William T. Snyder, Dean
William A. Miller, Associate Dean
William K. Stair, Associate Dean
Andrew W. Spickard, Associate Dean

The College of Engineering

The college has ten major undergraduate curricula in which a student may specialize: aerospace, chemical, civil, electrical, industrial, mechanical, metallurgical, and nuclear engineering; engineering physics, and engineering science.

Agricultural engineering is based in the College of Agriculture with facilities located on the Agricultural Campus. The agricultural engineering curriculum is offered cooperatively by the College of Agriculture and the College of Engineering. Details of the curriculum may be found in the College of Agriculture section of this catalog.

Facilities

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

Ferris Hall. This building houses the offices, classrooms, laboratories, and shops of the electrical engineering department, and the Water Resources Laboratory. There is also a remote input/output terminal and computer graphics facility connected with The University of Tennessee Computing Center.

Estabrook Hall. Some operations of the Departments of Civil Engineering and Engineering Science and Mechanics and of the Engineering Experiment Station are carried out in Estabrook Hall. A basic engineering lecture room, four engineering drawing laboratories, and engineering drawing staff offices are located on the second floor.

Perkins Hall. This building houses the Departments of Civil Engineering, Engineering Science and Mechanics, Engineering Experiment Station, and the Offices of the Dean of the College of Engineering. The building contains laboratories, faculty offices, and classrooms.

Nuclear Engineering Building. This build-
ing houses operations of the nuclear engineering department and contains laboratories and equipment for monitoring, counting, and investigating various nuclear phenomena. It also houses subcritical reactors.

Nathan W. Dougherty Engineering Building
This building, the most recent and largest of the engineering buildings, houses the Departments of Chemical, Metallurgical and Polymer Engineering, and Mechanical and Aerospace Engineering. In addition to classrooms and instructional laboratories, it provides modern facilities for various types of research.

Alumni Memorial Auditorium-Gymnasium
A portion of this building is housing classrooms, and laboratories of the Department of Industrial Engineering.

Berry Hall
This building is used by the Department of Civil Engineering and the Engineering Experiment Station for maintenance and research work.

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 named in part through the untried 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 to students in the college in order to combine significant experience in industry with academic preparation.

Cooperative work assignments differ from part-time or summer employment in that they involve regularly scheduled cycles of full-time academic quarters alternated with full-time work quarters—usually six, a minimum of five—in career-related, planned assignments of progressive complexity and responsibility. In exposing the student in this manner to the world of work, the college and the facilities of industry join together to offer a broader and richer preparation for postgraduate employment and for life in general than can be provided by a conventional academic program alone. This experience in an industrial and professional environment contributes to the student's maturity, increases the scope of acquaintances and contacts, and enables the student to define more clearly educational and career interests and objectives. Some of the experience received is at a subprofessional level not available to an engineer after graduation, yet is of great significance in total education and effectiveness.

Admission to the Cooperative Engineering Program is open to academically qualified freshman and sophomore students. A fall application period conducted in early October is the source of most candidates placed for the following summer or fall; a late application period may be held in May for students who failed to apply during the previous fall and who hope for placement the subsequent winter. Students must be attending the College of Engineering at the time of application. Those in school fall quarter who are undecided about co-op participation should nevertheless apply during the fall application period, and then request that the applications be held until they are ready to make a definite commitment, since all applications are considered by all placements for which they are qualified.

In general, students begin their work periods after completing their freshman academic work and continue them until beginning the senior year in the fall. Applicants must be able to schedule a minimum of five work periods alternating with academic quarters prior to beginning their senior year and the fall quarter. With very few exceptions, transfer students must complete a minimum of two academic quarters in the College of Engineering at UTK before beginning co-op participation.

Students in the Cooperative Engineering Program are classified as follows in terms of standard hours credit completed in the standard undergraduate program for their anticipated degree in engineering:

Freshman
Sophomore
Junior
Senior
Second degree and transfer students will be assigned "equivalent quarters completed" (not dependent upon hours completed) which will indicate progress toward the engineering degree. Total hours completed are not an applicable measure of the progress of such students.

Such students who wish to co-op must plan very carefully in order to fit into the established schedule of courses prepared for co-ops. Students planning to transfer should begin working as soon as possible with an advisor from the department they plan to enter in order to meld into the co-op schedule at an optimum time. A brochure with further details may be obtained from the Cooperative Engineering Program Office, University of Tennessee, Knoxville, Tennessee 37996-2350.

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 eight major subjects: aerospace engineering, chemical engineering, electrical, 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 aerospace, civil, electrical, industrial, mechanical, and nuclear engineering. Information concerning graduate programs is given in the Graduate Catalog.

Graduate Program at the UT Space Institute
At the University of Tennessee Space Institute near Tullahoma, graduate-level courses are offered in engineering fields such as aerospace, electrical, and mechanical engineering, and in mathematics and physics. Current programs lead to the M.S. and Ph.D. degrees. Information may be obtained from the Registrar, The University of Tennessee Space Institute, Tullahoma, TN 37388.

Engineering Experiment Station
William T. Snyder, Director

The management of the Engineering Experiment Station is vested in the president of the University, the dean of engineering and the director.

An advisory committee consisting of the heads of the departments of the college and the heads of departments in allied scientific fields may assist in determining policy and procedures. Members of the faculty of the college are available for consultation and advice in technical matters.

The station is organized to conduct research underlying engineering practice and to aid in the development of the state's resources and industries insofar as funds available will permit. Inquiries from industries concerning technical questions which interest them are welcomed.

Bulletins are published from time to time giving the results of various investigations. Upon request, unpublished results of current studies are made available to interested parties.

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). Currently accredited engineering curricula at UTK include aerospace, agricultural, chemical, civil, electrical, engineering science, industrial, mechanical, metallurgical, and nuclear.

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. 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.
3. 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.
4. 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
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.

The college assumes an obligation to answer 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 college. However, the structure and permissible courses of the non-technical (humanities-social sciences) elective requirements are established by the respective departments. Therefore, individual departments may delete courses from this list, require certain courses, or require selection of courses from specific subgroups. Students should consult their departments for any restrictions.

This list is intended to eliminate paper work for the commonly chosen electives and to illustrate the kinds of suitable courses. The list is not all inclusive, and it is recognized that individual students may desire to take courses not on the approved list. Those students should discuss their interests and desires with their academic advisor prior to registering for elective courses. Courses are to be used to satisfy degree requirements. Also the catalog may state prerequisites for upper-division courses in the list. In such cases, students are encouraged to consult the instructor in the particular course. With respect to student records these lists are handled by means of a substitution sheet which originates with the advisor. Courses which are primarily skill development courses, involve mathematics or science, are intended for specialists in another field (such as education), or which are very elementary in nature are usually not approved as humanities-social science electives in an engineering curriculum. A minimum of 24 quarter hours of acceptable humanities-social science electives are required in all programs.

**ELECTIVE COURSES IN HUMANITIES AND SOCIAL SCIENCES**

**Area I. Human, Economic, and Political Relationships to Engineering**

A. Governance and Political Science
B. Economics
C. Sociology and Psychology
D. Human Values

**Area II. Society—It's Culture, History, and Literature**

A. Fine Arts
B. American Culture
C. History
D. Literature
E. Anthropology

**Area III. Technology and Society**

A. Human Habitat
B. Technology Assessment
C. Communication
D. Resources

Courses in the list which follows are selected by the committee with revisions as course offerings and needs change. They are recommended as satisfying the non-technical (humanities-social sciences) elective requirements. These courses, involved in the curricula of the college. However, the structure and permissible courses of the non-technical elective content of each engineering curriculum are established by the respective departments. Therefore, individual departments may delete courses from this list, require certain courses, or require selection of courses from specific subgroups. Students should consult their departments for any restrictions.

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cannot be used as humanities-social science electives. Individual departments determine the appropriate substitutions.

Approval of Electives and Substitutions. Not later than the beginning of the third quarter prior to anticipated graduation, each student shall discuss with an advisor the status of the student's study. Any necessary additions to or substitutions in the program, or electives requiring special approval, shall be cleared in written form at that time, and it is each student's responsibility to see that all necessary approvals are secured. Inattention to such matters may delay graduation.

ADVISING CONFERENCE

The relationship between an engineering student and an advisor is an important one, and a student should go to the advisor for assistance or information at any time. All students are required to see their advisor during the Fall Quarter (or during one other quarter if they are not in school during the fall). Engineering students normally are asked to see their advisors during the two-week period immediately preceding the advance registration period. A record of the advising conference is needed in order to advance register. During other quarters of the year, the student's department determines whether or not an advisor must be consulted prior to advance registration. An advising conference record card must be presented in order to advance register for these quarters also, though an actual conference is required only once a year for most students.

CURRICULA, TABULAR VIEW

Following are the course requirements for the various engineering curricula. The numbers in the columns indicate the number of quarter hours of credit for each course. Columns represent the three principal quarters of the academic year—fall, winter, and spring. This is not a schedule, and courses are available in quarters other than those indicated here. This listing is a guide, not a rigid schedule. Individual course prerequisites should be strictly adhered to, even if courses are not taken in the quarters indicated. Although the requirements for each degree can be completed in four academic years (five for the cooperative program), the quality of the learning experience is much more important than the speed with which the curriculum is completed.

Humanities-social studies electives are the same as non-technical electives in these tabulations. Questions about individual courses should be directed to the department responsible for the course; questions about a particular curriculum should be directed to the major department.

Prerequisites. Before registering for any engineering course, a student should make certain that any necessary background work has been completed. Refer to the course descriptions to determine what is needed. In addition to specific prerequisites listed, it is assumed that a student taking freshman or sophomore engineering courses has completed all freshman courses, whether specifically listed as a prerequisite or not. When this is not the case, a student should seek advice from the advisor or department responsible for the course in question before registration so as to minimize the chances of academic difficulty. Students who do not have prescribed prerequisites may be dropped from a course at any time during a quarter when the lack of prerequisites is discovered.

### Aerospace Engineering

<table>
<thead>
<tr>
<th>Hours</th>
<th>Credit</th>
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<tbody>
<tr>
<td>Freshman</td>
<td>3 3</td>
</tr>
<tr>
<td>Math 1840-50-60</td>
<td>3 3 3</td>
</tr>
<tr>
<td>Chemistry 1110-20-30</td>
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<td>English 1010-20-33</td>
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</tr>
<tr>
<td>Graphics 1410-20-30</td>
<td>3 3 3</td>
</tr>
<tr>
<td>Basic Engineering 1310-20-30</td>
<td>4 4 4</td>
</tr>
<tr>
<td>Basic Engineering 1410-20-30</td>
<td>3 3 3</td>
</tr>
<tr>
<td>Aerospace 2040-20-30</td>
<td>3 3 3</td>
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<tr>
<td>Mathematics 2840-50-60</td>
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### Agricultural Engineering

<table>
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<tr>
<td>Agricultural Engineering 1130</td>
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<tr>
<td>Engineering 2010</td>
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<tr>
<td>Engineering 2010 or 1010</td>
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</tr>
<tr>
<td>Engineering 2010 or 1010</td>
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<td>4 4 4</td>
</tr>
<tr>
<td>Physics 2510-20-30</td>
<td>3 3 3</td>
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</tbody>
</table>

| Junior | 3 3 3 |
| Agricultural Engineering 3100 | 3 3 3 |
| Agricultural Engineering 3110-20-30 | 4 4 4 |
| Electrical Engineering 3110-20-30 | 3 3 3 |
| Electrical Engineering 3110-20-30 | 3 3 3 |
| Engineering Science and Mechanics 3110 | 3 3 3 |
| Engineering Science and Mechanics 3110 | 3 3 3 |
| Computer Science 3150 | 3 3 3 |
| Computer Science 3150 | 3 3 3 |
| Mechanical Engineering 3311 | 3 3 3 |
| Mechanical Engineering 3311 | 3 3 3 |
| Speech 2311 or 2361 | 3 3 3 |
### Chemical Engineering

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<tr>
<td>Math 1840-50-60</td>
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<tr>
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<tr>
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<td>Physics 2340-20</td>
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<tr>
<td>Math 2840-50-60</td>
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<tr>
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Total: 201 hours

### Biomedical Engineering

**Available in Engineering Science Degree Program.**

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<tr>
<td>Mathematics 1840-50-60</td>
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<td>Sophomore</td>
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<td>Physics 2310-20</td>
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<tr>
<td>Biology 1210-20</td>
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<tr>
<td>Engr. Sci. &amp; Mech. 3311, 3700, 3110</td>
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<td>Engr. Sci. &amp; Mech. 3410</td>
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<tr>
<td>Humanities/social science electives</td>
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Total: 198 hours

### Electrical Engineering

<table>
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<tr>
<td>Math 1840-50-60</td>
<td>4 / 4 / 4</td>
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Total: 201 hours

### Mechanical Engineering

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### Communication Science

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<tr>
<td>Humanities/social science electives</td>
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</table>

Total: 201 hours

### Energy Conversion and Power Systems

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>Freshman</td>
<td>1 / 2 / 3</td>
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<tr>
<td>Mathematics 1840-50-60</td>
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</tr>
<tr>
<td>Chemistry 1110-20-30</td>
<td>3 / 3 / 3</td>
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<tr>
<td>Graphics 1410-20</td>
<td>3 / 3 / 3</td>
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<td>4 / 4 / 4</td>
</tr>
<tr>
<td>Physics 2310-20</td>
<td>3 / 3</td>
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<tr>
<td>Chemistry 4320</td>
<td>3 / 3</td>
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<tr>
<td>Physics 2340-20</td>
<td>3 / 3</td>
</tr>
<tr>
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<td>4 / 4</td>
</tr>
<tr>
<td>Humanities/social science electives</td>
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Total: 201 hours

### Plasma and Electro-Optics Engineering

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<tr>
<td>Mathematics 1840-50-60</td>
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<td>Chemistry 1110-20-30</td>
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<td>Graphics 1410-20</td>
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<td>4 / 4</td>
</tr>
<tr>
<td>Humanities/social science electives</td>
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Total: 204 hours

### Systems and Networks

<table>
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<tr>
<th>Course</th>
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<tbody>
<tr>
<td>Freshman</td>
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<tr>
<td>Mathematics 1840-50-60</td>
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<tr>
<td>Chemistry 1110-20-30</td>
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<td>Graphics 1410-20</td>
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<td>4 / 4</td>
</tr>
<tr>
<td>Humanities/social science electives</td>
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</tbody>
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Total: 204 hours
### Humanities/social science electives

<table>
<thead>
<tr>
<th>Hours</th>
<th>Credit</th>
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</thead>
<tbody>
<tr>
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<td>4</td>
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</tbody>
</table>

Total: 204 hours

### Computer Engineering

| 1Elec. Engr. 4600 | 3 |
| 1Elec. Engr. 4700 | 3 |
| 2Elec. Engr. 4610 | 3 |
| 2Elec. Engr. 4620 | 3 |
| 1Elec. Engr. 4800 | 3 |
| 1Elec. Engr. 4820 | 3 |
| 1Elec. Engr. 4830 | 3 |
| 1Elec. Engr. 4850 | 3 |
| Economics 2510 | 4 |
| Economics 4100 | 4 |
| Humanities/social science electives | 4 |

Total: 204 hours

### Electronics and Instrumentation

| Elect. Engr. 4690-90, 4600 | 3 |
| Elect. Engr. 4370 | 3 |
| Elect. Engr. 4700 | 3 |
| 1Elec. Engr. 4100 | 3 |
| Elect. Engr. 4400 | 8 |
| Elect. Engr. 4740 | 3 |
| 1Elec. Engr. 4610 | 3 |
| Economics 2510 | 4 |
| 1Elec. Engr. 4850 | 3 |
| Elect. Engr. 4350 | 3 |
| Humanities/social science electives | 4 |

Total: 224 hours

### Bioelectric Option

| Biology 1210-20-30 | 4 |
| Chemistry 2230 | 4 |
| Zoology 3080-3089 | 5 |
| Elect. Engr. 4850 | 3 |
| Elect. Engr. 4900 | 3 |
| Elect. Engr. 4370 | 3 |
| Humanities/social science electives | 4 |

Total: 206 hours

### Engineering Physics

<table>
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<tr>
<td>Math 1840-50-60</td>
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<td>English 1010-11-20-33</td>
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<td>Eng. Sci. &amp; Mech. 3700, 3711, 3110</td>
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Total: 197 hours

### Industrial Engineering

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<tbody>
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<tr>
<td>Math 1110-20-30</td>
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<tr>
<td>Math 1010-1011, 1020-33</td>
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<tr>
<td>Graphics 1410-20</td>
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<tr>
<td>Basic Engineering 1510-20-30</td>
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<tr>
<td>Basic Engineering 1410</td>
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<tr>
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<tr>
<td>Physics 2310-20-30</td>
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<tr>
<td>Met. Engr. 2110</td>
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<tr>
<td>Engr. Sci. &amp; Mech. 3700, 3711, 3110</td>
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<td>Math electives</td>
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<td>Humanities/social science electives</td>
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Total: 204 hours

### Metallurgical Engineering

<table>
<thead>
<tr>
<th>Hours</th>
<th>Credit</th>
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<tbody>
<tr>
<td>Freshman</td>
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</tr>
<tr>
<td>Chemistry 1110-20-30</td>
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<tr>
<td>Basic Engineering 1410</td>
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<tr>
<td>Sophomore</td>
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<tr>
<td>Math 2310-20-30</td>
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<tr>
<td>Math Electives</td>
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<tr>
<td>Humanities/social science electives</td>
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</table>

Total: 204 hours
Basic Engineering and Graphics

(Non-Departmental Unit)

Basic Engineering (179)
Coordinator: J. E. Stoneking

1310 Basic Mechanics I (4) Forces in a plane; free body diagram analysis; equilibrium in two dimensions; applications to frames and machines; friction; introduction to forces in space. Required of all engineering students except engineering physics majors. Coreq: Math 1840. 4 hrs. lec.

1320 Basic Mechanics II (4) Position and displacement vectors; particle kinetics using Newton's laws; impulse-momentum, work-energy; introduction to simple harmonic motion. Prereq: 1310; coreq: Math 1850. 4 hrs. lec.

1330 Basic Thermodynamics (4) Introduction to thermodynamics fluid statics, and mechanics. Buoyancy, forces on submerged surfaces; Bernoulli's equation; first law of thermodynamics; work, heat, and other forms of energy. Required of all engineering students except engineering physics majors. Prereq: 1310; coreq: Math 1850. 3 hrs. lec.

1410 Engineering Computations (2) Familiarization and introduction to the university computing systems for problems. BASIC language. Prereq: Math 1840. 2 hrs. and open computation lab.

Graphics (443)
Coordinator: E. K. Boyce

Basic Faculty:
Professors C. A. Newton (Emeritus), M.S. Syracuse; W. W. Thomas, Jr. (Emeritus), B.S. Tennessee; Associate Professors G. H. Parkham, Jr. (Emeritus), B.S. Cincinnati; E. K. Boyce, M.S. Tennessee; W. A. Lyday, Jr., M.S. Tennessee.

1310-20-30 Fundamentals of Engineering Graphics (2,2,2) Graphic representation of three-dimensional shape and size by orthogonal and pictorial projection; sketching and dimensioning; tolerances. Problem solving utilizing spatial relationships and graphical vector analysis; and graphic presentation of engineering data. Must be taken in sequence. Two 3-credit hours or three 2-credit hours or three 2-hour periods.

1410-20 Fundamentals of Engineering Graphics (3,3) Graphical representation of three-dimensional shape and size; space relationships. Graphic presentation of engineering data. Required of all engineering students. Must be taken in sequence. One lecture and three 2-hour periods or two 3-hour periods.

Engineering Studies (Non-Departmental Unit)

Engineering Studies (338)
Coordinator: E. E. Stansbury

4100 History of Engineering (4) History of technology and engineering with emphasis on identification of and developments in major areas such as transportation, communication, energy, manufacturing, design, and materials. Relationship to social and political structures of historical periods. Open to all students.

Chemical, Metallurgical, and Polymer Engineering

Professors:
H. F. Johnson (Head), D. Eng., Yale, P.E.; D. C. Bogue, Ph.D., Delaware; C. R. Brooks, Jr., Ph.D. Tennessee; E. S. Clark, Ph.D. California (Berkeley); O. L. Culbertson (Emeritus), Ph.D. Texas; L. W. Crawford, Ph.D., Cincinnati; J. F. Fellers, Ph.D., Akron; G. C. Frazier Jr., D. Eng., Johns Hopkins; J. M. Holmes, Ph.D., Tennessee; H. W. Hsu, Ph.D., Wisconsin; C. D. Lundin, Ph.D., Rensselaer Polytechnic Institute; C. F. Moore, Ph.D. Louisiana State; B. F. Oliver, Ph.D., Pennsylvania State; J. J. Perona, Ph.D., Northwestern, P.E., Associate Dept. Head, Chemical Engineering; J. W. Prados (Vice President for Academic Affairs), Ph.D. Tennessee; J. E. Sonneveld, Ph.D. Tennessee, Associate Dept. Head, Metallurgical Engineering; T. J. W. Stansbury, Ph.D., Cincinnati; C. O. Thomas1, Ph.D. Tennessee; M. A. Wright, Ph.D. Wisconsin.

Associate Professors:
W. T. Becker, Ph.D., Illinois; D. D. Bruns, Ph.D., Houston; R. M. Counce, Ph.D., Tennessee.

Assistant Professor:
F. Weber, Ph.D., University of Minnesota.

1Alumni Distinguished Service Professor

Separate complete curricula are offered in chemical engineering and in metallurgical engineering. However, the first two years of these curricula are nearly identical and a decision as to choice can be made in the second year. Both curricula are arranged to provide a central core of courses with flexibility in the upper-division years to permit emphasis on preparation for graduate study or technical employment.

Elective Courses in Humanities and Social Studies. The chemical and metallurgical engineering curricula require a minimum of 24 quarter-hours of humanities—social science courses which are to be selected from the list on pages 130—131. A minimum of 12 hours must be taken from a single sub-group under one of the three areas.

Elective courses in humanities—social science electives must be taken from a single subgroup under one of the three areas.

1Not required in the cooperative program.

Nuclear Engineering

Hours Credit
Freshman I II III
Math 1840-50-60 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 4 4 4
Math 1110-12-33 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Chemistry 1110-20-30 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 4 4 4
Basic Engr. 1310-30-20 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 4 4 4
Physics 1410-20 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Basic Engr. 1410 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 2 2 2
Sophomore I II III
Math 2840-50-60 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 4 4 4
Physics 2310-20 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Math 3150 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Chemistry 3110 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Humanities/social science electives ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 4 4 4
Junior I II III
Math 4610, 4550 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Physics 3710-20-30 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Elect. Engr. 3110-20 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 4 4 4
Chem. Engr. 4310-20 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Nuclear Engr. 3010 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Ind. Engr. 4520 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Technical electives ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Humanities/social science electives ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 4 4 4
Senior I II III
Nuclear Engr. 4110-20-30 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Nuclear Engr. 4210-20-30 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Nuclear Engr. 4710-20-30 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 4 4 4
Chem. Engr. 4810-20 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 3 3 3
Humanities/social science electives ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 4 4 4
Total: 199 hours

Separate complete curricula are offered in chemical engineering and in metallurgical engineering. However, the first two years of these curricula are nearly identical and a decision as to choice can be made in the second year. Both curricula are arranged to provide a central core of courses with flexibility in the upper-division years to permit emphasis on preparation for graduate study or technical employment.

Elective Courses in Humanities and Social Studies. Both chemical and metallurgical engineering curricula require a minimum of 24 quarter-hours of humanities—social science courses which are to be selected from the list on pages 130—131. A minimum of 12 hours must be taken from a single sub-group under one of the three major headings.

Graduation in either chemical or metallurgical engineering requires a minimum grade point average of 2.00 for all departmental courses.

PROGRESSION TO UPPER-DIVISION PROGRAMS

Progression of chemical or metallurgical 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 80 quarter hours of Lower-Division engineering curriculum course work with an overall GPA of at least 2.4. This must include Chemical and Met. Eng. 2010 and 2020 for chemical engineering majors, and 2010 and 2030 for metallurgical engineering majors.

Provisional Status: Students who have completed 80 quarter 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 under PUSHING 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 12 hours of 3000-level required courses.

Total: 200 hours

Departments of Instruction

Agricultural Engineering

(See College of Agriculture)
courses specified by the department. Further progression to upper-division courses is dependent upon this minimum level of performance.

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

Transfer Students at the Upper-Division level are admitted on a Provisional Status basis only. Any student presenting more than 40 hours of Lower-Division engineering curriculum 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 majors in Chemical Engineering, metallurgical engineering, or polymer engineering are offered.

A program leading to the M.S. and Ph.D. degrees with specialization in polymer science and engineering in chemical or metallurgical engineering is available with the consent of the Department of Chemistry which offers a degree with similar specialization.

These programs have been strengthened by fellowships or grants provided by industrial and governmental agencies. The University's Graduate School operates a Resident Graduate Program at Oak Ridge, Kingsport, and Chattanooga. See the Graduate Catalog for detailed information.

Chemical and Metallurgical Engineering (227)


2011 Sophomore Inspection Trip (0) Inspection trip to industrial plant. Usually scheduled in fall on ETEA day. Required for chemical engineering and metallurgical engineering majors. S/N/NC.


2030 Process Principles and Materials III (4) Materials structure—property relationships for metals, inorganic and organic compounds, with emphasis on mechanisms of control of properties by chemical composition, thermal and mechanical treatment; crystallography, imperfections, mechanical properties, heat treatment, molecular weight, and particle size distributions. Prereq: Chemistry 1130, Math 1860. 3 hrs. and 1 lab period. F, S, SU.

3100 Introduction to the Materials of Technology (4) Examination of sources, processing, and properties of metallic, ceramic, polymeric, and composite materials based upon an historical perspective and current practices in technology, architecture, and art. Lectures and demonstrations. Open to students in all colleges. Prereq: Introductory science course.

4310-20 Seminar (1,1) Presentation and discussion of economic, political, humanitarian, and other topics of interest to chemical and metallurgical engineers. S/N/NC. 4310 - F : 4320 - W, S.

Chemical Engineering (226)

3010 Industrial Inspection Trips I (4) Technology of chemical process industries. Orientation to Tennessee industry; plant trips. S/N/NC.


3230 Special Problems (3) Investigation of chemical engineering problems.

3410 Flow of Fluids (4) Differential and overall momentum balances, mechanical energy balances; flow in tubes, piping systems, and packed beds; metering devices, pumps. Prereq: Chemet. Engr. 2020, Math 2850. 3 hrs. and 1 lab. W, S.

3420 Heat Transfer (4) Differential and overall energy balances; steady and unsteady state, heat conduction in simple geometries; heat transfer in tubes and heat exchangers; condensation and boiling radiation. Prereq: 3410. 3 hrs. and 1 lab. F, W.

3440 Stagewise Operations (3) Analytical and graphical methods to stagewise separatory operations. Prereq: Chemistry 3420. W, S.

3450 Diffusional Operations (3) Diffusion simultaneous heat and mass transfer, applications including humidification, gas absorption, extraction. Prereq: 3420, Chemistry 3420. F, W.

3610 Introduction to Process Dynamics and Control (3) Process modeling and control of control system design. Mathematical models for several industrial processes are developed from a mass, component and energy balance basis. The models are compared to both industrial and laboratory data. Model linearization, Lagrange transfer analysis techniques, block diagram algebra, transfer function models, industrial sensors and values. Lab. Prereq: Math 2840, Chemet. 2020. S, SU.

3620 Industrial Process Control (3) Design and theory for practical industrial process control. Experimental process modeling (process identification), feedback control, cascade control, feedforward control, degrees of freedom, stability analysis, controller tuning. Control systems will be designed for a number of typical industrial unit operations. Lab. Prereq: 3810. F.

4010-20 Thesis (3,3) Investigation and report of elementary chemical engineering problem. E.

4110 Chemical Engineering Data Analysis (3) Statistical and numerical data analysis and extrapolation of statistical properties of samples and source systems; empirical modeling of processes; statistical process control. Prereq: Math 3150. F, W.

4120 Probabilistic Chemical Engineering Systems (3) Experiment designs, simulation of stochastic systems, predictive techniques; and analysis of networks in the process industries. Prereq: 4110.

4130 Introduction to Optimization (3) Principles and applications of optimization techniques to chemical process design; unconstrained optimization, equality constrained optimization, inequality constrained optimization, and dynamic programming. Prereq: Math 2840.

4150 Computers in Chemical Engineering (3) Introduction to computer solution of Chemical Engineering problems. Applications of general computer programming techniques. The applications studied include: Process design, statistics, mathematical modeling, computer graphics, and engineering computation. Prereq: Math 3150. W.

4220 Chemical Engineering Laboratory (3) Laboratory investigations of controlling factors in chemical engineering operations. Prereq: 3440-50, 4530. F, W, S.

4320 Project Laboratory (3) Laboratory investigation of chemical engineering problem, stressing techniques of group effort. May be repeated. E.


4420 Process Design and Economic Analysis (4) Development of process information into an integrated design concept. Consideration of general and characteristic features, capital investment, operating costs, and economic merit. Prereq: 4410, 4530. S, F.

4430 Special Problems in Design and Economics (3) Extension of 4420 for student participation in A.I. Ch. E. honours design course; other advanced design projects. Prereq: 4420.

4450 Hydrocarbon Processing (3) Study of specialized characterization of physical properties of fossil raw materials and products, and of processes for conversion of fossil fuel raw materials into products needed in industrial energy, industrial raw material and consumer markets. Prereq: 3440.

4470 Sulfur Removal from Coal and Associated Problems (3) Chemical and physical properties of domestic coals; selective sulfur control using beneficiated systems, fluidized beds, catalytic hydrogenation, solvent recovery, thermal desulfurization, catalytic desulfurization. Prereq: 4410, 4530. S.

4480 Coal Processing to Liquid Fuels (3) Characterization of various coals with respect to liquid fuelification methods; conversion of biomass to liquid fuels; and economic feasibility. Prereq: 4410, 4530. S.


4540 Fluid-Solid Operations (3) Heat and mass transport in fixed and fluidized beds; applications include absorption, ion exchange, crystallization. Prereq: 3440-50.


4730 Mass and Energy Flow in Biological Systems (3) Basic physicochemical and biological principles applicable to biological systems. Derivations of general equations of biomass and energy transfer. Thermodynamics of transport and equilibrium in biological systems. Discussion of Volterra's equation with biological clocks, etc. Prereq: Consent of instructor.

4740 Introduction to Transport Phenomena in Biological Systems (3) Application of principles of transport phenomena to biological systems. Transfer of chemical and various cellular active transports; structure and rheology of physiological fluids, membrane and interfacial phenomena; analysis and design of artificial organs. Prereq: 3440 and 3450, or consent of instructor.

4750 Microbiological Process Engineering (3) Application of chemical engineering principles and design concept to microbial processes, continuous culture of microorganisms, food processing and pharmaceutical processes. Prereq: 3440, 3450, or consent of instructor.

4760 Principles of Biochemical Separation (3) Fundamentals of modern biochemical separation methods; classroom demonstrations, design of production and analytical systems. Prereq: Consent of instructor.

4999 Special Problems in Chemical Engineering (3) Chemical engineering problems related to special developments.
opments in industrial practice or engineering research. Prereq: Consent of instructor. May be repeated. Maximum credit 9 hours.

4190-30 Engineering Internship in Industrial Problems (0,3) Internship in industrial practice, to be directed by a faculty instructor and by engineers from a company of the student’s choice. Work to be dedicated by a faculty instructor and by engineers from a company of the student’s choice. Internship will require two quarters of participation. 4190 S/NC. Prereq: 3610-20 and consent of instructor.

GRADUATE
Consult the Graduate Catalog for listing of graduate level courses.

Metallurgical Engineering (679)

2040 Experimental Methods in Metallurgy (4) Lectures provide subject bases for laboratory experiments. Topics are selected from metallography, ceramics, and plastics. Prereq: 3040 or consent of instructor. S.

2110 Engineering Materials I (3) Introductory course covering the chemical, physical, and microstructural properties of solids and liquids. Prereq: 2110. S, SU.


3150 Engineering Materials IV (3) Extension of 3140 with emphasis on mechanisms of reaction of engineering materials with aqueous and gaseous environments. Prereq: 2110 or 3110 or Chem. Engr. 2030. W, S, SU.

3160 Engineering Materials V (3) Extension of 3150 with emphasis on microstructural changes in small grain size engineering materials. Prereq: 3150. W, S, SU.

3170 Engineering Materials VI (3) Extension of 3160 with emphasis on interactions of radiation with solids to produce changes in engineering properties. Prereq: 3160. S, SU.

3180 Engineering Materials VII (3) Extension of 3170 to biomedical applications of materials. Prereq: 3170. W, S, SU.

3210 Plastic Deformation (4) Phenomena and theory of plasticity of single and polycrystalline materials. Applicable concepts of crystallography and x-ray diffraction; use of stereographic projections. Prereq: Chem. Engr. 2030. 3 hrs. and 1 lab. F.

3220 Diffusion and Annealing (3) Introduction to solid state point defects, solid solutions, diffusion equations and mechanisms, annealing of cold worked structures. Prereq: 3140. W.


3310 Biomedical Applications of Materials for Life Sciences (3) Principles of engineering materials; metals, polymers, and ceramics; methods of fabrication of components; corrosion; applications of prosthetic devices and dental materials. Prereq: Chemistry 1110-20-30 or equivalent. 3 hrs. and 1 lab. S.

3520 Materials Behavior and Chemical Process Equip- ment Design (3) Mechanical, metallurgical, and chemical considerations in design of chemical processing equipment. Prereq: Chem. Engr. 2030 or equivalent; 3150; Chem. Engr. 3420. W.

3710 Metallurgical Applications in Manufacturing Tech- nology (3) Fabrication methods and principles of metallic and ceramic materials; metal forming; casting; joining; heat treatment. Prereq: 3110. S.

4010-20 Thesis (3-6,3-6) Investigation and report on graduate level engineering problem. Prereq: Sophomore standing in engineering. E.

4230-40 Project Laboratory (3,3) Laboratory investigations beyond 2110, 3110 or Chem. Engr. 2030. 3 hrs. or 2 hrs. and 1 lab. W.

3010 Industrial Inspection Trips (1) Technology of metallicurgical industries, emphasizing Tennessee industry; plant trips. S/NC.

3040 Metallurgical Thermodynamics (4) Applications of laws of thermodynamics to problems of metallurgical interest. Second law and entropy; auxiliary functions; relationship between free energies and phase diagrams; reaction equilibria in gases and between gaseous and solid phases. Prereq: 2110 or equivalent. 3 hrs. and 1 lab. F.

3550 Production Metallurgy (3) Principles of roast- ing, smelting, and refining. Gas liquid equilibria, slag- ming, preferred orientation. Plane stress vs. plane strain loading; failure by stress rupture; effect of metallurgical and environmental factors; fatigue; residual stresses; creep and stress rupture, effect of microstructure; finite plastic strain and plastic stress-strain relations; fabrication by forging, rolling, deep drawing; formability testing. Prereq: 4730 or M.E. 3650. 3 hrs. and 1 lab. F. Recommended for Mechanical, Eng. and Eng. Science students. F.

4760 Casting and Welding (3) Principles and processes of casting and welding: heat transfer, solidification, segregation, gas porosities, shrinkage, welding defects, thermal treatments, associated stresses. Prereq: 3120 or 3520. 3 hrs. or 2 hrs. and 1 lab.

GRADUATE
Consult the Graduate Catalog for listing of graduate level courses.

Polymer Engineering (805)

4230-40 Project Laboratory (3,3) Laboratory investigation of polymer engineering problem. Written report required for each quarter.

4910 Applied Polymer Science (3) First course in physical and chemical principles of polymer science. May be repeated for a maximum of 6 credits.

4920 Polymer Processing (3) Rheological properties of polymers and principles of manufacturing processing operations of fiber, plastics, and rubber industries; dimensional analysis and scale-up, flow through dies and pipelines, screw extrusion, spinning of fibers, injection molding. Prereq: Senior standing in engineering or science. Not for graduate credit by polymer engineering majors.

4950 Principles of Fiber Textile Engineering (3) Chemical and crystalline structure of important fibers; melt, wet and dry spinning of man-made fibers; drawing and texturizing; preparation of yarn; dyeing, weaving, knitting, and finishing. Emphasis on qualitative aspects. Prereq: Senior standing in engineering or science. S.

4940 Plastics Fabrication Operations (3) Lecture and laboratory course treating unit operations of plastics industry. Types and mechanisms of operation of machinery used and structure and properties of fabricated parts. Operations include extrusion, co-extrusion, injection molding including structural foam, thermofoming, blow molding, rotational molding, etc. Prereq: 4230 or equivalent in engineering or science. S.

GRADUATE
Consult the Graduate Catalog for listing of graduate level courses.

Civil Engineering

Including Environmental Engineering Professors:


*Associate Professor
**Professor

Civil Engineering

Including Environmental Engineering Professors:


Associate Professors:

BACHELOR OF SCIENCE PROGRAM

The curriculum in civil engineering is designed to provide training in fundamental engineering sciences and in certain non-technical and 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 (27 hours maximum), a student can specialize as primary or secondary areas of study in construction, environmental engineering, geotechnical/materials, structures, transportation, or water resources. Primary specialization will be shown on the student’s transcript.

Students are required to maintain a cumulative grade point average of at least 2.00 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 and humanities/social science electives at the departmental office. Students must consult these lists prior to registering for elective courses.

MASTERS OF SCIENCE AND MASTER OF ENGINEERING PROGRAMS

Graduate programs in civil engineering and environmental engineering leading to the degree of Master of Engineering 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.

Civil Engineering (254)

2260 Engineering Surveys (4) Measurement through the application of surveying techniques; the theory of errors and their analysis; fundamental concepts of horizontal, vertical, and angular measurement; basic surveying operations and computations, 3 hrs. lectures and one 3 hr. lab. Prereq: Math 1850.

2310 Seminar (1) Presentation and discussion of topics related to civil engineering.

2360 Route Surveying (3) Emphasis on basic principles and practical applications of horizontal and vertical alignment of transportation routes, specifically covering simple, compound, reverse and parabolic curves and spirals. Earthwork computations. Prereq: 2260.


3210 Stresses in Framed Structures (3) Reactions, moments, shears, and stresses in trusses and framed structures from fixed loads; influence lines and reactions, moments, shears, and stresses. Prereq: Engr. Science Mech. 3311.

3230 Design of Framed Structures (3) Selection of rolled beams; design of compression and tension members for axial and bending stresses. Prereq: 3210, coreq: 4410.


3320 Computer Applications in Civil Engineering (1) Solution of Civil Engineering problems through the use of digital computers. Prereq: Basic Engr. 1410.

3360 Surveying Practice (3) Route surveying procedures. Two 3-hr. labs. Coreq: 2960.

3600 Transportation Planning (3) Emphasis on transportation problems and perspectives, both rural and urban; use of the planning process to establish existing travel patterns, modeling of demand, proposing alternatives and their evaluation, and plan implementation. Prereq: Junior standing.

3610 Transportation Engineering (3) Introductory course on design, construction, maintenance, and operation of various transportation facilities and terminals. Prereq: Junior standing.


4119 Concrete Design (3) Reinforced concrete beams and columns, use of standard specifications. Prereq: 3210 and 3710.

4120 Concrete Design (3) Reinforced concrete continuous beams and floor slabs; footing and retaining walls. Prereq: 4110 and 4410.


4230 Legal and Ethical Aspects of Engineering (3) Legal principles underlying engineering work; laws of contracts, torts, agency, real property; problems of professional registration and ethics.

4240 Structural Design (3) Plate girders, composite steel and wood girders, catenary, trusses, and design of small industrial building. Two 3-hr. periods. Prereq: 3230 and 4410.

4260 Photogrammetry (3) Methods of plotting maps from aerial photographs; stereoscopic plotting instruments; applications. Prereq: 3600, or Forestry Summer Camp for forestry majors.

4310 Soil Mechanics II (3) The compressibility of fine grain soils and the theory of time rate of consolidation. Shear strength of soils. Failure theories. 2 hrs. lecture and 1 lab.

4320-30 Seminar (2,1) Selected topics dealing with historical and modern civil engineering achievements and professional and ethical responsibilities. Prereq: Senior standing and completion of all junior level non-elective engineering courses.

4410 Deformations and Statically Indeterminate Structures (3) Deflections of beams and trusses; analysis of statically indeterminate beams, trusses, bents, and frames. Prereq: 3210.

4420 Analysis of Framed Structures (3) Maximum stresses due to moving loads; uses of influence lines; lateral forces due to earthquake and wind; analysis of portal, building frames, and space frames. Prereq: 4410.

4430 Construction Methods and Equipment (3) Fundamental operations in construction and selection of equipment; production rates, balancing of equipment, and cost estimates. Prereq: 3710.

4460 Land Surveying (3) Procedures of locating properties; evaluating evidence; procedures to describe property; to create land divisions, and to prepare plots; laws of land surveying. Prereq: 2260 or equiva lent.

4510-20 Advanced Structural Design (3,3) Plastic design of steel girders in 4510; design of typical short span steel highway bridges in 4520. Prereq: 3230 for 4510; 3230 and 4110 for 4520.


4560 Stabilization of Soils (3) Mechanical stabilization of soils by compaction, drainage, and blending; chemical stabilization of soils with admixtures; water-proofing and modifying soils and additives. 2 hrs. of lecture and 1 lab. Prereq: 3310.

4600 Highway Engineering I (3) Design, construction, operation, and maintenance of highway facilities; includes integration of system planning and project planning to design and construction procedures. Prereq: 2360, 3600 and 3610.

4620 Airport Planning and Design I (3) Emphasis on airport master planning. Included for consideration on the air side are runway configuration, capacity, geometrics, and lighting; and on the land side are included terminal layout and design, and ground access systems and parking. Prereq: 3500, 3610.

4640 Traffic Engineering (3) Characteristics of driver, vehicle, and roadway and their interrelationship; traffic studies; basic considerations of traffic circulation and control, and development of urban transportation planning studies. Prereq: Senior Standing.

4650 Highway Engineering II (3) Integration and application of various engineering principles and techniques to process of planning, locating, and design of highway facility through comprehensive team project. 1 lecture and 2 labs. Prereq: 4560.

4690 Airport Planning and Design II (3) Integration and application of principles of airport master planning for purpose of site selection and design of an airport facility through comprehensive team project; includes environmental evaluation of design. 1 lecture and 2 labs. Prereq: 4560.

4710 Portland Cement Concrete Mix Design (3) Properties and test of portland cement concrete, methods of concrete mix design, non-destructive concrete evaluation testing, use of concrete admixtures. 2 lectures and 1 lab. Prereq: 3710.

4720 Asphalt and Bituminous Concrete (3) Properties and test of various combination of bituminous asphalts, mix design and bituminous concrete. Emphasis on use of asphalt in transportation construction projects. 2 lectures and 1 lab. Prereq: 3710.

4731-32 Earthquake Resistant Structure I, II (4,4) (Same as Architecture 4731-32)

4800 Introduction to Civil Engineering Systems (3) Methods of modeling civil engineering systems and their specific application to problems of transportation, environment, water resources, and materials. Prereq: Senior standing or consent of instructor.

4850 Elementary Structural Matrix Methods (4) (Same as Architecture 4850 and Engineering Science and Mechanics 4850.)

4860 Structural Wood Design (3) The application of structural design principles to structural members of various combinations of wood products. Beams, columns, and diaphragm construction with plywood are covered. Identification of different types of fastening and connections. Prereq: 3230.

4890 Civil Engineering Systems Design and Management (3) Introduction to basic systems engineering concepts within civil engineering context; discussion of the role of decision maker and use of optimal principles of engineering planning. Prereq: Computer Science 3150.

4910 Special Topics (1-3) Topics relating to recent developments and current practice in civil engineering through supervised self-study. Prereq: Consent

Assistant Professors:
R. M. Bennett, Ph.D. Illinois; E. C. Drumm, Ph.D. Arizona, P.E.; R. B. Robinson, Ph.D. Iowa State, P.E.

1Fred N. Peetee Professor
2Tenneco Professor
3Cordea Professor
4IBM Professor
5Space Institute, Tutulahoma
of individual instructor and approved by department head. May be repeated.

**GRADUATE**

Consult the Graduate Catalog for listing of graduate level courses.

**Environmental Engineering (344)**

3120 Hydraulics (3) Application of basic and developed principles of hydraulics. Flow measurement; flow in open conduits; uniform and nonuniform open channel flows; pipes and tunnels; basic hydraulics; flow similitude and models. Two lectures and one 3-hr. lab. Prereq: Engr. Mech. 3110.


3520 Engineering Aspects of Air Pollution and Solid Waste Systems (3) Engineering aspects of solid waste and air pollution systems. Specifically, quantifiable capabilities will be developed related to management, generation, collection, treatment and disposal of solid wastes and air pollutants. Prereq: Math 2860.

4000 Environmental Protection (3) A rationale is developed for managing water resources, bodies and wastewaters, air environment, solid wastes common insects and rodents, food and excrement of humans and animals to promote the health, to prevent efficiency and comfort, and to safeguard the balances in natural ecosystems. The principles of environmental protection are emphasized. Includes objectives of design and practice without detailing design or practice methods. Prereq: Senior standing.

4030 Environmental Engineering Chemistry (3) Fundamentals of chemistry which relate to generation, formation analysis, and removal of environmental contaminants. Prereq: Chemistry 1130 and senior standing.

4150 Urban Water Management (3) Introduction to urban water modeling; evaluation of optimum urban water policies; formulation of system constraints and analysis of design; and utilization of processing; management of storm water for beneficial use. Prereq: 3330.

4210 Water Resources Engineering Design (3) Planning and design of a multipurpose dam project, including reservoir, dam and discharge control works. Considerations of dam safety and environmental impact. Microcomputer applications. Prereq: 3330 or consent of instructor.

4220 Water Resources Engineering Development (3) Multi-objective evaluation procedures for comparing and selecting among water resources development alternatives; achieving project optimality; single- and multiple-criterion analyses; and sensitivity topics in new developments in water resources engineering. Prereq: 3330 or consent of instructor.

4330 Hydrologic Design (3) Application of frequency and regression analysis to hydrologic design of water resources systems; unstable surface runoff and streamflow modeling; urban peak runoff design using kinematic wave theory; evaluation of effects of land use changes on steam flow quantity and quality. Prereq. 3330.

4510 Elements of Water and Wastewater Transport Systems (3) Introduction to theory and design of water transportation and distribution systems and wastewater collection systems. Prereq. 3120.

4520 Elements of Water and Wastewater Treatment Systems Design (3) Introduction to unit operations and processes in design of water and wastewater systems; Prereq: Engr. Sci. and Mech. 3110 or consent of instructor.

4525 Water and Wastewater Treatment Plant Design (3) Detailed process design of water and/or municipal industrial wastewater treatment plants; sludge handling systems; design and disposal of residuals. Prereq: 4520 or equivalent.

4530 Environmental Engineering Laboratory (3) Standard analytical techniques for evaluation of specific air, water, and solid waste pollutants. 2 hrs. and 1 lab. Prereq: 4030.

4600 Solid and Hazardous Waste Management (3) Magnitude and characteristics of solid and hazardous waste problems; collection systems; disposal systems including landfill, incineration, composting, fixation, resource recovery, and proposed new technologies; current and future regulations. Prereq: Junior standing.

4700 Air Pollution-Air Resource Management (3) Introductory course on concepts of air pollution; analysis of relationship among emission sources, meteorology and topographic factors, and adverse effects on receptors; engineering approaches for air pollution control. Prereq: Senior standing.

4820 Environmental Engineering Law (3) Legal aspects of water and air pollution, drainage, land use, controls, and environmental impact statements with emphasis upon federal-state relations, recent legislation and court decisions, and enforcement. Prereq: Senior standing.

4910-20-30 Special Topics (1-3,1-3,1-3) Topics relating to recent developments and current practice in environmental engineering through supervised self-study. Prereq: Consent of individual instructor and approved by department head. May be repeated.

**GRADUATE**

Consult the Graduate Catalog for listing of graduate level courses.

**Electrical Engineering (320)**

Professors:
- W. L. Green (Head), Ph.D. Texas A & M; I. Alexeff, Ph.D. Wisconsin, P.E.; J. M. Bailey, Ph.D. Georgia Institute of Technology; A. O. Bishop, Jr., Ph.D. Clemson; T. V. Blalock, Ph.D. Tennessee; R. E. Bodenheimer, Ph.D. Northwestern; D. W. Boudinot, Ph.D. Vanderbilt; R. C. Gonzalez, Ph.D. Florida; J. M. Googe, Ph.D. Georgia Institute of Technology; P. E. E. L. Hall, Ph.D. Missouri; G. W. Hoffman, Ph.D. Harvard; J. C. Hung, Ph.D. New York, P.E.; E. J. Kennedy, Ph.D. Tennessee; P.E. W. O. Leftfliit (Emeritus); M.S. Tennessee; H. P. Neff, Ph.D. Auburn, P.E.; M. O. Pace, Ph.D. Georgia Institute of Technology; J. F. Pierce, Ph.D. Pittsburgh; P. E.; R. W. Rochelle, Ph.D. Maryland; J. R. Roth, Ph.D. Clemson; B. Smith, Jr. (Emeritus); M.S. Illinois, P.E.; F. W. Symonds, Ph.D. Nottingham (England); J. D. Tillman, Jr., Ph.D. Auburn; C. H. Weaver, Ph.D. Wisconsin, P.E.

Associate Professors:

Assistant Professors:
- D. Brzakovc, Ph.D. University of Florida; R. D. Joseph, Ph.D. Case Institute of Technology.

1Halliburton Professor
2IBM Professor
3On Leave of Absence
4Distinguished Professor
5Weston Fulton Professorship
6John Fisher Young Professorship
7Tenneco, Inc. Professor
8Space Institute, Utah

**UNDERGRADUATE**

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 also contains a suitable amount of cultural elective 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 specialize in any one of the following areas of electrical engineering: bioelectric 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 except the bioelectric engineering option are continued through the M.S. and Ph.D. programs. The senior year curriculum is sufficiently flexible to allow a student to take several courses outside of the chosen area of specialization.

Generally, all of the freshman and junior course work is offered every quarter and the senior work is scheduled so that the student may enter at the beginning of any quarter. This arrangement allows maximum flexibility, since the student may elect the normal four-year schedule, may choose to graduate in three calendar years, or may take the Cooperative Engineering Program. In addition to the usual research and teaching, facilities on electronics, microwaves, solid state devices, and control equipment, the department has both digital and analog computers.

**PROGRESSION TO UPPER-DIVISION STATUS**

Progression of electrical engineering majors to the upper-division programs of the department is competitive and is based on the space available in the department. Faculty considered the student's performance, the overall grade point average, grades earned in courses required in the lower-division curricula of the College of Engineering, and seriousness of purpose and interest in departmental programs as exemplified by regular and orderly progress through the prescribed curriculum without abuse of withdrawal and course repeat privileges.

Students will be evaluated during the quarter registered for Electrical Engineering 2030. Transfer students may take nine (9) quarter hours in departmental courses before evaluation if EE 2030 transfer credit is valid. Those who are not accepted into the upper-division program of the department will not be permitted to register for any upper-division courses within the department. Such students will also be counseled and advised of certain educational alternatives.

**MASTERS OF SCIENCE PROGRAM**

Graduate work leading to the Master of Science degree may be completed during one academic year of full-time study or the degree may be obtained in two or three years of study in the evening.

Graduate assistantships and scholarships are available for outstanding students. Graduate assistants may obtain the master's degree in one calendar year.

Course work leading to the degree of Master of Science in Electrical Engineering is offered in the evening. Each course meets for two and one-half hours each week.

**THE DOCTORAL PROGRAM**

Graduate work leading to the degree of Doctor of Philosophy with a major in electrical engineering is offered. The department also participates in the engineering science doctoral program.

General policies of the Graduate School, residence, language, research, examination, and admission to candidacy requirements are explained in the Graduate Catalog.
3010 Transient Analysis (3) Analysis of transient responses, overwinding and filter design, use of transform methods and classical differential equation methods for system analysis; complex frequency concept and pole-zero representation and application to engineering problems. Prereq: 2050. E.

3030 Basic Electronics I (3) Basic digital switching circuits. Prereq: 3820. 3 hrs. including project laboratory. E.

3060 Energy System Operation (3) Engineering applications of physical electronics, plasma effects and devices. Topics include electronic amplifiers, transformers, and power supplies; theory of operation of field-effect transistors and applications in simple circuits. Prereq: 2030. 3 hrs. including biweekly lab. E.

3100 Basic Electronics II (3) Physical operation of junction diode and other device. Introduction to compensation. Prereq: 3720. Lab option-

3180 Plasma I (3) Engineering applications of physical electronics, plasma effects and devices. Topics include electronic amplifiers, transformers, and power supplies; theory of operation of field-effect transistors and applications in simple circuits. Prereq: 2030. 3 hrs. including biweekly lab. E.

3270 Linear Systems Analysis (3) Steady-state and transient response; block diagram transformation; signal flow graph; analogous systems, properties of second order system; introduction to feedback theory; stability criteria. Prereq: 3010 and Math 3150; coreq: 3180. 3 hrs. including occasional labs. E.

3610 Basic Electronics I (3) Band theory fundamentals; theory and applications of p-n junctions, simple power supplies; theory of operation of field-effect transistors and applications in simple circuits. Prereq: 2030. 3 hrs. including project laboratory. E.

3820 Basic Electronics II (3) Physical operation of bipolar transistors and vacuum tubes with applications in basic amplifiers. Integrated circuit fundamentals. Prereq: 3810. 3 hrs. including project laboratory. E.

4020 Direct Energy Conversion (3) Scattered wave description of circuits, to include isolators and amplifiers, couplers and power dividers, circu-
tors, phase shifters, loading and interconnection of systems. Power generation and amplification by vacuum tubes and semiconductor elements. Microwave switching, filtering and multiplexing. Prereq: 3060. 3 hrs. including bi-weekly lab.

4090 Energy System Operation (3) Energy system component modeling and system structure. Basic analysis techniques in loadflow, economic dispatch, transient stability, faults, and system protection. Prereq: 3060. E.

4180 Introduction to Artificial Intelligence (3) Same as Computer Science 4210.

4550 Elements of Network Synthesis (3) Energy rela-

4710 Introduction to Feedback System Design (3) Mathematical formulation of control systems; steady-state error and error constants; root-locus methods; optimum gain adjustment; compensation networks; introduction to compensation. Prereq: 3720. Lab option-

4720 Magnetohydrodynamics (3) Engineering applications of physical electronics, plasma effects and devices. Topics include electronic amplifiers, transformers, and power supplies; theory of operation of field-effect transistors and applications in simple circuits. Prereq: 2030. 3 hrs. including biweekly lab. E.

4750 Electro-Acoustics (3) Wave equation for sound, radiation from pistons, impedance of a piston, loud-speakers, horns, speaker systems, phonograph records and reproduction, tone recording and reproduction, noise reducing systems. Prereq: senior standing.

4850 Simulation, Transmission, and Protection (3) Principles of laser and maser operation based on classical concepts and electrical engineering analogies. Consideration of practi-
cal devices and applications. Prereq: Senior standing. E.

4940 Laser and Masers (3) Basic digital switching circuits. Prereq: 3820. 3 hrs. including project laboratory. E.

5000 Microwave Circuits and Electronics (3) Scattered wave description of circuits, to include isolators and amplifiers, couplers and power dividers, circu-
tors, phase shifters, loading and interconnection of systems. Power generation and amplification by vacuum tubes and semiconductor elements. Microwave switching, filtering and multiplexing. Prereq: 3060. 3 hrs. including bi-weekly lab.

5200 Introductions (3)Principles of laser and maser operation based on classical concepts and electrical engineering analogies. Consideration of practi-
cal devices and applications. Prereq: Senior standing. E.

5470 Magnetohydrodynamics (3) This course involves the study of electrically conducting fluids flowing through a magnetic field. Industrial applications to be studied include magnetic levitation and fluid cooling, magnetic separation, liquid–metal pumps and electromagnetic guns. Plasma applications concern plasma injectors for ther-
omagnetic fusion machines and the study of plasma containment in a magnetic field. Prereq: Senior standing.

5630 Antennas and Propagation (3) Radio frequency waves, homogeneous media. Waves in free space, earth’s troposphere, and ionosphere. Waves reflections from earth. Prereq: 3069. E.

5670 Electro-Acoustics (3) Wave equation for sound, radiation from pistons, impedance of a piston, loud-speakers, horns, speaker systems, phonograph records and reproduction, tone recording and reproduction, noise reducing systems. Prereq: senior standing.

5990 Analog Signal Processing Circuits for Elec-
tronic Instrumentation (3) Use of operational amplifiers, instrumentation amplifiers, and other integrated circuits in signal processing. Design examples such as active filters, amplifiers, attenuators, function generators, active rectifiers, and synchronous demodulators. Analysis of interfacing problems between transduc-
ers and signal processing circuits. Prereq: 3530. 3 hrs. including project laboratory.
4610 Analog-Digital Systems (3) Principles of analog computing components. Applied to analog computing with emphasis on engineering area. Characteristics of analog multipliers, dividers, and function generators. Presents comparators, digital to analog conversion, and interface techniques. Prereq: 3180 and 3830. 3 hrs. including biewly lab.

4620 Sequential Machine and Digital System Theory (3) Design aspects of pulse-mode, clock-mode, and level-synchronous digital circuits. Prereq: 3830. 3 hrs. including project laboratory.

4630 Digital System Organization and Design (3) System organization of digital systems including minicomputer and microprocessor architectures and comparisons. Characteristics of ALU and CPU structures, storage systems (RAM, ROM, and PROM building blocks), and input/output systems. Control Unit organization to include serial/parallel modes of operation, synchronous/asynchronous time sequencing, and microprogramming of control functions. Prereq: 3180. 3 hrs. including biewly lab.

4660 Bioelectric Instrumentation (3) Nature and origin of bioelectric potentials, transducers, amplifier requirements, recording systems, and noise problems. Prereq: Senior Standing.

4680 Electric Amplifiers (3) Feedback amplifier principles. Wideband linear amplifiers. Audio and radiofrequency amplifier circuits. Prereq: 3830, 3720. 3 hrs. including project laboratory.

4690 Communications Electronics (3) Receiver and transmitter circuits for communications. Prereq: 3040, 3830. 3 hrs. including project laboratory.

4700 Digital Integrated Electronics (3) Comparators, logic gates, flipflops, registers, counters, memories, analog/digital conversion, A/D and D/A conversion, clamping, and sweep circuits. Prereq: 3830, 3180. 3 hrs. including project laboratory.

4740 Integrated Circuits (3) Processing and fabrication of active and passive components for monolithic and hybrid circuits. Design techniques for linear and digital circuits. Prereq: 3830. 3 hrs. including project laboratory.

4750 Interactive Computer Graphics (3) (Same as Computer Science 4750 and Geography 4750.)

4780 Synchronous Machines (3) Construction and application of synchronous machines, analysis of performance from equivalent circuit models for round rotor and salient pole machines, Park’s transformation to the 2-axis model, use of this model in transient studies; extension of the 2-axis concept to the generalized theory of electrical machines. Prereq: 3690.

4790 Controllable Motor Drives (3) Constructional features of the usual types and design parameters. The usual variations of the d.c. motor, A.C. servomotor, stepping motor; development of transfer functions and examples of their application in control system. Prereq: 3090.

4800 Hardware-Software Interface in Minicomputer and Microprocessor System Design (3) Minicomputer system structure and processor interface design. Hardware-software interaction and trade-off. Priority interrupt structures. Telecommunications. Project oriented, contract course. Completion of two projects, one utilizing a minicomputer and the other a microcomputer, are minimal course requirements. Prereq: 3180.

4810 Discrete-Data Systems (3) Introduction to analysis and design of discrete data control systems using frequently used techniques. Random data filtering techniques; application of digital computers in closed-loop feedback systems. Prereq: 3720.

4820 Introduction to Pattern Recognition (3) Role of pattern recognition within framework of artificial intelligence. Basic ideas of statistical and adaptive techniques. Typical applications of pattern recognition to problems of practical significance. Computer simulation of elementary pattern recognition problems. Prereq: Either 3100 and Computer Science 3150, or Statistics 3450 and Computer Science 1510. (Same as Computer Science 4820.)

4830 Digital Image Processing (3) Principal methods of coding, storing, and processing images by means of dedicated computer techniques. Course is project oriented. Prereq: 3100 and Computer Science 3150, or Statistics 3450 and Computer Science 1510. (Same as Computer Science 4830.)

4850 Small Computer Systems (3) Basic structure of small computers, input-output techniques, interrupt structures, peripheral devices, system software, and assembly language programming. Course is project oriented. Prereq: Basic Eng. 1410, Computer Science 1510 or 3150, or consent of instructor. (Same as Computer Science 4850.)

4910-20-30 Special Electrical Engineering Problems (3,3,3) Problems in electrical engineering involving library and experimental research.

GRADUATE
Consult the Graduate Catalog for listing of graduate level courses.

Engineering Physics
Professor W. M. Bugg (Head); Physics staff as shown on page 197.

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.

The courses in the engineering physics curriculum are shown in tabular form on page 198. Descriptions of the physics courses are found on page 198.

Engineering Science and Mechanics


Associate Professors: B. Antar, Ph.D. Texas; E. K. Boyce, M.S. Tennes- see; J. E. Caruther, Ph.D. Georgia Institute of Technology; R. J. Jendrucko, Ph.D. Virginia, P.E.; W. A. Lyday, M.S. Tennessee; A. Matthews, Ph.D. Illinois, P.E.; T. F. Moriarty, Ph.D. Illinois, P.E.; W. E. Scott, Ph.D. Johns Hopkins; M. O. Sollman, Ph.D. Tennessee, P.E.; J. Steinheck, Ph.D. Chicago; J. F. Wasserman, Ph.D. Cincinnati, P.E.

Assistant Professors: J. A. M. Boulet, Ph.D. Stanford; W. F. Jones, Ph.D. Clemson;

BACHELOR OF SCIENCE PROGRAM

The curriculum in engineering science provides students an opportunity for education which is broad in engineering science, mathematics, and physical (or biological) science. It prepares a student for a career in engineering development and research, professional education at the M.S. level, 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 is essentially an elective curriculum which provides for those special interests of students that cannot be accommodated in other programs. Examples of special interest elective groups presently available in the engineering science program are biomedical engineering, engineering mechanics, engineering analysis and synthesis, environmental sciences, engineering materials, and non-destructive evaluation. Other elective groups are being developed and will be available in the future.

The biomedical engineering elective group provides the basic background for an engineer to contribute to the fields of biology and medicine in such technical areas as the design of research and diagnostic equipment, the development of artificial organs, and the application of the engineering sciences to 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 engineering schools, including The University of Tennessee Center for the Health Sciences in Memphis.

The engineering mechanics elective group focuses on analytical, computational techniques and experimental methods used in investigating the interaction of forces and matter. 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 theoretical background for students wishing to pursue engineering graduate studies.

The engineering analysis and synthesis elective group affords a concentration on the application of such techniques as numerical analysis and similitude for the solution of practical engineering problems. As such, heavy emphasis is placed on the use of digital computer in the study leading to the interaction of forces and matter. 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 theoretical background for students wishing to pursue engineering graduate studies.

The engineering analysis and synthesis elective group affords a concentration on the application of such techniques as numerical analysis and similitude for the solution of practical engineering problems. As such, heavy emphasis is placed on the use of digital computer in the study leading to the interaction of forces and matter. 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 theoretical background for students wishing to pursue engineering graduate studies.

The environment sciences elective group provides the opportunity for the student to apply engineering principles to the solution of environmental and ecological problems. This program gives the necessary background to achieve a high level of...
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 program'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.

### Engineering Science and Mechanics (335)

- **2720 Dynamics (3)** Absolute and relative kinematics of rigid bodies; kinematics of rigid bodies using Newton's laws, work-energy, and impulse momentum. Prereq: Basic Engr. 3150.
- **3010 Seminar (1)** Discussions of engineering profession. Field trips and career planning. S/N.
- **3110-20 Fluid Mechanics (3,3)** Basic laws of fluids, effects of viscosity and compressibility; empirical analysis; Navier-Stokes equations; boundary-layer concepts; potential flow. Must be taken in sequence. Prereq: 2720 or 3700, Math 2840, coreq for 3110; Mech. Engr. 3311 or equivalent.
- **3310-20 Mechanics of Materials (4,4)** Concepts of stress and strain, stress strain relations, and Mohr's circle; stresses and displacements in thin-walled pressure vessels, shafting; determinate, indeterminate, and non-homogeneous beams; column theory. Must be taken in sequence. Prereq: Basic Engr. 3150; coreq: Math 2840.
- **3311 Mechanics of Materials (4)** Concepts of stress and strain; stress strain relations and Mohr's circle; static analysis of members; area moment of inertia; stress and displacement analysis of axially-loaded members; torsion; bending. Not for departmental graduate credit. Prereq: Basic Engr. 1310; coreq: Math 2840.
- **3410 Introduction to Biomedical Engineering (4)** Introduces the facets and opportunities of biomedical engineering, and provides basic terminology and background knowledge for the field. Subjects include anatomy, physiology, biomaterials, mathematical models of body systems, etc. Coreq: Math 2840 or consent of instructor.
- **3420 Introduction to Clinical Engineering (3)** Engineering applications in the clinical/hospital setting; description, analysis, and design of health care delivery systems; hospital organization and structure; clinical use of biomedical equipment; principles of safety engineering in the hospital and applicable codes, standards and regulations. Prereq: 3410, Physics 2320, or consent of instructor.
- **3510 Materials of Engineering (4)** Mechanical properties of engineering materials; behavior of materials under load. 3 hrs. or 2 hrs. and 1 lab. Prereq: 3311 and Met. Engr. 2110 or Must be taken in sequence.
- **3700 Dynamics (4)** Kinematics of rigid bodies; mass moments of inertia; coulomb friction; kinematics of rigid bodies using force, mass, acceleration; work-energy; impulse-momentum. Not for departmental graduate credit. Prereq: Basic Engr. 1320, Math 2840.
- **3710 Intermediate Dynamics (3)** Three-dimensional dynamics of particles and rigid bodies; dynamics of bodies with varying mass; central force motion; Lagrange's equations. Prereq: 2720 or 3700 and Math 2850.
- **4010 Project in Design and Development (4)** Investigates, design, and report of an engineering science project. Prereq: Senior standing and a grade of C or better in 3311, 3700, and 3110.
- **4020 Computer - Aided Design (3)** Use of computer graphics and analysis for design of practical systems, structures, and components. Evaluation of design alternatives. Prereq: 4810 or consent of instructor.
- **4011 Project in Design and Development (3)** Investigation, design, and report of an engineering science project. Prereq: Senior standing.
- **4520 Biomedical Fluid Mechanics (3)** Discusses objectives, review foundations, and present developments in biomedical fluid mechanics. Properties of human blood and blood vessels, determinants of cardiac performance, analysis and measurement of flow and pressure in arteries, nonsmoothed analysis of circulatory system, mechanics of microcirculation. Applications to areas of hemoysis, thrombosis, and fluid dynamics of heart assist devices. Prereq: 4500 or a course in fluid mechanics or consent of instructor.
- **4530 Biomechanics (3)** Discuss objectives, review foundations, and present developments in biomechanics of injury and prosthesis, material compatibility of prosthetic devices, and biomechanical problems related to impact. Prereq: 3311 or 4500 or consent of instructor.
- **4540 Fracture-Safe Design (3)** A critical review of mechanical properties of materials that are indicative of fracture, residual strength, reliability for transition temperature, R-curves, stress intensity factors, and J-integrals; the use of these properties in design. 3 hrs. and 1 lab. Prereq: 3311 and Met. Engr. 2110. (Same as Met. Engr. 4540.)
- **4550 Design of Artificial Internal Organs (3)** Study of the design, development and evaluation of artificial internal organs including Federal regulation and ethical considerations. Review of the design and development of existing and new developments. Prereq: 3110, 3410, Math 2850.
- **4580 Principles of Non-destructive Testing (3)** (Same as Physics 4580.)
- **4610 Experimental Stress Analysis (3)** Basic concepts: theory, techniques, and instrumentation of resistance strain gauges; theory and techniques of brittle coating method; introduction to other stress analysis methods. Prereq: 3111, Elec. Engr. 2820 or 3110. 2 hrs. and a 3-hr. lab.
- **4620 Dynamic Data Acquisition (4)** Instrumentation of measuring systems for dynamic events and responses; signal conditioning; oscilloscopes, oscillographs, frequency analyzers, signal averaging, peak memory, digital and hybrid data retrieval, data processing, data transmission: data processing: Prereq: 3311, 4710, Elec. Engr. 3120. 3 hrs. and a 3-hr. lab.
- **4630 Introductory Photomechanics (3)** Introduction to photoelasticity, photoelastic coating method, More and Mayo's method, Interferometry. Prereq: 3111, Physics 2320. 2 hrs. and a 3-hr. lab.
- **4710 Fundamentals of Vibrations (3)** Free and forced vibrations of damped and undamped lumped parameter systems; energy methods. Prereq: 2720 or 3700.
- **4910-20 Engineering Analysis (4,3)** Integration of fundamental physical laws and mathematical methods of analysis with emphasis on application to realistic engineering problems. Prereq: 3110, 3311, and Computer Science 3150.
- **4850 Elementary Structural Matrix Methods (4)** (Same as Architecture 4850 and Civil Engineering 4850.)
- **4910-20 Special Engineering Science Topics (3)** Problems related to recent developments and practice. Open to juniors or seniors with consent of instructor. May be repeated once.
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 service management, systems research, 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 take an approved list of prerequisite course work. A non-thesis option with 45 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, Technology, 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 emphasizes 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 prograda

3610 Human Factors in Work Design I (3) Human capabilities and limitations which must be reflected in: work place layout; working environment specifications; tools, equipment, and vehicle design; and in design of industrial communication-control systems. Prereq: Junior standing.

3610 Human Factors in Work Design I (3) Human capabilities and limitations which must be reflected in: work place layout; working environment specifications; tools, equipment, and vehicle design; and in design of industrial communication-control systems. Prereq: Junior standing.

3610 Human Factors in Work Design I (3) Human capabilities and limitations which must be reflected in: work place layout; working environment specifications; tools, equipment, and vehicle design; and in design of industrial communication-control systems. Prereq: Junior standing.

3610 Human Factors in Work Design I (3) Human capabilities and limitations which must be reflected in: work place layout; working environment specifications; tools, equipment, and vehicle design; and in design of industrial communication-control systems. Prereq: Junior standing.
lems in selection or replacement of equipment. Deci-
sions among engineering alternatives involving capital
requirements, quality of life, equipment, and rate of
return of investment.

4530 Case Studies in Engineering Economy (3) Exten-
sion of basic engineering economy principles to actual
problems faced by competitive firms and regulated
industries. Case studies taken from literature in
form of classroom discussion. Out-of-class assign-
ment involves working with local companies to evaluate
make or buy options, leasing versus cash purchases,
equipment replacement studies, energy source econ-
omies, etc. Prereq: 4520.

4540 Industrial Development (3) Factors other than
mechanical or chemical which enter into successful
industries. Focus on development of manufacturing enterprise. Cost and
location studies and market analysis to determine the
commercial feasibility of new plants or projects.

4590 Simulation (3) Generation of outcome of com-
plex random processes by computer. Models of complex
systems using available simulation languages. Simu-
lation as design tool in industrial systems. Prereq:
3430 and Computer Science 3150.

4600 Predetermined Time Systems (3) Work design
and measurement using a predetermined time system
such as Methods Time Measurement, Basic Motion
Time-Study, or Work Factor. Theory and applica-
tion. Prereq: 3630.

4610 Human Factors in Work Design II (3) Human
compatibilities and limitations affecting work pro-
cesses, working environments, design of tools and
equipment, and communications and response in man-
machine systems. Prereq: 3600, 3630, or consent of
instructor.

4830 Health Systems Engineering (3) Hospital man-
agement systems and means by which they may be
improved through application of modern industrial
engineering principles and techniques. Prereq: 3620.

4840 Industrial Plant Problems Analysis (3) Indus-
trial problems, application of industrial engineering, field
assignment in local industry, problem definition, anal-
ysis, and presentation. Prereq: 3630, 3440, 3510,
3520, 4520, 4860.

4870 Mini-Computer Applications in Industrial Engi-
neering (3) Introduction to computer hardware and
man-computer interfaces; emphasis on small com-
puters as an element of larger systems; applications
and limitations of small computers in solving industri-
al engineering problems. Prereq: Senior standing.

4910-20-30 Special Industrial Engineering Topics (3,3,3)
May be repeated for credit. Prereq: Consent of
instructor.

4950 Industrial Safety (3) Development of organization
and procedures for control of accidents; stu-
dents with emphasis on OSHA Rules and Regulations.
Prereq: Senior standing.

GRADUATE
Consult the Graduate Catalog for listing of
graduate level courses.

Mechanical and
Aerospace Engineering

Professors:
D. R. Pitts (Head), Ph.D. Georgia Institute of Tech-
nology; J. F. Bailey (Emeritus), Ph.D. Lehigh, P.E.;
G. W. Braun1, (Emeritus), Ph.D. Gattingen; F. G.
Collins1, Ph.D. California (Berkeley), P.E.; A. J.
Edmondson, Ph.D. Texas A & M, P.E.; W. Frost1,
Ph.D. Washington; G. W. Garrison1, Ph.D. North
Carolina State University; B. H. Goetsch1 (Emer-
itus), Ph.D. Berlin (Germany); K. E. Hanwell1, Ph.
California Institute of Technology, P.E.; W. H.
Heiser1, Ph.D. Massachusetts Institute of Technol-
ogy; W. H. Heising1, Ph.D. Illinois Institute of
Technology, P.E.; R. W. Holland, M.S. Tennessee,
P.E.; W. S. Johnson, Ph.D. Clemson, P.E.; E. O.
Kurozuke1, Ph.D. Oklahoma State; R. J. Kranz,
Ph.D. Oklahoma; M. Kuroskal1, Ph.D. California
Institute of Technology, P.E.; H. Liston, Jr., (Vice
President), M.E.A.; J. E. George, Washington, R.L. Oast

well, M. S. Case, P.E.; M. W. Milligan, Ph.D. Ten-
nessee; P. M. Newman1 (Emeritus), Ph.D. Colum-
bia, P.E.; P. R. Peters1, Ph.D. Brussels; F.
Shahraki1, Ph.D. Oklahoma; F. H. Speckhart2,
Ph.D. Georgia Institute of Technology, P.E.; W. K.
Stair, M.S. Tennessee; J. M. Tucker (Emeritus),
M.S. Illinois; J. W. White, Ph.D. Stanford; H. J.
Wil-
kerson, Ph.D. Tennessee State; J. M. Wu1, Ph.D.
California Institute of Technology; Y. C. Wu1, Ph.D.
California Institute of Technology; R. L. Young1,
Ph.D. Northwestern, P.E.

Associate Professors:
R. V. Armill, Ph.D. VPI & SU; S. E. Becker, Ph.D.
North Carolina State, P.E.; C. W. Brown, M.S.
Tennessee, P.E.; R. Crawford1, Ph.D. Tennessee;
J. A. Euler, Ph.D. Purdue; T. H. Moulten1, Ph.d.
Tennessee; M. Parang, Ph.D. Oklahoma; J. R. Par-
sons, Jr., Ph.D. North Carolina State; R. J.
Schulz1, Ph.D. Pennsylvania State.

Assistant Professors:
P. E. George, II, Ph.D. Purdue; M. Keyhani, Ph.D.
Ohio State.

Space Institute, Tullahoma.

IBM Professor

BACHELOR OF SCIENCE PROGRAM

Separate, complete curricula are offered in aerospace engineering and mechanical engi-
neering; 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 develop-
ment of the particular engineering sciences of the aerospace and mechanical engi-
neering fields. In the senior year an opportunity is provided for the student to apply this
fundamental knowledge to mechanical and
aerospace engineering problems. Both cur-
ricula are arranged with flexibility in the
upper-division years to permit emphasis on
preparation for graduate study or technical
employment.

Aerospace engineering has scientific foun-
dations close to those of mechanical
engineering. The aerospace engineer, how-
ever, devotes attention particularly to the
research, development, design, testing, and
production of aerospace vehicles—aircraft,
spacecraft, missiles; auxiliary systems—
heating, cooling, guidance, control; and pro-
duction systems—diesel engines, turbo-jets,
rampets, and rockets. Emphasis in the senior
year is directed toward these topics and the
program culminates in a major aerospace
design project.

The mechanical engineering has its foundation in the basic sciences and requires an under-
standing of such areas of applied science as solid and fluid mechanics, thermodynamics,
heat transfer, structures, vibrations, materials science and manufacturing processes, and
instrumentation in order to resolve the complex engineering problems of the
real world.

In the mechanical engineering curriculum the student, with the aid and approval of an
advisor, must select a senior year program of mechanical engineering and technical
 electives. The following areas of concentra-
tion are available:

Energy, A study of energy conversion

systems and the laws governing energy transformation. This area includes the design and analysis of conventional and
future power generating systems utilizing various energy sources. The central courses are Mech. Engr. 4140-50-60.

Environment, A study of the systems which control the environment within
enclosed spaces. Possible topics include the design and analysis of cooling, heating, and refrigeration, and heat pump devices
encompassing heating, cooling, ventilation, humidifying, and noise control. The central courses are Mech. Engr. 4710-20-30.

Manufacturing, A study of manufacturing methods and production processes common
to mass production industries. The study areas include the selection of processes,
design of tools and fixtures, numerical control
tool and analysis and design of the total
manufacturing system. The central courses are Mech. Engr. 4621-22-23-24 with related courses in metallurgy.

Machine Design, The study and applica-
tion of the principles of mechanics, materials, and manufacturing processes to the design and analysis of machine ele-
machines, structures, and systems. The central courses are Mech. Engr. 4680 and 4690.

Propulsion, The study of propulsion devices for ground vehicles, aircraft, and
spacecraft. The topics include the analysis and design of internal combustion engines, gas turbines, jet engines, and rocket engines
using conventional and non-conventional fuels. The central courses are Mech. Engr. 4810 and Aero. Engr. 4250-60.

Aerospace, The study of aircraft and spacecraft including the mechanics of flight
and related systems and propulsion devices. Key elements include the analysis and
design of a variety of aerospace vehicles and
systems. The central courses are Aero. Engr. 4240-50-60.

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, selected lower division courses, and evi-
dence of satisfactory and orderly progress
through the prescribed curriculum.

Full Status: A Lower Division student in the department may apply for progression to
Upper Division Programs after completing
81 quarter hours of Lower Division engineer-
ing curriculum course work with an overall
GPA of at least 2.4.

Provisional Status: Students who have completed 81 quarter hours of Lower Divi-
sion engineering curriculum course work with an overall GPA between 2.0 and 2.4
may apply for provisional status. The grant-
ing of Provisional Status is based on the
availability of space in departmental pro-
grams 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 12 hours of 3000 level required
engineering courses (including 9 specified hours in the department). Further progres-
sion 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 with the exception of Engr. Sci. 3440 and Aero. Engr. 2040. 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 are afforded a Professional Status basis only. Any student presenting more than 42 hours of Lower Division engineering curriculum course work by Transfer Credit 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 levels 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 or Doctor of Philosophy in engineering, and Doctor of Philosophy with specialization in mechanical engineering or aerospace engineering are available to graduates of recognized undergraduate curricula in mechanical or aerospace engineering and to graduates of other curricula who satisfy the necessary prerequisite courses. The general requirements for advanced degrees are summarized in the Graduate Catalog.

Mechanical Engineering (650)


3660 Manufacturing Processes (3) Selection of processes as related to the design of machine parts. Casting, hot and cold forming, metal removal, and welding. Manufacturing tolerances and surface finishes. 2 hrs. and one 2-hr. lab. Prereq: Met. Engr. 2110. E.

3510 Engineering Analysis (3) Advanced analysis techniques for problems of aerospace and mechanical engineering. Emphasis on approximate methods. Prereq: Computer Science 3150. E.

4010 Thesis (3) Problem investigation and report. Prereq: Senior standing. E.

4140 Energy Conversion Systems (3) Operating and design characteristics of energy conversion systems including new technology development; selected direct conversion techniques. Prereq: 3330; coreq: 4420.

4150 Energy Conversion Systems (3) Fossil fuel energy conversion systems with emphasis on coal technology. Prereq: 4140. A.

4160 Design of Energy Conversion Systems (3) Synthesis and design of complete energy conversion system including economic and technical aspects. Participation in team design effort including formal presentations and design report. Prereq: 4150 and Ind. Engr. 4520.

4170 Turbo-Machinery (3) Basic principles of turbomachinery; systematic methods of analysis, design, performance evaluation. Prereq: Aerospace Engr. 3511.

4180 Energy Production and Utilization (3) Thermodynamic constraints on energy sources and concepts; energy conservation schemes. Prereq: Senior standing in engineering or consent of instructor. A.

4220 Environmental Noise (3) Basic principles of acoustics—measurement and control of noise in industrial and community environments. Prereq: Senior standing in engineering or consent of instructor. A.

4310 Seminar (1) Discussion of topics related to engineering; includes inspection trips to industrial plants. Prereq: Senior standing. S/N/G.

4320 Seminar (1) Formal oral presentations by students on engineering; written and technical talks. Prereq: Senior standing. S/N/G.

4420 Heat Transfer (3) Heat transfer by free and forced convection, heat transfer in phase change, heat exchanger applications. Prereq: 3440; coreq: Aerospace Engr. 3511. E.

4450 Lubrication (3) Hydrodynamic theory of lubrication of sliding bearings; application of Navier-Stokes equations to infinite and finite bearings; analytical and numerical solutions; applications to design. Prereq: 3440, Aerospace Engr. 3511. W.

4471-91 Experimental Mechanical Engineering (3,3) Experimental methods and measurements of force, length, time, temperature, pressure, transport rates, and physical properties. Planning, conducting, analyzing, and reporting experimental tests run according to test standards and other specifications. Prereq: 3311, 3430, 3440, Engr. Sci. & Mech. 3320 for 4471; 4471 and 4420 for 4491. 4471-F, W, 4491-F, W, SU.

4511-21 Systems and Controls I and II (3,3) Analytical models of physical systems comprised of combinations of mechanical, electrical, and thermal components; feedback control systems, transient and frequency domain analysis; non-linear control of linear systems; sampled data systems, digital filters. Prereq: 3620 or AE 3620, AE 3511, and Elec. Engr. 3130; coreq: 4471 for 4511; Prereq: 4511 for 4521. 4511-F, W, 4521-F, W.

4612 Manufacturing Processes (3) Comparison of machining methods; plastic production, metrology. Prereq: 3620 and 4420. A.

4621 Tool Design (3) Principles underlying tool and die design, design of high-volume production tools and molds, work holding fixtures. Prereq: 3650-60 or consent of instructor.

4623 Numerical Control Processing (3) Application of advanced programming techniques to mechanical, electrical, and computerized numerical control systems. Prereq: Computer Science 3150. W.


4625 Manufacturing Process Engineering (3) Product specification: dimensional analysis of size and form; true position tolerance theory; tolerance analysis; and workpiece control for production to tolerance. Prereq: 3660 or Ind. Engr. 4040.

4631 Energy Methods in Mechanical Design (3) Application of strain energy principles in complex beams and structures. Prereq: 3620, 3650, and Computer Science 3150 or consent of instructor. F.

4660 Materials and Manufacturing Processing (3) Selection of materials in design process, emphasizing relationship between stresses and strain analysis, material properties, environment, temperature, manufacturing technology, and cost. Prereq: 3650, 3660.


4691 Machine Design (5) Innovative design of complete machine; documentation including specifications, design calculations, working drawings, and cost analysis. Written and oral report. Prereq: 4670-80, Ind. Engr. 4520. F, S.

4710 Thermal Environmental Systems (3) Vapor compression and absorption cycles; heat pump systems; moist air properties; psychrometric processes. Prereq: 3620, 3430.

4720 Thermal Environmental Systems (3) Design analysis of air washers, cooling towers and extended surface coils; solar radiation; building heat transmission, physiological effects. Prereq: 4420, 4710.


4740 Solar Energy Utilization (3) Nature and availability of solar radiation; review of selected heat transfer topics pertinent to solar energy collection and use; design analysis of solar energy collectors and method of storage; selected applications. Prereq: 3321, 4420, or consent of instructor. A.

4770 Thermal Engineering I (3) Analysis of selected topics in thermal engineering; modeling of thermal systems and components; energy resources, environmental impact, combustion, turbomachinery, and thermodynamic cycle. Prereq: 3330 and 4420. F, W.

4780 Thermal Engineering II (3) Analysis of selected topics in thermal engineering including modeling of thermal systems and components; multi-mode heat transfer and radiation; design and analysis of systems; second law analysis. Prereq: 3330 and 4420. W, S.

4791 Thermal Engineering Design (5) Design of a complete thermal-fluid system including economic, technical, and optimization aspects. Participation in team design effort including formal presentations and
Aerospace Engineering (018)

2040 Introduction to Aerospace Engineering (1) Presentation and discussion of topics related to aerospace engineering. S/N/C. F., W., S.

3040 Seminar (1) Presentation and discussion of topics related to aerospace engineering. Prereq: Junior standing. S/N/C.


3620 Mechanical Vibrations (3) Free and forced vibrations of single and multiple degree vibrating systems, balancing of rotating machinery. Prereq: 3160 and Mech. Engr. 3910. W.


4010 Thesis (3) Problem investigation and report. Prereq: Senior standing. F., W., S.

4100-20-30 Aerodynamic Fundamentals (2) Atmosphere, dynamics and thermodynamics of perfect gases, fluid flow types, airflow theory, wing theory, drag. For non-engineering majors only. Prereq: Consent of instructor.

4120 Aircraft Propulsion and Performance (3) Propulsion systems for aircraft; static, performance, altitude, and special performance problems, maneuver, control, and stability. Non-engineering majors only. Prereq: 4110.

4210 Compressible Flow (3) One-dimensional internal flow; shock and expansion waves, friction and non-adiabatic flow. Prereq: 3511 and Mech. Engr. 3321. F.

4320 Low Speed Aerodynamics (3) Potential flow theory; kinematics and dynamics of perfect fluids; analysis and design of aerodynamic bodies. Prereq: 3511 and Mech. Engr. 3321. F.

4320 Viscous Flow (3) Boundary layer theory; laminar and turbulent flow; compressibility effects; numerical solution methods. Prereq: 3511 and Mech. Engr. 3610, 4420. S.


4621 System Design (3) Synthesis and design of a complete aerospace system including economic and technical aspects. Participation in team design effort including formal presentations and design report. Prereq: 4250 and Ind. Engr. 4520. S.

4320 Seminar (1) Discussion of topics related to engineering includes inspection trips to industrial plants. Prereq: Senior standing. S/N/C. F.

4320 Seminar (1) Formal oral presentations by students on current research. Prereq: Senior standing. W.


4510 Airplane Performance (3) Introduction to airfoil and wing characteristics, drag, propellers; static performance and maneuvers; theory and design of control surfaces; stability. Prereq: 3511. W.

4590 Selected Topics in Aerospace Science (3) Current problems in aerospace science; topics in science and engineering required for an understanding of the several areas of aerospace science. Prereq: Consent of instructor.

4592 Selected Topics in Aerospace Science (1,4) Current problems and topics in aerospace science; topics in science and engineering required for an understanding of the several areas of aerospace science. Prereq: Consent of instructor. Title will vary.

GRADUATE

Consult the Graduate Catalog for listing of graduate level courses.

Nuclear Engineering (7/16)


Associate Professors: E. M. Katz, Ph.D. Tennesse, P.E.; L. F. Miller, Ph.D. Texas A & M, P.E.; B. R. Upadhyaya, Ph.D. California (San Diego), P.E.

*Honorary.

BACHELOR OF SCIENCE PROGRAM

The curriculum in nuclear engineering is designed to provide basic training in many of the fields encountered in the applications of nuclear and radioactive materials. The first two years are concerned with the fundamental processes in engineering, physics, mathematics, chemistry, and English. The last two years encompass scientific and engineering courses equipping the student for entry into a variety of work in industry, research, or graduate studies.

MASTER OF SCIENCE AND MASTER OF ENGINEERING PROGRAMS

A graduate degree to a degree of Master of Science and Master of Engineering is available to graduates of recognized undergraduate curricula in engineering and physics. Each applicant will be advised as to the necessary prerequisite courses before entering the program.

The general requirements of the master's degrees 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.

3140-20-30 Seminar (1,1,1) Presentation and discussion of topics related to nuclear engineering. S/N/C.


3150 Dynamics and Controls (3) Systems differential equations; solution by classical methods; Laplace transform methods; frequency response, stability, and control. Coreq: 4110.

3210-20 Thermodynamics (4,4) Properties and laws of thermodynamic systems. First and second laws used to analyze power plant systems—both fossil and fission. Prereq: Math 2860 and Basic Engr. 1330.


4110-20-30 Introduction to Nuclear Reactor Theory (3,3,3) Nuclear structure, radioactive decay laws, neutron interaction; fission process, chain-reacting systems; diffusion equation including multigroup diffusion theory, neutron moderation, critical scattering properties; perturbation theory. Prereq: Physics 3730 or consent of instructor.

4140 Thermonuclear Systems (3) Fusion reactions; properties of plasmas; plasma containment, plasma diagnostics; thermonuclear devices. Prereq: Physics 3730; Math 4550.

4210-20 Nuclear Engineering Laboratory (3,3,3) Radiation detection and counting instrumentation, counting statistics, half-life and decay schemes, gamma spectrometry, cross-section measurements, analog computation, diffusion properties of neutrons, critical loading experiments, control rod calibration, statistical weight, shielding, xenon poisoning, prompt critical reactor behavior, fission density, and adjoint flux. Prereq: 4110 (or registration therein), or equivalent.


4160-20 Reactor Power Systems (3,3,3) Nuclear structure, decay laws, neutron diffusion, time behavior of reactors, heat removal, analysis of reactor power plants; economic, safety, and environmental aspects of nuclear power. Prereq: Math 4610; non-nuclear engineering students only.

4710 Energy Transport (4) Development of differential and integral energy conservation equations; conduction, convection, and radiation heat transfer; application of nuclear reactor fuel elements and heat exchangers. Prereq: 3010.

4720 Reactor Thermal Design (4) Hydrodynamics and heat transfer in boiling systems; boiling crises; fuel element thermal design, steam generator design. Prereq: 4710.

730 Nuclear Reactor Design (3) First order reactor design, integration with non-nuclear heat transfer and power conversion system, economic evaluation; optimization procedures, description of typical systems. Coreq: 4130.

4810 Radiation Shielding (3) Types of radiation sources, gamma ray and neutron attenuation, biological effects of ionization, shield design. Prereq: Physics 3730; Math 4550.

4820 Reactor Kinetics and Controls (3) Derivation of kinetic equations; basic kinetic parameters; transient response with feedback; control and protective systems. Prereq: 4110.
4840 Nuclear Reactor Safety (3) Presentation of reactor safety concepts and criteria; credible accidents; fission product release and transport; containment systems; accident analysis; engineered safeguards. Prereq: 4120.

4930 Nuclear Fuel Management (3) Discussion of problems associated with processing of nuclear materials; fuel cycle analysis; burn-up calculation. Prereq: 4120.

GRADUATE
Consult the Graduate Catalog for listing of graduate level courses.