Ingram School of Engineering

Phone: (512) 245-1826 Office: Roy F. Mitte Building, Room 5202
Fax: (512) 245-7771 Web: http://www.engineering.txstate.edu

Degree Programs Offered

- BS, major in Electrical Engineering
- BS, major in Industrial Engineering
- BS, major in Manufacturing Engineering

The BS with a major in Electrical Engineering provides students the background that is essential for the conception, design, development, and manufacture of electrical, electronic and information technology products and systems. Students may specialize in either of the areas of networks and communication systems or micro and nano devices and systems. Proficiency in mathematics is especially important in Electrical Engineering. In order to be admitted to the EE program, a student needs to be qualified to take MATH 2417 or higher.

The BS with a major in Industrial Engineering provides students the background that is essential for improving the productivity, quality, safety, and cost effectiveness of all types of systems and processes. Industrial engineers are typically engaged in the areas of quality assurance, ergonomics, production & operations management, facilities design, work design, system optimization, information technology, and industrial safety.

The BS with a major in Manufacturing Engineering is designed to provide students with the mathematics, science, management, engineering, and applications skills needed to become manufacturing engineers. These engineers are typically responsible for promoting manufacturability, process planning, tool design, cost estimation, factory layout, work methods, quality assurance, automation, and systems integration. The degree has a concentration in general manufacturing or semiconductor/high technology manufacturing.

For information on engineering technology, industrial technology, or the 3/2 pre-engineering option in physics, please see the Departments of Technology and Physics sections of this catalog.

Mission Statement

1. To provide students with an exceptional education in various disciplines of engineering,
2. To establish, through dedicated faculty, a nationally recognized research program, preparing interested students to achieve excellence in graduate studies and research, and
3. To serve the State of Texas and the nation by creating highly skilled, diverse, and motivated professionals capable of technological innovation and dedicated to the improvement of society.

Vision Statement

The Ingram School of Engineering will be a nationally recognized institution of higher education, serving students and employers with a complete set of accredited engineering programs supported by a faculty which maintains high standards of teaching, research, and service. To accomplish this vision, we will:

1. Engage undergraduate and graduate students with innovative, multidisciplinary, and nationally recognized funded research programs,
2. Emphasize quality undergraduate and graduate education using a practical, interactive, and contemporary learning environment,
3. Produce first-generation professional college graduates as part of an HSI-designated university; be recognized for exceptional community service; and create tight bonds with alumni who will serve as professional mentors, sponsors, and advisors.

4. Promote a student-centered culture based on collegiality, scholarship, enthusiasm, integrity, and mutual respect among diverse faculty, staff, and students.

Educational Objectives

1. Graduates who perform as engineering leaders in the global marketplace.
2. Graduates who understand and apply the principles of math, science, and engineering in manufacturing, electronic, and industrial related activities.
3. Graduates who contribute to the profitable growth of businesses.
4. Graduates who maintain high standards of professional and ethical responsibility.
5. Graduates who pursue lifelong learning.

Bachelor of Science
Major in Electrical Engineering
(with Micro and Nano Devices and Systems Specialization)

Minimum required: 137 semester hours

General Requirements:

1. In order to declare Electrical Engineering as a major, students must meet one of the following prerequisites: ACT Math score of 24 or higher, SAT Math score of 520 (re-centered) or higher, or credit for one of the following math courses with a grade of "C" or higher: MATH 1315, 1317, 1319, or 1329. Students who do not meet the above prerequisites may choose Pre- Electrical Engineering as their major. Pre-Electrical Engineering students who complete one of the following math courses with a grade of "C" or higher may declare Electrical Engineering as their major: MATH 1315, 1317, 1319, or 1329.
2. All Electrical Engineering majors must complete Electrical Engineering (EE) course prerequisites with a grade of "C" or higher.
3. A minimum of 9 writing intensive hours and a total of 36 advanced hours are required to graduate. An advanced course is one that is numbered above 3000 and below 5000.
4. Departmental requirements that also satisfy the general education core curriculum requirements for the following components: mathematics- MATH 2471; natural science- CHEM 1341/1141 and PHYS 1430; and social science- ECO 2301. See the University College section of this catalog for the English literature requirements.
5. If two years of the same language are taken in high school, then no additional language hours will be required for the degree. In the absence of such high school language, two semesters of the same modern language must be taken at the college level.

Freshman Year – 1st Semester	Hours
CHEM 1341, 1141	4
ENGR 1413	4
MATH 2471	4
US 1100	1
ENG 1310	3
Total	**16**

Freshman Year – 2nd Semester	Hours
PHYS 1430	4
ENGR 2300	3
MATH 2472	4
ENG 1320	3
HIST 1310	3
Total	**17**

Freshman Year – Summer I	Hours
HIST 1320	3
PFW one course	1
Total	**4**

Freshman Year – Summer II	Hours
PHIL 1305	3
ENG Literature (see gen. req. 2)	3
Total	**6**

Sophomore Year – 1st Semester	Hours
EE 2300	3
MATH 3323	3
MATH 3373	3
PHYS 2425	4
ECO 2301	3
Total	**16**

Sophomore Year – 2nd Semester	Hours
EE 2320	3
MATH 3375	3
MATH 3377	3
PHYS 2435	4
CS 1428	4
Total	**17**

Sophomore Year – Summer Session	Hours
COMM 1310	3
POSI 2310	3
PFW one course	1
Total	**7**

Junior Year – 1st Semester	Hours
EE 3300	3
EE 3340	3
ENGR 3315	3
IE 3320	3
POSI 2320	3
Total	**15**

Junior Year – 2nd Semester	Hours
EE 3320	3
EE 3350	3
EE 3355	3
EE 3370	3
ART, DAN, MU, or TH 2313	3
Total	**15**

Senior Year – 1st Semester	Hours
EE 4350	3
EE 4352	3
EE 4390	3
TECH 4392	3
Total	**12**

Senior Year – 2nd Semester	Hours
EE 4355 or TECH 4394	3
EE 4358	3
EE 4391	3
MFGE 4376	3
Total	**12**

Bachelor of Science
Major in Electrical Engineering
(with Networks and Communication Systems Specialization)

Minimum required: 137 semester hours

General Requirements:

1. In order to declare Electrical Engineering as a major, students must meet one of the following prerequisites: ACT Math score of 24 or higher, SAT Math score of 520 (re-centered) or higher, or credit for one of the following math courses with a grade of "C" or higher: MATH 1315, 1317, 1319, or 1329. Students who do not meet the above prerequisites may choose Pre- Electrical Engineering as their major. Pre- Electrical Engineering students who complete one of the following math courses with a grade of "C" or higher may declare Electrical Engineering as their major: MATH 1315, 1317, 1319, or 1329.

2. All Electrical Engineering majors must complete Electrical Engineering (EE) course prerequisites with a grade of "C" or higher.
3. A minimum of 9 writing intensive hours and a total of 36 advanced hours are required to graduate. An advanced course is one that is numbered above 3000 and below 5000.
4. Departmental requirements that also satisfy the general education core curriculum requirements for the following components: mathematics- MATH 2471; natural science- CHEM 1341/1141 and PHYS 1430; and social science- ECO 2301. See the University College section of this catalog for the English literature requirements.
5. If two years of the same language are taken in high school, then no additional language hours will be required for the degree. In the absence of such high school language, two semesters of the same modern language must be taken at the college level.

Freshman Year – 1st Semester	**Hours**
CHEM 1341, 1141	4
ENGR 1413	4
MATH 2471	4
US 1100	1
ENG 1310	3
Total	**16**

Freshman Year – 2nd Semester	**Hours**
PHYS 1430	4
ENGR 2300	3
MATH 2472	4
ENG 1320	3
HIST 1310	3
Total	**17**

Freshman Year – Summer I	**Hours**
HIST 1320	3
PFW one course	1
Total	**4**

Freshman Year – Summer II	**Hours**
PHIL 1305	3
ENG Literature (see gen. req. 2)	3
Total	**6**

Sophomore Year – 1st Semester	**Hours**
EE 2300	3
MATH 3323	3
MATH 3373	3
PHYS 2425	4
ECO 2301	3
Total	**16**

Sophomore Year – 2nd Semester	**Hours**
EE 2320	3
MATH 3375	3
MATH 3377	3
PHYS 2435	4
CS 1428	4
Total	**17**

Sophomore Year – Summer Session	**Hours**
COMM 1310	3
POSI 2310	3
PFW one course	1
Total	**7**

Junior Year – 1st Semester	**Hours**
EE 3300	3
EE 3340	3
ENGR 3315	3
IE 3320	3
POSI 2320	3
Total	**15**

Junior Year – 2nd Semester	**Hours**
EE 3320	3
EE 3350	3
EE 3355	3
EE 3370	3
ART, DAN, MU, or TH 2313	3
Total	**15**

Senior Year – 1st Semester	**Hours**
EE 4350	3
EE 4370	3
EE 4377	3
EE 4390	3
Total	**12**

Senior Year – 2nd Semester	**Hours**
EE 4372	3
EE 4374, 4376, 4378 (choose two)	6
EE 4391	3
Total	**12**

Bachelor of Science
Major in Industrial Engineering
Minimum required: 133 semester hours

General Requirements:

1. In order to declare Industrial Engineering as a major, students must meet one of the following prerequisites: ACT Math score of 24 or higher, SAT Math score of 520 (re-centered) or higher, or credit for one of the following math courses with a grade of "C" or higher: MATH 1315, 1317, 1319, or 1329. Students who do not meet the above prerequisites may choose Pre-Industrial Engineering as their major. Pre-Industrial Engineering students who complete one of the following math courses with a grade of "C" or higher may declare Industrial Engineering as their major: MATH 1315, 1317, 1319, or 1329.
2. A minimum of 9 writing intensive hours and a total of 36 advanced hours are required to graduate. An advanced course is one that is numbered above 3000 and below 5000.
3. Departmental requirements that also satisfy the general education core curriculum requirements for the following components: mathematics- MATH 2471; natural science- CHEM 1341/1141 and PHYS 1430; and social science- ECO 2301. See the University College section of this catalog for the English literature requirements.
4. If two years of the same language are taken in high school, then no additional language hours will be required for the degree. In the absence of such high school language, two semesters of the same modern language must be taken at the college level.
5. Six hours of IE electives to be chosen from: HA 3308 (fall, spring, summer I/II), HA 3340 (fall, spring, summer I/II); HIM 3310 (fall), HIM 3363 (fall); IE 4330 (fall), IE 4340 (fall); MFGE 4367 (spring), MFGE 4392 (spring), MFGE 4395 (fall); TECH 2330 (fall), TECH 4330 (fall), TECH 4391 (summer I).

Freshman Year – 1st Semester	**Hours**
CHEM 1341, 1141	4
ENG 1310	3
ENGR 1413	4
MATH 2471	4
US 1100	1
Total	**16**

Sophomore Year – 1st Semester	**Hours**
PHYS 2425	4
COMM 1310	3
MATH 3323	3
POSI 2310	3
MFGE 2332	3
HIST 1320	3
Total	**19**

Junior Year – 1st Semester	**Hours**
ENGR 3311	3
ENGR 3315	3
ENGR 3373	3
IE 3320	3
PHIL 1305	3
PFW one course	1
Total	**16**

Freshman Year – 2nd Semester	**Hours**
PHYS 1430	4
ENG 1320	3
ENGR 2300	3
HIST 1310	3
MATH 2472	4
Total	**17**

Sophomore Year – 2nd Semester	**Hours**
CS 1428	4
MATH 3375	3
ART, DAN, MU, or TH 2313	3
ECO 2301	3
POSI 2320	3
Total	**16**

Junior Year – 2nd Semester	**Hours**
IE 3310	3
IE 3330	3
IE 3340	3
IE 4355	3
ENG Literature (see gen. req. 2)	3
PFW one course	1
Total	**16**

Senior Year – 1st Semester	Hours
IE 4310	3
IE 3360	3
IE 4380	3
IE Elective (see gen. req. 4)	3
MFGE 4396	3
IE 4370	3
Total	**18**

Senior Year – 2nd Semester	Hours
IE 4320	3
IE 4350	3
IE 4360	3
IE Elective (see gen. req. 4)	3
~~MGT 3303~~ MATH 3373, MATH 3377, PHYS 2435, PHYS 3315 or CHEM 1342/1142	3-4
Total	**15-16**

Bachelor of Science
Major in Manufacturing Engineering
(with General Manufacturing Concentration)

Minimum required: 127 semester hours

Manufacturing Engineering Mission Statement

Our mission is

1. To sustain a quality, student-centered, industry-oriented engineering curriculum,
2. To attract students and prepare them with the knowledge, practical skills, and abilities to perform as highly competent engineers in the global marketplace and/or in graduate studies,
3. To produce graduates skilled in materials and manufacturing processes; process, assembly and product engineering; manufacturing competitiveness and systems design.

General Requirements:

1. A minimum of 9 writing intensive hours and a total of 36 advanced hours are required to graduate. An advanced course is one that is numbered above 3000 and below 5000.
2. Departmental requirements that also satisfy the general education core curriculum requirements for the following components: mathematics- MATH 2471; natural science- CHEM 1341/1141 and PHYS 1430; and social science- ECO 2301. See the University College section of this catalog for the English literature requirements.
3. If two years of the same language are taken in high school, then no additional language hours will be required for the degree. In the absence of such high school language, two semesters of the same modern language must be taken at the college level.
4. Six hours of Manufacturing Processes elective to be chosen from: TECH 1330 (fall, spring), TECH 4330 (fall), MFGE 4367 (spring), or MFGE 4392 (spring).
5. Three hours of Manufacturing Systems Management elective chosen from: IE 4355 (spring), IE 4380 (fall, spring, summer I) , or MATH 3348 (fall).

Freshman Year – 1st Semester	Hours
CHEM 1141, 1341	4
ENGR 1413	4
MATH 2471	4
US 1100	1
ENG 1310	3
PFW one course	1
Total	**17**

Freshman Year – 2nd Semester	Hours
PHYS 1430	4
ENGR 2300	3
ENG 1320	3
MATH 2472	4
ART, DAN, MU, or TH 2313	3
Total	**17**

Sophomore Year – 1st Semester	Hours
IE 3320	3
MATH 3323	3
MFGE 2332	3
PHYS 2425	4
HIST 1310	3
PFW one course	1
Total	**17**

Sophomore Year – 2nd Semester	Hours
CS 1428	4
MATH 3375	3
COMM 1310	3
ECO 2301	3
HIST 1320	3
Total	**16**

Junior Year – 1st Semester	Hours
ENGR 3311	3
ENGR 3373	3
MFGE 4396	3
MGT 3303	3
PHIL 1305	3
Total	**15**

Junior Year – 2nd Semester	Hours
ENGR 3315	3
IE 3330	3
MFGE 3316	3
MFGE 4376	3
ENG Literature (see gen. req. 2)	3
POSI 1310	3
Total	**18**

Senior Year – 1st Semester	Hours
IE 3360	3
MFGE 4363	3
MFGE 4395	3
Manufacturing Processes (see gen. req. 4)	3
POSI 2320	3
Total	**15**

Senior Year – 2nd Semester	Hours
Manufacturing Systems Management (see gen. req. 5)	3
MFGE 4365	3
MGT 4330	3
Manufacturing Processes (see gen. req. 4)	3
Total	**12**

Bachelor of Science
Major in Manufacturing Engineering
(with Semiconductor Manufacturing Concentration)

Minimum required: 133 semester hours

General Requirements:

1. A minimum of 9 writing intensive hours and a total of 36 advanced hours are required to graduate. An advanced course is one that is numbered above 3000 and below 5000.
2. Departmental requirements that also satisfy the general education core curriculum requirements for the following components: mathematics- MATH 2471; natural science- CHEM 1341/1141 and PHYS 1430; and social science- ECO 2301. See the University College section of this catalog for the English literature requirements.
3. If two years of the same language are taken in high school, then no additional language hours will be required for the degree. In the absence of such high school language, two semesters of the same modern language must be taken at the college level.
4. Three semester hours of Semiconductor Manufacturing elective to be chosen from: PHYS 4320 (see dept.), PHYS 4340 (see dept.), or MFGE 4394 (see dept.).
5. Three hours of Manufacturing Systems Management elective chosen from: IE 4355 (spring), IE 4380 (fall, spring, summer I), or MATH 3348 (fall).

Freshman Year – 1st Semester	Hours
CHEM 1141, 1341	4
ENGR 1413	4
MATH 2471	4
US 1100	1
ENG 1310	3
PFW one course	1
Total	**17**

Freshman Year – 2nd Semester	Hours
ENGR 2300	3
MATH 2472	4
PHYS 1430	4
ART, DAN, MU, or TH 2313	3
ENG 1320	3
Total	**17**

Sophomore Year – 1st Semester	Hours
IE 3320	3
MATH 3323	3
MFGE 2332	3
PHYS 2425	4
HIST 1310	3
PFW one course	1
Total	**17**

Sophomore Year – 2nd Semester	Hours
CS 1428	4
MATH 3375	3
COMM 1310	3
ECO 2301	3
HIST 1320	3
Total	**16**

Junior Year – 1st Semester	Hours
ENGR 3311	3
ENGR 3373	3
MFGE 4396	3
MGT 3303	3
TECH 4374 or EE 2320	3
PHIL 1305	3
Total	**18**

Junior Year – Summer I	Hours
EE 2300	3
Total	**3**

Senior Year – 1st Semester	Hours
IE 3360	3
MFGE 4363	3
MFGE 4395	3
ENG Literature (see gen. req. 2)	3
POSI 2320	3
Total	**15**

Junior Year – 2nd Semester	Hours
ENGR 3315	3
MFGE 3316	3
MFGE 4376	3
IE 3330	3
POSI 2310	3
Total	**15**

Senior Year – 2nd Semester	Hours
Semiconductor Manufacturing Elective (see gen. req. 4)	3
MFGE 4392	3
MFGE 4365	3
Manufacturing Systems Management (see gen. req. 5)	3
MGT 4330	3
Total	**15**

Courses in Electrical Engineering (EE)

2300 Introduction to Electrical Engineering. (3-2) Introduction to the profession of Electrical Engineering and its specialties, fundamental dc circuit analysis, electrical components, and laboratory skills. Prerequisite: MATH 2471.

2320 Digital Logic. (3-2) Boolean Logic, combinatorial and sequential circuits, and overview of microcomputer architecture. Corequisite: CS 1428.

3300 Circuit Analysis. (3-2) Analysis and design of electrical circuits, transient and steady state response, and loop and nodal analysis. Prerequisites: MATH 3323 and PHYS 2425.

3320 Microprocessors. (3-3) Introduction to microprocessors, principles of operation, assembly language programming, timing analysis, and I/O interfacing. Prerequisites: EE 2320.

3340 Fields and Waves. (3-0) Wave propagation, Maxwell's equations, transmission lines, wave guides, and antennas. Prerequisites: MATH 3373 and PHYS 2435. Corequisite: EE 3300.

3350 Electronics I. (3-3) Analysis and design of active device equivalent circuits with emphasis on transistors, switching circuits, and operational amplifiers. Prerequisites: EE 3300.

3355 Solid State Devices. (3-1) Semiconductor materials, principles of carrier motion, operating principles and circuit models for diodes, bipolar transistors and field-effect transistors. Introduction to integrated circuits. Prerequisites: EE 3300.

3370 Signals and Systems. (3-0) Frequency domain representation of signals and systems and frequency domain concepts for circuit analysis and design. Transfer function and frequency response, Laplace and z-transforms, Fourier series, Fourier transform, and sampling. Prerequisites: EE 3300.

4350 Electronics II. (3-3) Analysis and design of integrated circuits, feedback, and frequency response. Prerequisites: EE 3350.

4352 Introduction to VLSI Design. (3-1) Analysis of design of CMOS integrated circuits. Introduction to CAD tools for VLSI design. Corequisites: EE 4350.

4355 Analog and Mixed Signal Design. (3-2) Operational amplifier design applications, feedback, offset, stability, and compensation. Introduction to random signals and noise, discrete time circuitry analog-to-digital converters, and digital-to-analog converters. Prerequisites: EE 3370 and 4350.

4358 Introduction to Microelectromechanical Systems. (3-1) Fabrication techniques for microelectromechanical devices and systems. Introduction to the design of micromechanical transducers. Corequisite: TECH 4392.

4370 Communication Systems. (3-3) Transmission of signals through linear systems, analog and digital modulation, filtering, and noise. Prerequisites: EE 3300, 3370, and IE 3320.

4372 Communication Networks. (3-1) Data communication concepts, protocols, algorithms, 7-layer OSI model, physical media, LAN architecture and components, Ethernet, FDDI, TCP/IP, and related standards. Corequisite: EE 4370.

4374 Introduction to Wireless Communication. (3-1) Principles, practice, and system overview of mobile systems. Modulation, demodulation, coding, encoding, and multiple access techniques. Prerequisites: EE 4370.

4376 Introduction to Telecommunications. (3-1) Fundamentals of telecommunications, telephone networks, switching and transmission systems, circuit and packet switching, cell processing, and queuing theory and applications. Prerequisites: EE 4370.

4377 Introduction to Digital Signal Processing. (3-1) Discrete systems, convolution, spectral analysis, and FIR and IIR filter design. Prerequisites: EE 3370.

4378 Data Compression and Error Control Coding. (3-2) Introduction to information theory, information content of messages, entropy and source coding, data compression, channel capacity data translation codes, and fundamentals of error correcting codes. Prerequisites: EE 4370.

4390 Electrical Engineering Design I. (1-3) Team-based design of a system or component, which will include oral presentations and written reports. Corequisite: EE 4350 or EE 4370.

4391 Electrical Engineering Design II. (1-3) Advanced team-based design of a system or component, which will include oral presentations and written reports. Prerequisites: EE 4390.

4399 Special Topics in Electrical Engineering. (3-0) This course will cover advanced topics that cannot be fitted into a regular course in the curriculum. Prerequisite: Faculty advisor approval.

4399A Dynamic Data Acquisition and Analysis. (3-0)

4399B Overview of Information Theory and Coding. (3-0)

Courses in Engineering (ENGR)

1313 Engineering Design Graphics. (2-2) An introductory communications course in the tools and techniques utilized to produce various types of working drawings. Principles of multiview projections, geometric relationships, shape and size description, and pictorial methods are included with emphasis on technical applications and design problem solving.

2300 Materials Engineering. (3-0) Structure, properties and behavior of engineering materials including metals, polymers, composites and ceramics. Mechanical, electrical, magnetic, thermal, and optical properties are covered. Prerequisites: MATH 1315; CHEM 1341.

3190 Cooperative Education. (0-1) Completion of technical/engineering practice-related special projects. Projects must relate to students' major and result in a term paper. Prerequisite: Approval of program coordinator.

3311 Mechanics of Materials. (3-1) This course covers the principles of mechanic materials and includes the following topics: stress and strain; elastic modulus and Poisson's ratio; constitutive equations; torsion; bending; axial, shear and bending moment diagrams; deflection of beams; and stability of columns. Prerequisite: MATH 3375.

3315 Engineering Economic Analysis. (3-0) Interest formulas, economic equivalence, rate of return analysis, techniques of economic analysis for engineering decisions and an introduction to cost estimation. Prerequisite: MATH 1315.

3360 Structural Analysis. (3-1) Structural engineering fundamentals to include design loads, reactions, force systems, functions of a structure, and the analysis of statically

determinate and indeterminate structures by classical and modern techniques. Prerequisite: ENGR 3311.

3373 Circuits and Devices. (3-1) DC and AC circuit analysis, network theorems, electromechanical devices, electronic devices and an introduction to amplifiers, oscillators and operational amplifiers. Prerequisite: PHYS 2425.

4390 Internship. (0-20) Supervised on-the-job professional learning experience in engineering and other technical areas. This course provides practical work experience in their particular field of interest.

Courses in Industrial Engineering (IE)

(WI) **3310 Project Planning, Scheduling, and Management.** (3-0) Basic principles governing the efficient and effective management of engineering projects. Topics include project planning, scheduling, and cost estimation procedures.

3320 Engineering Statistics. (3-0) Fundamentals of probability and statistical inference for engineering applications, probability distributions, parameter estimation, hypothesis testing, and analysis of variance. Prerequisite: MATH 2472.

3330 Quality Engineering. (3-0) Quality assurance systems, quality costs, statistical quality control, and approaches for engineering quality into products and processes. Prerequisite: IE 3320.

3340 Operations Research. (3-0) This course teaches models in operations research including linear programs, the simplex method, duality theory, sensitivity analysis, integer programs, and network flows. The emphasis is in learning to recognize, formulate, solve, and analyze practical industrial problems. The course also teaches commercial mathematical programming languages. Prerequisites: CS 1428 and MATH 2472.

3360 Methods Engineering and Ergonomics. (3-0) Survey of methods for assessing and improving performance of individuals and groups in organizations. Techniques include various basic industrial engineering tools, work analysis, data acquisition and application, performance evaluation and appraisal, and work measurement procedures. Prerequisite: IE 3320 or TECH 3364.

4310 Design of Industrial Experiments. (3-0) Experimental design for engineering applications. Topics include factorial designs, fractional factorial designs, response surface methodology, evolutionary operations, and the design of robust products and processes. Prerequisite: IE 3320.

4320 Integrated Production Systems. (3-0) Basic concepts in the design and control of integrated production systems to include forecasting, inventory models, material requirements planning, scheduling, planning, and shop floor control. Coverage will include both traditional and kanban systems. Prerequisite: IE 3340.

4330 Reliability Engineering. (3-0) Reliability of components and systems, reliability models, life testing, failure analysis, and maintainability. Prerequisite: IE 3320.

4340 Optimization Techniques. (3-0) Mathematical modeling and computational methods for linear, integer, and nonlinear programming problems. Prerequisite: IE 3340.

4350 Supply-Chain Engineering. (3-0) The analysis of supply chain problems to include facility location, customer assignment, vehicle routing, inventory management, and the role of information and decision support systems in supply chains. Prerequisite: IE 3340.

4355 Facilities Planning. (3-0) Planning, design, and analysis of facilities. Emphasizes the principles and methods used for solving plant layout, facility location, material handling, automation, computer integration, and warehouse operations.

(WI) **4360 Human Factors Design.** (3-1) Capstone course emphasizing the application of human factors engineering to systems design. Prerequisites: IE 3320; TECH 4345.

4370 Probabilistic Operations Research. (3-0) Probabilistic models in operations research to include queuing theory, simulation, and Markov chains. Emphasis will be placed on modeling applications to solve problems in industry and computing. Prerequisite(s): IE 3320 or MATH 3305, CS 1428.

4380 Industrial Safety. (3-0) This course is a survey of occupational safety and hazards control. Topics include the history of occupational safety; hazard sources related to humans, environment, and machines; and engineering management of hazards.

4399 Special Topics in Industrial Engineering. (3-0) This course will cover advanced topics that cannot be fitted into a regular course in the curriculum. Prerequisite: Faculty advisor approval.

4399A Six Sigma Methodologies. (3-0)

4399B Human Computer Interaction. (3-0)

Courses in Manufacturing Engineering (MFGE)

2132 Manufacturing Processes Lab. (0-2) Hands-on experience in variety of material removal processes such as turning, milling, drilling, and CNC machining; joining processes such as gas/arc welding, and soldering; metal casting, polymer and composite processing, and microelectronics manufacturing. Prerequisite or corequisite: MFGE 2332.

2332 Material Selection and Manufacturing Processes. (3-1) Overview of material processing, material selection and process parameter determination. Processes covered include: material removal, forming, casting, polymer processing, semiconductor manufacturing and assembly processes. Laboratory activities provide opportunities for applying the design through manufacture activities of the product cycle. Prerequisite: ENGR 2300.

3316 Computer Aided Design and Manufacturing. (3-1) Topics include design process, description of wireframe/surface/solid models, transformation and manipulation of objects, finite element analysis, data exchange, process planning, machine elements, fundamentals of numerical control programming for turning and milling processes, fundamentals of CAD/CAM systems, CNC code generation by CAD/CAM software, waterjet, and plasma cutting. Prerequisites: ENGR1313, 3311; MFGE2332.

4355 Design of Machine Elements. (3-0) This course will cover the general procedures in designing various machine elements. These elements include shafts and flexible elements, springs, welded/riveted/brazed joints, screw fasteners, rolling/sliding contact bearings, gears, cams, and followers. Emphasis will be placed on using standard design practices. Prerequisite: ENGR 3311 or TECH 2351.

(WI) **4363 Concurrent Process Engineering.** (2-3) Integrated design and development of products and processes; impact of ethical issues on design; the discussion of real-world engineering problems and emerging engineering issues with practicing engineers; preparation of reports; plans or specifications; cost estimation; project management, communication and the fabrication of an engineered product/system. Prerequisites: ENGR 3311, MFGE 4365, and senior standing.

4365 Tool Design. (3-1) Design of single and multi-point cutting tools, jig and fixture design, gage design, and the design of tooling for polymer processing and sheet metal fabrication. Laboratory projects will involve the use of computer aided design and rapid prototyping. Prerequisite: MFGE 3316 or ENGR 3316.

4367 Polymer Properties and Processing. (3-1) Structure, physical & mechanical properties, design considerations and processing methods for polymer-based materials are presented. Processing methods include: injection molding, blow molding, thermoforming, compression molding, extrusion, filament winding, lay-up methods, vacuum bag molding and poltrusion. Prerequisite: MFGE 2332.

4376 Control Systems and Instrumentation. (3-0) The theory of automated control systems and its applications to manufacturing systems are covered in this course. Topics covered include: modeling of systems, time and frequency domain feedback control systems, stability analysis, transducer and sensor technology and digital control. Prerequisites: MATH 3323, PHYS 1430 and either MFGE 2332 or EE 3370.

4392 Microelectronics Manufacturing I. (3-0) Provides an overview of integrated circuit fabrication including crystal growth, wafer preparation, epitaxial growth, oxidation, diffusion, ion-implantation, thin film deposition, lithography, etching, device and circuit formation, packaging and testing. The laboratory component involves production and testing of a functional semiconductor device. Prerequisites: CHEM 1141 and CHEM 1341.

4394 Microelectronics Manufacturing II. (3-0) Topics include: atomic models for diffusion, oxidation and ion implantation; topics related to thin film processes i.e. CVD, PVD; planarization by chemical-mechanical polishing and rapid thermal processing; and process integration for bipolar and MOS device fabrication. Students will design processes and model them using a simulation. Prerequisite: MFGE 4392.

(WI) **4395 Computer Integrated Manufacturing.** (3-1) An overview of computer integrated manufacturing is presented. Topics include control strategies for manufacturing systems, automated material handling systems, production planning, shop floor control, manufacturing execution systems, manufacturing databases and their integration, data communication and protocols and man/machine interfaces. Prerequisite: MFGE 3316 or ENGR 3316 or TECH 4375.

(WI) **4396 Manufacturing Systems Design.** (3-2) Applications of simulation modeling to the design and analysis of manufacturing systems are presented in this course. Topics covered include queuing theory and discrete event simulation methods. Design projects will involve the use of current simulation language for modeling and analysis of manufacturing systems. Prerequisites: IE 3320.

4399 Special Topics in Manufacturing Engineering. (3-0) This course will cover advanced topics that cannot be fitted into a regular course in the curriculum. Prerequisite: Faculty advisor approval.

4399A Reverse Engineering and Rapid Prototyping. (3-0)

4399B Introduction to Reinforced Polymer Nanocomposites in Industrial Applications. (3-0)