

# Department of Industrial & Manufacturing Engineering & Technology

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

**FACULTY** Professors Emanuel, Feng, Krishnamoorthi, Kroll, Lin, Newton (emeritus), Shareef, Sverdlin, Tayyari; Associate Professors, Ness (chair), Saboury; Adjunct Professors Griffin, Stenger.

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.)

## Objectives

### Industrial Engineering (BSIE)

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

#### Outcomes

Industrial Engineering graduates will have:

- (a) an ability to apply knowledge of mathematics and science to mathematical modeling and to problems related to systems that produce products and services;
- (b) an ability to design and conduct experiments, as well as to analyze data and interpret experimental results;
- (c) an ability to design or select components or processes of a production or service system to obtain desired output based on performance, economic, and productivity criteria;
- (d) an ability to function on multi-disciplinary teams, an understanding of the concurrent approach to process

- and product development, and an ability to perform project management;
- (e) an ability to identify, formulate, and find optimal solutions to system problems, while considering physical and economic constraints as well as safety and ergonomics issues;
- (f) an understanding of professional and ethical responsibilities of an industrial engineer;
- (g) an ability to utilize modern tools and techniques to effectively communicate technical requirements and functionality in oral, written, and graphical forms;
- (h) the broad education necessary to understand the impact of engineering solutions in a global and societal context;
- (i) a recognition of the need for, and an ability to engage in, continuous improvement projects and life-long learning;
- (j) a knowledge of contemporary issues facing engineers;
- (k) an ability to use techniques, skills and modern engineering tools necessary for industrial engineering practice, utilizing supporting technologies or techniques including economic measurement, information systems design, occupational ergonomics, human behavior, systems planning, and total quality management.

### Manufacturing Engineering (BSMfE)

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

#### Outcomes

Manufacturing Engineering graduates will have:

- (a) an ability to apply knowledge of mathematics and science to manufacturing process, materials, project management, and design of manufacturing systems, emphasizing discrete piece part manufacture;
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data related to manufacturing processes, materials evaluation, and manufacturing systems;

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- (c) an ability to design, select, and control a manufacturing system and its components or processes to meet desired needs;
  - (d) an ability to function on multi-disciplinary teams, an understanding of the concurrent approach to process and product development, and the ability to perform manufacturing project management;
  - (e) an ability to identify, formulate, and solve manufacturing engineering problems considering constraints, costs, benefits, and competitiveness of comparative processes and materials, through a hands-on approach;
  - (f) an understanding of the professional and ethical responsibilities of a manufacturing engineer;
  - (g) an ability to utilize modern tools and techniques to effectively communicate technical requirements and functionality in oral, written, and graphical forms;
  - (h) the broad education necessary to understand the impact of manufacturing engineering solutions in a global and societal context;
  - (i) a recognition of the need for, and an ability to engage in, lifelong learning;
  - (j) a knowledge of contemporary issues facing engineers;
  - (k) an ability to use the techniques, skills, and modern engineering tools necessary for manufacturing engineering practice utilizing supporting technologies including design for assembly, design for manufacturability, computer aided design, computer aided manufacturing, and rapid prototyping.
- (d) the ability to integrate multiple technical concepts and societal considerations for the solution of open-ended design problems and in the design of systems;
  - (e) interpersonal skills and the ability to work as part of an interdisciplinary team;
  - (f) an ability to identify, formulate, and solve manufacturing problems considering constraints, costs, benefits, and competitiveness of comparative processes and materials;
  - (g) an ability to utilize modern tools and techniques to effectively communicate technical requirements and functionality in oral, written, and graphical forms;
  - (h) a recognition of the need for and an ability to engage in lifelong learning;
  - (i) an understanding of the professional and ethical responsibilities of a manufacturing professional;
  - (j) the broad education necessary to understand the impact of manufacturing solutions in a global and societal context;
  - (k) a knowledge of contemporary issues facing manufacturing professionals including a commitment to quality, timeliness, and continuous improvement.

### Manufacturing Engineering Technology (BSMfET)

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

#### Outcomes

A Manufacturing Engineering Technology graduate will have:

- (a) a strong background in manufacturing processes and materials for discreet piece part manufacture, considering nomenclature recognition, limits, costs, benefits, etc. of comparative processes and materials through a hands-on approach;
- (b) strong mathematics, science, and computer skills with emphasis on programs that aid process and product analysis and control, as well as the ability to apply a concurrent approach to process, product, and equipment design with supporting technologies such as: DFM, DFA, CAD, CAM, CAE and rapid prototyping;
- (c) an ability to conduct experiments, as well as to analyze and interpret data related to manufacturing processes, materials evaluation, and manufacturing systems;

### 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.M.F.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)

IME 587 Occupational Safety and Health .....	3
IME 585 Occupational Ergonomics.....	3
HS 460 Basic Science of Human Movement.....	3

### Electives (6 hours)

Choose one of the following two courses:

IME 386 Industrial and Managerial Engineering.....	3
HS 480 Motion Analysis.....	3

Choose one course from the following group:

IME 383 Industrial Management (not open to IME majors)..	3
IME 466 Facilities Planning.....	3
PSY 310 Industrial and Organizational Psychology .....	3
PSY 405 Issues in Applied Psychology .....	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. Stu-

dents 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
IME 522 Manufacturing Quality Control
IMT 262 Applied Statistics & Quality Control

#### Management Methods for Quality.....3

BMA 352 Managing in Organizations
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### 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

IME 512 Design and Analysis of Experiments
IME 524 Advanced Quality Control

#### Information Systems

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

#### Quality in Design

IME 526 Reliability Engineering
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#### 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

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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  
\*IME 591 Design for Manufacturability  
\*IME 491 Manufacturing Design  
\*IME 493 Mechanical Design  
\*IMT 392 Mechanical Component Design I

### Automation

M E 441 Mechanical Control Systems  
M E 560 Principles of Robotic Programming  
\*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  
IME 522 Manufacturing Quality Control  
\*IMT 362 Metrology & Instrumentation  
IME 311 Engineering Statistics  
Q M 263 Quantitative Analysis II

<sup>1</sup>To meet the ABET requirements for humanities and social sciences, some general education courses must be selected according to the IE approved list. They may be taken in any sequence and not necessarily in the semester indicated. Other University general education requirements are satisfied by specific courses required above.

<sup>2</sup>See "Approved Electives-IE."

## 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 IME employment opportunities as well as for graduate training in IME, or such associated professions as law or business. This diversity of career opportunities is a major reason that students choose IME. 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 IME 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 Intro. to Industrial & Manufacturing Eng. ....	1
IME 103 Computer Aided Graphics.....	2
MTH 121 Calculus I.....	4
CHM 110 General Chemistry I.....	3
CHM 111 General Chemistry I Lab .....	1
ENG 101 English Composition.....	3
Gen. Ed. Social Forces Economics <sup>1</sup> .....	3
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	17

#### Second Semester

IME 105 Introduction to Computers & Computation .....	2
MTH 122 Calculus II.....	4
PHY 110 University Physics I.....	4
COM 103 The Oral Communication Process.....	3
Gen. Ed. - Western Civilization <sup>1</sup> .....	3
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	16

**Sophomore Year**

*First Semester*

IME 117 Computer Numerical Applications .....	2
IME 301 Engineering Economy I .....	3
MTH 223 Calculus III .....	4
PHY 201 University Physics II.....	4
C E 150 Mechanics I .....	3
—	16

*Second Semester*

C E 301 Mechanics of Materials .....	3
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
—	18

**Junior Year**

*First Semester*

IME 312 Engineering Statistical Methods.....	3
IME 313 Operations Research I.....	3
IME 325 Transport Phenomena.....	3
Gen. Ed. - Fine Arts <sup>1</sup> .....	3
Gen. Ed. - Human Values <sup>1</sup> .....	3
—	15

*Second Semester*

IME 314 Operations Research II.....	3
IME 466 Facilities Planning.....	3
IME 522 Manufacturing Quality Control .....	3
Manufacturing Elective <sup>2</sup> .....	3
Gen. Ed. - Social Forces <sup>1</sup> .....	3
—	15

**Senior Year**

*First Semester*

IME 497 Information Systems Design .....	3
IME 561 Simulation of Human/Machine Systems.....	3
IME 585 Occupational Ergonomics.....	3
E E 327 Fundamentals of Electrical Engineering I.....	3
PSY 310 Industrial & Organizational Psychology .....	3
—	15

*Second Semester*

IME 499 Senior Industrial Design Project.....	4
IME 583 Production Planning and Control.....	3
Tech Elective <sup>2</sup> .....	3
Gen. Ed. - Eng. 305 Technical Writing <sup>1</sup> .....	3
Gen. Ed. - Non-Western Civilization <sup>1</sup> .....	3
—	16
Total	128

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

**Approved Electives – IME**

**Manufacturing Electives**

- IMT 342 Advanced Manufacturing Processes I
- IMT 344 Advanced Manufacturing Processes II
- IMT 346 Computer-Aided Manufacturing & Automation I
- IMT 362 Metrology and Instrumentation
- IMT 446 Computer-Aided Manufacturing & 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**

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
- CON 392 Construction Scheduling
- CON 394 Construction Labor and Unions
- CON 396 Construction Estimating
- 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 112 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

**BSIE Combined with MBA Program**

Undergraduate students in the industrial engineering program may combine their studies and earn an MBA degree in five and one-half years or fewer. Students may include all of the prerequisites for the MBA program as part of their required 128 undergraduate semester hours. Careful scheduling is required and should be coordinated with the student's undergraduate advisor and director of graduate programs.

Students electing this option must be fully admitted before registering for graduate-level courses and have the

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written approval of the director of graduate programs. Students should contact the director of graduate programs during their sophomore year for particular information

### 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.

### BSMFE Combined with MBA Program

Undergraduate students in the manufacturing engineering program may combine their studies and earn an MBA degree in five and one-half years or fewer. Students may include most or all of the prerequisites for the MBA program as part of their required 128 undergraduate semester hours. Careful scheduling is required and should be coordinated with the student's undergraduate advisor and direc-

tor of graduate programs.

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 Intro. to Industrial & Manufacturing Eng. ....	1
IME 103 Computer Aided Graphics.....	2
MTH 121 Calculus I.....	4
CHM 110 General Chemistry I.....	3
CHM 111 General Chemistry I Lab .....	1
ENG 101 English Composition.....	3
Gen. Ed. Social Forces Economics <sup>1</sup> .....	3
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##### Second Semester

IME 105 Intro. to Computers and Computation.....	2
MTH 122 Calculus II.....	4
PHY 110 University Physics I.....	4
COM 103 The Oral Communication Process.....	3
Gen. Ed. - Western Civilization <sup>1</sup> .....	3
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	16

#### Sophomore Year

##### First Semester

IME 117 Computer Numerical Applications .....	2
IME 301 Engineering Economy I.....	3
MTH 223 Calculus III .....	4
PHY 201 University Physics II.....	4
C E 150 Mechanics I .....	3
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	16

##### Second Semester

IME 386 Industrial and Managerial Engineering.....	3
IME 341 Introduction to MFG Processes .....	3
IME 331 Fundamentals of Materials Science .....	3
C E 301 Mechanics of Materials .....	3
MTH 224 Differential Equations .....	4
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	16

#### Junior Year

##### First Semester

IME 311 Intro. to Engineering Statistical Methods.....	3
IME 395 Solid Modeling & Rapid Prototyping.....	3
IME 325 Transport Phenomena.....	3
IME 333 Materials Science Lab.....	1
IME 431 Material Engineering <b>or</b> IME 433 MFG Properties of Materials.....	2
Gen. Ed. Human Values.....	3
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	15

<sup>1</sup>See "Approved Electives—MFE."

<i>Second Semester</i>	
IME 441 Materials Processing I <b>or</b>	
IME 443 Materials Processing II .....	3
IME 522 Manufacturing Quality Control .....	3
IME 466 Facilities Planning.....	3
Gen. Ed. Fine Arts.....	3
Gen. Ed. Social Forces.....	3
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	15
<b>Senior Year .....</b>	<b>.....</b>
<i>First Semester</i>	
IME 445 Computer Aided Manufacturing .....	4
IME 491 Manufacturing Design <b>or</b>	
IME 493 Mechanical Design .....	4
IME 516 Simulation of Human/Machine Systems.....	3
E E 327 Fundamentals of Electrical Engineering.....	3
Gen. Ed. Non Western Civ .....	3
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	17
<i>Second Semester</i>	
IME 499 Senior Industrial Design Project.....	4
IME 591 Design for Manufacturability .....	3
ENG 305 Technical Writing .....	3
Tech Elective <sup>3</sup> .....	6
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	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**

Any 300-level or higher IME course not required in the program.

Any advisor-approved 300-level or higher IMT course.

**Other Courses**

Any civil, electrical, or mechanical engineering course (CE, EE, ME) numbered 300 or higher.

Any advisor-approved mathematics or science course not required in the program.

**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 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.

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**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 100 Fundamentals of General Chemistry.....3  
 CHM 101 Fundamentals of General Chemistry Lab.....1  
 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 Intro. to Industrial & Manufacturing Eng.....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 Emphasis**  
 Select A, B, or C..... 12 hrs.

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

**B. Manufacturing Systems Concentration**  
 IMT 448 Tooling Systems .....3  
 IMT 464 Process Design and Planning.....3  
 IMT 446 Computer Aided Manufacturing  
 and 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.

**Approved Technical Electives** .....9 hrs.  
 Tech Elective I .....3  
 Tech Elective II .....3  
 Tech Elective III .....3  
 The nine hours of approved technical electives 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.

Total Hours 125

**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  
 IME 531 Nonmetallic Materials  
 IME 533 Composite Materials  
 IME 541 Forming Process  
 IME 543 Materials Removal Process  
 IME 545 Joining & Fabrication  
 IME 553 Advanced Computer Aided Manufacturing  
 IME 563 Process Engineering  
 IME 568 Introduction to Expert Systems and Artificial Intelligence  
 IME 583 Production Planning and Control  
 IME 590 Geometric Modeling  
 IME 591 Design for Manufacturability

**Other Courses**

Engineering Courses (CE, EE, IME, 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 IME and MFE techniques and tools. Not open to students with credit in any 200-level or above IME, ME, 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 & Computation in Industrial & Manufacturing Engineering****2 hrs.**

Use of computers in IME 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 and industrial engineering students who alternate periods of full-time school with periods of full-time academic or career-related work in industry. Satisfactory/Unsatisfactory. Prerequisites: sophomore standing in the College of Engineering and Technology, 2.0 overall grade point average at Bradley, approval of engineering and technology Co-op coordinator and Co-op advisor.

**IME 300 The World of Metals (Gen. Ed. TS)****3 hrs**

Designed for students concerned with metals and those with a general interest in the history of the metals upon which all civilization since the Stone Age has relied. Modern metallurgical technology, heat treatment, periodic table of elements, aspects of materials science and engineering, and history of technical procedures. Draws upon many modern and ancient texts. Not open to majors in engineering and technology.

**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 sam-

pling, designing experiments, a system for quality. Not open to IME 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 Method****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 110, 111, 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 110, 111, PHY 201.

## College of Engineering and Technology

**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 IME 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 386, IME 311, IME 313. Corequisite: IME 312.

**IME 386 Industrial and Managerial Engineering 3 hrs.**  
Principles of IME 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 Schedule of Classes. Course may be repeated under different topics for maximum of six hours credit. Prerequisite: consent of instructor.

**IME 431 Materials Engineering 2 hrs.**  
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 materi-

als. 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 IME 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 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.

**IME 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.

**IME 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, and analysis of variance. Prerequisite: IME 503 or consent of instructor.

**IME 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.

**IME 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: IME 503 or consent of instructor. Not open to students with credit in IME 313 and 314.

**IME 515 Linear Programming & Network Analysis 3 hrs.**  
Theoretical and computational aspects of linear programming; application to practical problems. Prerequisite: IME 117; MTH 202; consent of instructor.

**IME 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.

**IME 524 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: IME 522 or consent of instructor.

**IME 526 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: IME 511 or consent of instructor.

**IME 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.

**IME 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.

**IME 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 441.

**IME 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 341; IME 441.

## College of Engineering and Technology

### **IME 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.

### **IME 553 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.

### **IME 555 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.

### **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.

### **IME 561 Simulation of Human/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: IME 117; IME 311; MTH 202.

### **IME 563 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.

### **IME 566 Advanced Facility Planning 3 hrs.**

Extension of IME 466. Facility design consideration of internal and external service functions; logistic concerns; design flexibility. Prerequisites: IME 383 or IME 386 or IME 500.

### **IME 568 Introduction to Expert Systems and Artificial Intelligence 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.

### **IME 570 Selected Topics in Industrial and Manufacturing Engineering 1-3 hrs.**

Topics of special interest which may vary each time course is offered. Topic stated in current Schedule of Classes. May be repeated up to a maximum of 6 hrs. Combined credit for IE 590 and IME 570 may not exceed six hours. Prerequisite: consent of instructor.

### **IME 583 Production Planning and Control 3 hrs.**

Analysis of 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: IME 386; minimum grade of C in IME 311 and IME 313 or consent of instructor.

### **IME 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: IME 564; consent of instructor.

### **IME 585 Human Factors Engineering 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: CE 150; IME 311; IME 386.

### **IME 587 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.

### **IME 590 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.

### **IME 591 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 341; IME 395.

### **IME 592 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 method-

ology to tribological problems in engineering design and manufacturing. Prerequisites: IME 331 or ME 351 or consent of instructor.

## 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 100.
- IMT 262 Applied Statistics & 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 232, IMT 262, IMT 324.

**IMT 394 Dynamics of Machines** **3 hrs.**  
Velocities, accelerations, and forces in existing mechanisms. Design and analysis of linkages, cams, rolling contact, and drive trains. Prerequisites: IMT 322.

## College of Engineering and Technology

**IMT 409 Selected Manufacturing Projects 1-4 hrs.**  
Individual or small team projects. May be of an experimental, analytical, or creative nature. May be repeated for a maximum of 6 hours credit. Prerequisite: Junior/Senior standing and consent of instructor.

**IMT 410 Selected Manufacturing Topics 1-4 hrs.**  
Topics of special interest which may vary each time course is offered. Topic is stated in current Schedule of Classes. May be repeated for a maximum of 6 hours credit. Prerequisite: Junior/Senior standing and consent of instructor.

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

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

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

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

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

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