ph. D. North Carolina State, P. E.; C. Peters (Space Institute, Tallahoma), D. Applied Science Brussels; F. Shahrokhli (Space Institute, Tallahoma), Ph. D. Oklahoma; G. V. Smith, Ph. D. Pennsylvania State, P. E.; F. H. Speckhart (IBM Professor), Ph. D. Georgia Institute of Technology, P. E.; W. K. Stair (Emeritus), M. S. Tennessee; J. M. Tucker (Emeritus), M. S. Illinois; H. J. Wilkerson, Ph. D. Tennessee, P. E.; C. C. Wilson, Ph. D. Purdue; J. M. Wu (Space Institute, Tallahoma), Ph. D. California Institute of Technology, R. L. Young (Space Institute, Tallahoma), Ph. D. Tennessee, P. E.

Associate Professors:

S. E. Becker, Ph. D. North Carolina State, P. E.; R. A. Crawford (Space Institute, Tallahoma), Ph. D. Tennessee; T. H. Moudlen (Space Institute, Tallahoma), Ph. D. Tennessee; R. J. Schultz (Space Institute, Tallahoma), Ph. D. Tennessee; P. E.; A. D. Vakili (Space Institute, Tallahoma), Ph. D. Tennessee.

Assistant Professors:

R. V. Dubey, Ph. D. Clemson, S. M. Jung (Space Institute, Tallahoma), Ph. D. Pennsylvania State; R. Keyhani, Ph. D. Ohio State; K. E. Nguyen, Ph. D. Colorado.

### BACHELOR OF SCIENCE PROGRAM

Separate curricula are offered in aerospace engineering and mechanical engineering; however, the first two years of these curricula are identical. During the first two years, the curricula provide for training and study in the basic sciences of physics, mathematics, chemistry, and engineering common to these fields. The third year of both programs continues with the development of the particular engineering sciences of the aerospace and mechanical engineering fields. In the senior year an opportunity is provided for the student to apply this fundamental knowledge to mechanical and aerospace engineering problems. Both curricula are arranged in the upper-division years to prepare the student for graduate study or technical employment.

Aerospace engineering has scientific foundations close to those of mechanical engineering. The aerospace engineer, however, devotes attention particularly to the research, development, design, testing, and production of aerospace vehicles - aircraft,
spacecraft, missiles; auxiliary systems - heating, cooling, guidance, control; and propulsion systems - piston engines, turbo-jets, ramjets, rockets. Emphasis in the senior year is directed toward these topics and the program builds upon in a major aerospace design project.

Mechanical engineering, the most versatile engineering discipline, has its foundation in the basic sciences and requires an understanding of such areas of applied science as solid and fluid mechanics, thermodynamics, heat transfer, structures, vibrations, mechanical design, manufacturing processes, and instrumentation in order to resolve the complex engineering problems of the real world. A major design project in the senior year builds upon this background in a capstone experience.

PROGRESSION TO UPPER-DIVISION PROGRAMS

Progression to Upper Division Programs is competitive and is based on departmental capacity. Factors considered include overall grade point average, performance in selected lower division courses, and evidence of satisfactory and orderly progress through the prescribed curriculum.

A minimum cumulative grade point average of 2.0 for all departmental courses taken at UT is required for graduation.

FULL STATUS: A Lower Division student in the department may apply for progression to upper Division Programs after completing 52 semester hours of Lower Division engineering curriculum and with overall GPA of at least 2.4.

PROVISIONAL STATUS: Students who have completed 52 semester hours of Lower Division engineering curriculum course work with an overall GPA between 2.0 and 2.4 may apply for provisional status. The granting of Provisional Status is based on the availability of space in departmental programs after Full status students have been accommodated. Provisional Status students are required to demonstrate their abilities to perform satisfactorily in Upper Division courses by attaining a minimum GPA of 2.0 in at least 11 semester hours of 300 level required engineering courses (included 8 specified hours in the department). Further progression to upper division courses is dependent upon this minimum level of performance.

Any student with an overall GPA below 2.0 will not be admitted to mechanical or aerospace engineering courses. Students who have not been progressed to an Upper Division Program may apply for provisional status. The granting of Provisional Status is based on the availability of space in departmental programs after Full status students have been accommodated. Provisional Status students are required to demonstrate their abilities to perform satisfactorily in Upper Division courses by attaining a minimum GPA of 2.0 in at least 11 semester hours of 300 level required engineering courses (included 8 specified hours in the department). Further progression to upper division courses is dependent upon this minimum level of performance.

Any student with an overall GPA below 2.0 will not be admitted to mechanical or aerospace engineering courses. Students who have not been progressed to an Upper Division Program will be dropped from departmental class rolls.

TRANSFER STUDENTS: At the Upper Division level students are admitted on a Provisional Status basis only. Any student presenting more than 28 semester is considered a Transfer Student.

LOSS OF FULL STATUS: Students who progress to Upper Division Programs are expected to maintain an overall GPA of at least 2.0 and a concurrent GPA of at least 2.0 in departmental courses. Failure to maintain these minimum level of performance will result in a review of the overall progress of the student through the prescribed curriculum and probable loss of Full Status.

GRADUATE STUDY PROGRAMS

Graduate programs leading to the degrees of Master of Science and Doctor of Philosophy with specialization in mechanical engineering or aerospace engineering are available to graduates of recognized undergraduate curriculum in mechanical or aerospace engineering and to graduates of the curricula who satisfy the necessary prerequisite courses. The general requirements for advanced degrees are summarized in the Graduate Catalog.

NUCLEAR ENGINEERING

Professors:
T. W. Kerlin (Head), Ph. D. Tennessee, P. E.;
H. L. Dodds, Ph. D. Tennessee, P. E.;
J. B. Russell (Part-time), Ph. D. Georgia Institute of Technology; J. T. Mihalceo (Part-time), Ph. D. Tennessee; F. P. Pasqua (Emeritus), Ph. D. Northwestern, P. E.;
R. B. Perez, Ph. D. Madrid (Spain);
H. C. Roland, Ph. D. Tennessee;
P. N. Stevens, Ph. D. Northwestern, P. E.;
J. E. Turner (Part-time), Ph. D., (Vanderbilt),
P. E.; N. Uckan (Part-time), Ph. D. Michigan,
R. E. Uhrig (Distinguished Professor), Ph. D. Iowa State, P. E.

ASSOCIATE PROFESSORS:
E. M. Katz, Ph. D. Tennessee, P. E.;
L. F. Miller, Ph. D. Texas A&M, P. E.;
T. H. Scott, Ph. D. Florida, P. E.;
B. R. Upadhyaya, Ph. D. California, P. E.

BACHELOR OF SCIENCE PROGRAM

The curriculum is designed to provide a thorough educational experience for students interested in careers in nuclear engineering. The first two years are concerned with the fundamental courses needed as preparation for upper division courses. In the last two years students take scientific and engineering courses which equip them for entry into industry, research, or graduate studies.

MASTER OF SCIENCE PROGRAM

A graduate program leading to a degree of Master of Science is available to graduates of recognized undergraduate curriculum in engineering and physics. Each applicant will be advised as to the necessary prerequisite courses before entering the program. The general requirements of the masters' 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.
18 hours required. (See College of Engineering General Requirements.)

**CHEMICAL ENGINEERING**

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Hours Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Engineering 200, 240</td>
<td>7</td>
</tr>
<tr>
<td>Chemistry 310-319, 371</td>
<td>7</td>
</tr>
<tr>
<td>Mathematics 200, 231, 241</td>
<td>8</td>
</tr>
<tr>
<td>Physics 231</td>
<td>3</td>
</tr>
<tr>
<td>Humanities/Social Science</td>
<td>5</td>
</tr>
<tr>
<td>Electrical Engineering 301</td>
<td>3</td>
</tr>
<tr>
<td>Junior</td>
<td></td>
</tr>
<tr>
<td>Chemical Engineering 330, 340, 310, 360, 380</td>
<td>14</td>
</tr>
<tr>
<td>Chemistry 350, 351</td>
<td>6</td>
</tr>
<tr>
<td>Material Science and Engineering 201</td>
<td>3</td>
</tr>
<tr>
<td>Chemistry Option</td>
<td>3</td>
</tr>
<tr>
<td>1 Humanities/Social Science</td>
<td>6</td>
</tr>
<tr>
<td>Senior</td>
<td></td>
</tr>
<tr>
<td>Chemical Engineering 450, 440, 480, 410, 490</td>
<td>16</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>9</td>
</tr>
<tr>
<td>Humanities/Social Science</td>
<td>6</td>
</tr>
<tr>
<td>Total: 132 hours</td>
<td></td>
</tr>
</tbody>
</table>

1 Must take 3 of these 5 courses which are 3 hour lectures and 1 hour lab each.

**CIVIL ENGINEERING**

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Hours Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics 241, 231, 200</td>
<td>8</td>
</tr>
<tr>
<td>Physics 231</td>
<td>3</td>
</tr>
<tr>
<td>English 459</td>
<td>3</td>
</tr>
<tr>
<td>Geology 210</td>
<td>3</td>
</tr>
<tr>
<td>Engineering Science and Mechanics 231</td>
<td>3</td>
</tr>
<tr>
<td>Civil Engineering 210*221, 251</td>
<td>9</td>
</tr>
<tr>
<td>Mechanical Engineering 331</td>
<td>9</td>
</tr>
<tr>
<td>Humanities/Social Science</td>
<td>3</td>
</tr>
<tr>
<td>Junior</td>
<td></td>
</tr>
<tr>
<td>Electrical and Computer Engineering 301</td>
<td>3</td>
</tr>
<tr>
<td>Civil Engineering 330, 361, 352, 390</td>
<td>12</td>
</tr>
<tr>
<td>Civil Engineering 321, 335, 380, 340, 395</td>
<td>15</td>
</tr>
<tr>
<td>Humanities/Social Science</td>
<td>3</td>
</tr>
<tr>
<td>Senior</td>
<td></td>
</tr>
<tr>
<td>Civil Engineering 440, 471, 480, 400, 405</td>
<td>14</td>
</tr>
<tr>
<td>Engineering Electives</td>
<td>6</td>
</tr>
<tr>
<td>Civil Engineering Electives</td>
<td>6</td>
</tr>
<tr>
<td>Humanities/Social Science</td>
<td>12</td>
</tr>
<tr>
<td>Total: 137 hours</td>
<td></td>
</tr>
</tbody>
</table>

1 See College list of approved courses.

**ELECTRICAL AND COMPUTER ENGINEERING**

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Hours Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics 231, 200, 241</td>
<td>8</td>
</tr>
<tr>
<td>Physics 231, 232</td>
<td>7</td>
</tr>
<tr>
<td>Electrical and Computer Engineering 201, 202, 209</td>
<td>251, 252</td>
</tr>
<tr>
<td>Material Science and Engineering 201</td>
<td>3</td>
</tr>
<tr>
<td>Basic Engineering 201</td>
<td>3</td>
</tr>
<tr>
<td>Humanities/Social Science Electives</td>
<td>6</td>
</tr>
<tr>
<td>Junior</td>
<td></td>
</tr>
<tr>
<td>Electrical and Computer Engineering 311, 321, 331, 341, 351</td>
<td>9</td>
</tr>
<tr>
<td>Electrical and Computer Engineering 312,319, 320, 329</td>
<td>6</td>
</tr>
<tr>
<td>Electrical and Computer Engineering 332,339, 361,369</td>
<td>9</td>
</tr>
<tr>
<td>Electrical and Computer Engineering 338,339</td>
<td>9</td>
</tr>
<tr>
<td>Humanities/Social Science Electives</td>
<td>4</td>
</tr>
<tr>
<td>Senior</td>
<td></td>
</tr>
<tr>
<td>Electrical and Computer Engineering Senior Electives</td>
<td>18</td>
</tr>
<tr>
<td>Humanities/Social Science Electives</td>
<td>3</td>
</tr>
<tr>
<td>Mechanical Engineering 331</td>
<td>3</td>
</tr>
<tr>
<td>Electrical Engineering 322 or Engineering Science and Mechanics 231</td>
<td>3</td>
</tr>
<tr>
<td>Total: 135 hours</td>
<td></td>
</tr>
</tbody>
</table>

1 Must take 3 of these 5 courses which are 3 hour lectures and 1 hour lab each.

**ENGINEERING PHYSICS**

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Hours Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 137 (311, 138 (132)</td>
<td>8</td>
</tr>
<tr>
<td>Mathematics 141, 142</td>
<td>8</td>
</tr>
<tr>
<td>Chemistry 120, 130</td>
<td>8</td>
</tr>
<tr>
<td>English 101, 102</td>
<td>8</td>
</tr>
<tr>
<td>Basic Engineering 100, 111</td>
<td>4</td>
</tr>
<tr>
<td>Senior</td>
<td></td>
</tr>
<tr>
<td>Physics 237 (231, 238 (232)</td>
<td>7-8</td>
</tr>
<tr>
<td>Mathematics 241, 231</td>
<td>7</td>
</tr>
<tr>
<td>Engineering/Techn. Elective</td>
<td>6</td>
</tr>
<tr>
<td>Humanities/Social Science Elective</td>
<td>12</td>
</tr>
<tr>
<td>Junior</td>
<td></td>
</tr>
<tr>
<td>Physics 311, 321, 312, 421</td>
<td>13</td>
</tr>
<tr>
<td>Physics Lab Elective</td>
<td>6</td>
</tr>
<tr>
<td>Engineering/Techn. Elective</td>
<td>6</td>
</tr>
<tr>
<td>Humanities/Social Science Elective</td>
<td>6</td>
</tr>
<tr>
<td>Senior</td>
<td></td>
</tr>
<tr>
<td>Physics 431, 432, 412</td>
<td>9</td>
</tr>
<tr>
<td>Physics 411</td>
<td>3</td>
</tr>
<tr>
<td>Engineering/Techn. Elective</td>
<td>6</td>
</tr>
<tr>
<td>Electives</td>
<td>9</td>
</tr>
<tr>
<td>Total: 128 hours</td>
<td></td>
</tr>
</tbody>
</table>

1 Honors courses (137-38, 237-38) are recommended to qualified students. Transfer students from other engineering departments may substitute Basic Engineering 121-131 for Physics 137, but must show training in heat and thermodynamics or take Physics 138 (132).
2 A total of 12 hours of engineering electives plus 1 hour of technical electives are required.
3 Engineering electives should form a coherent group.
4 Humanities/Social Science courses approved by the department.
5 Must be selected from approved college list.

**ENGINEERING PHYSICS: BIOMEDICAL ENGINEERING CONCENTRATION**

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Hours Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 231, 232</td>
<td>7</td>
</tr>
<tr>
<td>Engineering and Mechanics 231, 271, 321, 341</td>
<td>12</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>6</td>
</tr>
<tr>
<td>Junior</td>
<td></td>
</tr>
<tr>
<td>Basic Engineering 201</td>
<td>2</td>
</tr>
<tr>
<td>Electrical and Computer Engineering 301</td>
<td>3</td>
</tr>
<tr>
<td>Engineering Science and Mechanics 322 or 442</td>
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</tr>
<tr>
<td>Engineering Science and Mechanics 301, 351</td>
<td>4</td>
</tr>
<tr>
<td>Material Science and Engineering 201</td>
<td>3</td>
</tr>
<tr>
<td>Mechanical Engineering 331</td>
<td>3</td>
</tr>
<tr>
<td>Industrial Engineering 405</td>
<td>2</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>6</td>
</tr>
<tr>
<td>Humanities/Social Science Elective</td>
<td>3</td>
</tr>
<tr>
<td>Humanities/Social Science Elective</td>
<td>6</td>
</tr>
<tr>
<td>Total: 136 hours</td>
<td></td>
</tr>
</tbody>
</table>

1 Courses (including biomedical engineering courses) approved by the student’s advisor and the department which, when taken together, form a biomedical engineering emphasis. Pre-med, pre-vet, and pre-dentistry programs include biology and organic chemistry courses as part of these electives.
2 Appropriate course approved by the department.
3 Humanities/Social Science courses approved by the college.

**INDUSTRIAL ENGINEERING**

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Hours Credit</th>
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</thead>
<tbody>
<tr>
<td>Mathematics 241, 231, 200</td>
<td>8</td>
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<tr>
<td>Physics 231, 232</td>
<td>7</td>
</tr>
<tr>
<td>Engineering Science and Mechanics 321</td>
<td>3</td>
</tr>
<tr>
<td>Statistics 251</td>
<td>3</td>
</tr>
<tr>
<td>Industrial Engineering 405, 302</td>
<td>6</td>
</tr>
<tr>
<td>Industrial Engineering 405, 302, 300, 400</td>
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</tr>
<tr>
<td>Industrial Engineering 301, 304</td>
<td>8</td>
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<tr>
<td>Nuclear Engineering 310, 311</td>
<td>6</td>
</tr>
<tr>
<td>Economics 201</td>
<td>4</td>
</tr>
<tr>
<td>Accounting 201</td>
<td>3</td>
</tr>
<tr>
<td>Humanities/Social Science Electives</td>
<td>3</td>
</tr>
<tr>
<td>Technical Elective</td>
<td>3</td>
</tr>
<tr>
<td>Industrial Engineering 401, 402, 403, 404</td>
<td>19</td>
</tr>
<tr>
<td>Industrial Engineering Elective</td>
<td>3</td>
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<tr>
<td>Total: 139 hours</td>
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</table>

**MATERIALS SCIENCE AND ENGINEERING**

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Hours Credit</th>
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<tbody>
<tr>
<td>Mathematics 241, 202</td>
<td>6</td>
</tr>
<tr>
<td>Materials Science and Engineering 201, 202</td>
<td>6</td>
</tr>
<tr>
<td>Materials Science and Engineering Concentration</td>
<td>2-4</td>
</tr>
<tr>
<td>Physics 231, 232</td>
<td>7</td>
</tr>
</tbody>
</table>
### Sophomore Concentration Courses

A. Metallurgical Engineering (Materials Science and Engineering 203, 205) 4
B. Polymer Engineering (Chemistry 110) 4
C. Materials Engineering (Materials Science and Engineering 201, 202, 204) 8

### Junior Concentration Courses

A. Metallurgical Engineering (Materials Science and Engineering 310, 320) 6
B. Polymer Engineering (Materials Science and Engineering 330, 340, 342) 7
C. Materials Engineering (Materials Science and Engineering 340, 360) 6

### Senior Concentration Courses

A. Metallurgical Engineering (Materials Science and Engineering 421, 422, 423, 424, 470) 5 (Technical Elective) 3
B. Polymer Engineering (Materials Science and Engineering 442, 443, 444) 9 (Technical Elective) 6 (Materials Science and Engineering Elective) 3
C. Materials Engineering (Materials Science and Engineering 310, 470, 471, 472) 12 (Materials Science and Engineering Elective) 6

### MECHANICAL ENGINEERING

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics 231, 241, 200</td>
<td>8</td>
</tr>
<tr>
<td>Physics 231, 232</td>
<td>7</td>
</tr>
<tr>
<td>Basic Engineering 201</td>
<td>2</td>
</tr>
<tr>
<td>Material Science and Engineering 201</td>
<td>6</td>
</tr>
<tr>
<td>Mechanical Engineering 331</td>
<td>3</td>
</tr>
<tr>
<td>Humanities/Social Sciences Elective</td>
<td>6</td>
</tr>
<tr>
<td>Electrical and Computer Engineering 302</td>
<td>5</td>
</tr>
<tr>
<td>Humanities/Social Sciences Elective</td>
<td>2</td>
</tr>
<tr>
<td>Mechanical Engineering 451, 466, 475, 449, 431</td>
<td>13</td>
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</tbody>
</table>

### NUCLEAR ENGINEERING

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
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<tbody>
<tr>
<td>Mathematics 200, 231, 241</td>
<td>7</td>
</tr>
<tr>
<td>Physics 231, 232</td>
<td>2</td>
</tr>
<tr>
<td>Nuclear Engineering 201, 203, 202, 204</td>
<td>8</td>
</tr>
<tr>
<td>Electrical and Computer Engineering 301</td>
<td>3</td>
</tr>
<tr>
<td>Humanities/Social Sciences Elective</td>
<td>6</td>
</tr>
<tr>
<td>Mechanical Engineering 401, 403, 405, 402, 404, 406</td>
<td>20</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>6</td>
</tr>
<tr>
<td>Humanities/Social Sciences Elective</td>
<td>6</td>
</tr>
</tbody>
</table>

Total: 136 hours