COLLEGE OF
ENGINEERING AND TECHNOLOGY

The College of Engineering and Technology offers undergraduate programs of study leading to baccalaureate degrees as follows:

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Our mission is to educate and graduate well-integrated individuals who possess the technical and social competence and confidence to succeed in professional practice and advanced education. To accomplish this mission we have established the following objectives:

Our graduates should have:

1. sufficient knowledge and understanding of the appropriate scientific and mathematical fundamentals upon which to develop their professional skills;
2. skill in integrating knowledge and applying this understanding to professionally define problems and produce effective solutions;
3. effective written, oral, and graphic communication skills;
4. awareness and understanding of diverse cultures and social conditions, past and present, in which their professional and personal endeavors will take place;
5. commitment to continuing professional growth and the ethical development of their chosen discipline.

Objectives of the undergraduate curricula focus on the attainment of professional competence, the achievement of intellectual maturity and personal growth, and the development of social responsibility. All the College’s programs seek to facilitate creative communication between technologists, engineers, and scientists and those educated in the liberal arts and other disciplines. The College’s courses provide the basic bodies of knowledge with which the methods and philosophies of engineering and engineering technology are developed.

The education stresses professionalism both for today and for the future.

General and special entrance requirements are listed in the admissions section of the catalog. For graduation, students in the College must satisfy Bradley’s all-University degree requirements as specified elsewhere in this catalog as well as the specific degree requirements of the program in which they major. The programs’ requirements, which incorporate requirements of appropriate professional accrediting agencies, are listed in their respective curriculum sections of this catalog.

Effective academic advisement is stressed in the College; students are required to consult regularly with their academic advisor to plan their course schedules. However, students are individually responsible for insuring that their program’s requirements are met.

Specific college requirements are:

1. A minimum grade point average of 2.00 (C) must be earned in all courses taken in the College of Engineering and Technology. (See departmental program descriptions for additional requirements.)
2. All students majoring in programs in the College of Engineering and Technology are required to pass, while at Bradley, a minimum of one junior or senior level course in which writing of papers, essays, and the like is given substantial emphasis and critical evaluation.

Community college transfer students entering the College of Engineering and Technology with adequate preparation can complete their degree requirements in approximately two years. Such persons are urged to consult as early as possible with the Bradley department in which they will seek a major to make sure they meet the transfer admission requirements of their intended major. Because the fields of engineering and engineering technology are dynamic and rapidly changing, students transferring into the College from other programs in the University are usually expected to complete their major’s graduation requirements as found at the time of transfer. A change of major may result in a change of requirements.

Students who maintain continuous enrollment and who complete work toward the baccalaureate degree within five years from the date of entry may graduate under either the catalog in effect at the time of entrance or under the catalog in effect at the time of graduation. A change in major could mean meeting new requirements in force at the time of the change as a condition for acceptance into that major. Students whose work has been interrupted for one or more semesters may be held...
to requirements in effect at the time of their re-
enrollment.

In addition to the undergraduate programs described in this catalog, the College offers graduate work leading to Master of Science degrees in civil, electrical, industrial, mechanical, and manufacturing engineering. These graduate programs are described in detail in the Graduate Catalog.

Special Academic Programs

Cooperative Education

The College participates with employers in an optional Cooperative Education Program. Students alternate periods of full-time study with full-time employment. The program provides academic- or career-related work experiences. To be eligible, the student must have sophomore standing and a 2.0 minimum overall grade point average at Bradley.

Internships

Engineering internships provide engineering and technology students in good academic standing (2.0 grade point average or better) an opportunity to participate in a full-time internship semester and/or summer away from campus providing career-related work experience. This internship is equivalent in work-time to a full-time cooperative education assignment. Interns will be monitored in the same way as EGT cooperative education students. Participating students will enroll in EGT 210, EGT 310, or EGT 410 for zero credit hours. While on a full-time internship assignment, students are considered to have full-time student status, making normal progress toward a degree in a recognized University program, and are entitled to all student privileges at the University. Also while on a full-time internship assignment, students may register for additional hours of classroom study upon departmental approval.

Practicums

Engineering practicum undergraduate students enrolled in chemistry, civil engineering, computer science, construction, electrical engineering, industrial engineering, manufacturing engineering, manufacturing engineering technology, mechanical engineering, and physics have an opportunity for off-campus employment for 10-20 hours per week. Students are assigned technically challenging projects with a near-term economic benefit. Participating students will be enrolled in EGT 200, EGT 300, or EGT 400 for zero credit hours. While participating in the practicum program, students may wish to enroll in fewer credit hours of academic courses. Such students are still considered by the University to have full-time status, making normal progress towards a degree in a recognized University program. However, students who wish to enroll in less than 12 semester hours of credit should consult the director of financial assistance about possible impact on financial aid and/or insurance benefits.

Course Descriptions

EGT 200  Sophomore Engineering Practicum
0 hrs.
Solving technically challenging problems with a near-
term economic benefit. Only for students approved for practicum by the Dean's Office. Pass/fail.

EGT 210  Sophomore Engineering Internship
0 hrs.
Full-time internship away from campus for engineering and technology students to gain academic or career-
related work experience in industry. May be repeated only with consent of internship coordinator and internship faculty advisor. Satisfactory/Unsatisfactory. Prerequisites: sophomore standing in College of Engineering and Technology, 2.0 overall grade point average at Bradley, approval of internship coordinator and internship faculty advisor.

EGT 300  Junior Engineering Practicum
0 hrs.
Solving technically challenging problems with a near-
term economic benefit. Only for students approved for practicum by the Dean’s Office. Pass/fail.

EGT 310  Junior Engineering Internship
0 hrs.
Full-time internship away from campus for engineering and technology students to gain academic or career-
related work experience in industry. May be repeated only with consent of internship coordinator and internship faculty advisor. Satisfactory/Unsatisfactory. Prerequisites: junior standing in the College of Engineering and Technology, 2.0 overall grade point average at Bradley, approval of internship coordinator and internship faculty advisor.

EGT 400  Senior Engineering Practicum
0 hrs.
Solving technically challenging problems with a near-
term economic benefit. Only for students approved for practicum by the Dean’s Office. Pass/fail.

EGT 410  Senior Engineering Internship
0 hrs.
Full-time internship away from campus for engineering and technology students to gain academic or career-
related work experience in industry. May be repeated only with consent of internship coordinator and internship faculty advisor. Satisfactory/Unsatisfactory. Prerequisites: senior standing in the College of Engineering and Technology, 2.0 overall grade point average at Bradley, approval of internship coordinator and internship faculty advisor.
Department of Civil Engineering and Construction

The baccalaureate program in civil engineering is accredited by the Engineering Accreditation Committee of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone (410) 347-7700.

The baccalaureate program in construction is accredited by the American Council for Construction Education and is a charter member of the Associated Schools of Construction.

FACULTY Emeritus Professors Dini, Muvdi, Guest; Professors Adrian, Al-Khafaji (Chair); Associate Professors Fuessel, Rebholz, Seckler; Assistant Professors Dickel, Foo, Malekchery-Maleki, Nassar, Rahman, Rasheed; Temporary Instructor George.

The Department of Civil Engineering and Construction offers undergraduate programs in both civil engineering (B.S.C.E.) and construction (B.S.C.).

Mission

Produce graduates who possess a keen awareness of the global dimensions of our profession, leadership skills required to serve our society, and the technical knowledge to pursue multiple career paths including advanced degrees. To achieve our mission, our department will strive to achieve the following program objectives:

1. Offer a practice-oriented and ABET-accredited program in civil engineering that employs a systematic assessment process to ensure that graduates possess the intellectual curiosity and thirst for lifelong learning needed to excel in a wide range of civil engineering careers and/or to pursue advanced degrees.

2. Offer programs that provide the academic environment needed to promote leadership skills, teamwork, communication skills, good citizenship, ethics, and public service so that graduates have the needed experience and professionalism to be leaders in their profession and society.

3. Offer a broad program in international activities to ensure that graduates have the needed understanding of relevant global issues and other cultures to pursue careers overseas and have the competitive edge to thrive in our complex and multicultural world.

4. Pursue relevant and mutually beneficial partnerships with the professional community to ensure that our graduates and faculty continue to benefit from and contribute to the professional community.

5. Offer a well-publicized reward system that values excellence in the traditional areas of teaching, scholarship, and service to ensure continued fulfillment and improvement of programs and outcomes.

6. Promote and encourage new academic initiatives through continued integration of emerging and evolving technologies and new design concepts so that our graduates are inspired to develop and grow professionally.

7. Secure the financial resources necessary to sustain the quality, distinctiveness, and imaginative programs that can effectively respond to the needs of a changing world.

Civil Engineering

The Department of Civil Engineering and Construction offers an ABET-accredited BSCE program that provides students the necessary background for continued professional growth and prepares them for engineering careers. The program offers a broad spectrum of specialties including structures, water resources, environmental engineering, transportation, highway and pavement design, geotechnical engineering, and construction management. The curriculum is designed to give students the broad technical background required for modern civil engineering practice and/or to pursue higher education. Students are trained to be leaders who understand their critical roles in the development and maintenance of society’s infrastructure.

The program is founded on a strong core in mathematics as well as natural and engineering sciences. Design practices in civil engineering are integrated throughout the curriculum, culminating in a capstone design course under the supervision of well-qualified faculty and industrial partners. A sequence of courses in the humanities and social sciences helps students understand the impact of engineering solutions on society. The courses selected in the humanities and social sciences are chosen to provide both breadth and depth and meet university general education requirements. An approved list of courses that satisfy these requirements may be obtained from the student’s academic advisor.

The curriculum gives students as much flexibility in technical electives as possible while meeting all accreditation requirements. The student may select either the civil engineering program or the civil engineering program with the environmental engineering option. Typical four-year curricula are given for both programs.

Facilities

The curriculum is supported by 14 cutting-edge laboratory and computer facilities equipped with modern hardware and software. Laboratories include multimedia, ArchiCad modeling, simulation, emerging technologies, fluid mechanics/hydraulics, surveying, concrete design, asphalt pavement design, construction, structural, geotechnical, estimating, design projects, machine shop, and research. The department has four computer laboratories, three using PCs and the fourth Macintosh G4’s. The computers have a wide range of software, including multimedia software such as Authorware and Toolbook, Autocad 2000, Photoshop, Dreamweaver, Fireworks, SAP 2000, Working Model (a simulation program), word processing, spreadsheets, Powerpoint, database management programs, etc. The computer facilities are available to CEC students on a 24-hour basis.

Internationalization and the Global Explorer Program

The Global Explorer Program is designed to expand the professional capabilities, stimulate intellectual growth, and broaden the personal perspective of all participants. Arrangements have been made with universities around the world to send our students overseas either for short courses, a semester, or an entire year. The department is
committed to giving all of our students the opportunity to study overseas. Students with financial need have received financial support that enables them to study abroad for equal to or less than what it would cost to study on campus. Financial aid is available to students choosing to study for a semester or a year overseas at another institution. Since 1995, close to 150 students have studied overseas. Each year, more than 20 students go to England and Denmark to study under the guidance of CEC faculty.

Scholarships Currently 40 annual and endowed scholarships are available to students.

Placement For the past five years CEC graduates have had a 100% placement, with starting salaries that are very competitive nationwide. Employers perceive our students as having the capability to “hit the ground running” with a minimum amount of supervision.

Leadership A focus of the department is the development of leadership skills in our students. Students are encouraged to participate in student professional organizations and academic honorary organizations by being officers or committee chairs. Leadership skills are also developed through service and outreach programs that teach good citizenship. Our students have designed and built playgrounds and running tracks and have done work for Women’s Strength, and the South Side Mission. Many of our students, both in civil engineering and construction, participate in the outstanding “Bridge Pal” program designed to foster an interest in engineering by high school and grade school students.

Faculty Qualifications The faculty have published more textbooks than any other civil engineering or construction department of a similar size in the United States. These textbooks are used at a large number of highly regarded institutions. CEC faculty have received numerous awards for teaching excellence and scholarship, as well as for their professional contributions. They have conducted research for national, state, and local sponsors, benefitting society and our students.

Graduate Program In addition to the undergraduate program described above, the Department offers a graduate program leading to the Master of Science in Civil Engineering degree. Details of this program may be found in the Graduate Catalog. The graduate program allows talented undergraduate students to engage in scholarly research activities and to enroll in advanced courses to meet their special interests and needs.

Freshman Year

First Semester
CE 100 Intro. to Civil Engineering ......................... 1
ENG 101 English Composition ............................ 3
MTH 121 Calculus I ........................................... 4
COM 103 Oral Communication Process ................... 3
Gen. Ed. 1 - Western Civilization ....................... 3
Gen. Ed. 1 - Non-Western Civilization .................. 3

Second Semester
CE 150 Mechanics I .......................................... 3
MTH 122 Calculus II ......................................... 4
PHY 110 University Physics I ............................... 4
CON 132 Construction Graphics ......................... 2
CE 124 Emerging Technologies in Civil Engineering .... 2

Sophomore Year
First Semester
CE 206 Surveying ............................................ 2
CE 250 Mechanics II ......................................... 3
CHM 161 General Chemistry I .............................. 4
MTH 223 Calculus III ........................................ 4
CE 224 CADD in Civil Engineering ....................... 3

Second Semester
CE 202 Digital Computation & Numerical Methods .... 3
CE 301 Mechanics of Materials ............................ 3
CE 303 Structural Materials Lab ........................... 2
CHM 162 General Chemistry II ............................. 3
Gen. Ed. 1 - Fine Arts ...................................... 3
MTH 224 Elementary Differential Equations ............ 4

Junior Year
First Semester
CE 304 Fluid Mechanics ..................................... 3
CE 359 Structural Analysis ................................... 4
Engineering Science Elective 2 ........................... 3
Gen. Ed. 1 - ENG 305 Technical Writing ................. 3
CE 308 Geotechnical Engineering ........................... 4

Second Semester
CE 310 Probability, Statistics, & Decision Making ...... 3
CE 360 Intro. to Environmental Engineering ............. 4
CON 396 Construction Estimating ......................... 3
CE 356 Pavement Design .................................... 3
Basic Science 2 .................................................. 3

Senior Year
First Semester
CE 403 Reinforced Concrete .................................. 3
CE 442 Design of Steel Structures .......................... 3
Gen. Ed. 1 - Social Forces ................................... 3
Electives 2 ...................................................... 6

Second Semester
CE 498 Civil Engr. Design Project ......................... 3
Electives 2 ...................................................... 6
Gen. Ed. 1 - Human Values ................................... 3
Gen. Ed. 1 - Social Forces ................................... 3

Total Hours 129

1 General education courses may be selected from an approved list for each category. They may be taken in any sequence, not necessarily in the semester indicated. The general education sequence must reflect depth of study; see your academic advisor for an approved list. Other University general education requirements are satisfied by specific courses required above.

2 Technical electives must be chosen from an approved list. See “Technical Electives.”
Civil Engineering Technical Electives

18 credit hours
All electives selected by the student should be approved by the student’s academic advisor. The student should select his/her technical electives to reflect career objectives. Students wishing to enroll in a CE graduate-level course must have a minimum 2.5 GPA in CE courses.

1. Basic Science
   Students may apply up to a maximum of 9 semester hours but not less than 3 semester hours from the following courses:
   Any physics course above 200
   Any biology course
   Any chemistry course above CHM 166
   Any geological science course above 101

2. Engineering Science
   Students may apply up to a maximum of 9 semester hours but must take IME 301, EE 327, or ME 301.
   ME 301 Thermodynamics I
   ME 302 Thermodynamics II
   ME 521 Intermediate Fluid
   ME 556 Mechanics of Composite Materials
   ME 577 Finite Element Methods in Engineering
   IME 301 Engineering Economy I
   IME 313 Operations Research I
   EE 205 Fundamentals of Circuit Analysis
   EE 327 Fundamentals of Electrical Engineering I
   EE 328 Fundamentals of Electrical Engineering II

3. Civil Engineering
   Students must select a minimum of 6 semester hours.
   **Group A: Civil Engineering Science Courses**
   Students may apply up to a maximum of 9 semester hours.
   CE 465 Surface Water Hydrology
   CE 508 Advanced Soil Mechanics
   CE 510 Advanced Numerical Methods
   CE 541 Transport Phenomena in Environmental Systems
   CE 544 Advanced Hydraulics
   CE 546 Groundwater Hydrology and Hydraulics
   CE 555 Environmental Regulations and Policy
   CE 560 Advanced Structural Analysis
   CE 573 Advanced Mechanics of
   CE 575 Structural Dynamics
   CE 591 Special Topics I
   CE 592 Special Topics II
   **Group B: Civil Engineering Design**
   Students may apply up to a maximum of 12 semester hours and not less than 3 semester hours.
   CE 422 Foundation Analysis and Design
   CE 430 Water Supply and Hydraulic Engineering
   CE 515 Advanced Foundation Engineering
   CE 542 Physiochemical Process Design
   CE 543 Biological Process Design
   CE 550 Geoenvironmental Engineering
   CE 562 Advanced Steel Design
   CE 565 Advanced Concrete Design
   CE 567 Prestressed Concrete
   CE 591 Special Topics I
   CE 592 Special Topics II

4. Mathematics, Business, and Computer Science
   Students may apply up to a maximum of 6 semester hours.
   Any mathematics course above MTH 224
   Any business, accounting, marketing or economics course.
   Any computer science course above CS 202

5. Other
   Students may apply up to a maximum of 6 semester hours.
   CE 191 Special Topics I
   CE 192 Special Topics II
   CE 291 Special Topics I
   CE 292 Special Topics II
   CE 391 Special Topics I
   CE 392 Special Topics II
   CE 491 Special Topics I
   CE 492 Special Topics II
   CE 522 Advanced CADD
   CE 524 Multimedia Applications in CEC
   CE 526 Advanced Cost Estimating for Construction Projects
   CE 528 Advanced Scheduling
   CE 529 Construction Contract Administration
   CE 536 TQM Principles in Construction
   CE 537 Simulation in CEC
   CON 356 Construction Industry Safety Practices
   CON 390 Microcomputers in Construction
   CON 392 Construction Management
   CON 394 Construction Labor and Unions
   CON 395 Construction Claims and Change Orders
   CON 489 Alternate Material Structures
   CON 492 Construction Contracts
   CON 494 Advanced Construction
   CON 495 Construction Cost Control

Civil Engineering with Environmental Engineering Option

The Peterson’s Guide states that environmental engineering involves the engineering control of activities, processes, and systems that affect the environment—adversely or favorably. Primary emphasis is on the scientific and engineering development, design, and operation of water resource quality management systems involving agricultural, industrial, and municipal water supply treatment; wastewater treatment; solid waste disposal; remediation of contaminated sites; and reclamation (recycling). Also considered are gaseous and solid waste analyses and the design and management of process control systems.

The field of environmental engineering has undergone significant growth over the past decade, a documented trend that is expected to continue well into the 21st century. This growth has brought with it a need for trained personnel to address existing environmental concerns and prevent future problems.

The Congressional Office of Technology Assessment has stated that, nationwide, the demand for professionals trained in the area of hazardous waste cleanup alone grew from 5,000 in 1985 to 11,500 in 1990, and was expected to double again by 1995. The overall demand is estimated to be as many as 5,000 new environmental engineers per year, but only one-third are currently being supplied by educational programs.
Environmental Engineering Concentration Technical Electives

1. All electives selected by the student should be approved by the student's academic advisor. It is important for the student to be aware of prerequisites when selecting electives. The student should plan his/her technical elective selections with his/her academic advisor during his/her junior year.

2. Engineering Science Elective-Fall Semester of Junior Year
   The student shall select one of the following three courses.
   a. ME 301 Thermodynamics
   b. EE 327 Fundamentals of Electrical Engineering I or EE 205 Fundamentals of Circuit Analysis
   c. IME 301 Engineering Economics

3. Environmental Science Elective-Spring Semester of Junior Year
   The student shall select one environmental science course from the listing of basic science electives listed below.
   a. BIO 300 Population, Resources and the Environment
   b. BIO 395 General Microbiology
   c. BIO 460 Ecology
   d. CHM 250 Organic Chemistry
   e. GES 150 Principles of Engineering Geology
   f. GES 312 Structural Geology and Tectonics
   g. GES 410 Principles of Geochemistry
   h. GES 461 Introductory Geophysics

4. All technical electives should be selected from the approved listing. The approved listing is designed such that the student may select their technical electives to develop a geoenvironmental or an environmental engineering management focus. The student may also select their technical electives from both areas. The student must select their technical electives such that they accumulate 3 semester hours of design. A listing of the approved technical electives follows on the next page.

Environmental Engineering Electives
Geoenvironmental Focus
GES 450 Hydrogeology
CE 508 Advanced Soil Mechanics
CE 510 Advanced Numerical Methods
CE 544 Advanced Hydraulics
CE 546 Groundwater Hydrology and Hydraulics
CE 555 Environmental Regulations and Policy
CE 591 Special Topics I
CE 592 Special Topics II
Course Descriptions

CE 100 Introduction to Civil Engineering
1 hr.
Introduction to the civil engineering and environmental engineering professions. Introduction to fundamental engineering concepts; engineering design; engineering ethics; professional societies; introductions to computers and computer applications. Cross-listed as CON 100. Prerequisites: freshman standing or consent of instructor.

CE 124 Emerging Technologies in CEC
2 hrs.
Examination of emerging computer technologies and their relevancy to Civil Engineering and Construction. Introduction to common software including spreadsheet, word processing, databases, graphics and presentation. Exposure to multimedia tools such as text, image, sound video and animation. Introduction to E-mail and Web page development. Cross-listed as CON 124.

CE 150 Mechanics I
3 hrs.
Analysis of two- and three-dimensional force systems by vector algebra. Application of principles of equilibrium to particles, rigid bodies, and simple structures. Friction, distributed forces, center of gravity, centroids, moments of inertia. British and metric systems of units and applications. Prerequisite: C or better in MTH 121. Corequisite: MTH 122.

CE 191, 192 Special Topics
1-3 hrs. each
Topics of special interest which may vary each time course is offered. Topics stated in current Schedule of Classes. If taken to satisfy one of the technical electives, applies only to the ABET “other” category. Prerequisite: freshman standing.

CE 199 Introduction to Multimedia in Engineering
1 hr.
Definition of multimedia; multimedia file formats; types of presentations; use of software tools to develop basic multimedia documents. Students will apply the discussed topics to elementary engineering problems based on their discipline. Prerequisite: freshman standing.

CE 200 Engineering Co-op
0 hrs.
Full-time cooperative education assignment for civil engineering students who alternate periods of full-time school with periods of full-time academic or career-related work in industry. Satisfactory/Unsatisfactory. Prerequisites: Sophomore standing in the College of Engineering and Technology; 2.0 overall grade point average at Bradley, approval of engineering and technology Co-op coordinator and Co-op faculty advisor.

CE 202 Digital Computation and Numerical Methods
3 hrs.
State-of-the-art algorithms used in solving complex engineering problems. Mathematical models involving ordinary and partial differential equations. Initial value, boundary value, and transient problems in civil engineering. Prerequisite: MTH 224 or concurrent enrollment.

CE 206 Surveying
2 hrs.
Theory and applications of measurements of horizontal distances, differences in elevations, horizontal angles, vertical angles, bearings, azimuths, and plane area. Simple horizontal circular curves, topographic surveys and mapping. Prerequisite: CON 132.

CE 224 CADD in Civil Engineering
3 hrs.
Examinations of the graphical capabilities of current computer aided design and drafting (CADD) systems. Theoretical and hands-on applications of the most widely used CADD systems available for civil engineering applications. Cross listed as CON 224.

CE 250 Mechanics II
3 hrs.
Kinematics and kinetics of particles and rigid bodies using vector analysis. Kinetics includes principles of force-mass-acceleration, work-energy, and impulse-momentum. Prerequisite: C or better in CE 150. Corequisite: MTH 223.

CE 291, 292 Special Topics
1-3 hrs. each
Topics of special interest which may vary each time course is offered. Topics stated in current Schedule of Classes. If taken to satisfy one of the technical electives, applies only to the ABET “other” category. Prerequisite: sophomore standing.

CE 299 Passive Multimedia Presentations in Engineering
1 hr.
Multimedia tools; passive presentations, storyboards; sound file acquisition and editing; still picture capturing and manipulation. Students will apply the discussed topics to intermediate engineering problems based on their discipline. Prerequisite: CE 199.

CE 301 Mechanics of Materials
3 hrs.
Internal forces; stress, strain, and their relations; stresses and deformations in axial and torsional loading; indeterminate problems; stresses and deformations in flexural members; transformation of stresses; introduction to member design; column buckling analysis. Prerequisite: C or better in CE 150 or equivalent.

CE 303 Structural Materials Laboratory
2 hrs.
Experimental study of mechanical properties of steel and concrete. Tensile, compressive, and flexural behavior of steel. Concrete mix design, brittleness, and microstructure. Mechanical properties of timber. Prerequisite: CE 301 or concurrent enrollment.
CE 304  Fluid Mechanics  
3 hrs.  
Fluid properties and fluid motion: basic laws of fluid motion in integral form; applications of basic laws in solving fluid flow problems. Hydrostatics, dimensional analysis, similitude, and incompressible viscous flow (both laminar and turbulent) in conduits. Introduction to open channel flow. Laboratory experiments to demonstrate theory and flow measurement in conduits and open channels. Prerequisite: C or better in CE 250; MTH 223.

CE 308  Geotechnical Engineering  
4 hrs.  
Physical properties of soils, soil profiles, and deposits. Soil strength determination. Flow of water through soil masses. Prerequisite: CE 301; CE 304 or concurrent enrollment.

CE 310  Probability, Statistics and Decision Making in Civil Engineering  
3 hrs.  
Basic probabilistic and statistical decision principles used in civil engineering design and practice. Probabilistic models and decision theory. Corequisite, MTH 224.

CE 320  Introductory Soil Mechanics  
3 hrs.  
Introduction to soil mechanics and foundation construction for non-CE majors. Soil index properties, classification, stress analysis, soil compaction, dewatering, excavations and foundation construction. Prerequisites: IMT 324 or CE 301; construction major.

CE 356  Pavement Design  
3 hrs.  
Pavement engineering and design. Selection testing, and use of highway pavement construction materials in relation to function, environment and cost. Structural properties of asphalt concrete: laboratory experiments. Prerequisites: CE 303, CE 308; CE 320.

CE 359  Structural Analysis  
4 hrs.  

CE 360  Introduction to Environmental Engineering  
4 hrs.  
Analysis techniques and design procedures for unit operations and unit processes of water and wastewater treatment. Techniques for examination of water and wastewater quality. Corequisite: CHM 162.

CE 370  Environmental Regulations and Policy  
3 hrs.  
Description and analyses of environmental regulation and policies for air, water, groundwater, and solid wastes. Conventional and hazardous wastes. Prerequisite: junior standing.

CE 391, 392 Special Topics  
1-3 hrs. each  
Topics of special interest which may vary each time course is offered. Topics stated in current Schedule of Classes. If taken to satisfy one of the technical electives, applies only to the ABET “other” category. Prerequisite: junior standing.

CE 399  Multimedia Authoring in Engineering  
2 hrs.  
Multimedia authoring tools, interactive presentations, screen sequence capturing and manipulation, designing a multimedia document, clip acquisition and management. Students will apply the learned topics to advanced engineering problems based on their discipline. Prerequisite: CE 299.

CE 401  Seminar  
1 hr.  
Papers, reviews, and discussion of current technical literature. Prerequisite: senior standing in civil engineering.

CE 403  Reinforced Concrete Design  
3 hrs.  

CE 422  Foundation Analysis and Design  
3 hrs.  
Analysis and design of footings, raft foundations, retaining walls, piles, and caissons, based on current theories and design considerations in soil mechanics, concrete, and steel. Prerequisites: CE 308, 403.

CE 430  Water Supply and Hydraulic Engineering  
3 hrs.  
Water use and wastewater generation. Conveying and distributing water. Wastewater and stormwater conveyance system design. Design of storage structures and other systems for water conservation and water use; open channel flow, closed conduit flow, hydraulic structures, hydraulic power conversion. Prerequisite: CE 304.

CE 442  Design of Steel Structures  
3 hrs.  
Design of metal structural members. Behavior of members and connections. Theoretical and practical considerations in member selection and joint design. Prerequisite: CE 359.

CE 465  Surface Water Hydrology  
3 hrs.  
Introduction to hydrological cycle. Hydrologic measurements and monitoring. Surface water hydrology: runoff and the catchment, hydrographs, unit hydrographs, hydrograph routing, urban and small watershed hydrology, hydrologic design, synthetic streamflows, simulation models, applications of probability and statistics to surface water hydrology. Prerequisites: CE 304, CE 310 or consent of instructor.

CE 491, 492 Special Topics  
1-3 hrs. each  
Topics of special interest which may vary each time course is offered. Topics stated in current Schedule of Classes. If taken to satisfy one of the technical electives, applies only to the ABET “other” category. Prerequisite: senior standing.
CE 498 Civil Engineering Design Project 3 hrs.
With faculty aid, students select a design project, plan its solution including the management of the project and perform the actual design as a member of a team. Oral and written report of final design with specifications, engineering drawings, and engineering cost estimate as well as an assessment of the impact on the environment. Prerequisites: senior standing; consent of department chair.

CE 499 Advanced Multimedia Authoring in Engineering 2 hrs.
Multimedia authoring review, web authoring, 3D animation, video capturing and manipulation, anatomy of a multimedia design document, application packaging and distribution. Students will apply the learned topics to develop an integrated engineering application based on their discipline. Prerequisites: CE 224, 399.

CE 508 Advanced Soil Mechanics 3 hrs.
Consolidation theory and settlements, stress-path method, strength and deformation behavior of soils, failure theories, confined flow, flow nets, numerical analysis of flow, unconfined flow, seepage through earth dams. Laboratory experiments on consolidation and shear strength. Prerequisites: CE 308.

CE 510 Advanced Numerical Methods with Engineering Applications 3 hrs.
Selected numerical methods and applications chosen to meet current needs for solving problems in civil engineering. Prerequisite: CE 202 or equivalent.

CE 515 Advanced Foundation Engineering 3 hrs.

CE 522 Advanced CADD 3 hrs.
Applications of CAD systems. Visualization and optimization of the processes used in construction through three-dimensional modeling and utilization in various civil engineering and construction applications. Prerequisite: CE 244 or CON 224 or consent of department chair.

CE 524 Multimedia Applications in Civil Engineering and Construction 3 hrs.
Application of state-of-the-art technology in projects during various phases from inception to completion including planning, design, procurement, construction, handing over, and operation and maintenance. Investigation of different available tools and technologies in recording, storing, and sharing project information. Prerequisite: senior or graduate standing in the College of Engineering and Technology.

Advanced techniques in taking-off quantities, pricing techniques, computer estimating, and bidding strategy models. Prerequisite: CON 396.

CE 528 Advanced Scheduling 3 hrs.
Project scheduling methods with emphasis on network scheduling techniques, work breakdown structure (WBS), resource and cost loading, scheduling under uncertainties, project time compression, resource leveling, scheduling for linear projects (LOB), time-cost trade-offs, project status, reporting and updating, schedules as tools for claims documentation. Case studies. Computer based. Prerequisite: CON 392.

CE 529 Construction Contract Administration 3 hrs.
Issues in the administration and implementation of a construction contract. Coordinating and controlling the construction project under legal and ethical considerations. Prerequisites: CON 492.

CE 536 TQM Principles in Construction 3 hrs.
Theory and analysis of the Total Quality Management system as applied within the construction industry. Case studies. Prerequisite: QM 262 or IME 311.

CE 537 Simulation in Construction 3 hrs.
Decision making using simulation and simulation languages to model construction operations. Simulation of construction process using what-if analysis. Role of simulation and decision making in the planning and scheduling phases in the construction industry. Topics include introduction to discrete event simulation, generation of random numbers, queuing, simulation languages for construction. Prerequisites: senior or graduate standing; consent of instructor.

CE 541 Transport Phenomena in Environmental Systems 3 hrs.
Phenomena that affect mass balance of contaminants in environmental systems. Advection, diffusion, dispersion, and interfacial mass transfer. Physical, chemical, and biological descriptions of these processes with mathematical models. Solutions to these models with illustrations from reactor engineering and surface water quality modeling. Application to actual process reactor. Prerequisites: senior or graduate standing; consent of instructor.

CE 542 Physiochemical Processes Design 3 hrs.
Design of physical and chemical unit processes and unit operations with an emphasis on water treatment. Design of aeration systems, coagulation and flocculation processes, sedimentation tanks, filtration systems, chemical precipitation processes, ion exchange processes, and disinfection processes. Advanced purification methods including adsorption, reverse osmosis, electro-dialysis, and membrane processes. Treatment and disposal of physiochemical process sludges. Prerequisite: CE 360.

CE 543 Biological Processes Design 3 hrs.
Application of concepts from microbiology and biology to environmental engineering systems. Detailed integrated design of wastewater treatment. Microbiology of wastewater treatment processes and soil bioremediation processes. Interaction between biogeochemical phenomena and microbial processes in an environmental engineering context. Prerequisite: CE 360.
CE 544  Advanced Hydraulics  
3 hrs.
Steady state closed conduit flow; flow in pipe networks. Hydraulic transient in pipelines. Open channel flow; gradually varied, spatially varied, rapidly varied flow in open channels; open channel transients. Water and wastewater treatment plant hydraulics. Sedimentation mechanics, sediment transport, design of unlined channels, bridge scour, reservoir sedimentation. Design and computer applications. Prerequisite: CE 430.

CE 546  Groundwater Hydrology and Hydraulics  
3 hrs.
Groundwater in the hydrological cycle, fundamentals of groundwater flow; flow net analysis; steady-state and transient well testing techniques for parameter estimation; multiple well systems; leaky aquifers; sea water intrusion; groundwater investigation; artificial recharge of aquifers, design of wells; subsidence and lateral movement of land surface due to groundwater pumping. Design and computer applications. Cross listed as GES 546. Prerequisites: CE 202, 304, or consent of instructor.

CE 550  Geoenvironmental Engineering  
3 hrs.

CE 555  Environmental Regulations and Policy  
3 hrs.
Description and analyses of environmental regulations and policies for air, water, groundwater, and solid wastes. Conventional and hazardous wastes. Toxicological, risk assessment, and regulatory aspects of solid and hazardous waste management; characterization of hazardous wastes and materials; waste reduction strategies; collection, storage, and transportation methods. Environmental impact statements. Prerequisite: CE 360.

CE 560  Advanced Structural Analysis  
3 hrs.
Direct stiffness method for the analysis of two-dimensional trusses and frames, equivalent nodal forces, thermal and settlement effects, principle of virtual work, space trusses, grid structures, static condensation, Lagrange multipliers, tapered elements. Prerequisites: CE 202, CE 359.

CE 562  Advanced Steel Design  
3 hrs.
Structural framing systems; rigid frame design; design of bracing; design of simple rigid and moment resisting connections; torsion of steel open sections; design of beams subjected to torsion; design of steel plate girders; design of composite beams. Prerequisite: CE 442.

CE 565  Advanced Reinforced Concrete  
3 hrs.
Advanced topics in flexural design; torsion in beams; behavior and design of slender columns; biaxial bending of columns; design of two-way slabs; behavior and design of frame-wall structural systems; inelastic analysis of flexural members; use of strut and tie analysis; yield line analysis; design of mat foundations. Prerequisite: CE 403.

CE 567  Prestressed Concrete  
3 hrs.
Theory and analysis of prestressed concrete members by various methods of prestressing; design of simple and continuous beams and slabs; prestress losses; composite beams. Extensive study of materials used in prestressed concrete. Precast concrete systems. Prerequisites: CE 403; senior or graduate standing.

CE 573  Advanced Mechanics of Materials  
3 hrs.
Two- and three-dimensional stress and strain at a point; two-dimensional elasticity; beams on elastic foundations; torsion of noncircular sections; curved beams; unsymmetrical bending; plastic collapse and limit analysis. Prerequisites: CE 301; senior or graduate standing.

CE 575  Structural Dynamics  
3 hrs.
Single degree of freedom systems; multi-degree of freedom systems; lumped mass and consistent mass—MDOF beams; free and forced vibrations; earthquake loading; impact and impulsive loads; numerical procedures. Prerequisites: CE 202, CE 359.

CE 591  Special Topics I  
1-3 hrs.
Topics of special interest, which may vary each time course is offered. Topic stated in current Schedule of Classes. Prerequisite: senior or graduate standing.

CE 592  Special Topics II  
1-3 hrs.
Topics of special interest, which may vary each time course is offered. Topic stated in current Schedule of Classes. Prerequisite: senior or graduate standing.

Construction

The construction industry is large, varied, and complex. It is intimately interwoven with, and exerts significant influence on, the overall economy of our nation. Constructors — the modern construction professionals — are educated in engineering and architectural principles in the building process, allowing effective communication with the many persons with whom contact is necessary: the design professionals (engineers and architects), specialty subcontractors, manufacturers and distributors of construction materials and products, financiers and others. Additionally, and most importantly, the constructor is a manager. The constructor’s education must include the essentials of contemporary management philosophy, sound business and construction practice, and enlightened human relations. This multidisciplinary curriculum has been developed from these aims which are in consonance with the goals of the Associated Schools of Construction, and with the philosophy of the American Institute of Constructors.

The program described below was developed for the typical student interested in general preparation for a construction career. A minor in business administration or management is possible by careful selection of electives and a total of 131 semester hours.

The Bachelor of Science in Construction (BSC) degree requires a minimum of 126 approved semester hours. (Courses taken to remove deficiencies, e.g., MTH 100, 109, 110, 112, and PHY 100, must be taken in addition to the approved 126 semester hours.)
Degree Requirements

Accreditation criteria are met by the following groups of courses:

**Group I — General Education**
1 ENG 101 English Composition ........................................ 3
2 ENG 300, 301, 304, 305, or 306 Advanced Writing .... 3
3 COM 103 Oral Communication Process ..................... 3
4 Western Civilization ................................................... 3
5 Non-Western Civilization ........................................... 3
6 Human Values .................................................................. 3
7 Fine Arts ........................................................................ 3
8 Fine Arts ........................................................................ 3

**Group II — Mathematics and Science**
1 MTH 115 or 121 Calculus I ........................................ 4
2 MTH 116 or 122 Calculus II ....................................... 4
3 PHY 107 or 110 Physics I ........................................... 4
4 Computer Programming Elective ................................. 3
5 GES 101, 102 Principles of Earth Science ................. 4

**Group III — Business Management**
1 ECO 221 Microeconomics ......................................... 3
2 ECO 222 Macroeconomics .......................................... 3
3 ATG 157 Accounting-Financial ................................ 3
4 ATG 158 Accounting-Managerial ............................... 3
5 BMA 352 Business Management ................................ 3
6 Business Electives ..................................................... 9

**Group IV — Construction Science**
CE/CON 124 Emerging Technologies in CEC ............... 2
CON 132 Construction Graphics .................................... 2
CON 262 Mechanical and Electrical Systems ............... 3
CON 270 Materials and Methods of Construction ....... 3
CON 487 Steel and Concrete ........................................ 3
CON 489 Alternate Materials ....................................... 3
CE 150 or IMT 222 Statics ......................................... 3
CE 206 Surveying ..................................................... 2
CE 301 or IMT 324 Strength of Materials ................. 3
CE 320 Introductory Soil Mechanics ......................... 3
CON 224 CADD in Construction ................................ 3

**Group V — Construction Management**
CON 100 Introduction to Construction ....................... 1
CON 342 Construction Equipment and Methods ........ 3
CON 372 Construction Methods Improvement ............ 3
CON 392 Construction Management ........................... 3
CON 396 Construction Estimating .............................. 3
CON 492 Construction Contracts ............................... 2
CON 498 Senior Project ............................................. 3
CON Electives ............................................................. 9

Elective (Group 4 or 5) .............................................. 3

Minimum semester hours required for BSC Degree 126

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Typical Curriculum

**Freshman Year**

**First Semester**

1 CON 100 Introduction to Construction .................. 1
2 CON 103 Oral Communication Process ................. 3
3 MTH 115 or MTH 121 Calculus I .......................... 4
4 ENG 101 English Composition .............................. 3
5 GES 101 Principles of Earth Science .................. 3
6 GES 102 Principles of Earth Science Lab. .............. 1

**Second Semester**

1 CON 132 Construction Graphics ............................. 2
2 ENG 101 English Composition .............................. 3
3 MTH 116 or MTH 122 Calculus II .......................... 3
4 PHY 107 or Physics 110 ........................................ 4
5 CS Elective ......................................................... 3

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**Sophomore Year**

**First Semester**

1 CE 150 Mechanics I or IMT 222 Statics ................. 3
2 ECO 221 Microeconomics ........................................ 3
3 ATG 157 Accounting-Financial ................................ 3
4 CON 270 Materials and Methods of Construction .... 3
5 CE 206 Surveying .................................................. 2
6 CON 224 CADD in Construction ............................ 3

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**Second Semester**

1 CE 301 or IMT 324 Strength of Materials ............. 3
2 ECO 222 Macroeconomics ........................................ 3
3 ATG 158 Accounting-Managerial .......................... 3
4 CON 262 Mechanical & Electrical Systems for Bldgs. ... 3
5 CE/CON 124 Emerging Technologies ................... 2
6 Gen. Ed. — Human Values ....................................... 3

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**Junior Year**

**First Semester**

1 ENG 300, 301, 304, 305, or 306 Adv. Writing ......... 3
2 CON 342 Construction Equipment and Methods .......... 3
3 CON 372 Construction Methods Improvement .......... 3
4 Management Elective ........................................... 3
5 Construction Elective ........................................... 3

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**Second Semester**

1 CON 352 Construction Safety ................................ 3
2 CON 392 Construction Management ........................ 3
3 BMA 352 Business Management ............................ 3
4 CON 396 Construction Estimating .......................... 3
5 CE 320 Intro. to Soil Mechanics ............................ 3

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**Senior Year**

**First Semester**

1 Gen. Ed. — Fine Arts ............................................... 3
2 CON 487 Steel and Concrete Structures ................... 3
3 CON 492 Construction Contracts ............................ 2
4 Construction or Construction Science Elective .......... 3
5 Management Elective ........................................... 3

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See Gen. Ed. list in the Schedule of Classes each semester.

1 Electives must be chosen from list available from the academic advisor.

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Second Semester

CON 498 Senior Project ................................................................. 3
CON 489 Alternative Material Structures .................................... 3
2 Construction Elective ................................................................. 3
2 Construction Elective ................................................................. 3
2 Management Elective ................................................................. 3

Total Hours 15

Course Descriptions

CON 100 Introduction to Construction
1 hr.
Introduction to the construction profession. Computer applications, problem solving concepts, design concepts and visual design; industry ethics, professional societies, and university services.

CON 124 Emerging Technologies in CEC
2 hrs.
Examination of emerging computer technologies and their relevancy to Civil Engineering and Construction. Introduction to common software including spreadsheet, word processing, databases, graphics and presentation. Exposure to multimedia tools such as text, image, sound video and animation. Introduction to E-mail and Web Page development. Cross-listed as CE 124.

CON 132 Construction Graphics
2 hrs.
Symbols, conventions, and details of construction drawings. Emphasis on interpretation and communication of requirements of contract drawings. Prerequisite: one unit of high school or college technical drafting or consent of instructor.

CON 200 Engineering Co-op
0 hrs.
Full-time cooperative education assignment for construction students who alternate periods of full-time school with periods of full-time academic or career-related work in industry. Satisfactory/Unsatisfactory. Prerequisite: Sophomore standing in the College of Engineering and Technology, 2.0 overall grade point average at Bradley, approval of engineering and technology Co-op coordinator and Co-op faculty advisor.

CON 224 CADD in Construction
3 hrs.
Examination of the graphical capabilities of current computer aided design and drafting (CADD) systems. Theoretical and hands-on applications of the most widely used CADD systems available for construction applications. Cross-listed as CE 224. Prerequisite: CON 132 or equivalent.

CON 262 Mechanical and Electrical Systems for Buildings
3 hrs.
Survey of basic principles, methods, and equipment for building component systems related to human health and comfort. Introduces psychrometric chart, building heating systems, electrical systems, plumbing. Prerequisite: PHY 107 or 110; CON 132.

CON 270 Materials and Methods of Construction
3 hrs.
Characteristics and use of basic construction materials; introduction to materials specifications.

CON 272 Materials and Methods of Construction II
3 hrs.
A study of materials and techniques of construction used in structural frames of wood, steel, and concrete; consideration of foundation, asphalt, and advanced interior construction methods. Prerequisite: CON 270.

CON 330 Housing
3 hrs.
Planning residential areas; geographic location, orientation, functions, and interrelationships of functions. Fundamentals of residential design which can result in quality living environments for all income levels. Prerequisite: junior standing.

CON 342 Construction Equipment and Methods
3 hrs.
Characteristics of contractor plant and construction equipment; methods for their efficient use. Prerequisite: junior standing in College of Engineering and Technology.

CON 352 Urban Environment
3 hrs.
Principles of land utilization and other elements related to planning and developing quality urban environments. Prerequisite: junior standing.

CON 356 Construction Industry Safety Practices
3 hrs.
Design of a safety program, risk analysis of a company's home office and field safety performance characteristics, potential problems, contingency planning, and safety audit analysis. Prerequisites: CON 270

CON 362 Advanced Environmental Technologies in Construction
3 hrs.
Survey of large scale integrated building component systems related to human health and comfort. Topics include lighting, electrical design and layout, vertical transportation, alarm and security systems, fire protection, total space conditioning, water treatment and sewage treatment, industrial piping design. Prerequisite: CON 262.

CON 372 Construction Methods Improvement
3 hrs.
Principles and methods for selection and installation of materials assemblies used in construction; industrialized and systems building; methods improvements. Prerequisite: CON 270.

CON 390 Microcomputers in Construction
3 hrs.
Applications of microcomputers in the construction industry. Prerequisite: junior standing in College of Engineering and Technology.

CON 392 Construction Scheduling
3 hrs.
Economic considerations and tools of management; cost reporting; scheduling. Emphasis on network methods of scheduling; resource allocation and least-cost expediting. Computer aided. Prerequisite: junior standing in College of Engineering and Technology.

CON 394 Construction Labor and Unions
3 hrs.
Union and non-union activities in construction industry: analysis, organizing, bargaining, contract language, jurisdictional disputes, training, and restrictions on operating non-union. Prerequisite: junior standing.

BRADLEY UNIVERSITY
CON 395  Construction Claims and Change Orders
3 hrs.
Record keeping and quantitative skill necessary for change orders and claims presentation or preparation. Prerequisites: junior standing in College of Engineering and Technology.

CON 396  Construction Estimating
3 hrs.
Material, equipment, and labor estimates of construction projects. Includes laboratory. Prerequisites: Junior standing in College of Engineering and Technology.

CON 408  Senior Seminar
2 hrs.
Consideration of selected construction problems; presentations by students and construction industry representatives. Prerequisite: final semester senior standing in construction.

CON 409  Special Topics
1-4 hrs.
Supervised individual study of special construction topics. Prerequisite: consent of department chair.

CON 472  Steel and Concrete Structures
3 hrs.
Introduction to structural analysis and design of steel and reinforced concrete members; application to construction problems. Prerequisites: MTH 116 or 122; CE 301 or IMT 324.

CON 487  Alternate Materials Structures
3 hrs.
Introduction to structural analysis and design of steel and reinforced concrete members; application to construction problems. Prerequisites: MTH 116 or 122; CE 301 or IMT 324.

CON 492  Construction Contracts
2 hrs.
Project manual concept; emphasis on Uniform System for Construction Specifications, general conditions of construction contracts, bidding requirements, and role of inspection in construction operations. Prerequisite: senior standing in College of Engineering and Technology.

CON 494  Advanced Construction Practices
3 hrs.
Construction ethics; responsibilities and professionalism; advanced areas of business practices in construction. Prerequisites: CON 392, 492; or consent of instructor.

CON 495  Construction Cost Control
3 hrs.
Applications of accounting to cost control of construction projects and firms. Student designs forms and systems to monitor costs of a construction project. Prerequisites: ATG 157, 158; senior standing.

CON 498  Senior Project
3 hrs.
Application of construction principles to industry projects. Prerequisites: senior standing in construction; consent of Department Chair.

Department of Electrical & Computer Engineering

The baccalaureate program in electrical engineering is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone (410) 347-7700.

FACULTY  Professors Anakwa, Schertz, Sennott, Shastry, Stewart; Associate Professors Ahn, Dempsey, Huggins (Chair), V. Prasad; Assistant Professors Irwin, Malinowski; Instructor Gutschlag.

The department offers degree programs in electrical engineering (B.S.E.E. and M.S.E.E.), and electrical engineering with computer option (B.S.E.E.). It takes special pride in the particularly close student-faculty relationships it has developed over the years. Entrance requirements can be obtained by contacting the chair of the ECE department.

Educational Objectives and Department Mission

Society has been transformed dramatically by the widespread use of electrical and electronic devices and systems and it is certain that even more dramatic changes are in store. These changes are fast paced and are driven by electrical and computer engineers working in many different areas including communications, computers, controls, electronics, microprocessors, integrated circuits, signal and information processing, wireless components and systems, and software development. The engineering process is complex and practitioners perform many roles such as research, design, development, product application, manufacturing, and system integration as well as marketing, sales and management. Bradley electrical engineering graduates have been involved in all of these endeavors, and it is the goal of the Bradley ECE program to continue to educate the next generation of electrical and computer engineers to meet the challenges of the future.

In this dynamic profession, the Bradley ECE faculty recognize that each career path is unique, based on the individual’s particular ambitions, capabilities and interests. By coupling the focus on undergraduate education and depth of faculty expertise with the small student-to-faculty ratio and design project sequence, the ECE faculty can respond to the needs and interest of each student in the electrical engineering program. However, the ECE faculty also recognize that there are common elements to success in the profession. These are the ability to acquire, generate, and use new knowledge; the ability to complete complex electrical engineering projects; and the experience, knowledge, skills and capabilities to progress professionally. These common elements for success in the electrical engineering profession are the basis for the educational objectives of the program. These objectives are as follows.

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1. Each graduate from the program will demonstrate the ability to acquire, apply, and synthesize new knowledge as required for success.
2. Each graduate from the program will successfully achieve a major engineering outcome, consistent with the individual’s position, within his/her first three years working in the electrical engineering professions or obtain an advanced degree from a highly selective graduate program.
3. Each graduate from the program will demonstrate the ability to grow professionally, advance the technology, and assume increasing responsibility. A significant number of them will attain leadership positions in their industries or profession.

In order to meet these objectives, students graduating from Bradley’s electrical engineering program will achieve the following outcomes.

i) A graduate from the program will demonstrate knowledge of the mathematical and scientific foundation of electrical engineering.
ii) A graduate from the program will demonstrate knowledge of and the ability to apply techniques and technology of electrical engineering.
iii) A graduate from the program will complete a design project sequence, culminating in a capstone project at or near the professional level.
iv) A graduate from the program will demonstrate the ability to acquire new knowledge as needed for success in the electrical engineering profession.
v) A graduate from the program will meet Bradley’s general education requirements, which are based on the principles of liberal education.
vi) A graduate from the program will have experience in communicating technical information and working on teams.
vii) A graduate from the program will understand the importance of professional and ethical behavior.

It is the mission of the ECE Department to provide the intellectual and physical environment in which students achieve these outcomes. The intellectual component of this environment is supplied by the ECE faculty members, in their roles as mentors, advisors, and engineering professionals, as well as by the curriculum they establish for the programs. The physical component consists of quality facilities equipped with modern instrumentation, components, computers, and software.
Work on the senior capstone project begins at the start of the fall semester in EE 419. The primary deliverables for this course are to:

- choose a senior project and ECE faculty advisor,
- develop a detailed functional description of the project,
- develop a detailed system block diagram of the project and description of its operation,
- present a proposal covering a design and an implementation plan for the project, and
- establish a web page for the project.

In addition to the effort on the capstone project, the students in EE 419 work on teams to review and analyze the deliverables for other senior projects. Lab work associated with the capstone senior project starts in the last half of the fall semester in EE 451 and is completed in EE 452 the following semester.

The senior capstone project is a major educational component of the program. It involves the student in design at or near the professional level and requires the formulation of design specifications, consideration of alternative solutions, feasibility considerations, time management, allocation of design responsibilities, and detailed system documentation. Project advising is done on a distributed basis with the student choosing his/her project advisor from among the members of the ECE faculty.

In addition to the technical part of the program described above, the student must also meet the University General Education requirements (see “Academic Regulations” in this catalog.) As part of the General Education requirement, the student gains effective communication skills via introductory and advanced English composition and a speech course. The General Education requirements also provide the foundation for a liberal education, which helps the student understand and participate in society as a responsible human being. Courses include Western Civilization (CIV 100), Introduction to Economics (ECO 100), as well as selections from non-western civilization, social forces, human values, and fine arts. For these last four categories, the student chooses from a list of approved courses.

A wide range of career opportunities is available to the electrical engineering graduate in many different technical areas and industries. For those who wish to continue their professional studies, details of the M.S.E.E. program are given in the Bradley University Graduate Catalog.

## Programs of Study

### Electrical Engineering

Credit in the following courses must be obtained to meet degree requirements in electrical engineering, leading to the Bachelor of Science in Electrical Engineering.

#### Freshman Year

**First Semester**

EE 101 Intro. Electrical Engineering ....................... 1
EE 102 Computer and Programming in EE ................. 2
MTH 121 Calculus I .......................................... 4
CHM 161 General Chemistry I ............................... 4
ENG 101 English Composition .............................. 3
Gen. Ed. – CIV 100 Western Civilization ........................ 3

**Second Semester**

EE 201 Digital Hardware Organization .................... 2
EE 205 Fundamentals of Circuit Analysis ................... 4
EE 221 Structured Programming with C .................... 3
MTH 223 Calculus III ........................................ 4
PHY 201 University Physics II ............................. 4

**Sophomore Year**

**First Semester**

EE 206 Sophomore Laboratory ................................ 2
Approved Math Elective ..................................... 3
MTH 224 Differential Equations ............................ 4
PHY 202 Applied Quantum Physics .......................... 3
Gen. Ed. – Social Forces .................................... 3

**Second Semester**

EE 301 Signals & Systems I .................................. 3
EE 303 Principles of Electronics I .......................... 3
EE 305 Electromechanical Systems .......................... 4
EE 332 Junior Laboratory II .................................. 2
EE 381 Electromagnetic Fields .............................. 3

**Junior Year**

**First Semester**

EE 205 Fundamentals of Circuit Analysis ................... 4
EE 206 Sophomore Laboratory ................................ 3
EE 301 Signals & Systems I .................................. 3
EE 303 Principles of Electronics II ........................ 3
EE 305 Electromechanical Systems .......................... 4
EE 332 Junior Laboratory II .................................. 2
EE 381 Electromagnetic Fields .............................. 3
Gen. Ed. – Human Values .................................... 3

**Second Semester**

EE 302 Signals and Systems II .............................. 3
EE 304 Principles of Electronics II ........................ 3
EE 305 Electromechanical Systems .......................... 4
EE 332 Junior Laboratory II .................................. 2
EE 381 Electromagnetic Fields .............................. 3
Gen. Ed. – Social Forces .................................... 3

**Senior Year**

**First Semester**

EE 419 Engineering Analysis and Design ................... 2
EE 451 Senior Laboratory I .................................. 2
Approved EE Electives ....................................... 6
Approved EE or Technical Elective ......................... 3
ME 301 Thermodynamics ..................................... 3

**Second Semester**

EE 402 Undergraduate Design Seminar ..................... 1
EE 452 Senior Laboratory II .................................. 3
Approved EE Elective ....................................... 3
Approved EE or Technical Elective ......................... 3
EE 301 Engineering Economy ............................... 3
Gen. Ed. – Non-Western Civilization ................. 3

Total Hours 131
Electrical Engineering with Computer Option

The demand for and continuing advances in computers and digital systems have created opportunities for professionals capable of not only designing computer systems but also applying these systems to a broad range of applications. Such fields as communications, automatic control, robotics, and signal processing have benefited greatly from developments in the digital area. Additionally, the development of modern computers requires a thorough understanding of the methodologies of software and hardware design.

The department offers an option to students desiring to specialize in this branch of electrical engineering and it requires students to take 20 semester hours of course work in the digital area. The required courses are digital hardware organization (EE 101 and EE 201), computational techniques for electrical engineering (EE 102), structured programming (EE 221), and microprocessors (EE 365). Three EE electives must also be taken in the digital area which includes courses such as digital image processing (EE 533), digital signal processing (EE 534), logic design (EE 561), computer structures (EE 562), VLSI design (EE 563), microprocessor and PC architecture (EE 565), and memory and interfacing (EE 566). See your advisor for a current list of approved EE digital electives. Students in the option are also required to take two approved EE or technical electives. These courses must be at the 300 level or above and can be from various departments such as CE, EE, IE, ME, MFE, CS, or MTH. The courses do not have to be in the digital area and should be chosen with career goals in mind. For example, students interested in the application of digital systems to communications or controls should consider course pairs EE 531 and EE 532 or EE 431 and EE 432, respectively, as electives.

The computer option of electrical engineering differs from the regular program in that it requires three EE digital electives. It is also expected that the students in the option focus their project work in the digital area. Credit in the following courses must be obtained to meet degree requirements in the computer option of electrical engineering, leading to the Bachelor of Science in Electrical Engineering.

**Freshman Year**

**First Semester**
- EE 101 Intro. Electrical Engineering .................. 1
- EE 102 Computational Techniques for EE .......... 2
- MTH 121 Calculus I ..................................... 4
- CHM 161 General Chemistry I .......................... 4
- ENG 101 English Composition .......................... 3
- Gen. Ed. — CIV 100 Western Civ. or 1
- ECO 100 Intro. to Economics .......................... 3

**Second Semester**
- COM 103 Oral Communication Process ............... 3
- MTH 122 Calculus II .................................... 4
- PHY 110 University Physics I .......................... 4
- Gen. Ed. — Fine Arts .................................. 3
- Gen. Ed. — ECO 100 Intro. to Economics1
- or CIV 100 Western Civilization ..................... 3

**Sophomore Year**

**First Semester**
- EE 201 Digital Hardware Organization ............... 2
- EE 205 Fundamentals of Circuit Analysis ............ 4
- EE 221 Structured Programming with C .............. 3
- MTH 223 Calculus III ................................... 4
- PHY 201 University Physics II ........................ 4

**Second Semester**
- EE 206 Sophomore Laboratory ........................... 2
- Approved Math Elective .................................. 3
- MTH 224 Differential Equations ........................ 4
- PHY 202 Applied Quantum Physics .................... 3
- Gen. Ed. — Social Forces ................................ 3

**Junior Year**

**First Semester**
- EE 301 Signals & Systems I .............................. 3
- EE 303 Principles of Electronics I ....................... 3
- EE 365 Microprocessors .................................. 3
- EE 331 Junior Laboratory I ............................... 3
- ENG 300, 301, 305, or 306 Advanced Writing ........ 3

**Second Semester**
- EE 302 Signals and Systems II ......................... 3
- EE 304 Principles of Electronics II .................... 3
- EE 305 Electromechanical Systems ...................... 4
- EE 332 Junior Laboratory II ............................. 2
- EE 381 Electromagnetic Fields ......................... 3
- Gen. Ed. — Human Values ................................ 3

**Senior Year**

**First Semester**
- EE 419 Engineering Analysis and Design ............. 2
- EE 451 Senior Laboratory I ............................. 2
- EE Digital Electives ..................................... 6
- Approved EE or Technical Elective ..................... 3
- ME 301 Thermodynamics I .............................. 3

**Second Semester**
- EE 402 Undergraduate Design Seminar ................ 1
- EE 452 Senior Laboratory II ............................. 3
- EE Digital Elective ....................................... 3
- Approved EE or Technical Elective ..................... 3
- Gen. Ed. — Non-Western Civilization ................. 3
- IME 301 Engineering Economy ......................... 3

Total Hours 131

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1 General education courses must be selected from an approved list for each category. They may be taken in any sequence, not necessarily in the semester indicated. Other University general education requirements are satisfied by specific courses required above.
Elective Descriptions

Math electives must be approved by your advisor and include courses such as MTH 202 (Introduction to Numerical Analysis), MTH 207 (Elementary Linear Algebra), MTH 301 (Combinatorics), MTH 302 (Introduction to Graph Theory), MTH 325 (Probability and Statistics I). See your advisor for the most current list.

EE electives are available in the areas of applied electromagnetics, communications, controls, digital signal processing, digital and computer systems, embedded systems, wireless components and systems and VLSI design. Approved EE electives include all 400- and 500-level EE courses except for EE 419, EE 451, and EE 452. Special topic courses are often available. See your advisor for the most current list of approved electives.

EE digital electives include:
- EE 533 Digital Image Processing
- EE 534 Digital Signal Processing
- EE 535 Engineering Applications of Neural Networks
- EE 561 Digital Systems: Logic Design
- EE 562 Digital Systems: Computer Structures
- EE 563 Advanced Electronics VLSI System Design
- EE 565 Digital Systems: Microprocessor & PC Architecture
- EE 566 Digital Systems: Memory and Interfacing
- Special Topics: Object Oriented Programming
- Special Topics: Advanced VLSI
- Special Topics: Web Programming
- Special Topics: Communication Networks
- Special Topics: VHDL

Other special topics courses may also be approved. See your advisor for the most current list.

Technical electives include most 300-level (or above) technical courses in computer science, mathematics, physics, or civil, industrial, mechanical, or manufacturing engineering, except for one- or two-hour courses and ME 549. All technical electives must be approved by your advisor.

Course Descriptions

EE 101 Introductory Electrical Engineering
1 hr.
Selected concepts of digital system analysis and design.

EE 102 Computers and Programming in Electrical Engineering
2 hrs.
Introduction to computers and operating systems; introduction to programming in a high level language appropriate to electrical engineering.

EE 200 Engineering Co-op
0 hrs.
Full-time cooperative education assignment for electrical engineering students who alternate periods of full-time school with periods of full-time academic or career-related work in industry. Satisfactory/Unsatisfactory. Prerequisites: Sophomore standing in the College of Engineering and Technology, 2.0 overall grade point average at Bradley, approval of engineering and technology Co-op coordinator and Co-op faculty advisor.

EE 201 Digital Hardware Organization
2 hrs.
Continuation of EE 101: memory elements, sequential circuits, data representation and codes, computer structures, instructions, and software concepts. Prerequisite: EE 101.

EE 205 Fundamentals of Circuit Analysis
4 hrs.

EE 206 Sophomore Laboratory
2 hrs.
Experimental work related to sophomore electrical engineering courses. Prerequisites: EE 201 and 205, with a minimum grade of C.

EE 221 Structured Programming with C
3 hrs.
C programming language: lexical elements, conversions, expressions, declarations, external definitions, preprocessing directives, and library. The C philosophy. Required for computer engineering option. Cross listed as CS 221. Prerequisites: EE 102 or CS 106; EE 201 or CS 206 or equivalent.

EE 301, 302 Signals and Systems I, II
3 hrs. each
Time and frequency domain analysis of linear systems. Lumped, distributed, time-varying, and discrete-time systems; network topology; state variable techniques; stability; analysis and transmission of random signals; signal processing. Prerequisite: EE 206. EE 301 prerequisite for EE 302.

EE 303, 304 Principles of Electronics I, II
3 hrs. each
Non-linear circuits; incremental analysis of multi-terminal active networks; circuits; microelectric circuits; analog and digital circuits. Prerequisite: EE 206. EE 303 prerequisite for EE 304.

EE 305 Electromechanical Systems
4 hrs.
Processes and devices for energy conversion; transformers, electromechanical devices including transducers and rotating machinery; modeling of electromechanical systems. Prerequisites: EE 206; PHY 110 or equivalent.

EE 311 Digital Hardware Organization
3 hrs.
Introduction to Boolean algebra, combinational and sequential circuit design, computer organization, and microprocessors. Not open to students with credit in EE 101 or EE 201.

EE 327 Fundamentals of Electrical Engineering I
3 hrs.
Analysis of circuits; transient and steady state phenomena; general analysis techniques. Open to non-electrical engineering students only. Prerequisite: MTH 224.

EE 328 Fundamentals of Electrical Engineering II
3 hrs.
Electronics; magnetic fields and circuits; magnetic coupling; energy conversion; electromechanics; rotating devices; digital techniques; control systems. Prerequisite: EE 327.

EE 331 Junior Laboratory I
3 hrs.
Experimental work related to junior electrical engineering courses. Requires written assignments and an individual design project. Corequisites: EE 301, 303, 305.
EE 332   Junior Laboratory II  
2 hrs.  
Continuation of EE 331. Requires written assignments and an individual design project with oral presentation. Prerequisites: EE 301, 331. Corequisite: EE 304.  
EE 365   Microprocessors  
3 hrs.  
Design of microprocessor-based systems applied to real situations; control and data acquisition. Programming practice on several commercial microprocessors. Prerequisite: EE 201 or consent of instructor.  
EE 381   Electromagnetic Fields  
3 hrs.  
Static electric fields; steady current; static magnetic fields of electric currents and ferromagnetic materials; charged particles in electric and magnetic fields. Prerequisite: EE 206.  
EE 402   Undergraduate Design Seminar  
1 hr.  
Students work in teams on a large-scale electrical engineering project, considering technical and non-technical factors in seeking an optimal solution. Prerequisite: senior standing in EE.  
EE 409, 410   Special Topics  
1-6 hrs. each  
Topics of special interest which may vary each time course is offered. Topic stated in current Schedule of Classes. Prerequisite: consent of instructor.  
EE 419   Engineering Analysis and Design  
2 hrs.  
Development of professional method for formulation and resolution of technical problems; oral presentation of findings. Prerequisite: senior standing in EE.  
EE 431, 432   Control System Theory  
3 hrs. each  
Linear, non-linear, and discrete automatic control systems; classical and modern control theory; computer-aided design and simulation. Prerequisite: senior standing in EE.  
EE 451   Senior Laboratory I  
2 hrs.  
Experimental work based on student’s choice of EE electives. Requires written and oral presentations and a design project proposal. Prerequisites: credit in EE 301, 302, 303, 304, 331, 332; a grade of C or better in six of the following courses: EE 301, 302, 303, 304, 331, 332, 305, and 381; credit or concurrent enrollment in two EE electives.  
EE 452   Senior Laboratory II  
3 hrs.  
Design project laboratory. Students select individual projects drawn from industry, faculty research, and technical literature. Requires an oral project presentation and a written report. Prerequisites: EE 451; consent of department chair.  
EE 530   Random Variables and Signals  
3 hrs.  
Correlation functions; power-density spectra; transmission of random signals through linear and non-linear systems; linear mean square estimation. Prerequisite: EE 302 or graduate standing.  
EE 531   Communication Theory  
3 hrs.  
Optimum filtering; analogue and digital communication; detection theory. Prerequisite: EE 530.  
EE 532   Information Theory  
3 hrs.  
Coding theory; memory and memoryless systems. Prerequisite: EE 530.  
EE 533   Digital Image Processing  
3 hrs.  
Design of computer-based imaging systems; multidiimensional filtering and quantization methods for image enhancement, restoration, and pattern recognition. Prerequisite: EE 302 or MTH 325.  
EE 534   Digital Signal Processing  
3 hrs.  
Representation and analysis of discrete time signals and systems. Finite and infinite impulse response filter design; computer-aided-design; Fast Fourier Transform; implementation of digital filters. Prerequisite: EE 302.  
EE 535   Engineering Applications of Neural Networks  
3 hrs.  
Provides a working knowledge of the theory, design, and engineering applications of artificial neural networks. Emphasis will be directed to low-level implementation such as embedded microcontrollers and integrated circuits. Specific architectures such as correlation matrix memory, perceptron, adaline, multilayer networks, radial-basis function networks, and Hopfield networks will be examined as well as their corresponding learning rules. Prerequisite: EE 302 or graduate standing.  
EE 540   Dynamic Systems Analysis  
3 hrs.  
Advanced techniques for analysis of electrical, mechanical and electromechanical systems. State function concepts are emphasized with applications for determining state equations, system stability, and control. Prerequisite: EE 302 or graduate standing.  
EE 550   Electromagnetic Theory  
3 hrs.  
Time-varying electric and magnetic fields; Maxwell’s equations; plane waves in conducting and dielectric media; transmission lines; wave guides; antennas. Prerequisite: EE 381.  
EE 551   Radio Frequency Circuits and Systems  
3 hrs.  
Review of transmission lines, impedance matching and transformations, S-parameters, passive R.F. junctions, R.F. amplifier design, R.F. systems, and front end design. Prerequisites: EE 205, 206.  
EE 555   Optical Fiber Communication  
3 hrs.  
EM wave propagation in silica glass and step index optical fibers, LP modes, multimode and singlemode fibers, optical transmitters and receivers, design of optical fiber communication systems meeting industry standards. Prerequisite: EE 381 or consent of instructor.  
EE 561   Digital Systems: Logic Design  
3 hrs.  
Boolean algebra; logical design; storing and switching phenomena. Prerequisite: EE 304 or graduate standing.
EE 562  Digital Systems: Computer Structures
3 hrs.
Use of hardware programming language to design a small computer or other digital system: busing; control units; interfacing; transfer design. Prerequisite: EE 201.

EE 563  Advanced Electronics — VLSI System Design
3 hrs.
Design and implementation of very-large-scale-integrated systems (VLSI). Integrated circuit devices, subsystems, and architecture. Computer-aided-design (CAD) and design testing. Prerequisite: EE 304 or graduate standing.

EE 565  Digital Systems: Microprocessor and PC Architecture
3 hrs.
Architecture of PC-compatible computers; 32-bit processor architecture and assembly language programming; standard busses. Design of peripheral cards to interface with the standard PC bus architectures. Prerequisites: EE 365 or consent of instructor.

EE 566  Digital Systems: Memory and Interfacing
3 hrs.
Design of single-board computers using 32-bit processors; processor architecture and assembly language programming. Introduction to RISC processors. Prerequisites: EE 365 or consent of instructor.

EE 575, 576  Power Systems I, II
3 hrs. each
Analysis of electric power systems: fault studies; load flow; economic loading; stability; relaying; high voltage DC transmission; lightning and switching transients. Prerequisite: senior or graduate standing in EE. EE 575 prerequisite for EE 576.

Electrical Engineering Technology

EET 320  Electricity and Power
3 hrs.
Fundamentals of direct current and alternating circuits, transformers, rotating machinery, electrical and electronic control, and electrical energy. Not open to EET majors. Prerequisites: IMT 214; PHY 108 or equivalent.

Electrical Engineering Technology

The EET program is being phased out and no new students will be admitted. The program listed below is for the convenience of continuing students.

Credit in the following required and elective courses must be obtained to meet the degree requirements in electrical engineering technology. A minimum of 124 hours is required for graduation, of which 9 hours must be approved Group II electives, 9 hours must be approved 300- or 400-level EET electives, and 9 hours can be from either category. Group II electives include, but are not limited to, courses in business, computer science, or manufacturing technology that enhance the student’s career options.

Freshman Year
First Semester
EET 151 Circuit Analysis I ............................................ 4
MTH 109 College Algebra ........................................... 3
MTH 110 Trigonometry ............................................... 2
ENG 101 English Composition ..................................... 3
Gen. Ed. — CIV 100 Western Civilization1 ........................ 3

Second Semester
EET 152 Circuit Analysis II ........................................... 4
TMH 225 Technical Calculus I .................................... 3
PHY 107 General Physics .......................................... 4
CS 106 Computers and Programming I ......................... 3
MFE 172 Computer-Aided Graphics I ............................ 3

Sophomore Year
First Semester
EET 261 Electronics I .................................................... 3
EET 265 Sophomore Laboratory I ................................. 1
EET 290 Digital Systems Technology I .......................... 3
TMH 226 Technical Calculus II .................................... 3
PHY 108 General Physics II ....................................... 4
COM 103 .................................................................... 3

Second Semester
EET 262 Electronics II ................................................... 3
EET 266 Sophomore Laboratory II ............................... 1
Approved Group II Elective ........................................ 3
EET 336 System Concepts ............................................ 3
TMH 227 Technical Calculus III .................................. 3
ECO 100 Intro. to Economics (Gen. Ed.—Soc. Forces)3 ...... 3

Junior Year
First Semester
EET 351 Measurements I .............................................. 2
EET 346 Transmission Fundamentals .......................... 3
EET 361 Electronics III ................................................ 3
Gen. Ed. — Fine Arts1 .................................................. 3
Approved Group II Electives .................................... 3

1 General education courses must be selected from an approved list for each category. They may be taken in any sequence, not necessarily in the semester indicated. Other University general education requirements are satisfied by specific courses required above.

2002-2003 UNDERGRADUATE CATALOG
Engineering Physics Program

“Engineering physicists explore the universe in search of solutions for problems that need to be understood.”

Students majoring in engineering physics will receive a Bachelor of Science degree with a major in engineering physics. This degree is offered through the cooperation of the faculties of the Department of Physics and the College of Engineering and Technology. The program is monitored by the Engineering Physics Advisory Committee which is made up of representatives from the physics department and the College of Engineering and Technology. The physics department is responsible for the administration of the program.

The program is designed to provide the student with a strong background in basic science and mathematics while at the same time developing in them the ability to apply pertinent knowledge to the practice of engineering. Graduates of the program will be prepared to pursue graduate studies in physics, engineering, or related fields and to hold significant positions in government and industry. Like most engineers employed in research and development, the engineering physicist will be involved in designing, developing, and supervising the construction of new and often unique devices utilizing basic scientific information. The strong background of the engineering physicist in the basic and engineering sciences and mathematics affords the graduate of the program a wide variety of employment and educational opportunities. Many of these opportunities are different from those of the traditional engineering disciplines, particularly at the entry level of employment.

Specified Core Courses

All courses named specifically in the curriculum outline are required. For more specific information see the Physics Department material in the College of Liberal Arts and Sciences section of this catalog. Substitution or waiver of these courses for other courses taken at Bradley or transferred into the program from another institution can be made only at the discretion of the Engineering Physics Advisory Committee.

General Education Requirements

The student’s selection of humanities and social science courses should provide a broad education consistent with the objectives of the engineering profession. It is recommended that two of the courses chosen to meet the non-western civilization (NW), fine arts (FA), human values (HL or HP) or social forces (SF) general education requirements be taken from the same program with one being lower level (100 or 200 level) and one being advanced level (300 or above). Students who wish to transfer courses from another institution to meet the general education requirements must have them approved by a transfer admissions counselor.

Engineering Topics

Upon entering the University students will work in close consultation with academic advisors in physics and engineering to develop a four-year sequence of courses which forms a curriculum with a particular engineering emphasis. These courses are taken from an approved list.
Engineering Physics Courses

Core

First Semester
- PHY 199 Freshman Seminar ........................................ 1
- CHM 161 General Chemistry I ..................................... 4
- MTH 121 Calculus I ..................................................... 4
- ME 101 Foundations of Mechanical Engineering or Gen Ed (FA) .................................................... 2-3
- ME 103 Computation Techniques for ME or EE 101 Intro EE .................................................... 1
- ENG 101 English Composition ..................................... 3

Second Semester
- PHY 110 University Physics I ....................................... 4
- CHM 162 Engineering Chemistry ................................. 3
- MTH 122 Calculus II .................................................... 4
- COM 103 Oral Communication Process ...................... 3
- ME 102 Engin. Design Graphics or EE 102 Computers and Programming in EE ............ 2

Sophomore Year

First Semester
- PHY 201 University Physics II ...................................... 4
- MTH 223 Calculus III ................................................... 4
- Gen Ed (CIV 100) ......................................................... 3
- Gen Ed (FA or HV, Philosophy) .................................... 3
- Engineering Topics (Approved) ................................. 3

Second Semester
- PHY 202 Applied Quantum Physics ............................. 3
- PHY 350 Applied Quantum Physics Lab ....................... 1
- MTH 224 Differential Equations ................................... 4
- Gen Ed (Social Forces) .................................................. 3
- Engineering Topics (Approved) ................................. 3

Junior Year

First Semester
- PHY 305 Electricity and Magnetism .................................. 3
- PHY 301 Classical Mechanics ....................................... 3
- ENG 305 Technical Writing ........................................... 3
- Engineering Topics (Approved) ................................. 6-3
- Gen Ed (Human Values - Philosophy) .......................... 3-0

Second Semester
- PHY 361 Electronics .................................................. 3
- PHY 306 Electromagnetic Waves ................................. 3
- MTH 207 Linear Algebra ............................................. 3
- Engineering Topics (Approved) ................................. 6

Total Hours 129-130
Department of Industrial & Manufacturing Engineering & Technology

The baccalaureate programs in industrial engineering and manufacturing engineering are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. The baccalaureate program in manufacturing engineering technology is accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012. Telephone: (410) 347-7700.

FACULTY Professors Emanuel (Chair), Krishnamoorthi, Newton (emeritus), Nisanci, Shareef, Tayyari; Associate Professors Feng, Kroff, Lin, Ness, Saboury, Sverdlin, Whelchel; Adjunct Professors Griffin, Stenger, Wittry.

The department offers three baccalaureate degree programs:
• Industrial engineering (B.S.I.E.),
• Manufacturing engineering (B.S.Mf.E.),
• Manufacturing engineering technology B.S.Mf.E.T.

Missions

Industrial Engineering (BSIE)

The mission of the program is to develop in our graduates a strong problem-solving ability based upon a technical and scientific foundation that treats production as a system and integrates the various aspects of each system into a whole, whether in manufacturing or services. This ability will prepare graduates to pursue careers in settings across a multitude of fields from health care and banking to manufacturing and logistics as well as to seek advanced degrees in related fields.

Objectives

Industrial Engineering graduates will have:
(a) an ability to apply knowledge of mathematics and science to mathematical modeling and to problems related to systems that produce products and services;
(b) an ability to design and conduct experiments, as well as to analyze data and interpret experimental results;
(c) an ability to design or select components or processes of a production or service system to obtain desired output based on performance, economic, and productivity criteria;
(d) an ability to function on multi-disciplinary teams, an understanding of the concurrent approach to process and product development, and an ability to perform project management;
(e) an ability to identify, formulate, and find optimal solutions to system problems, while considering physical and economic constraints as well as safety and ergonomics issues;
(f) an understanding of professional and ethical responsibilities of an industrial engineer;
(g) an ability to utilize modern tools and techniques to effectively communicate technical requirements and functionality in oral, written, and graphical forms;
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context;
(i) a recognition of the need for, and an ability to engage in, continuous improvement projects and life-long learning;
(j) a knowledge of contemporary issues facing engineers;
(k) an ability to use techniques, skills and modern engineering tools necessary for industrial engineering practice, utilizing supporting technologies or techniques including economic measurement, information systems design, occupational ergonomics, human behavior, systems planning, and total quality management.

Manufacturing Engineering (BSMfE)

The mission of the program is to provide education to equip our graduates with a strong technical and scientific foundation that treats manufacturing as a system and integrates the areas of manufacturing processes, engineering materials, product design, automation, and manufacturing management. The graduates will have the necessary tools to pursue careers in settings that include automotive, aerospace, and heavy and light equipment manufacturers and to seek advanced degrees in related fields.

Objectives

Manufacturing Engineering graduates will have:
(a) an ability to apply knowledge of mathematics and science to manufacturing process, materials, project management, and design of manufacturing systems, emphasizing discrete piece part manufacture;
(b) an ability to design and conduct experiments, as well as to analyze and interpret data related to manufacturing processes, materials evaluation, and manufacturing systems;
(c) an ability to design, select, and control a manufacturing system and its components or processes to meet desired needs;
(d) an ability to function on multi-disciplinary teams, an understanding of the concurrent approach to process and product development, and the ability to perform manufacturing project management;
(e) an ability to identify, formulate, and solve manufacturing engineering problems considering constraints, costs, benefits, and competitiveness of comparative processes and materials, through a hands-on approach;
(f) an understanding of the professional and ethical responsibilities of a manufacturing engineer;
(g) an ability to utilize modern tools and techniques to effectively communicate technical requirements and functionality in oral, written, and graphical forms;
(h) the broad education necessary to understand the impact of manufacturing engineering solutions in a global and societal context;
(i) a recognition of the need for, and an ability to engage in, lifelong learning;
(j) a knowledge of contemporary issues facing engineers;
(k) an ability to use the techniques, skills, and modern engineering tools necessary for manufacturing engineering practice utilizing supporting technologies including design for assembly, design for manufacturability, computer aided design, computer aided manufacturing, and rapid prototyping.

Manufacturing Engineering Technology (BSMfET)
The mission of the Manufacturing Engineering Technology program is to equip our graduates with a strong technical foundation that integrates manufacturing processes, materials, manufacturing management, automation, and product design. The graduates will have the necessary tools to pursue careers in settings that include automotive, aerospace, heavy and light equipment manufacturers, as well as seek advanced degrees in related fields.

Programmatic Distinctions
In choosing a career option, the student should be aware of the respective functions of the engineer and engineering technologist. Generally speaking, the engineer conceives, designs, and advances the development of products and systems. On the other hand, the engineering technologist implements, maintains, and tests products and systems. The engineer creates new technologies while the engineering technologist applies existing technologies.

The distinction between industrial engineering and manufacturing engineering is one of breadth vs. depth. Industrial engineers are involved with the design, improvement, and management of technical systems. These systems may be located in service industries such as banks, hospitals, and government as well as in manufacturing industries. Manufacturing engineers are involved in the design, installation, and improvement of the production process and generally are limited to manufacturing industries.

The engineering student’s selection of humanities and social science courses provide a broad education consistent with the objectives of the engineering profession. Courses should be selected to provide both breadth and depth and not be limited to unrelated introductory courses. This objective can be met by taking two courses in the same department with at least one being at the 300 level or above. Students minoring in business are permitted to use ECO 100/221 and ECO 222 to meet this requirement.

The department works closely with industry and has an outstanding industrial & manufacturing engineering & technology department Advisory Council consisting of distinguished members from industry, government, and education.

Student Organizations
Student chapters of the American Society for Materials (ASM), American Society for Quality (ASQ), Institute of Industrial Engineers (IIIE), Society of Automotive Engineers (SAE), American Foundrymen’s Society (AFS), and Society of Manufacturing Engineers (SME) are sponsored by the department to support and encourage the professional development of the students. The department is also a strong supporter of the student chapter of the Society of Women Engineers (SWE).

Honor societies for industrial engineering students (Alpha Pi Mu) and for manufacturing students (Beta Tau Epsilon) are also represented.

The department offers master’s degrees in industrial engineering (M.S.I.E.) and manufacturing engineering (M.S.MF.E.)

Minor in Applied Ergonomics
Today’s fast-paced work systems and advancements in technology have increased repetitious tasks and, consequently, increased the risk of ergonomic-related problems. The minor in applied ergonomics prepares students in engineering, physical therapy, nursing, business administration, mathematics, and science with the foundation and skills to address these problems in their work area, thereby complementing the focus of their majors and enhancing employment opportunities. The minor in applied ergonomics requires a total of 15 semester hours.

Required courses (9 hours)
IE 527 Occupational Safety and Health .................... 3
IE 528 Occupational Ergonomics ............................. 3
HS 460 Basic Science of Human Movement ............... 3

Electives (6 hours)
Choose one of the following two courses:
IME 386 Industrial and Managerial Engineering .......... 3
HS 480 Motion Analysis ......................................... 3

Choose one course from the following group:
IME 383 Industrial Management (not open to IE majors) 3
IME 466 Facilities Planning .................................... 3
PSY 310 Industrial and Organizational Psychology .... 3
PSY 405 Issues in Applied Psychology ..................... 3
SOC 316 Sociology of Work .................................... 3
BMA 352 Managing in Organizations ...................... 3
BMA 356 Human Resource Management ................... 3

Minor in Quality Engineering
The minor in quality engineering is designed to give students in engineering, mathematics, science, and business an opportunity to learn the methodologies for designing, producing, and delivering quality products and services. This experience should prepare students better for future careers and give them a competitive edge in the job market.

Requirements
A minimum of 21 hours must be taken from the following list of required and elective courses. At least 9 hours must be taken from the College of Engineering and Technology.

Students desiring admission to the minor must have completed one semester of college calculus. A second semester of college calculus is strongly encouraged. Admission to the minor as well as the granting of the minor must be approved by the chair of the IMET Department.

Required Courses (12 hrs.)
Fundamentals of Probability and Statistics ..................... 6
Choose one pair
IME 311, 312 Engineering Statistics I, II
MTH 325, 326 Probability and Statistics I, II
QM 262, 263 Quantitative Analysis I, II
Basic Quality Methods, Quality Costs & Quality Systems, TQM .................................................. 3
Choose one
IME 302 Introduction to Quality Engineering
IE 522 Manufacturing Quality Control
IMT 262 Applied Statistics & Quality Control
Management Methods for Quality .................................................. 3
BMA 352 Managing in Organizations

Electives (9 hrs.)
Choose no more than one course from each area

Metrology
IMT 362 Metrology & Instrumentation
ME 303 Instrumentation and Measurement
EET 351 & 352 Measurements I & II (taken for 4 hours credit)

Advanced Diagnostic Tools
IE 512 Design and Analysis of Experiments
IE 582 Advanced Quality Control

Information Systems
IME 497 Information Systems Design
BMA 372 Information Technology
CS 310 Information Structures and Management

Quality in Design
IE 530 Reliability Engineering

Other Quality-Related Areas
Other courses to be approved by the IMET Dept.

Elective Courses
Students must choose one additional course from each of the four concentration areas listed. Students must complete a minimum of five credit hours from the courses designated with *.

Facilities and Management
BMA 352 Managing in Organizations
IME 301 Engineering Economy
IME 383 Industrial Management
CON 394 Construction Labor & Unions
CON 492 Construction Contracts
IME 466 Facilities Planning

Design
*IME 103 Computer Aided Graphics
*IME 395 Solid Modeling & Rapid Prototyping
M E 448 CAD in Mechanical Engineering
*MFE 525 Design for Manufacturability
*IME 491 Manufacturing Design
*IME 493 Mechanical Design
*IME 392 Mechanical Component Design I

Automation
M E 411 Mechanical Control Systems
M E 462 Robotics
*IMT 346 Computer Aided Manufacturing & Automation I
*IME 445 Computer Aided Manufacture

Product Assurance
IME 302 Introduction to Quality Engineering
*IMT 262 Applied Statistics & Quality Control
IE 522 Manufacturing Quality Control
*IMT 362 Metrology & Instrumentation
IME 311 Engineering Statistics
Q M 263 Quantitative Analysis II

Minor in Manufacturing
The minor in manufacturing is designed to provide students in engineering and business with adjunct knowledge of value to their chosen major. Students may choose a minor in manufacturing to advance their personal career goals or to prepare for graduate studies. This experience should give students a competitive edge in the job market.

Requirements
A minimum of 21 hours must be taken from the following list of required and elective courses. Students desiring admission to the minor must have completed one semester of college calculus. A second semester of college calculus is strongly encouraged. Admission to the minor as well as the granting of the minor must be approved by the chair of the IMET department.

Required Courses
1. IME 301 Engineering Economy or
   IME 383 Industrial Management or
   BMA 353 Operations Management (for business majors only) .................................................. 3
   and
   IME 333 Materials Science in Engineering Lab ........ 1
   or
   IMT 232 Physical Metallurgy ............................... 4
2. IME 331 Fundamentals of Materials Science or
   ME 351 Engineering Materials Science I (for ME majors only) .................................................. 3
   and
   IME 333 Materials Science in Engineering Lab ........ 1
   or
   IMT 232 Physical Metallurgy ............................... 4
3. IME 341 Intro to Manufacturing Processes .......... 3

Industrial Engineering Major
Finding a better way is the goal of the industrial engineer. Whether it be a simple system such as an assembly line worker’s hand tools or a large computerized police manning and scheduling system, the industrial engineer is always striving to produce a more efficient human-machine system. The industrial engineer applies engineering methods to a variety of activities in the design, production, and distribution of goods and services; works in organizations including manufacturing, hospitals, commerce, and government agencies; and operates in such specific professional areas as human work measurement, management systems design, human factors engineering, applied statistics, operations research, reliability and quality control, and systems engineering. Industrial engineering is the combination of engineering and business administration.

The curriculum provides a sound basis in the fundamentals of engineering, physical and behavioral sciences, and theoretical and applied mathematics. The emphasis on problem solving of both structured and unstructured types prepares the student for a wide variety of IE employment opportunities as well as for graduate training in IE, or such associated professions as law or business. This diversity of career opportunities is a major reason that students choose IE. The student is encouraged to select a minor in a supporting area such as business, quality engineering, computer science, manufacturing, math, psychology, or economics. Some minors will require additional hours beyond BSIE requirements.
All faculty teaching in the IE program have had full-time industrial experience. The emphasis of the department is therefore directed toward real-world problems. During the senior year, students work under faculty supervision on actual problems that exist in the community in both manufacturing organizations and service organizations such as hospitals, city government, air transport companies, court systems, and utility companies.

**Freshman Year**

**First Semester**
- IME 101 Introduction to Industrial & Manufacturing Eng. 1
- IME 105 Introduction to Computers and Computation 2
- MTH 121 Calculus I 4
- CHM 161 General Chemistry 4
- ENG 101 English Composition 3

**Second Semester**
- IME 103 Computer Aided Graphics 2
- IME 117 Computer Numerical Applications 2
- MTH 122 Calculus II 4
- PHY 110 University Physics I 4
- COM 103 The Oral Communication Process 3

**Sophomore Year**

**First Semester**
- IME 301 Engineering Economy I 3
- MTH 223 Calculus III 4
- PHY 201 University Physics II 4
- Gen. Ed. - Human Values 3
- C E 150 Mechanics I 3

**Second Semester**
- IME 311 Introduction to Engineering Statistical Methods 3
- IME 386 Industrial & Managerial Engineering 3
- MTH 224 Differential Equations 4
- IME 331 Fundamentals of Material Science 3
- IME 305 Engineering Economy II 2
- Gen. Ed. - Western Civilization 3

**Junior Year**

**First Semester**
- IME 312 Engineering Statistical Methods 3
- IME 313 Operations Research I 3
- IME 325 Transport Phenomena 3
- C E 301 Mechanics of Materials 3
- Gen. Ed. - Fine Arts 3

**Second Semester**
- IME 314 Operations Research II 3
- IME 466 Facilities Planning 3
- MFE Elective 3
- Gen. Ed. - Social Forces 3

**Senior Year**

**First Semester**
- IME 497 Information Systems Design 3
- I E 516 Simulation of Man/Machine Systems 3
- I E 528 Occupational Ergonomics 3
- E E 327 Fundamentals of Electrical Engineering I 3
- PSY 310 Industrial & Organizational 3

**Second Semester**
- IME 499 Senior Industrial Design Project 4
- I E 564 Production Planning 3
- Tech Elective 3
- Gen. Ed. - Eng. 305 Technical Writing 3
- Gen. Ed. - Non-Western Civilization 3

Total 128

Students must have a cumulative grade point average of 2.25 in all IMET Department courses for graduation.

**Approved Electives – IE**

**Manufacturing Electives**
- IMT 342 Advanced Manufacturing Processes I
- IMT 344 Advanced Manufacturing Processes II
- IMT 346 Computer-Aided Manufacturing and Automation I
- IMT 362 Metrology and Instrumentation
- IMT 446 Computer-Aided Manufacturing and Automation II
- IME 341 Introduction to Manufacturing Processes
- IME 395 Solid Modeling & Rapid Prototyping
- IME 441 Materials Processing I
- IME 443 Materials Processing II
- IME 445 Computer Aided Manufacturing
- IME 560 Principles of Robotic Programming

**Technical Electives**
- IE 512 Design and Analysis of Experiments
- IE 515 Linear Programming
- IE 530 Reliability Engineering
- IE 582 Advanced Quality Control
- IE 584 Advanced Production Planning
- IE 588 Introduction to Expert Systems

Any engineering course (CE, EE, IME, ME) numbered 300 or higher that is not already specifically required in the curriculum.

- CON 396 Construction Estimating
- CON 394 Construction Labor and Unions
- CON 396 Construction Estimating
- CON 495 Construction Cost Control

Any business management and administration course numbered BMA 342 or higher.

- Any economics course except ECO 100.
- Any finance course numbered FIN 315 or higher.
- Any international business course (IB).
- Any marketing course numbered MTG 304 or higher.
- Any quantitative methods course numbered QM 326 or higher.

Any biology course except BIO 300.
- Any chemistry course numbered CHM 162 or higher, except CHM 300.
- Any computer science course numbered CS 106 or higher.

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To meet the ABET requirements for humanities and social sciences, some general education courses must be selected according to the IE approved list. They may be taken in any sequence and not necessarily in the semester indicated. Other University general education requirements are satisfied by specific courses required above.

See "Approved Electives – IE."

2002-2003 UNDERGRADUATE CATALOG
Any geological sciences course except GES 300.  
Any mathematics course numbered MTH 301 or higher. 
PSY 306 Experimental Psychology 
PSY 307 Cognitive Psychology 
PSY 308 Social Psychology 
PSY 403 Physiological Psychology 
PSY 404 Sensation and Perception 
ENG 304 Research in Individual Disciplines 
ENG 306 Business Communication 

**Manufacturing Engineering Major**

Manufacturing engineering is one of the newest and most dynamic fields of the engineering professions. It involves the development and coordination of the entire manufacturing process from product design through after-sale service.

Advanced manufacturing systems are dramatically transforming the world for the better. The manufacturing engineer is a key architect, evolver, and implementer of that change.

Manufacturing engineers apply their knowledge of the sciences of materials, processes, and information to the design, integration, and advancement of products and systems of manufacture. They understand value-added concepts through effective transformation of materials into products.

The manufacturing engineer is responsible for research, development, design, planning, implementation, and operation of manufacturing systems. Throughout his/her professional career the manufacturing engineer is expected to progress from a technical strategist to operations integrator to manufacturing strategist. The manufacturing engineer works as a member of a team. His/her role encompasses not only technological factors but also human, economic, and environmental factors.

The manufacturing engineering program is designed to provide the student with a broad intellectual horizon together with a firm technical foundation necessary to meet future challenges in manufacturing engineering. The curriculum builds on a solid foundation of science and mathematics and combines a broad base of engineering sciences and their application to analysis, synthesis, and creative design.

The program provides studies of design, materials, processes, automation, and system integration with a focus on problem solving. It emphasizes concepts of design for manufacture, computer integration, and quality improvement.

Laboratory experience is an essential component of the manufacturing engineering program. Five laboratories are well equipped to serve the program in computer aided graphics and design, computer integrated manufacturing and robotics, materials science and engineering, materials removal and fabrication, and computer aided manufacturing.

Graduates from the program have a wide range of career options in industry, government, research, service, and entrepreneurship. Graduates may also choose to advance their education through post-graduate studies.

Credit in the following courses must be obtained to meet degree requirements in manufacturing engineering. A minimum grade point average of 2.25 in IMET department courses must be achieved for graduation.

<table>
<thead>
<tr>
<th>Freshman Year</th>
<th>First Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>IME 101 Introduction to IE &amp; MFG ..........................</td>
<td>1</td>
</tr>
<tr>
<td>IME 105 Introduction to Computers &amp; Computation ...</td>
<td>2</td>
</tr>
<tr>
<td>MTH 121 Calculus I ...........................................</td>
<td>4</td>
</tr>
<tr>
<td>CHM 161 General Chemistry I ................................</td>
<td>4</td>
</tr>
<tr>
<td>COM 103 The Oral Communication Process ..................</td>
<td>3</td>
</tr>
<tr>
<td>GEN ED Eastern Civ ............................................</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>17</td>
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<table>
<thead>
<tr>
<th>Second Semester</th>
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</thead>
<tbody>
<tr>
<td>IME 103 Computer Aided Graphics ..................</td>
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<tr>
<td>IME 117 Computer Numerical Applications ....</td>
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<tr>
<td>MTH 122 Calculus II ......................................</td>
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<tr>
<td>PHY 110 University Physics I ........................</td>
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<tr>
<td>ENG 101 English Composition ..........................</td>
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<td><strong>Total</strong></td>
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<table>
<thead>
<tr>
<th>Sophomore Year</th>
<th>First Semester</th>
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</thead>
<tbody>
<tr>
<td>IME 301 Engineering Economy I ........................</td>
<td>3</td>
</tr>
<tr>
<td>C E 150 Mechanics I ....................................</td>
<td>3</td>
</tr>
<tr>
<td>MTH 223 Calculus III ..................................</td>
<td>4</td>
</tr>
<tr>
<td>PHY 201 University Physics II ........................</td>
<td>4</td>
</tr>
<tr>
<td>GEN ED Social Forces ....................................</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>17</td>
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</table>

<table>
<thead>
<tr>
<th>Second Semester</th>
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</thead>
<tbody>
<tr>
<td>IME 386 Industrial and Managerial Engineering ........</td>
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<tr>
<td>IME 341 Introduction to MFG Processes ................</td>
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<tr>
<td>IME 331 Fundamentals of Materials Science ............</td>
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<tr>
<td>IME 333 Materials Science Lab ..........................</td>
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<tr>
<td>C E 301 Mechanics of Materials ..........................</td>
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<tr>
<td>GEN ED Fine Arts ..........................................</td>
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<tr>
<td><strong>Total</strong></td>
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<table>
<thead>
<tr>
<th>Junior Year</th>
<th>First Semester</th>
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</thead>
<tbody>
<tr>
<td>IME 311 Introduction to Engineering Statistical Methods ..................</td>
<td>3</td>
</tr>
<tr>
<td>IME 395 Solid Modeling &amp; Rapid Prototyping ..................</td>
<td>3</td>
</tr>
<tr>
<td>IME 325 Transport Phenomena ..................................</td>
<td>3</td>
</tr>
<tr>
<td>IME 431 Material Engineering or IME 433 MFG Properties of Materials ......</td>
<td>2</td>
</tr>
<tr>
<td>MTH 224 Differential Equations ................................</td>
<td>4</td>
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<td><strong>Total</strong></td>
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<tr>
<th>Second Semester</th>
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<tbody>
<tr>
<td>IME 441 Materials Processing I or IME 443 Materials Processing II ........</td>
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<tr>
<td>I E 522 Manufacturing Quality Control ..........................</td>
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<tr>
<td>IME 466 Facilities Planning ....................................</td>
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<tr>
<td>GEN ED Human Values ............................................</td>
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<tr>
<td>GEN ED Social Forces ..........................................</td>
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<td><strong>Total</strong></td>
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<table>
<thead>
<tr>
<th>Senior Year</th>
<th>First Semester</th>
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<tbody>
<tr>
<td>IME 445 Computer Aided Manufacturing ..................</td>
<td>4</td>
</tr>
<tr>
<td>IME 491 Manufacturing Design or IME 493 Mechanical Design ........</td>
<td>4</td>
</tr>
<tr>
<td>I E 516 Simulation of Man/Machine Systems ..............</td>
<td>3</td>
</tr>
<tr>
<td>E E 327 Fundamentals of Electrical Engng. .............</td>
<td>3</td>
</tr>
<tr>
<td>GEN ED Non Western Civ ....................................</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

*See “Approved Electives–MFE,”*
Second Semester
IME 499 Senior Industrial Design Project ................. 4
MFE 525 Design for Manufacturability .................... 3
ENG 305 Technical Writing ..................................... 3
Tech Elective* ...................................................... 6
Total ........................................................................ 16

Approved Electives—MFE
Six hours of technical electives should be taken during
the last three semesters of the program and should be
selected to emphasize an academic focus of interest.
Three hours must be in engineering design. Electives
must be approved by the students’ academic advisor.

Manufacturing Engineering Electives
Choose at least one
IME 431 Materials Engineering
IME 433 Manufacturing Properties of Materials
IME 441 Materials Processing I
IME 443 Materials Processing II
IME 491 Manufacturing Design
IME 493 Mechanical Design
IME 560 Principles of Robotic Programming
MFE 520 Geometric Modeling
MFE 525 Design for Manufacturability
MFE 531 Nonmetallic Materials
MFE 533 Composite Materials
MFE 541 Forming Process
MFE 543 Material Removal Process
MFE 545 Joining & Fabrication
MFE 550 Just-In-Time Manufacturing
MFE 551 Process Engineering
MFE 555 Artificial Intelligence in Manufacturing
MFE 563 Advanced Computer Aided Manufacturing
MFE 581 Selected Topics in Manufacturing Engineering

Other Courses
Any civil, electrical, industrial, or mechanical engineering
course (CE, EE, IE, ME) numbered 300 or higher.
Any chemistry, computer science, mathematics, or
course (CHM, CS, MTH, PHY) numbered 300 or higher.

Manufacturing Engineering Technology Major
Industry today is surrounded by problems that are often
difficult to identify and even harder to solve. They
include government regulation, consumerism, inflation,
foreign competition, high labor cost, and the skyrocketing
cost of doing business. In order to solve such problems, it
is necessary to educate individuals to combine theory
and practice for the effective implementation of state-of-
the-art technologies.

Toward this goal, the Department offers a
Manufacturing Engineering Technology baccalaureate
program with the following Technical Concentrations:
• Manufacturing Design
• Manufacturing Systems
• Student Designed

This program reflects the pressing needs of industry by
integrating studies of mechanical design, modern
manufacturing processes, materials science and
technology, digital techniques, management practices, and
social sciences. Graduates are placed in various phases of
management, production, product development, test and
evaluation, sales, and service. In addition to the Technical
Concentrations, the curriculum is designed for the
development of competence in the areas of mathematics,
physics, chemistry, and other technical sciences such as
mechanics, strength of materials, electronics, and computer
science. Laboratory activities support the basic concepts
studied, while providing familiarity with actual hardware,
its theory of operation, and its uses in the current state of
the art. Complementary courses may be taken in business
management, engineering, and the physical sciences.

The Manufacturing Design Concentration emphasizes
the design and selection of production machinery and
equipment and the link between product design and
production in terms of manufacturability. The program
has technical depth in the specialty areas of product or
component design and development, as well as in the
area of manufacturing processes and their applications in
industry. Laboratory experiences are provided in the
areas of manufacturing processes, materials, numerical
control, strength of materials, and computer graphics and
design. The graduates will be able to do their own layout
work and calculations related to design and selection of
machine components, analysis of experimental results,
determining manufacturability.

The Manufacturing Systems Concentration
emphasizes the optimal design and selection of
production processes and their control. The curriculum
embodies the technical and practical phases in design,
development, manufacturing, programming, and
utilization of materials. Laboratory experiences are
provided in the areas of machine tool processes, thermal
processes, metrology, numerical control, materials,
robotics, and computer graphics. Courses are designed to
afford the student an opportunity to acquire knowledge
and to provide for the application of the basic principles
of the physical sciences related to manufacturing.

The Student Designed Concentration is available to
transfer students, from community colleges, that have
pursued technical programs that have a different
emphasis than the above concentrations. This will allow
the student (with approval by the program advisor) to
design a Manufacturing Engineering Technology program
to meet their defined career objectives.

Credit in the following courses and in courses listed
under the approved technical emphasis must be obtained
to meet the degree requirements in Manufacturing
Engineering Technology. A minimum grade point average
of 2.25 in IMET Department courses must be achieved for
graduation.

Manufacturing Engineering Technology Program

General Education ...................................................... 27 hrs.
ENG 101 English Composition ................................ 3
ENG 305 Technical Writing ...................................... 3
COM 103 The Oral Communication Process .............. 3
ECO 100 Introduction to Economics ......................... 3
Social Forces Elective ........................................... 3
Western Civ Elective ............................................. 3
Non-western Civ Elective ...................................... 3
Human Values Elective .......................................... 3
Fine Arts Elective .............................................. 3
IMT 212 Tech Calculus I ........................................... 3
IMT 214 Tech Calculus II .......................................... 3
IMT 216 Tech Calculus III ......................................... 3
PHY 107 General Physics I ...................................... 4
PHY 108 General Physics II ..................................... 4
CHM 149 Fundamentals of General Chemistry ............ 4
IME 105 Intro. to Computers & Computation .............. 2
IME 117 Computer Numerical Applications ................. 2

Technical Core .................................................. 35 hrs.
IME 101 Introduction to Industrial & Manufacturing 1
Engineering .......................................................... 1
IME 103 Computer Aided Graphics ....................... 2
IME 341 Introduction to Manufacturing Processes ...... 3
IME 395 Solid Modeling & Rapid Prototyping .......... 3
IMT 232 Physical Metallurgy .................................. 3
IMT 262 Applied Statistics & Quality Control .......... 3
IMT 332 Non-metallic Materials ............................. 3
IMT 342 Advanced Manufacturing Processes I or 3
IMT 344 Advanced Manufacturing Processes II ...... 3
IMT 346 Computer Aided Manufacturing & Automation I, 3
IMT 362 Metrology & Instrumentation ................... 3
IME 383 Industrial Management .............................. 3
IME 498 Senior Industrial Project .......................... 4

Approved Technical Electives .......................... 9 hrs.
Tech Elective I .................................................. 3
Tech Elective II .................................................. 3
Tech Elective III .................................................. 3

Approved Technical Emphasis
Select A, B, or C ................................................. 12 hrs.

A. Manufacturing Design Concentration
IMT 392 Mechanical Component Design I ............ 3
IMT 394 Dynamics of Machines .............................. 3
IMT 492 Mechanical Component Design II ............ 3
IMT 494 Computer Aided Systems Design .............. 3

B. Manufacturing Systems Concentration
IMT 448 Tooling Systems ....................................... 3
IMT 464 Process Design & Planning ....................... 3
IMT 446 Computer Aided Manufacturing & Automation II 3
IMT 342 or IMT 344 (Second Manufacturing Processes 3
course) .......................................................... 3

C. Student Designed
A related group of courses, selected by the student, 3
and approved by the program advisor to meet student 3
defined career objectives.

Total Hours 125

Approved Technical Electives
The nine hours of approved technical electives should be 3
taken during the last three semesters of the program and 3
should be selected to emphasize an academic focus of 3
interest. Three hours must be in manufacturing. Electives 3
must be approved by the student’s academic advisor.

IMT Electives - Manufacturing Design Concentration
IMT 448 Tooling Systems ....................................... 3
IMT 464 Process Design & Planning ....................... 3
IMT 446 Computer Aided Manufacturing & Automation II 3
IMT 342 or IMT 344 (Second Manufacturing Processes 3
course) .......................................................... 3

IMT Electives - Manufacturing Systems Concentration
IMT 392 Mechanical Component Design I ............ 3
IMT 394 Dynamics of Machines .............................. 3
IMT 492 Mechanical Component Design II ............ 3
IMT 494 Computer Aided Systems Design .............. 3
IMT 409 Selected Manufacturing Projects ............... 3
IMT 410 Selected Manufacturing Topics ................. 3

Manufacturing Engineering Electives
IME 433 Manufacturing Properties of Materials ... 3
MFE 520 Geometric Modeling .................................. 3
MFE 525 Design for Manufacturability .................... 3
MFE 531 Nonmetallic Materials .............................. 3
MFE 533 Composite Materials .............................. 3
MFE 541 Forming Process ..................................... 3
MFE 543 Materials Removal Process ....................... 3
MFE 545 Joining & Fabrication ............................... 3
MFE 550 Just-in-Time Manufacturing ....................... 3
MFE 551 Process Engineering ............................... 3
MFE 555 Artificial Intelligence in Manufacturing ... 3
MFE 563 Advanced Computer Aided Manufacturing ... 3

Other Courses
Engineering Courses (CE, EE, IE, ME, CON).
Science courses (CHM, CS, MTH, PHY).
Approved technical courses from community colleges.

Course Descriptions
IME 101 Introduction to Industrial & Manufacturing 1 hr.
Engineering Survey of industrial and manufacturing engineering.
Introduction to IE and MFE techniques and tools. Not open to students with credit in any 200-level or above 1
IME, IE, or MFE course.

IME 103 Computer Aided Graphics 2 hrs.
Computer aided drafting, theory of orthographic 2
projection, sections, auxiliaries, and basic dimensioning.

IME 105 Introduction to Computers and Computation in Industrial and Manufacturing Engineering 2 hrs.
Use of computers in IE and MFE environments, use of 2
various packages, LAN and WAN usage.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IME 105</td>
<td>Probability Models</td>
<td>3 hrs.</td>
<td>Probability models; multi-variable analysis, step-wise design of statistical experiments, multiple regression, response surface analysis, distribution of random vectors, function of random variable sample statistics. Required semester project. Extensive use of statistical computer software. Prerequisite: IME 311 with C or better.</td>
</tr>
<tr>
<td>IME 300</td>
<td>Engineering Co-op</td>
<td>0 hrs.</td>
<td>Full-time cooperative education assignment for manufacturing engineering students who alternate periods of full-time school with periods of full-time academic or career-related work in industry. Satisfactory/Unsatisfactory. Prerequisites: sophomore standing in the College of Engineering and Technology, 2.0 overall grade point average at Bradley, approval of engineering and technology Co-op coordinator and Co-op advisor.</td>
</tr>
<tr>
<td>IME 301</td>
<td>Engineering Economy I</td>
<td>3 hrs.</td>
<td>Analysis of economic aspects of engineering decisions. Effect of interest and other cost factors on evaluation of engineering alternatives. Roles of mathematical models and other techniques in economical design and test of products. Introduction to value engineering. Prerequisite: MTH 121.</td>
</tr>
<tr>
<td>IME 302</td>
<td>Introduction to Quality Engineering</td>
<td>3 hrs.</td>
<td>Definition of quality, need for quality in products and services, methods of assuring quality, fundamentals of probability and statistics, process control methods, acceptance sampling, designing experiments, a system for quality. Not open to IE majors. Prerequisite: One semester college calculus.</td>
</tr>
<tr>
<td>IME 305</td>
<td>Engineering Economy II</td>
<td>2 hrs.</td>
<td>Continuation of IME 301. Economic aspects of engineering decisions including techniques of obtaining cost data, product costing, and break-even analysis. Industrial practices. Prerequisite: IME 301.</td>
</tr>
<tr>
<td>IME 311</td>
<td>Introduction to Engineering Statistical Methods</td>
<td>3 hrs.</td>
<td>Engineering data collection and analysis; discrete and continuous probability models; confidence intervals; tests of hypotheses; regression analysis; essentials of statistically designed experiments; engineering application of statistical methods. Extensive use of statistical computer software. Prerequisite: MTH 122.</td>
</tr>
<tr>
<td>IME 312</td>
<td>Engineering Statistical Methods</td>
<td>3 hrs.</td>
<td>Extension of IME 311: Probability models, multi-variable analysis, step-wise design of statistical experiments, multiple regression, response surface analysis, distribution of random vectors, function of random variable sample statistics. Required semester project. Extensive use of statistical computer software. Prerequisite: IME 311 with C or better.</td>
</tr>
<tr>
<td>IME 313</td>
<td>Operations Research I</td>
<td>3 hrs.</td>
<td>Philosophy and techniques of operations research. Emphasis on elementary model building and concepts of optimization, structure of problem solving; linear programming, transportation and assignment algorithms; game theory; network analysis, branch and bound theory; dynamic programming; decision theory involving one stage problems. Prerequisite: MTH 223</td>
</tr>
<tr>
<td>IME 314</td>
<td>Operation Research II</td>
<td>3 hrs.</td>
<td>Probabilistic models of operations research; inventory theory, Markov chains, queueing theory, and simulation. Prerequisites: Min. grade of C in IME 311, 313</td>
</tr>
<tr>
<td>IME 333</td>
<td>Materials Science Laboratory</td>
<td>1 hr.</td>
<td>Laboratory practices and experience for basic materials science investigations. Mechanical testing, metallographic examination and thermal treatment of metals, non-destructive and destructive testing of non-metallic materials. Corequisite: IME 331.</td>
</tr>
<tr>
<td>IME 383</td>
<td>Industrial Management</td>
<td>3 hrs.</td>
<td>Principles of management applied to design of organizations’ physical facilities and operation systems. Not open to IE majors.</td>
</tr>
<tr>
<td>IME 385</td>
<td>Introduction to Logistics Engineering</td>
<td>3 hrs.</td>
<td>Logistics terms and definitions; logistics as a design process; supply chain concepts; analyzing, designing, and implementing logistics system. Prerequisites: IME 386, IME 311, IME 313. Corequisite: IME 312.</td>
</tr>
<tr>
<td>IME 386</td>
<td>Industrial and Managerial Engineering</td>
<td>3 hrs.</td>
<td>Principles of IE applied to design of an organization’s physical facilities and operating systems. Analysis and measurement of human work applied to work system design. Laboratory and interdisciplinary community projects. Prerequisites: computer competency. Corequisite: 2nd semester of calculus.</td>
</tr>
</tbody>
</table>
IME 395  Solid Modeling and Rapid Prototyping  
3 hrs.  
Principles of solid modeling and 3D drafting. Solids, surfaces, wire frames, pictorial representation, advance dimensioning, tolerancing, geometric dimensioning and tolerancing, drafting for production, techniques of rapid prototyping. Prerequisites: IME 103, 105, 341.

IME 409  Selected Projects in Industrial and Manufacturing Engineering  
1-6 hrs.  
Projects may be of an experimental, analytical, or creative nature. Course may be repeated for a maximum of 6 hours credit. Prerequisites: senior standing and consent of instructor.

IME 410  Selected Topics in Industrial and Manufacturing Engineering  
1-6 hrs.  
Topics of special interest which may vary each time course is offered. Topic stated in current Schedule of Classes. Course may be repeated under different topics for maximum of six hours credit. Prerequisite: consent of instructor.

IME 431  Materials Engineering  
2 hrs.  

IME 433  Manufacturing Properties of Materials  
2 hrs.  

IME 441  Materials Processing I  
3 hrs.  
Principles, techniques, limitations, and applications of metal cutting and forming processes. Phenomena of tool life, tool wear, surface integrity, resultant properties, and tolerances of these operations. Traditional forging, rolling, drawing, and extrusion processes; processing limits and resultant effects on material and component properties. Non-traditional methods and processing economics. Extensive laboratory work. Prerequisites: IME 311, 325, 331, 341.

IME 443  Materials Processing II  
3 hrs.  
Principles, techniques, limitations, and applications of metal casting and non-metallic molding processes, traditional metal joining processes, fabrication, and assembly. Basic phenomena of near-net-shape manufacturing, tooling and equipment required, tolerances and economics. Emphasis on manufacturing parameters, design, and the resultant effects of material structure and properties. Extensive laboratory work. Prerequisites: IME 311, 325, 331, 341.

IME 445  Computer Aided Manufacturing  
4 hrs.  
Computer applications to the manufacturing processes of machining (numerical control), material handling (robotics), and the integration of computer aided design (CAD) with computer aided manufacturing (CAM). Laboratory in program generation, simulation, and equipment usage. Prerequisites: IME 341, IME 395.

IME 466  Facilities Planning  
3 hrs.  
Physical organization of work places and departments to optimize objectives such as material movement, safety, and worker satisfaction. Review of IE methods for work place design and productivity measurement and economic decision making. Computer solutions for layout problems and mathematical models for location problems. Prerequisite: IME 383 or IME 386.

IME 491  Manufacturing Design  
4 hrs.  
Static and dynamic design, analysis, specification, and financial analysis of manufacturing equipment specific to a particular product. A systems approach to the integration of machine tools, work holding, materials handling, processing, measurement, and operator interface. Laboratory in tool design, modular tool construction, and virtual modeling of tooling systems. Corequisites: IME 445 and senior standing.

IME 493  Mechanical Design  
4 hrs.  
Design of linkages, cams, gears, gear trains, welded and brazed joints, springs, shafts, and flexible elements; for both static and dynamic loads. Prerequisite: CE 301.

IME 497  Information Systems Design  
3 hrs.  
Analysis and design of computer based information systems: definition of data bases, measures of effectiveness, management-staff interface. Case studies from engineering, manufacturing, and service environments. Prerequisite: Senior standing in engineering.

IME 499  Senior Industrial Design Project  
4 hrs.  
Application of engineering principles to solve a real-world problem. Student works as member of a team assigned to a problem in a manufacturing, processing, service, or governmental organization. Requires a professional written and oral report. Prerequisites: 30 hours of IMET Department courses with a minimum 2.25 GPA; COM 103; consent of course coordinator.

IME 560  Principles of Robotic Programming  
3 hrs.  
Programming of industrial robotic manipulators with external inputs, tactile sensing and vision sensing. A design project is required. Cross-listed as ME 560. Prerequisite: graduate or senior standing in engineering or computer science.
Industrial Engineering

IE 500 Engineering Economy and Costs
3 hrs.
Analysis of the economic aspects of engineering decisions including the time value of money and the techniques of obtaining cost data. Does not count towards MSIE. Prerequisite: graduate standing in engineering or consent of instructor.

IE 503 Engineering Quantitative Analysis
3 hrs.
Probability, random variables, distributions, inference, regression, linear programming, simulation. Does not count towards MSIE. Prerequisites: graduate standing in engineering or consent of instructor.

IE 511 Engineering Statistical Analysis
3 hrs.
Concepts in probability and statistics from practical and theoretical angles. Definition of probability, random variable, distribution, important discrete and continuous distributions, sampling distribution of X-bar, Central Limit Theorem, t, chi-squared and F distributions, estimation, hypothesis testing, regression analysis of variance. Prerequisite: IE 503 or consent of instructor.

IE 512 Design and Analysis of Experiments
3 hrs.
Design and analysis of experiments in research, development, and production activities. Experimental designs for evaluating significance of main effects and interactions of several variables. Treatment of problems of measurement, planning, and evaluating programs. Prerequisite: two semesters of statistics or consent of instructor.

IE 514 Introduction to Operations Research
3 hrs.
Mathematical model building and use of deterministic and non-deterministic tools in problem solving. Problem solving structure, linear programming, transportation and assignment algorithms, game theory, networks, branch and bound algorithms, dynamic programming, deterministic and stochastic inventory models, markov chains, queueing theory and simulation. Prerequisite: IE 503 or consent of instructor. Not open to students with credit in IE 331 and 334.

IE 515 Linear Programming
3 hrs.
Theoretical and computational aspects of linear programming: application to practical problems. Prerequisite: MTH 202; consent of instructor.

IE 516 Simulation of Man/Machine Systems
3 hrs.
Procedures and rationale for planning, designing, and implementing computer simulation experiments used to analyze human-machine systems in engineering, business, and social sciences. Prerequisites: MTH 202; IE 311.

IE 522 Manufacturing Quality Control
3 hrs.
Analysis of factors affecting product quality during manufacturing; process control charts; process capability studies; error of measurement; sampling plans; motivation programs; quality audit; organization. Prerequisites: one semester of statistics or consent of instructor.

IE 527 Occupational Safety and Health
3 hrs.
OCCUPATIONAL SAFETY AND HEALTH
Injury and illness statistics. Employer's responsibilities and bookkeeping requirements. Hazard analysis and systems safety, occupational and environmental hazards and controls. Prerequisites: consent of instructor.

IE 528 Occupational Ergonomics
3 hrs.
Functional anatomy and physiology of muscle and skeletal systems and their relationship to work design. Work physiology, kinesiology, and anthropometry in relation to their application in workplace design and hand tool design. Utilization of physical work capacity and job demands for job design, personnel assignment, and assessment of work-rest scheduling. Prerequisites: one semester statistics, statics, human motion study.

IE 530 Reliability Engineering
3 hrs.
Specification, prediction, and evaluation of product reliability and maintainability. Use of models for failure distribution exponential, Weibull, lognormal and analytical and graphical methods for failure data analysis. Test plans and accelerated testing models. Design methods for increasing reliability and maintainability. Prerequisites: IE 511 or consent of instructor.

IE 564 Production Planning and Control
3 hrs.
Analysis of services-production-inventory systems using common planning and scheduling techniques. Mathematical models for project planning, aggregate planning, master scheduling, and inventory analysis. Interface with quality control and computer systems. Prerequisites: IE 306; minimum grade of C in IE 312 and IE 314.

IE 568 Advanced Quality Control
3 hrs.
Comparative study of philosophies of using quality as a business management tool, with special reference to Deming's. Theory of control charts and a study of their strengths and weaknesses. Special control charts such as CUSUM chart, median chart, moving average chart, and their application. The latest published articles used to keep up-to-date in quality technology. Prerequisite: IE 522 or consent of instructor.

IE 584 Advanced Production Planning
3 hrs.
Planning methods for converting to or creating Just-in-Time and/or group technology systems. Analytical and behavioral aspects. Prerequisite: IE 564 or consent of instructor.

IE 588 Introduction to Expert Systems
3 hrs.
Knowledge-based systems design and implementation; expert system shells and programming environments; validation and implementation of expert systems; case studies/laboratories. Cross listed as CIS 588. Prerequisites: two semesters of computer programming and one semester of statistics, or consent of instructor.

IE 590 Topics in Industrial Engineering
1-3 hrs.
Topics of special interest which may vary each time course is offered. Topic stated in current Schedule of Classes. May be repeated up to a maximum of 6 hrs. Prerequisite: consent of instructor.
Manufacturing Engineering

MFE 520  Geometric Modeling  
3 hrs.  
Computer-based representations of the shape and spatially dependent attributes of real or conceived physical objects. Techniques and concepts needed to couple the digital computer with the techniques of geometric modeling and graphics display for analysis and viewing. Prerequisite: IME 395; MTH 223.

MFE 525  Design for Manufacturability  
3 hrs.  
The design process; interaction of materials, processes, and design; economic considerations; design considerations for machining, casting, forging, extrusion, forming, powder metallurgy; designing with plastics; design for assembly; projects and case studies. Prerequisites: IME 395; IME 341.

MFE 527  Tribology  
3 hrs.  
An introduction to systems approach to tribology, surface topography, physical, chemical, and geometric nature of surfaces. Mechanics of contact between surfaces. Various theories of friction and wear, hydrodynamic, elastohydrodynamic, and boundary lubrication. Frictional instabilities. Rolling contact problems. Application of system methodology to tribological problems in engineering design and manufacturing. Prerequisites: IME 331 or ME 351 or consent of instructor.

MFE 531  Nonmetallic Materials  
3 hrs.  
Recent developments and applications of polymeric and ceramic materials. Selection and design criteria, material properties, process engineering, quality considerations, and failure prevention. Prerequisite: IME 331.

MFE 533  Composite Materials  
3 hrs.  
Science and technology of modern composite materials: properties, design, toughening mechanisms, fabrication methods, evaluation, mechanisms of failure and quality assurance. Prerequisite: IME 331.

MFE 541  Forming Processes  
3 hrs.  
Analytical methods in metal forming processes including slab approach, upper bound techniques, slip-line field and viso-plasticity methods. Forging, rolling, extrusion, drawing, sheet forming, near net-shape processes, and CAD/CAM. Prerequisite: IME 443.

MFE 543  Material Removal Processes  
3 hrs.  
Current and future trends in: mechanics of chip generation; forces and energies in cutting and dynamometry; thermal aspects of machining; cutting tool materials; friction, wear, vibrations and tool life; applications of engineering fundamentals to design and analysis of machining operations with emphasis on computer control. Prerequisites: IME 441 or IME 341.

MFE 545  Joining and Fabrication  
3 hrs.  
Principles of advances in joining and fabrication of engineering materials including metallic, nonmetallic, and electronic materials. Process science and technology with emphasis on casting, welding, and microjoining of electronic components. Physical and mathematical modeling of various processes. Prerequisite: IME 331.

MFE 550  Just-In-Time Manufacturing  
3 hrs.  
Just-In-Time production (stockless production, zero inventories) for improving manufacturing productivity. Implementation techniques and results in Western and Japanese manufacturing environments; an integrated implementation plan. Prerequisite: IME 386.

MFE 551  Process Engineering  
3 hrs.  
The process design function interaction with product design, and the responsibilities within a manufacturing organization. Selection and design of machinery, tools, and methods. Computer aided process design and interactive accessing of machining data and tooling element of group technology and expert systems. Prerequisites: IME 395, 443.

MFE 555  Artificial Intelligence in Manufacturing  
3 hrs.  

MFE 563  Advanced Computer Aided Manufacturing  
3 hrs.  

MFE 565  Computer Integrated Manufacturing  
3 hrs.  
Computer Integrated Manufacturing (CIM); elements of hardware and software within the manufacturing automation environment. Islands of factory automation and their interactions, information flow and Local Area Networks within the CIM architecture, standardization of electronic data and interfaces. Prerequisite: IME 386.

MFE 581  Selected Topics in Manufacturing Engineering  
1-3 hrs.  
Topics of special interest which may vary each time course is offered. Topics stated in current Schedule of Classes may include: advances in manufacturing processes, materials, design, computer applications, manufacturing productivity, etc. Each course may be repeated to a maximum of 6 hours credit. Prerequisite: senior or graduate standing.
Manufacturing Engineering Technology

**IMT 200  Co-op Assignment**

0 hrs.
Full-time cooperative education assignment for manufacturing engineering technology students who alternate periods of full-time school with periods of full-time academic or career-related work in industry. Satisfactory/unsatisfactory. Prerequisites: sophomore standing in the College of Engineering and Technology, 2.0 overall gradepoint average at Bradley, approval of engineering and technology co-op coordinator and co-op advisor.

**IMT 212  Technical Calculus I (Gen. Ed. MA)**

3 hrs.
Differentiation and integration of algebraic functions; applications to technology. Prerequisite: minimum grade of C in MTH 112.

**IMT 214  Technical Calculus II (Gen. Ed. MA)**

3 hrs.
Continuation of IMT 212: trigonometric, exponential, and logarithmic functions; special integration techniques; conic sections. Prerequisites: minimum grade of C in IMT 212.

**IMT 216  Technical Calculus III (Gen. Ed. MA)**

3 hrs.
Solution of first- and second-order differential equations; Fourier series; polar coordinates; calculus of functions of two variables. Prerequisite: minimum grade of C in IMT 214.

**IMT 222  Statics**

3 hrs.
Force systems in two and three dimensions: equilibrium; structures; distributed force; moments of inertia, friction, and work. Prerequisites: PHY 107, IMT 212 or MTH 115.

**IMT 232  Physical Metallurgy**

4 hrs.
Crystal structures, metallography, destructive and nondestructive evaluation, physical properties, and applications of ferrous materials and alloys. Lecture and lab. Prerequisites: PHY 108, CHM 149.

**IMT 262  Applied Statistics and Quality Control**

3 hrs.
Application of statistical methods: evaluating and designing experiments; fitting curves; determining confidence levels; aiding in selection and comparison of designs and products for quality control. Prerequisite: IMT 212.

**IMT 322  Dynamics**

3 hrs.
Study of particle and rigid body motion using principles of force-mass-acceleration, work-energy, and momentum. Prerequisites: IMT 222, IMT 214.

**IMT 324  Strength of Materials**

4 hrs.
Stresses, strains, shearing, bending moments, design of beams for strength and deflection. Combined stresses and strains, torsion, columns, and axial loaded members. Prerequisite: IMT 222 or equivalent.

**IMT 328  Mass and Energy Transfer**

4 hrs.

**IMT 332  Non-Metallic Materials**

3 hrs.
Properties, manufacturing techniques, and applications of nonmetallic materials including plastics, ceramics, composites, and electronic materials. Emphasizes design and processing considerations for quality products. Lecture and Lab. Prerequisite: IMT 232.

**IMT 342  Advanced Manufacturing Processes I**

3 hrs.
Principles of metal casting and nonmetallic molding processes, powder metal processes, traditional metal joining processes, fabrication and assembly. Tooling and equipment required, manufacturing parameters, tolerances and economics of these operations. Lecture and Lab. Prerequisites: IMT 232, IMT 324, IMT 328, IME 341.

**IMT 344  Advanced Manufacturing Processes II**

3 hrs.
Applications of machining processes. Analysis of tool forces, heat generation, deflection, operation parameters, and resultant surface qualities and integrity. Traditional forging, rolling, drawing and extrusion processes; processing limits. Processing economics and optimization. Lecture and Lab. Prerequisites: IMT 232, IMT 326, IMT 324, IMT 328, IME 341.

**IMT 346  Computer Aided Manufacturing & Automation I**

3 hrs.
Principles and applications of numerical control of machine tools. Programming in machine tool code, designing the machining process, and planning for quality. Specification and testing of static and dynamic machine tool accuracy and repeatability. Introduction to computer assisted numerical control programming. Overview of industrial robots, systems, concepts, end effectors, computer control, specifications, justifications, and programming. Lecture and Lab. Prerequisites: IME 105, IME 341. Corequisite: IMT 362.

**IMT 362  Metrology and Instrumentation**

3 hrs.
Instruments and their application to industrial process measurements; associated control functions of circuits; principles underlying various measuring elements; determination of quantities to be processed; feedback control problems. Prerequisites: PHY 107, IME 341, IMT 262.

**IMT 392  Mechanical Component Design I**

3 hrs.
Application of design principles covering: stress analysis, deflection, failure theories, fatigue, gears. Manufacturability and the use of references and manufacturers' data. Prerequisites: IMT 232, IMT 262, IMT 324.

**IMT 394  Dynamics of Machines**

3 hrs.
Velocities, accelerations, and forces in existing mechanisms. Design and analysis of linkages, cams, rolling contact, and drive trains. Prerequisites: IMT 322.

**IMT 409  Selected Manufacturing Projects**

1-4 hrs.
Individual or small team projects. May be of an experimental, analytical, or creative nature. May be repeated for a maximum of 6 hours credit. Prerequisite: Junior/Senior standing and consent of instructor.
IMT 410  Selected Manufacturing Topics  
1-4 hrs.  
Topics of special interest which may vary each time course is offered. Topic is stated in current Schedule of Classes. May be repeated for a maximum of 6 hours credit. Prerequisite: Junior/Senior standing and consent of instructor.

IMT 446  Computer Aided Manufacturing & Automation II  
3 hrs.  
Computer assisted process planning and estimating. Concepts of computer control and feedback mechanisms. Design considerations for machine tools, machining cells, robotics, and flexible manufacturing systems. Lecture and Lab. Prerequisite: IMT 346.

IMT 448  Tooling Systems  
3 hrs.  
Analysis, design, and layout of manufacturing tooling, including jigs and fixtures, gauging devices, and dies. Analysis of tooling for varying production volume, lead time, process capability, and cost. Laboratory in tooling and layout simulation. Prerequisites: IMT 342 or IMT 344; IMT 346, IMT 395.

IMT 464  Process Design & Planning  
3 hrs.  
Translation of product design into specifications for manufacturing equipment and methods, simultaneous engineering, CAD/CAM, and organizational structures. Production volumes, life cycles, flexibility, skills, and cost. Prerequisites: IMT 342 or IMT 344; IMT 346.

IMT 492  Mechanical Component Design II  
3 hrs.  
Application and design principles. Inelastic stresses, fasteners, weldments, springs, bearings, shafts, clutches, belts, and chains. Manufacturability and the use of references and manufacturers’ data. Prerequisite: IMT 392.

IMT 494  Computer Aided System Design  
3 hrs.  
Application of design principles to definition of component properties, as determined by vibration, static, dynamic, and thermal loading for production system components and component systems. Techniques include analytical and FEM procedures. Prerequisites: IMT 216, IMT 394, IMT 492.

IMT 498  Senior Industrial Project  
4 hrs.  
Application of engineering technology principles to solve a real-world problem. Student works as a member of team assigned to a problem in a manufacturing or processing organization. Requires a professional written and oral report. Prerequisites: 30 hours IMET Department courses with a minimum of 2.25 GPA; COM 103; consent of instructor.

Department of Mechanical Engineering

The baccalaureate program in mechanical engineering is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone (410) 347-7700.

FACULTY  Professors Mehta (Chair), Abou-Hanna, Elbella, Hurt (Emeritus), Okamura (Emeritus), Ratcliff (Emeritus), Safdari, Wessler (Emeritus); Associate Professors Deller, Fakheri, Morris, Peterson (Emeritus), Podlasek; Assistant Professors Kim, McGreevy, Zietlow.

Mission

The mission of the Mechanical Engineering Department is to produce mechanical engineering graduates who possess the acumen, competence, and skills needed to enter, succeed, and lead in professional practice and/or graduate school. The goal is to provide a learning and nurturing environment that stimulates faculty and students to collaborate in solving practical problems, motivates lifelong learning, and helps them reach their highest potential.

The objectives of the department are that a majority of the graduating students of the mechanical engineering program:
1. will be prepared to enter professional practice or pursue advanced studies
2. will be prepared to succeed in local, regional, national, and international practice
3. will be prepared for lifelong learning
4. will realize satisfaction in the educational investment
5. will be prepared to pursue opportunities in mechanical engineering
6. will be prepared to meet global technological and societal changing needs
7. will be prepared to interact globally with engineering technology

Mechanical engineering is the broadest and most versatile of the engineering professions. It utilizes a combination of human, material, and economic resources to translate ideas and theories into realistic problem solutions that satisfy the needs of society. Problems are solved in such varied areas as energy, environment, robotics, assistance for the handicapped, and air, land, sea, and space vehicles.

Mechanical engineers are particularly concerned with the application of the sciences of mechanics and energy to the generation, utilization, and conservation of energy, and to the design of mechanical systems which control forces, motions, and the flow of materials. No two mechanical engineers do exactly the same thing. Their specific careers are the result of choices depending on personal interests and the changing needs of society.

Computers are integrated throughout mechanical engineering. Microcomputers, graphics terminals, and workstations are incorporated into the laboratory where
the students receive hands-on experience with computer aided design, microprocessor based control, measurement and control systems, and the interfacing of microprocessors in the design of mechanical systems.

The breadth of mechanical engineering is illustrated by the organization of the American Society of Mechanical Engineers (ASME), which supports mechanical engineers engaged in many areas. Some of these areas are: applied mechanics, bioengineering, dynamic systems and control including robotics, fluids engineering, heat transfer, materials, management, aerospace, air pollution control, diesel and gas engine power, gas turbines, computer and microprocessor applications, and solar energy.

Mechanical engineers are employed in a variety of service and product industries, in government, and in education. Many are self-employed as consultants. The undergraduate program also offers a particularly broad technical background for persons wishing to enter graduate programs in business, law and medicine.

The faculty believes that engineers must be firmly grounded in the fundamentals of their field and the supporting areas of mathematics, communication, and the sciences, so that graduates will be able to adapt quickly to the rapid changes occurring in our technological society. Therefore the curriculum has been designed to stress the basic tools of knowledge and practice essential to launch one’s professional career and a lifelong process of continued learning.

The spectrum of mechanical engineering includes innovation and creation, research, design and synthesis, analysis, development, evaluation, production, and the marketing of machines, systems, and processes. Central to this activity is the design process which leads to the creation of solutions to real-world problems. Therefore the mechanical engineering curriculum integrates design experiences into all levels of the program and into a majority of the professional courses. This culminates in a required comprehensive design experience which is satisfied by a yearlong senior project and by the selection of a technical elective identified as satisfying this requirement in the program.

Studies in the humanities and social sciences serve not only to meet the objectives of a broad education, but also to meet the objectives of the engineering profession.

Therefore, studies in the humanities and social sciences must be planned to reflect a rationale or fulfill an objective appropriate to the engineering profession and the University’s educational objectives. Since the humanities and social science courses do not build on prerequisites in the same manner as engineering courses, we require at least one course at the 300 level or above to guide the student and ensure depth in his/her humanities and social science selection. The humanities and social science courses should be chosen to satisfy the University general education requirements, and it is recommended that two courses be taken in the same program with one being lower level and the other being at the 300 level or above.

Student chapters of the American Society of Mechanical Engineers (ASME), American Society for Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), and Society of Automotive Engineers (SAE) are sponsored by the department to support and encourage the professional development of the students. A national honorary society for mechanical engineering students, Pi Tau Sigma, is also represented.

In addition to the specific requirements listed for the College of Engineering and Technology, a minimum grade point average of 2.25 in mechanical engineering courses must be achieved for graduation.

Students wishing to pursue graduate study in mechanical engineering may refer to the graduate catalog where course work leading to the MSME degree is described.

**Freshman Year**

*First Semester*

MTH 121 Calculus I ........................................ 4  
COM 103 The Oral Communication Process ............. 3  
ENG 101 English Composition ................................ 3  
ME 101 Foundations of Mechanical Engineering ........ 2  
ME 103 Computational Techniques in Mech. Engineering ........................................ 1  
CHM 161 General Chemistry I .......................... 4  


Second Semester

MTH 122 Calculus II ........................................ 4  
CE 150 Mechanics I Statics ................................ 3  
PHY 110 University Physics I ............................. 4  
ME 102 Engineering Design Graphics ..................... 2  
CHM 162 Engineering Chemistry ........................ 3  


**Sophomore Year**

*First Semester*

MTH 223 Calculus III ....................................... 4  
CE 250 Mechanics II (Dynamics) .......................... 3  
PHY 201 University Physics II ............................. 4  
MTH 202 Introduction to Numerical Methods ............ 3  
ECO 100 Introduction to Economics ........................ 3  
(Gen. Ed. - Social Forces)


Second Semester

ME 301 Thermodynamics I .................................. 3  
MTH 224 Differential Equations ........................... 4  
CE 301 Mechanics of Materials ............................ 3  
ME 351 Engineering Math. Science I ....................... 3  
Gen. Ed. Western Civilization ............................ 3


**Junior Year**

*First Semester*

ME 302 Thermodynamics II .................................. 2  
ME 344 Kinematics and Dynamics of Machines .......... 3  
ME 303 Instrumentation and Measurement ................. 3  
EE 327 Fundamentals of Electrical Engineering I ........ 3  
ME 308 Thermodynamics of Fluid Flow .................... 4  
ENG 300, 301, 304, 305, or 306 Advanced Writing .... 3


*General education courses must be selected from an approved list for each category. They may be taken in any sequence not necessarily in the semester indicated. The courses selected must provide depth and not be limited to a selection of introductory courses. Other University general education requirements are satisfied by specific required courses.

*ME 410 and 411 — Enrollment in ME 410 and 411 is restricted to mechanical engineering students who are in the fourth year of the program.

*Departmental policy regarding approved technical electives is available in the department office.*
Second Semester
ME 341 Engineering System Dynamics .......................... 3
ME 342 Design of Machine Elements ........................... 3
ME 403 Mechanical Engineering Systems Laboratory .... 3
EE 328 Fund. of Electrical Engineering II ................... 3
ME 415 Introduction to Heat Transfer ........................ 3
Gen. Ed. – Non-Western Civilization1 ......................... 3

Total Hours 17

Senior Year
First Semester
ME 410 M.E. Senior Project ................................. 2
ME 441 Mechanical Control Systems ...................... 3
IME 301 Engineering Economy ............................. 3
Gen. Ed. – Human Values1 ................................. 3
Approved Design Technical Elective1 ...................... 3
Approved Technical Elective1 .............................. 3
Approved Technical Elective2 .............................. 3

Second Semester
ME 411 M.E. Senior Project ................................. 2
ME 354 Principles of Materials Science Lab .......... 3
Gen. Ed. – Social Forces3 ................................ 3
Gen. Ed. – Fine Arts1 ..................................... 3
Approved Technical Electives3 ......................... 6

Total Hours 17

Total Hours 135

Course Descriptions

ME 101  Foundations of Mechanical Engineering
2 hrs.
Nature of mechanical engineering as a profession and as a technological response to human needs. Emphases: design process, problem solving, and engineering experimentation. Prerequisite: consent of instructor or department chair.

ME 102  Engineering Design Graphics
2 hrs.
Principles and methods of graphic communications, integrated with creative design problem solving: multi-view projections; pictorial drawing; fundamentals of descriptive geometry, sections, and dimensioning. Prerequisite: ME 101 or consent of instructor.

ME 103  Computational Techniques in Mechanical Engineering
1 hr.
Computational techniques and programming methods for mechanical engineering problems. Prerequisite: consent of instructor or department chair.

ME 200  Engineering Co-op
0 hrs.
Full-time cooperative education assignment for mechanical engineering students who alternate periods of full-time school with periods of full-time academic or career-related work in industry. Satisfactory/ Unsatisfactory. Prerequisites: sophomore standing in the College of Engineering and Technology, 2.0 overall grade point average at Bradley, approval of engineering and technology Co-op coordinator and Co-op advisor.

ME 301  Thermodynamics I
3 hrs.
Emphasis on concepts, laws, and problem solving methodology: properties of materials, especially gases and vapors; simple equations of state; 1st and 2nd laws; introduction to cycles and systems. Prerequisites: ME 103 or equivalent; CHM 161; PHY 201; MTH 223.

ME 302  Thermodynamics II
2 hrs.
Continuation of ME 301 with emphasis on engineering applications: including more detailed analysis of vapor cycles, power cycles, refrigeration cycles, and heat pump cycles, enhanced second law analysis, and more complex processes that include mixtures, humidification, combustion, and equilibrium. Prerequisite: minimum grade of C in ME 301.

ME 303  Instrumentation and Measurement
3 hrs.
Theory and practice of measurements and instrumentation. Definition of a measurement system that meets specified needs: identification, selection, and specification of instrumentation components. Weekly laboratory. Prerequisites: PHY 201; prerequisites or concurrent enrollment in ME 301, EE 327, MTH 202.

ME 308  Thermodynamics of Fluid Flow
4 hrs.
Thermodynamics of fluid flow. Basic concepts of fluid mechanics; utility of the control volume approach to solving conservation equations governing the behavior of compressible and incompressible fluid flows. Design applications in thermal systems, aerodynamics, and convective heat transfer. Prerequisites: minimum grade of C in ME 301, MTH 224. Corequisite: ME 303.

ME 341  Engineering Systems Dynamics
3 hrs.
Engineering systems dynamics, including mechanical, electrical, fluid, and thermal elements. Concepts of modeling. Mathematical methods for understanding and creating desired response behavior of linear systems. Prerequisites: PHY 201; MTH 224; CE 250.

ME 342  Design of Machine Elements
3 hrs.
Application of stress analysis, deflection analysis, dynamic analysis, and materials to the design of mechanical components and machines. How available manufacturing processes influence nature of machine elements. Prerequisites: minimum grade of C in CE 301 and ME 351; prerequisites or concurrent enrollment in ME 303, ME 344, and ME 354.

ME 344  Kinematics and Dynamics of Machines
3 hrs.
Kinematic and dynamic analysis and synthesis of mechanisms and machines; kinematics of linkages, cams and gearing systems; different analysis methods. Static and dynamic forces; balancing of rotating and reciprocating machines. Integration of these topics in solving open-ended design problems. Prerequisites: MTH 202, CE 250; prerequisite or concurrent enrollment in ME 341.

ME 351  Engineering Materials Science I
3 hrs.
Atomic and crystalline structure of solid materials commonly used in engineering applications. Effects of internal structure on physical properties of materials. Prerequisites: CHM 161; PHY 201.

BRADLEY UNIVERSITY
ME 354  Principles of Materials Science Laboratory Practices
3 hrs.
Topics and experiments involving thermal analysis, mechanical measurements, phase transformation, mechanical deformation, diffusion, corrosion, and electrical properties of materials. Prerequisite: minimum grade of C in ME 351 or equivalent.

ME 403  Mechanical Engineering Systems Laboratory 2 hrs.
Student team investigations of thermal and mechanical systems emphasizing definition, design, and execution of experiments involving system modeling and analysis. Written reports and oral presentations are required. Prerequisites: COM 103; minimum grade of C in ME 303, CE 301, ME 308; Prerequisites or concurrent enrollment in 300-level English composition, ME 302, ME 341, ME 415.

ME 407  Power Plant Design 3 hrs.
Comprehensive study of equipment and thermodynamic cycles relating to modern, fossil fueled power plants. Development of thermal-hydraulic designs for heat exchangers, condensers, steam generators, and turbines for a proto-typical plant. Extensive computational parametric studies for understanding salient parameters governing selection of optimal hardware configurations. Prerequisites: ME 302, 308.

ME 409  Mechanical Engineering Projects 1-4 hrs. each semester
Special topics or projects of an experimental, analytical, or creative nature. May be repeated up to 16 credit hours. Prerequisite: consent of instructor.

ME 410  Mechanical Engineering Senior Project I 2 hrs.
Individual or small team investigation of open-ended engineering problems. Emphasis on problem definition, planning, analysis, synthesis and evaluation. May involve experimentation and/or construction of models. Prerequisites: Senior standing in ME and consent of instructor.

ME 411  Mechanical Engineering Senior Project II 2 hrs.
Continuation and completion of senior project begun in ME 410. Prerequisites: ME 410 and consent of instructor.

ME 415  Introduction to Heat Transfer 3 hrs.
Steady state and transient conduction; external and internal forced convection and free convection; radiation; heat exchanger design. Prerequisites: ME 302, ME 308.

ME 441  Mechanical Control Systems 3 hrs.
Sequencing control theory of linear feedback control systems; examples taken from applications encountered by mechanical and manufacturing engineers. Time and frequency response techniques. Analysis and design of fluid powered control systems. Microprocessors and computer control applications. Prerequisites: ME 341; EE 327.

ME 448  Computer Aided Design in Mechanical Engineering 3 hrs.
Design of mechanical systems and components enhanced by applications of computer graphics. Computer graphics hardware characteristics; transformation and projection geometry; space curves and surface presentations; solid geometric representations. User application CAD packages for finite element analysis and mechanisms and systems simulation. Prerequisite: senior standing in ME or consent of instructor.

ME 462  Fundamentals of Robotics 3 hrs.
Introduction to robotic systems and implications for mechanical, industrial, electrical, and manufacturing engineers. Emphasis on design of robotic systems; evaluation of competing robotic systems; off-line programming of robotics; and role of robotics in global industrial competitiveness. Plant visits to observe robotics in operation; hands-on experience using open-loop and closed-loop robots. Lab exercises: off-line programming, control by external sensors, control by vision systems. Prerequisites: ME 304, EE 328, ME 441 or consent of instructor.

ME 501  Advanced Thermodynamics 3 hrs.
Laws and concepts of classical thermodynamics: real gases and equations of state; availability; irreversibility; property relations; potential functions; equilibrium; multicomponent systems. Prerequisite: ME 302.

ME 502  Problems in Advanced Dynamics 3 hrs.
Application of analytical and graphical methods to problems involving velocities, accelerations, working and inertia forces. Prerequisite: ME 341.

ME 503  Internal Combustion Engines 3 hrs.
Thermodynamic analysis, thermo-chemistry, and performance characteristics of spark ignition and compression ignition engines. Prerequisites: ME 301; ME 302 or consent of instructor.

ME 509  Solar Engineering 3 hrs.
Nature and characteristics of solar energy as a renewable energy resource. Solar geometry and radiation. Thermodynamics of solar systems; emphasis on 2nd Law considerations. Performance characteristics of collectors, storage systems, house heating systems, cooling and refrigeration, and photovoltaics. Comprehensive design project. Theory and performance characteristics of solar devices and application to design of a comprehensive solar energy system. Prerequisite: ME 415 or consent of instructor.

ME 512  Heat Transfer – Convection 3 hrs.
Non-isothermal flow of fluids in Cartesian, cylindrical, spherical, and other coordinate systems: slug flow, laminar flow, flow entrance effects, property variation effects, and turbulent flow. Prerequisite: ME 415.
ME 515  Intermediate Heat Transfer  
3 hrs.  
In-depth treatment of the three modes of heat transfer; design applications. Development of analytical and specific numerical skills needed for solving design problems involving heat transfer. Prerequisite: ME 415.

ME 520  Gas Dynamics  
3 hrs.  
One dimensional flow: wave and shock motion in subsonic and supersonic flow; flow with heat transfer and friction; viscosity effects; similarity. Introduction to multidimensional flow. Prerequisite: ME 308.

ME 521  Intermediate Fluid Mechanics  
3 hrs.  
Analysis of statics and dynamics of non-viscous and viscous fluids. Derivation of differential equations of motion. Potential flow; vortex motion; creeping motion; introduction to boundary layer theory; turbulence. Prerequisites: MTH 224; ME 308.

ME 533  Propulsion Systems  
3 hrs.  
Gas turbine analysis; stationary power plants; turboprop, turbojet, and ramjet engines; rocket propulsion; application of thermodynamics. Prerequisite: ME 308.

ME 534  Environmental Engineering - Air Conditioning  
3 hrs.  
 Heating and cooling of moist air; solar radiation; computation of heating and cooling loads; study of heating, ventilating, and cooling systems and equipment; design project. Prerequisite: ME 301.

ME 535  Environmental Engineering - Refrigeration  
3 hrs.  
Mechanical vapor compression refrigeration cycles; refrigerants; absorption refrigeration; miscellaneous refrigeration processes; cryogenics; semester design project. Prerequisite: ME 301.

ME 536  Industrial Pollution Prevention  
3 hrs.  
Industrial pollution prevention for small quantity generators such as foundries, metal fabrication, electroplating, electronics, soldering, wood products, cleaning, degreasing, and coating. Study of emerging technologies for pollution prevention. Relationships among energy consumption, waste production, and productivity enhancement. Actual plant assessments. Prerequisite: consent of instructor.

ME 537  Building Energy Management  
3 hrs.  
The energy problem. Energy consumption patterns in existing and new buildings. Analysis of energy saving strategies for existing buildings; developing designs for new, energy efficient buildings, including reliability, comfort, and economic considerations. Formal oral presentations.

ME 540  Advanced Mechanical Vibrations  
3 hrs.  
Principles of vibrations in one or more degrees of freedom; application to machine members. Prerequisite: ME 341; MTH 224.
ME 556  Mechanics of Composite Materials  
3 hrs.
Mechanical behavior, analysis, and design of various advanced composite materials; introduction to composite materials and their applications; elasticity of anisotropic solids; micromechanics of fiber reinforced composites and particulate composites; short fiber composites; macromechanics of laminated composites; thermal stresses; failure criteria; fracture and fatigue, reliability, testing, and design of composite materials. Emphasis on developing simple microcomputer programs for analysis. Projects involve curing and testing composites. Prerequisite: CE 301.

ME 560  Principles of Robotic Programming  
3 hrs.
Programming of industrial robotic manipulators with external inputs, tactile sensing, and vision sensing. A design project is required. Cross-listed as IME 560. Prerequisites: graduate or senior standing in engineering or computer science.

ME 562  Analysis and Design of Robotic Systems  
3 hrs.
Underlying theories of robotic systems; implications for engineering design. Kinematic, dynamic, and control analysis of robotic arms; robotic systems design. Plant visits to observe robots in action; hands-on experience using open-loop and closed-loop robots. Prerequisites: ME 344, 304, 441; EE 328; or consent of department.

ME 573  Methods of Engineering Analysis  
3 hrs.
Application of principles of analog and digital computers and numerical methods to solve mechanical engineering problems. Prerequisites: ME 341; MTH 202, 224.

ME 577  Finite Element Methods in Engineering  
3 hrs.

ME 591  Topics in Mechanical Engineering  
1-3 hrs.
Topics of special interest which may vary each time course is offered. Topic stated in current Schedule of Classes. Graduate students may repeat the course under different topic names up to a maximum of 9 credits. Prerequisite: consent of instructor.