



COLLEGE OF ENGINEERING AND TECHNOLOGY

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

Program of Study	Degree Awarded
Civil Engineering (environmental engineering option)	B.S. in Civil Engineering
Construction	B.S. in Construction
Electrical Engineering (computer option)	B.S. in Electrical Engineering
Engineering Physics	B.S.
Industrial Engineering	B.S. in Industrial Engineering
Manufacturing Engineering	B.S. in Manufacturing Engineering
Manufacturing Engineering Technology	B.S. in Manufacturing Engineering Technology
Mechanical Engineering	B.S. in Mechanical Engineering

The mission of the college is to produce engineering graduates who possess the professional competence to enter and succeed in professional practice and/or graduate school. To achieve this, the programs emphasize:

1. knowledge and understanding of the appropriate fundamentals to ensure a solid foundation for the development of professional skills;
2. developing skills in integrating knowledge and applying understanding in a professional way to formulate problems and to produce efficient, economic, and effective solutions;
3. developing written, oral, and graphic communication skills;
4. cultivating an understanding and awareness of diverse cultures and social conditions, past and present, and an appreciation of human values in order to enhance the quality of life and contribute to the general welfare of society; and
5. commitment to continuing professional growth.

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 gradepoint 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 gradepoint average at Bradley.

Internships

Engineering internships provide engineering and technology students in good academic standing (2.0 gradepoint 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 payback. 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 gradepoint 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 gradepoint 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 gradepoint 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 Accreditation Board for Engineering and Technology.

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 McNabb, Dini, Muvdi, Guest; Professors Adrian, Al-Khafaji (Chair); Associate Professors Fuesse, Rebholz, Seckler; Assistant Professors Dicleli, Foo, Maillecheruvu, 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.).

Civil Engineering

Civil engineering offers an undergraduate curriculum which is designed to give a student the broad educational background necessary for modern day civil engineering practice. The program includes a strong core in mathematics as well as the natural and engineering sciences. Paralleling this science core is a sequence of courses in the humanities and social sciences.

The engineering student's selection of humanities and social science courses are to be chosen to provide a broad education consistent with the objectives of the engineering profession. The courses taken should be selected to provide both breadth and depth in the humanities and social sciences and not be limited to a selection of unrelated introductory courses. The Department of Civil Engineering and Construction requires civil engineering majors to select their humanities and social science courses (1) to satisfy the University general education requirements, and (2) to select two courses from the same program with one being lower level (defined as a 100 or 200 level course) and the other being a 300 or higher level course. An approved listing of the courses needed to satisfy these requirements may be obtained from the department's faculty academic advisor.

The program provides thorough preparation and professional training in the fundamentals of engineering. This enables the graduate to pursue a successful career in civil engineering, a field encompassing a broad spectrum of activities, including work in structures, water resources, environmental problems, transportation, foundations, and research and development, as well as higher education.

A specific requirement for graduation, in addition to those listed for the College of Engineering and Technology, is that a minimum grade point average of 2.25 must be achieved in CE courses.

In addition to the undergraduate program described above, the Department of Civil Engineering and Construction offers a graduate program leading to the

degree of Master of Science in Civil Engineering. Details of this program may be found in the Graduate Catalog.

Freshman Year

First Semester

CE 100 Intro. to Civil Engineering	1
ENG 101 English Composition	3
MTH 121 Calculus I	4
Gen. Ed. ¹ - Western Civilization	3
COM 103 Oral Communication Process	3
GES 150 Principles of Engineering Geology	3
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	17

Second Semester

CE 150 Mechanics I	3
MTH 122 Calculus II	4
PHY 110 University Physics I	4
CON 132 Construction Graphics	2
Gen. Ed. ¹ - Non-Western Civilization	3
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	16

Sophomore Year

First Semester

CE 206 Surveying	2
CE 250 Mechanics II	3
CHM 161 General Chemistry I	4
MTH 223 Calculus III	4
Gen. Ed. ¹ - Social Forces	3
CE 224 CADD in Civil Engineering	2
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	18

Second Semester

CE 202 Digital Computation & Numerical Methods	3
CE 301 Mechanics of Materials	3
CE 303 Structural Materials Lab	2
CHM 162 Engineering Chemistry	3
Gen. Ed. ¹ - Fine Arts	3
MTH 224 Elementary Differential Equations	4
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	18

Junior Year

First Semester

CE 304 Fluid Mechanics	3
CE 359 Structural Analysis	4
Engineering Science 2	3
Gen. Ed. ¹ - ENG 305	3
CE 308 Geotechnical Engineering	4
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	17

Second Semester

CE 306 Fluid Mechanics Lab	1
CE 360 Intro. to Environmental Engineering	4
IME 301 Engineering Economy	3
CON 396 Construction Estimating	3
Gen. Ed. ¹ - Social Forces	3
Basic Science ²	3
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	17

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.

Senior Year*First Semester*

CE 403 Reinforced Concrete	3
CE 456 Highway and Pavement Design	4
CE 493 Civil Engr. Design Project I	1
Gen. Ed. ¹ - Human Values	3
Electives ²	6
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	17

Second Semester

CE 442 Design of Steel Structures	3
CE 422 Foundation Analysis & Design	3
CE 498 Civil Engr. Design Project II	3
Electives ²	6
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	15

Total Hours	<hr/>
	135

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 gradepoint average 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 206
- Any geological science course above 101 except GES 150
- ME 351 Engineering Materials Science I

2. Engineering Science

Students may apply up to a maximum of 9 semester hours but must take ME 301, EE 327, or IE 311.

- ME 301 Thermodynamics I
- ME 302 Thermodynamics II
- ME 521 Intermediate Fluid Mechanics
- ME 556 Mechanics of Composite Materials
- ME 577 Finite Element Methods in Engineering
- IME 311 Intro. to Engineering Statistical Methods
- IME 312 Engineering Statistical Methods
- IME 313 Oper. Research I
- EE 205 Fundamentals of Circuit Analysis
- EE 327 Fund. of Elec. Engr. I
- EE 328 Fund. of Elec. Engr. 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 370 Environ. Regulations & Policy
- CE 450 Geoenvironmental Engineering
- CE 504 Advanced Hydraulics
- CE 508 Advanced Soil Mechanics
- CE 510 Advanced Numerical Methods With Engineering Applications
- CE 511 Advanced Mechanics of Materials
- CE 518 Subsurface Flow in Porous Media
- CE 545 Structural Dynamics
- CE 555 Solid and Hazardous Waste Management
- CE 557 Analysis of Environmental System
- CE 559 Management Models in Environmental Engineering

Group B: Civil Engineering Design

Students may apply up to a maximum of 12 semester hours and not less than 3 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 430 Water Supply and Hydraulic Engineering
- CE 460 Physiochemical Processes Design
- CE 470 Biological Processes Design
- CE 530 Prestressed Concrete
- CE 558 Industrial Waste Treatment Process Design
- CE 562 Advanced Structural Design I

4. Mathematics, Business, and Computer Science

Students may apply up to a maximum of 6 semester hours.

- Any math 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 580 Advanced Cost Estimating for Construction Projects
- CE 582 Construction Project Management
- CE 584 Construction Contract Administration
- CON 330 Housing
- CON 342 Construction Equipment and Methods
- CON 352 Urban Environment
- CON 390 Microcomputers in Construction
- CON 392 Construction Management
- CON 394 Construction Labor and Unions
- CON 395 Construction Claims and Change Orders
- CON 492 Construction Contracts
- CON 494 Construction Practice
- CON 500 Special Topics I
- CON 501 Special Topics II

² Technical electives must be chosen from an approved list. See "Technical Electives."

Civil Engineering with Environmental Engineering Concentration

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.

Freshman Year

First Semester

CE 100 Intro. to Civil Engineering	1
ENG 101 English Composition	3
MTH 121 Calculus I	4
Gen. Ed. ¹ - Western Civilization	3
Gen. Ed. ¹ - Social Forces	3
GES 150 Principles of Engineering Geology	3
	<hr/> 17

Second Semester

CE 150 Mechanics I	3
MTH 122 Calculus II	4
PHY 110 University Physics I	4
CON 132 Construction Graphics	2
COM 103 Oral Communication Process	3
	<hr/> 16

Sophomore Year

First Semester

CE 206 Surveying	2
CE 250 Mechanics II	3
CHM 161 General Chemistry I	4
MTH 223 Calculus III	4
Gen. Ed. ¹ - Non-Western Civilization	3
CE 224 CADD in Civil Engineering	2
	<hr/> 18

Second Semester

CE 202 Digital Computation and Numerical Methods	3
CE 360 Intro. to Environmental Engineering	4
CHM 162 Engineering Chemistry	3

Gen. Ed. ¹ - Fine Arts	3
MTH 224 Differential Equations	4
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Junior Year

First Semester

CE 304 Fluid Mechanics	3
Engineering Science Elective ²	3
CE 301 Mechanics of Materials	3
Gen. Ed. ¹ - ENG 305 Technical Writing	3
CE 308 Geotechnical Engineering	4
	<hr/> 16

Second Semester

CHM 315 Environmental Chemistry	3
CE 460 Physiochemical Processes Design	3
Environmental Science Elective (BIO 300, 395; CHM 250; GES 312, 410, 461)	3
CON 396 Construction Estimating	3
CE 370 Environmental Regulations and Policy	3
IME 301 Engineering Economy	3
	<hr/> 18

Senior Year

First Semester

CE 493 Civil Engineering Design Project I	2
CE 450 Geoenvironmental Engineering	4
Gen. Ed. ¹ - Human Values	3
CE 470 Biological Processes Design	3
Technical Electives ²	6
	<hr/> 18

Second Semester

CE 498 Civil Engineering Design Project II	2
CE 430 Water Supply and Hydraulic Engineering	3
Gen. Ed. ¹ - Social Forces	3
CE 306 Fluid Mechanics Lab	1
Technical Electives ²	6
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Total Hours

135

Environmental Engineering Concentration Technical Electives

- 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.
- Engineering science elective (fall semester of junior year)
The student shall select one of the following three courses.
ME 301 Thermodynamics I
EE 327 Fundamentals of Electrical Engineering I or
EE 205 Fundamentals of Circuit Analysis
IME 311 Engineering Statistics I
- Environmental science elective (spring semester of junior year)

The student shall select one environmental science course from the basic science electives listed below.
 BIO 300 Population, Resources and Environment
 BIO 395 General Microbiology
 CHM 250 Organic Chemistry
 GES 312 Structural Geology and Tectonics
 GES 410 Principles of Geochemistry
 GES 461 Introductory Geophysics

4. All technical electives should be selected from the approved listing. The student may select a geoenvironmental or an environmental engineering management focus or select technical electives from both areas. The student must select technical electives such that they accumulate 4 semester hours of design. The hours of design content appear in parenthesis following the course title, if applicable.

*Environmental Engineering Electives
 Geoenvironmental Focus*

GES 450 Hydrogeology
 CE 504 Advanced Hydraulics (1)
 CE 508 Advanced Soil Mechanics (1)
 CE 518 Subsurface Flow & Contam. Transport (1)
 CE 555 Solid and Hazardous Waste Management (1)
 CE 558 Industrial Waste Treatment Design (2)

Environmental Engineering Management Focus

GES 450 Hydrogeology
 CE 504 Advanced Hydraulics (1)
 CE 555 Solid and Hazardous Waste Management (1)
 CE 557 Analysis of Environmental Systems (1)
 CE 558 Industrial Waste Treatment Design (3)
 CE 559 Management Models in Environmental Engineering
 CE 580 Advanced Cost Estimating for Construction Projects
 CE 582 Construction Project Management
 CE 584 Construction Contract Administration

Course Descriptions

CE 100 Introduction to Civil Engineering
1 hr.

The civil engineering and construction professions. Computing systems, problem solving concepts, design concepts, and University services. Cross-listed as CON 100. Prerequisites: freshman standing or consent of instructor.

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 Academic Handbook. 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 suites 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
2 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 240 Statics and Dynamics
4 hrs.

Statics and dynamics of particles using vector methods. Introduction to dynamics of rigid bodies. Open only to non-majors. Prerequisite: PHY 110. Corequisite: MTH 223.

CE 250 Mechanics II
3 hrs.

Kinematics and kinetics of particles using vector analysis. Kinematics and kinetics of rigid bodies using 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 Academic Handbook. 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 axially loaded members; stresses and deformations in torsionally loaded members; stresses and deformations in flexural members; combined stresses; column analysis; statically indeterminate members; introduction to member design. 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. 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). Prerequisite: C or better in CE 250 or CE 240. Corequisite: MTH 224.

CE 306 Fluid Mechanics Laboratory
1 hr.

Demonstrates principles of fluid mechanics and open and closed conduit hydraulics; preparation and implementation of experimental procedures; analysis of data and appropriate conclusions; proper engineering report writing techniques. Flow measurement, energy conversion, viscosity studies, pipe flow, and open channel flow. Prerequisite: CE 304.

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, 304.

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: MFG 307 or CE 301; construction major.

CE 359 Structural Analysis
4 hrs.

Analysis of statically determinate structures including influence lines. Deflections by area-moment, conjugate beam, virtual work, and Castigliano's theorem. Analysis of statically indeterminate structures including influence lines. Classical solutions by consistent displacements, three-moment theorem, moment distribution, and slope deflection methods. Matrix methods for structural analysis by stiffness approach. Prerequisite: CE 301.

CE 360 Introduction to Environmental Engineering
4 hrs.

Analysis techniques and design procedures for unit operations and unit processes of water and waste water treatment. Techniques for examination of water and waste water 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 Academic Handbook. 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
3 hrs.

Theory and design of reinforced concrete structures: beams, columns, slabs, walls, and buildings. Current ACI Code provisions for elastic and ultimate design. Prerequisite: CE 359.

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 450 Geoenvironmental Engineering
4 hrs.

Soil composition and behavior. Development and movement of ground water. Soil sampling and monitoring of contaminants in groundwater. Drilling techniques based on soil type. Land disposal of wastes. Solidification of wastes, design of landfills. Processes affecting the distribution of inorganic and organic pollutants in the environment. Exchange among soil, water, sediment, and biota. Remediation of contaminated soil and groundwater at existing sites. Prerequisites: CE 308, 360.

CE 456 Highway and Pavement Design**4 hrs.**

Major areas of highway engineering and pavement design. Selection, testing, and use of highway construction materials in relation to function, environment, and cost. Structural properties of asphalt concrete; laboratory experiments. Prerequisites: CE 206; CE 308 or CE 320.

CE 460 Physiochemical Processes Design**3 hrs.**

Application of physical, chemical, and engineering techniques for water treatment and environmental control: aeration, coagulation, flocculation, sedimentation, filtration, precipitation, and disinfection. Advanced purification methods including adsorption and demineralization processes. Treatment and disposal of sludges produced by physiochemical processes. Prerequisite: CE 360.

CE 465 Surface and Ground Water Hydrology**3 hrs.**

Introduction to the hydrologic cycle. Measurement techniques, analysis techniques, and prediction methods. Emphasis on use of hydrological data analysis procedures in design of urban systems. Simulation of hydrologic systems; computer applications. Prerequisite: majors with senior standing in CE or geology, or consent of instructor.

CE 470 Biological Processes Design**3 hrs.**

Detailed integrated design of wastewater treatment. Emphasis on domestic wastewater treatment processes including primary and secondary sedimentation, biological treatment processes, advanced wastewater treatment, and sludge treatment and disposal. Prerequisite: CE 360.

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 Academic Handbook. If taken to satisfy one of the technical electives, applies only to the ABET "other" category. Prerequisite: senior standing.

CE 493 Civil Engineering Design Project I**2 hrs.**

First of a two-semester course design project sequence. With faculty aid, students select a design project and plan its solution. Oral and written report of preliminary plan. Prerequisites: senior standing; consent of Department Chair.

CE 498 Civil Engineering Design Project II**2 hrs.**

Second of a two-semester course design project sequence. Under faculty guidance, students perform the actual design for the project selected in CE 493. Oral and written report of final design. Prerequisites: CE 493; 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 504 Advanced Hydraulics**3 hrs.**

Hydraulic transients in pipeline and open channel flow; gradually varied, spatially varied, and rapidly varied flow in open channels; sedimentation mechanics, stream channel mechanics. Computer and design applications. Prerequisite: CE 304.

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. Prerequisite: 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 511 Advanced Mechanics of Materials**3 hrs.**

One, two, and three dimensional stresses and strains at point; theories of elastic strength; effect of loading on the member; torsion of noncircular sections; curved beams; unsymmetrical bending. Prerequisites: CE 301; senior or graduate standing; consent of instructor.

CE 530 Prestressed Concrete**3 hrs.**

Theory and analysis of prestressed concrete members by various methods of prestressing; linear and circular prestressing; design of simple and continuous beams and slabs; extensive study of materials used in prestressed concrete. Prerequisites: CE 403, 359; senior or graduate standing; consent of instructor.

CE 545 Structural Dynamics**3 hrs.**

Single degree of freedom systems, lumped-mass multidegree systems, and multidegree of freedom systems. Numerical evaluation of system responses due to blasts, wind, and earthquake loading. Applications. Prerequisites: CE 202, 359.

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 555 Solid and Hazardous Waste Management**3 hrs.**

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; engineering processes for the chemical, biological, and physical treatment of toxic and hazardous wastes; remediation of contaminated soil and groundwater at existing disposal sites. Prerequisite: CE 360.

CE 557 Analysis of Environmental Systems**3 hrs.**

Areas of environmental engineering not covered in CE 360: pollutant transport in air, surface water, and groundwater; environmental management of air and water resources. Prerequisites: senior or graduate standing; consent of instructor.

CE 558 Industrial Waste Treatment Process Design**3 hrs.**

Industrial survey and treatment technologies for liquid, solid, and gaseous wastes. Mixing of wastes and stream sanitation. Applications and design of treatment processes with emphasis on the aqueous chemistry of heavy metals and organic contaminants. Applied electrochemistry and redox reactions, and interfacial phenomena. Prerequisite: CE 360.

CE 559 Management Models in Environmental Engineering**3 hrs.**

Development, solution, and interpretation of management models used in environmental planning and management; mathematical programming techniques from operations research; trade-off analysis and risk assessment; management problems for conventional and toxic wastes in surface water, ground water, and air. Prerequisite: CE 360.

CE 562 Advanced Structural Design I**3 hrs.**

Multi-story steel frame analysis and design; rigid frame design; plate girder design. Extensive use of computer for design and analysis. Prerequisites: CE 359, 442; senior or graduate standing; consent of instructor.

CE 580 Advanced Cost Estimating for Construction Projects**3 hrs.**

Cost estimating for material, equipment, and labor for construction projects. Taking-off quantities, pricing techniques, computer estimating, and bidding strategy models. Prerequisites: IE 301; consent of graduate advisor.

CE 582 Construction Project Management**3 hrs.**

Procedures, techniques, and research efforts regarding improvement of construction productivity. On-site laboratories to utilize and evaluate productivity improvement techniques. Prerequisites: IE 301; consent of graduate advisor.

CE 584 Construction Contract Administration**3 hrs.**

Issues in the implementation of a construction contract. Coordinating and controlling the construction project under legal and ethical considerations. Prerequisites: CON 492 or consent of instructor.

CE 591 Special Topics I**1-3 hrs.**

Topics of special interest, which may vary each time course is offered. Topic stated in current Academic Handbook. 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 Academic Handbook. 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 128 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 128 semester hours.)

Degree Requirements

Accreditation criteria are met by the following groups of courses:

Group I — General Education

¹ ENG 101 English Composition	3
¹ ENG 300, 301, 304, 305, or 306 Advanced Writing	3
¹ COM 103 Oral Communication Process	3
¹ Western Civilization	3
¹ Non-Western Civilization	3
¹ Human Values	3
¹ Fine Arts	3

Group II — Mathematics and Science

¹ MTH 115 or 121 Calculus I	4
MTH 116 or 122 Calculus II	3, 4
¹ PHY 107 or 110 Physics I	4
CIS 102, CS 104, or CS 106 Programming	3
¹ GES 101, 102 Principles of Earth Science	4

Group III — Architectural, Engineering, and Construction Sciences

CON 262 Mechanical and Electrical Systems	4
CON 270 Materials and Methods of Construction	4
CON 486 Structures I	4
CON 488 Structures II	4

¹University general education requirement

CE 150 or MFG 206 Statics	3
CE 206 Surveying	2
CE 301 or MFG 307 Strength of Materials	3, 4
CE 320 Introductory Soil Mechanics	3
IME 301 Engineering Economy	3
CON 224 CADD in Construction	2
Construction Science Elective	3
<i>chosen from</i>	
CE 250 Mechanics II	
CE 359 Structured Analysis	
CE 456 Highway and Pavement Design	
IME 311 Engineering Statistics	

Group IV — Business and Management

¹ ECO 221 Microeconomics	3
¹ ECO 222 Macroeconomics	3
ATG 157 Accounting-Financial	3
ATG 158 Accounting-Managerial	3
BMA 352 Business Management	3
Business Electives	9

usually chosen from

QM 262 Quantitative Analysis I	
FIN 322 Business Finance	
MTG 315 Principles of Marketing	
BMA 342 The Legal Environment of Business	
BMA 355 Labor-Management Relations	
BMA 356 Human Resource Management	
BMA 357 Leadership and Interpersonal Behavior	
BMA 395 Real Estate Principles	

Group V — Construction

CON 100 Introduction to Construction	1
CON 132 Construction Graphics	2
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 493 Senior Project Planning	1
CON 494 Construction Practice	3
CON 498 Senior Project	3
CON Electives	5

chosen from

CON 330 Housing	
CON 352 Urban Environment	
CON 390 Microcomputers in Construction	
CON 394 Construction Labor and Unions	
CON 395 Construction Claims and Change Orders	
CON 409 Special Topics	
CON 495 Construction Cost Control	

Typical Curriculum

Freshman Year*First Semester*

CON 100 Introduction to Construction	1
COM 103 Oral Communication Process	3
MTH 115 or MTH 121 Calculus I	4
¹ Gen Educ. — Western Civilization	3
GES 101 Principles of Earth Science	3
GES 102 Principles of Earth Science Lab.	1
.....	15

Second Semester

CON 132 Construction Graphics	2
ENG 101 English Composition	3
MTH 116 or MTH 122 Calculus II	3, 4
PHY 107 or Physics 110	4
² CS Elective	3
.....	15-16

Sophomore Year*First Semester*

CE 150 Mechanics I or IMT 222 Statics	3
ECO 221 Microeconomics	3
ATG 157 Accounting-Financial	3
CON 270 Materials and Methods of Construction	4
CE 206 Surveying	2
CON 224 CADD in Construction	2
.....	17

Second Semester

CE 301 or IMT 324 Strength of Materials	3, 4
ECO 222 Macroeconomics	3
ATG 158 Accounting-Managerial	3
CON 262 Mechanical & Electrical Systems for Bldgs. ...	4
¹ Gen. Ed. — Non-Western Civilization	3
.....	16, 17

Junior Year*First Semester*

IME 301 Engineering Economy	3
CON 342 Construction Equipment and Methods	3
CON 372 Construction Methods Improvement	3
² Management Elective	3
² Construction Elective	2
¹ Gen. Ed. — Human Values	3
.....	17

Second Semester

¹ ENG 300, 301, 304, 305, or 306 Adv. Writing	3
CON 392 Construction Management	3
BMA 352 Business Management	3
CON 396 Construction Estimating	3
CE 320 Intro. to Soil Mechanics	3
.....	15

Senior Year*First Semester*

¹ Gen. Ed. — Fine Arts	3
CON 486 Structures I	4
CON 492 Construction Contracts	2
CON 493 Senior Project Planning	2
² Construction Science Elective	3
² Management Elective	3
.....	17

Second Semester

CON 498 Senior Project	2
CON 488 Structures II	4
CON 494 Construction Practice	3
² Construction Elective	3
² Management Elective	3
.....	15

Total Hours

128 or 129

² Electives must be chosen from the approved list under "Degree Requirements."

Course Descriptions

CON 100 Introduction to Construction

1 hr.

The civil engineering and construction professions. Computing systems, problem solving concepts, design concepts, and University services. Cross listed as CE 100.

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. 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.

CON 224 CADD in Construction

2 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. Prerequisites: CON 132 or equivalent.

CON 262 Mechanical and Electrical Systems for Buildings

4 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. Prerequisites: PHY 107 or 110; CON 132.

CON 270 Materials and Methods of Construction

4 hrs.

Characteristics and use of basic construction materials; introduction to materials specifications.

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 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 Management

3 hrs.

Economic considerations and tools of management: time-value of money; cost reporting; scheduling. Emphasis on network methods of scheduling; resource allocation and least-cost expediting. Computer aided. Prerequisites: approved CS elective; junior standing in College of Engineering and Technology.

CON 394 Construction Labor and Unions

2 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.

CON 395 Construction Claims and Change Orders

3 hrs.

Record keeping and quantitative skill necessary for change orders and claims presentation or preparation. Prerequisite: junior standing in College of Engineering and Technology.

CON 396 Construction Estimating

3 hrs.

Material, equipment, and labor estimates of construction projects. 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 486 Structures I

4 hrs.

Introduction to structural analysis and design of steel and timber; application to construction problems such as form work, structural members, connections, and construction processes. Prerequisites: MTH 116 or 122; MFG 307 or equivalent.

CON 488 Structures II

4 hrs.

Introduction to structural analysis and design of reinforced concrete; application to construction problems such as structural members, foundations, and construction processes. Prerequisites: CE 320 or concurrent enrollment; CON 270, 486.

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 493 Senior Project Planning**2 hr.**

Definition and planning of projects in construction. Prerequisites: senior standing in construction; consent of Department Chair.

CON 494 Construction Practice**3 hrs.**

Construction organization; contractor ethics; responsibilities and professionalism; construction contracts; financing; law. 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**2 hrs.**

Application of construction principles to industry projects. Prerequisites: CON 493; 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 and the baccalaureate program in electrical engineering technology is accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology.

FACULTY *Professors Anakwa, S. N. Prasad, Schertz, Sennot, 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.

Electrical Engineering

Modes of life have been transformed dramatically by the widespread use of electronic and computing devices and systems, and it is certain that even more dramatic changes are in store for society as a result of current progress in electrical engineering. This process is very dynamic and people entering the profession must be prepared to learn and refresh their creativity continuously as well as to be sensitive to the possible social consequences of their designs. The undergraduate electrical engineering curriculum is structured so that the graduate has the knowledge, skills, and experience to meet these challenges.

The technical part of the program gives the student the opportunity to build a solid foundation of basic physical principles and obtain experience in design as well as insight into the profession and practice of electrical engineering. The lecture sequence consists mostly of required core courses through which the student learns about and acquires problem solving and/or design skills in circuit analysis, structured programming in C++, analog and digital electronics, microprocessors, signals and systems, electromechanical systems, and electromagnetic fields. Furthermore, through elective courses in the last two semesters, the student can specialize in areas such as applied electromagnetics, communications, controls, digital signal processing, digital systems, embedded systems, and VLSI design. The student must also take course work in engineering economics and thermodynamics.

Though many design techniques are taught in the lecture courses, the student learns the practice of electrical engineering design primarily through the laboratory and project sequence. This sequence consists of five independent lab courses (EE 206, EE 331, EE 332, EE 451, and EE 452) as well as the project courses EE 402 and EE 419.

The lab courses integrate material from the lecture courses and are taught by experienced faculty members. In addition, small numbers of students allow for close interaction with the instructor. Furthermore, the laboratory facilities and equipment are modern and readily accessible.

Several aspects of design are taught in the sophomore and junior labs (EE 206, EE 331, and EE 332). The student's design experience in these courses includes synthesis to meet specifications, analysis, construction, testing, and evaluation with respect to specifications. Computers are often used in many of these steps. In addition, the sophomore and junior design projects associated with these courses are particularly valuable. They require the formulation of design problem statements and criteria, the consideration of alternative solutions, and system descriptions.

The design sequence culminates in the senior year with the senior microprocessor project and the senior capstone project. The prototype design and lab work for the microprocessor project is done in the first half of EE 451 during the fall semester. The student then builds on this effort in EE 402 during the spring semester. In this course, the student works with a team to prepare a proposal delineating the design and development of an electronic device based on the microprocessor project. The student also explores other aspects of engineering in EE 402 and, through the process, gains a broader view of the engineering profession.

Work on the senior capstone project commences at the start of the fall semester in EE 419. The deliverables for this course are to:

- choose a senior project for implementation in senior lab,
- develop a detailed functional description of the project,
- develop a detail block diagram of the project and description of its operation,
- develop a data sheet for the project,
- establish a web page for the project,
- identify and evaluate the patents, standards, and references applicable to the project, and
- give an oral presentation on the project.

In addition to the effort on the capstone project, the students in the class work on a team to review and analyze the deliverables for other senior projects. Lab work associated with the senior project starts in the last half of EE 451 during the fall semester 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.

Many of the lecture courses and all of the lab courses require the use of computers as well as the oral and/or written presentation of technical material.

The non-technical part of the program is consistent with 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. Courses include CIV 100 Western Civilization, ECO 100 Introduction to Economics, 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. To provide depth, two of these four courses must be from the same program with at least one at the 300 level. The student's academic advisor can provide a list of possible course combinations.

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 Graduate Catalog.

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 or ECO 100 Intro. to Economics ¹	3
	17

Second Semester

COM 103 Oral Communication Process	3
MTH 122 Calculus II	4
PHY 110 University Physics I	4
Gen. Ed. – Fine Arts ¹	3
Gen. Ed. – ECO 100 Intro. to Economics or CIV 100 Western Civilization ¹	3
	17

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. In addition, the general education courses must be selected to provide both depth and breadth and are not to be limited to a selection of unrelated introductory courses. Thus, it is required that two courses chosen to meet the non-western civilization, fine arts, human values, or social forces general education requirements also be taken from the same program with one being lower level (100 or 200 level) and one being advanced level (300 or above). A list of possible course combinations can be obtained from the student's academic advisor.

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
_____	17

Second Semester

EE 206 Sophomore Laboratory	2
MTH 202 Numerical Analysis or MTH 207 Elem. Linear Algebra or MTH 325 Probability and Statistics I	3
MTH 224 Differential Equations	4
PHY 202 Applied Quantum Physics	3
Gen. Ed. – Social Forces ¹	3
_____	15

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
_____	15

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 ¹	3
_____	18

Senior Year*First Semester*

EE 419 Engineering Analysis and Design	2
EE 451 Senior Laboratory I	2
Approved EE Electives ²	6
Approved EE or Technical Elective ²	3
ME 301 Thermodynamics	3
_____	16

Second Semester

EE 402 Undergraduate Design Seminar	1
EE 452 Senior Laboratory II	3
Approved EE Elective ²	3
Approved EE or Technical Elective ²	3
IE 301 Engineering Economy	3
Gen. Ed. — Non-Western Civilization ¹	3
_____	16

Total Hours	131
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Approved Electives—EE

EE electives are available in the areas of applied electromagnetics, communications, controls, digital systems and computers, microprocessor applications, signal processing, and VLSI design. Approved EE electives include all 400- and 500-level EE courses except for EE 419, EE 451, and EE 452, or the sequence EE 571, 575, and 576. All electives still must be approved by your advisor.

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.

EE digital electives include:

- EE 533 Digital Image Processing
- EE 534 Digital Signal Processing
- EE 561 Digital Systems: Logic Design
- EE 562 Digital Systems: Computer Structures
- EE 563 Advanced Electronics VLSI System Design
- EE 566 Digital Systems: Memory and Interfacing
- Special Topics: Object Oriented Programming
- Special Topics: Advance VLSI
- Special Topics: Web Programming
- Special Topics: Network Computing
- Special Topics: VHDL

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

Electrical Engineering with Computer Option

The continuing advances in computers and digital systems have created opportunities for professionals capable of applying these developments to a broad range of applications in engineering. 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 with C (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), PC and busses (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. There are also several

²See "Approved Electives EE"

appropriate computer science courses.

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 do their sophomore, junior, and senior projects in the digital area. All other requirements are the same as in the regular electrical engineering program and the student should review the description of that program.

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
	17

Second Semester

COM 103 Oral Communication Process	3
MTH 122 Calculus II	4
PHY 110 University Physics I	4
Gen. Ed. — Fine Arts ¹	3
Gen. Ed. — ECO 100 Intro. to Economics ¹	
or CIV 100 Western Civilization	3
	17

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
	17

Second Semester

EE 206 Sophomore Laboratory	2
MTH 202 Introduction to Numerical Methods or	
MTH 207 Elem. Linear Algebra or	
MTH 325 Probability and Statistics I	3
MTH 224 Elementary Differential Equations	4
PHY 202 Applied Quantum Physics	3
Gen. Ed. — Social Forces ¹	3
	15

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
	15

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 ¹	2
EE 381 Electromagnetic Fields	3
Gen. Ed. — Human Values	3
	18

Senior Year

First Semester

EE 419 Engineering Analysis and Design	2
EE 451 Senior Laboratory I	2
² EE Digital Electives	6
² Approved EE or Technical Elective	3
ME 301 Thermodynamics I	3
	16

Second Semester

EE 402 Undergraduate Design Seminar	1
EE 452 Senior Laboratory II ²	3
EE Digital Elective ¹	3
Approved EE or Technical Elective	3
Gen. Ed. — Non-Western Civilization	3
IME 301 Engineering Economy	3
	16

Total Hours

131

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.

Analysis of electric circuits. Transient and steady-state phenomena. General analysis techniques: loop and nodal equations, network theorems, and matrix methods. Corequisites: MTH 223, PHY 201.

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 an 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 Academic Handbook. 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; multidimensional 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 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 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 buses. 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 571 Semiconductor Electronics**3 hrs.**

Qualitative and quantitative study of electronic and thermal properties of semiconductor materials and devices. Prerequisite: PHY 501.

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 Civilization ³	3

15*Second Semester*

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

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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.

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
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	17

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	3
(Gen. Ed. — Social Forces) ³	
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	16

Junior Year*First Semester*

EET 351 Measurements I	2
EET 346 Transmission Fundamentals	3
EET 361 Electronics III	3
Gen. Ed. — Fine Arts ³	3
Approved Group II Electives	3
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	14

Second Semester

EET 352 Measurements II	2
ENG 300, 301, 304, 305, or 306	
Advanced Writing	3
MFG 213 Intro to Prod. Techniques	3
EET 390 Digital System Technology II	3
Gen. Ed. — Human Values ³	3
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	14

Senior Year*First Semester*

EET 441 Senior Laboratory I	1
Approved 300- or 400-level EET Elective(s)	6
Gen. Ed. — Non-Western Civilization ³	3
Approved Group II Elective	3
Approved Group II Elective or	
Approved 300- or 400-level EET Elective	3
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	16

Second Semester

EET 442 Senior Laboratory II	1
Approved 300- or 400-level EET Elective	3
Gen. Ed. — Social Forces & Institutions ³	3
Approved Group II Electives or	
Approved 300- or 400-level EET Electives	9
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	16

Total Hours

125

Engineering Physics Program

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

— W. G. Berlinger, class of 1986.

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

of course offerings in the departments of Civil Engineering and Construction, Mechanical Engineering, Electrical and Computer Engineering, Industrial and Manufacturing Engineering and Technology, and Physics. Engineering topics constitute 41 semester hours with the majority of the courses being engineering science and design. The course work must provide for a particular engineering orientation, such as materials engineering, signals and systems engineering, electromagnetism, or another emphasis that can be constructed from the list of approved courses.

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
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	15-16

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
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	16

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
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	17

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
Gen Ed (Non-Western Civilization)	3
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	17

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
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	18

Second Semester

PHY 361 Electronics	3
PHY 306 Electromagnetic Waves	3
MTH 207 Linear Algebra	3
Engineering Topics (Approved)	6
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	15

Senior Year

First Semester

PHY 501 Quantum Mechanics I	3
PHY and EGT Design Project	3
PHY 467 Stat. & Thermal Physics	3
Gen Ed (Social Forces)	3
Engineering Topics (Approved)	6
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	18

Second Semester

PHY and EGT Design Project	3
PHY 320 Optics	3
PHY 350 Optics Lab	1
PHY or MTH Elective	3
Engineering Topics (Approved)	6
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	16

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.

FACULTY Professors Emanuel (Chair), Krishnamoorthi, Newton, Nisançi, Shareef, Tayyari; Associate Professors Feng, Kroll, 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.

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 (IIE), 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 410 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

12

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.

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

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

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
- *IMT 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

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 and Manufacturing Engineering	1
IME 105 Introduction to Computers and Computation	2
MTH 121 Calculus I	4
CHM 161 General Chemistry	4
ENG 101 English Composition	3
Gen. Ed. Social Forces Economics ¹	3
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	17

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
	<hr/>
	15

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 ¹	3
C E 150 Mechanics I	3
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	17

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 ¹	3
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	18

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 ¹	3
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	15

Second Semester

IME 314 Operations Research II	3
IME 466 Facilities Planning	3
I E 522 Manufacturing Quality Control	3
MFE Elective ²	3
Gen. Ed. - Social Forces ¹	3
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	15

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
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	15

Second Semester

IME 499 Senior Industrial Design Project	4
I E 564 Production Planning	3
Tech Elective ²	3
Gen. Ed. - Eng. 305 Technical Writing ¹	3
Gen. Ed. - Non-Western Civilization ¹	3
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Total 128

Students must have a cumulative gradepoint 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 352 Urban Environment
CON 372 Construction Methods Improvement

¹To 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.

²See "Approved Electives-IE."

- CON 392 Construction Management
- CON 394 Construction Labor and Unions
- CON 396 Construction Estimating
- CON 495 Construction Claims and Change Orders
- 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.
- 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.

Freshman Year

First Semester

IME 101 Introduction to IE & MFG	1
IME 105 Introduction to Computers & Computation	2
MTH 121 Calculus I	4
CHM 161 General Chemistry I	4
COM 103 The Oral Communication Process	3
GEN ED Western Civ	3

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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
ENG 101 English Composition	3

15

Sophomore Year

First Semester

IME 301 Engineering Economy I	3
C E 150 Mechanics I	3
MTH 223 Calculus III	4
PHY 201 University Physics II	4
GEN ED Social Forces	3

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Second Semester

IME 386 Industrial and Managerial Engineering	3
IME 341 Introduction to MFG Processes	3
IME 331 Fundamentals of Materials Science	3
IME 333 Materials Science Lab	1
C E 301 Mechanics of Materials	3
GEN ED Fine Arts	3

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Junior Year

First Semester

IME 311 Introduction to Engineering Statistical Methods	3
IME 395 Solid Modeling & Rapid Prototyping	3
IME 325 Transport Phenomena	3
IME 431 Material Engineering or IME 433 MFG Properties of Materials	2
MTH 224 Differential Equations	4

15

Second Semester

IME 441 Materials Processing I or IME 443 Materials Processing II	3
I E 522 Manufacturing Quality Control	3
IME 466 Facilities Planning	3
GEN ED Human Values	3
GEN ED Social Forces	3
	<hr/> 15

Senior Year*First Semester*

IME 445 Computer Aided Manufacturing	4
IME 491 Manufacturing Design or IME 493 Mechanical Design	4
I E 516 Simulation of Man/Machine Systems	3
E E 327 Fundamentals of Electrical Engrg.	3
GEN ED Non Western Civ	3
	<hr/> 17

Second Semester

IME 499 Senior Industrial Design Project	4
MFE 525 Design for Manufacturability	3
ENG 305 Technical Writing	3
Tech Elective ³	6
	<hr/> 16

Total 128

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 physics 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, and 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

³See "Approved Electives—MFE."

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

Math, Science and Computer	25 hrs.
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 Science	17 hrs.
IMT 222 Statics	3
IMT 322 Dynamics	3
IMT 324 Strength of Materials	4
IMT 328 Mass & Energy Transfer	4
EET 320 Electricity & Power	3

Technical Core	35 hrs.
IME 101 Introduction to Industrial & Manufacturing 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	4
IMT 262 Applied Statistics & Quality Control	3
IMT 332 Non-metallic Materials	3
IMT 342 Advanced Manufacturing Processes I or 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
IMT 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

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 course)	3

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

Total Hours 125

Approved Technical Electives

The nine hours of approved 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 manufacturing. Electives must be approved by the student's academic advisor.

IMT Electives - Manufacturing Design Concentration

IMT 448 Tooling Systems
IMT 464 Process Design & Planning
IMT 446 Computer Aided Manufacturing & Automation II
IMT 342 or IMT 344 (Second Manufacturing Processes course)
IMT 409 Selected Manufacturing Projects
IMT 410 Selected Manufacturing Topics

IMT Electives - Manufacturing Systems Concentration

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

Manufacturing Engineering Electives

IME 433 Manufacturing Properties of Materials
MFE 520 Geometric Modeling
MFE 525 Design for Manufacturability
MFE 531 Nonmetallic Materials
MFE 533 Composite Materials
MFE 541 Forming Process
MFE 543 Materials 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

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 Engineering

1 hr.

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 IME, IE, or MFE course.

IME 103 Computer Aided Graphics

2 hrs.

Computer aided drafting, theory of orthographic 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 various packages, LAN and WAN usage.

IME 117 Computer Numerical Applications

2 hrs.

Continuation of IME 105; coding of numerical algorithms as applied to engineering functions. Includes laboratory. Prerequisite: IME 105. Corequisite: integral calculus.

IME 200 Engineering Co-op

0 hrs.

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 gradepoint average at Bradley, approval of engineering and technology Co-op coordinator and Co-op advisor.

IME 301 Engineering Economy I

3 hrs.

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.

IME 302 Introduction to Quality Engineering

3 hrs.

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.

IME 305 Engineering Economy II

2 hrs.

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.

IME 311 Introduction to Engineering Statistical Methods

3 hrs.

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.

IME 312 Engineering Statistical Methods

3 hrs.

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.

IME 313 Operations Research I

3 hrs.

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

IME 314 Operation Research II

3 hrs.

Probabilistic models of operations research: inventory theory, Markov chains, queuing theory, and simulation. Prerequisites: Min. grade of C in IME 311, 313

IME 325 Transport Phenomena

3 hrs.

Energy, heat, and mass transfer. Basic principles in thermodynamics, fluid flow, heat transfer, and mass diffusion. First and second laws of thermodynamics, work and adiabatic processes, reversible and irreversible processes, power. Fluid statics, pressure, energy, and losses. Heat conduction, convection, and radiation. Steady-state and transient mass diffusion. Prerequisites: CHM 161, PHY 201, MTH 223.

IME 331 Fundamentals of Materials Science

3 hrs.

Materials science in engineering. Structure of perfect solids: metals, plastics, composites, and ceramics. Structure of imperfect solids: phase equilibria; diffusion, mechanical properties, and plastic deformation; strengthening mechanisms; relation between mechanical properties and microstructural control; organic polymers; electrical conduction in materials; semi-conductors; magnetic materials. Prerequisites: CHM 161, PHY 201.

IME 333 Materials Science Laboratory

1 hr.

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.

IME 341 Introduction to Manufacturing Processes

3 hrs.

A laboratory-intensive introduction to manufacturing machinery and processes, tooling, and safety. Product specification interpretation and associated planning for tooling and methods. Material removal; forming operations; casting and molding of metals and plastics; joining techniques. Prerequisite: IME 103, 105.

IME 383 Industrial Management

3 hrs.

Principles of management applied to design of organizations' physical facilities and operation systems. Not open to IE majors.

IME 385 Introduction to Logistics Engineering
3 hrs.

Logistics terms and definitions; logistics as a design process; supply chain concepts; analyzing, designing, and implementing logistics system. Prerequisites: IME 306, IME 311, IME 318. Corequisite: IME 312.

IME 386 Industrial and Managerial Engineering
3 hrs.

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.

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 Academic Handbook. Course may be repeated under different topics for maximum of six hours credit. Prerequisite: consent of instructor.

IME 431 Materials Engineering
2 hrs.

Properties and selection of materials for engineering applications. Mechanical and thermal treatment of materials. Destructive and non-destructive testing. Corrosion control and prevention. Wear and fracture of engineering materials. Design and testing for fracture resistance. Emphasis on case studies and applications. Corequisite: IME 333.

IME 433 Manufacturing Properties of Materials
2 hrs.

Mechanical and physical properties of importance in manufacturing and their determination. Influence of temperature, strain rate, and anisotropy on material's performance. Material considerations in: metal-removal, metal-working, forming, and fabrication processes. Influence of production processes on the functioning of materials. Theories of brittle and ductile fracture. Case studies: analysis of failures in manufacturing materials. Prerequisite: IME 333.

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 313 and 314.

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 standards and regulations. 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 582 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 502 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 Academic Handbook. 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 visio-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.**

Concept of intelligent manufacturing. Manufacturing communication and information systems. Voice and vision systems. Knowledge-based expert systems. Knowledge representation. Inference engineering, knowledge data base, and manufacturing applications. Prerequisite: IME 117 or equivalent.

MFE 563 Advanced Computer Aided Manufacturing**3 hrs.**

Computer Aided Manufacturing (CAM) within the CAD/CAM and CIM contents. Computer Assisted Process Planning (CAPP), Computer Assisted Tool Design, Computer Assisted NC Programming (APT), Interactive Graphics, NC Programming, and the elements of computer control of manufacturing equipment (CNC). A semester project. Prerequisite: IME 445.

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 Academic Handbook 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 grade point 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 242 Introduction to Manufacturing Processes

3 hrs.

Manufacturing techniques, including material removal; forming operations; casting and molding of metals and plastics; and joining. Communication of specifications, referencing of practices and operating parameters, tool selection and set-up, measuring, safety, and an appreciation of the product and process development activities. Lecture and lab. Prerequisites: IME 103, MTH 112.

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.

An introduction to fluid dynamics, heat transfer, and thermodynamics. Heat, work, equilibrium, and reversible processes. Conservation of mass, linear momentum, and energy. Heat transfer by conduction, radiation, convection. Prerequisites: IMT 214; IMT 222.

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 262, 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 262, 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 262, IMT 232, 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 Academic Handbook. 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 395, IMT 346

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.

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

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 instrumentation, 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 year-long 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
	<hr/> 17

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
	<hr/> 16

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 ¹	3
(Gen. Ed. - Social Forces)	
	<hr/> 17

Second Semester

ME 301 Thermodynamics I	3
MTH 224 Differential Equations	4
CE 301 Mechanics of Materials	3
ME 351 Engineering Matls. Science I	3
Gen. Ed. Western Civilization ¹	3
	<hr/> 16

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
	<hr/> 18

Second Semester

ME 341 Engineering System Dynamics	3
ME 342 Mechanical Design IV	3
ME 304 Mechanical Laboratory	2
EE 328 Fund. of Electrical Engineering II	3
ME 415 Introduction to Heat Transfer	3
Gen. Ed. - Non-Western Civilization ¹	3
	<hr/> 17

Senior Year

First Semester

ME 410 M.E. Senior Project I ²	2
ME 441 Mechanical Control Systems	3
IME 301 Engineering Economy	3
Gen. Ed. - Human Values ¹	3
Approved Design Technical Elective ³	3
Approved Technical Elective ³	3
	<hr/> 17

Second Semester

ME 411 M.E. Senior Project ²	2
ME 354 Principles of Materials Science Lab	3
Gen. Ed. - Social Forces ¹	3
Gen. Ed. - Fine Arts ¹	3
Approved Technical Electives ³	6
	<hr/> 17
Total Hours	135

¹General 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.

²ME 410 and 411 — Enrollment in ME 410 and 411 is restricted to mechanical engineering students who are in the fourth year of the program.

³Departmental policy regarding approved technical electives is available in the department office.

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 and implementation; engineering approach to problem solving. Prerequisite: consent of Department Chair. Corequisite: ME 103 or equivalent.

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.

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 gradepoint 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: ME 103 or equivalent; PHY 201; MTH 224; engineering major. Corequisites: ME 301; EE 327.

ME 304 Mechanical Laboratory **2 hrs.**

Student investigation of laboratory problems emphasizing definition, planning, execution, analysis, design, written reports, and oral presentation. Prerequisites: COM 103; minimum grade of C in ME 303 or equivalent; CE 301, ME 308. Corequisite: 300-level English composition.

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 Mechanical Design IV **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.

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.

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.

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 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 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 511 Heat Transfer – Conduction
3 hrs.

General conduction equation in Cartesian, cylindrical, spherical, parabolic, and paraboloidal coordinate systems solved for various boundary conditions. Inversion theorem and residue theorem used to solve Laplace transform equation. Prerequisite: ME 415.

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 542 Kinematic Synthesis of Linkages**3 hrs.**

Design of planar and spatial linkage mechanisms to satisfy input-output motion requirements: rigid-body motion of the coupler for finitely-separated positions; coordination of shaft rotations; coupler-point path problems. Prerequisites: ME 344; MTH 202, 224.

ME 544 Mechanical Systems Analysis**3 hrs.**

Mathematical modeling of mechanical, electrical, pneumatic, hydraulic, and hybrid physical systems emphasizing a unified approach such as the Bond graph technique. LaPlace, state-variable, and matrix formulation of models. Systems response characteristics, prediction, and analysis. Prerequisite: ME 341.

ME 547 Fluid Power Control Systems**3 hrs.**

Definition and scope of fluid power control systems. Fluid properties. Continuity and power balance equations. Components function, operation, and dynamic performance. Use of perturbation theory for developing linearized transfer functions. Application of conventional control theory. Prerequisites: ME 301, ME 308.

ME 548 Optimization of Mechanical Systems**3 hrs.**

Development and application of optimization techniques in design of engineering systems and elements; mathematical modeling and formulation of design problems for optimization; different optimization methods including linear, non-linear, geometric and dynamic programming; shape optimization. Emphasis on development and choice of appropriate search methods, sensitivity analysis, and programming. Prerequisite: senior standing in engineering or consent of department.

ME 549 Microprocessor Interfacing in Mechanical Systems**3 hrs.**

Principles of microprocessor hardware and software; integration of microprocessor hardware and software in mechanical systems for data acquisition and control purposes (e.g., robotics, internal combustion engine monitoring systems, and pneumatic controls). Intensive hands-on laboratory exercises and practical problem solving. Introduction of "mechatronics." Prerequisites: ME 303; EE 328; proficiency in at least one computer language; or consent of instructor.

ME 554 Fracture of Solids**3 hrs.**

Mechanical failure caused by stresses, strains, and energy transfers in mechanical parts: conventional design concepts and relationship to occurrence of fracture; mechanics of fracture; fracture toughness; macroscopic and microscopic aspects of fracture; high and low cycle fatigue failures; creep; stress rupture; brittle fracture; wear; case studies of failure analysis. Emphasis on time-dependent failures. Prerequisites: ME 354 and CE 301.

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.**

Theory of finite element methods and applications in mechanical engineering: review of matrix algebra and basic theorem of elasticity. Direct formulation of plane truss element and variational formulations of plane stress/strain, axisymmetric solids, flexural beam, and flat plate elements. Element analysis and isoparametric formulation. Applications to problems of stability, vibrations, thermal stress analysis, and fluid mechanics. Computer programming techniques. Prerequisite: senior standing in ME or consent of instructor.

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 Academic Handbook. Graduate students may repeat the course under different topic names up to a maximum of 9 credits. Prerequisite: consent of instructor.