Mechanical and Aerospace Engineering

Major:
- Bachelor of Mechanical Engineering (p. 1)

Concentrations:
- Aerospace Engineering (p. 2)
- Energy Systems-Mechanical (p. 3)

Minors:
- Aerospace Engineering (p. 3)
- Human Movement Biomechanics (p. 3)
- Mechanical Systems (p. 3)
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Mechanical engineers apply principles of motion, energy, force, materials, and mathematics to design and analyze a wide variety of products and systems. The field requires an understanding of core concepts including mechanics, kinematics, thermodynamics, heat transfer, materials science and controls. Mechanical engineers use these core principles along with tools like computer-aided engineering and product life cycle management to design and analyze manufacturing plants, industrial equipment and machinery, heating and cooling systems, automotive systems, aircraft, robotics, medical devices, and more. Today, mechanical engineers are pursuing developments in such fields as composites, mechatronics, and nanotechnology, and are helping to create a more sustainable future.

The mechanical engineering curriculum serves as a broad-based education for positions in these diverse fields or for graduate study leading to advanced degrees. The first part of the mechanical engineering curriculum provides a firm foundation in mathematics, physics, chemistry, computer-aided drawing and conceptual design and the humanities. The second part of the curriculum provides the engineering science fundamentals and laboratory experiences necessary for testing and design, as well as continued learning in the humanities, arts, and social sciences. The final part of the curriculum emphasizes synthesis of knowledge through major design projects. The curriculum includes sufficient elective courses to permit a concentration in aerospace, energy systems and engineering as well as minors in several other areas.

The education experience, guided by the University of Dayton Catholic and Marianist heritage, seeks to prepare graduates who will:
- have the ability to apply mathematics, science and engineering fundamentals and computational tools to design components, systems and/or processes
- have the ability to design and conduct experiments and analyze and interpret data
- have the ability to communicate their ideas/solutions effectively
- serve as effective team members and leaders
- understand the social, environmental and economic impact of engineering in a global context
- be able to think critically about contemporary issues
- continue their personal and professional development by engaging in lifelong learning
- integrate ethical action, integrity, and service into their profession and lives

Faculty
Jamie Ervin, Chairperson
Professors Emeriti: Chuang, Doepker, Doyle, Eastep, Eimermacher, Jain, Schauer
Professors: Ervin, Hallinan, Kashani, Murray, Pinnell
Associate Professors: Bigelow, Chiasson, Choi, Myszka, Petrykowski, Rumpfkeil
Assistant Professors: Gunasekaran, Heyne, Kinney, Lowe, Mulford, M. Reissman, T. Reissman, Schrader
Lecturers: Henrick, Perkins
Faculty of Practice: Fehrman Cory

Bachelor of Mechanical Engineering (MEE) minimum 132 hours

Common Academic Program (CAP)¹

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>HST 103</td>
<td>The West &amp; the World</td>
<td>12 cr.</td>
</tr>
<tr>
<td>REL 103</td>
<td>Introduction to Religious and Theological Studies</td>
<td>3 cr.</td>
</tr>
<tr>
<td>PHL 103</td>
<td>Introduction to Philosophy</td>
<td>3 cr.</td>
</tr>
<tr>
<td>ENG 100</td>
<td>Writing Seminar I</td>
<td>3 cr.</td>
</tr>
<tr>
<td>CMM 100</td>
<td>Principles of Oral Communication</td>
<td>3 cr.</td>
</tr>
<tr>
<td>Math</td>
<td>Mathematics</td>
<td>3 cr.</td>
</tr>
<tr>
<td>Social Science</td>
<td>3 cr.</td>
<td></td>
</tr>
<tr>
<td>SSC 200</td>
<td>Social Science Integrated</td>
<td>3 cr.</td>
</tr>
<tr>
<td>Arts</td>
<td></td>
<td>3 cr.</td>
</tr>
<tr>
<td>Natural Sciences</td>
<td>7 cr.</td>
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</tbody>
</table>

Crossing Boundaries up to 12 cr. hrs.

Faith Traditions
Practical Ethical Action
Inquiry ⁶
Integrative
Advanced Study
Philosophy and/or Religious Studies (6 cr. hrs.)
Historical Studies (3 cr. hrs.) 7

Diversity and Social Justice 6 3 cr. hrs.

Major Capstone 9 0-6 cr. hrs.

The credit hours listed reflect what is needed to complete each CAP component. However, they should not be viewed as a cumulative addition to a student’s degree requirements because many CAP courses are designed to satisfy more than one CAP component (e.g., Crossing Boundaries and Advanced Studies) and may also satisfy requirements in the student’s major.

May be completed with ASI 110 and ASI 120 through the Core Program.

May be completed with ENG 100A and ENG 100B, by placement.

May be completed with ENG 114 or ENG 198 or ASI 120.

Must include two different disciplines and at least one accompanying lab.

U.S. History AP and CLEP credit will not satisfy this requirement.

May be completed with ASI 110 and ASI 120 through the Core Program. U.S. History AP and CLEP credit will not satisfy this requirement.

May not double count with First-Year Humanities Commons, Second-Year Writing, Oral Communication, Social Science, Arts, or Natural Sciences CAP components, but may double count with courses taken to satisfy other CAP components and/or courses taken in the student’s major.

The course or experience is designed by faculty in each major; it may, or may not, be assigned credit hours.

Major Requirements

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>CHM 123</td>
<td>General Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHM 123L</td>
<td>General Chemistry Laboratory</td>
<td>1</td>
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<tr>
<td>or PHY 210L</td>
<td>General Physics Laboratory I</td>
<td></td>
</tr>
<tr>
<td>CMM 100</td>
<td>Principles of Oral Communication</td>
<td>3</td>
</tr>
<tr>
<td>EGM 202</td>
<td>Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>EGM 303</td>
<td>Mechanics II</td>
<td>3</td>
</tr>
<tr>
<td>EGR 102</td>
<td>Introduction to the University Experience for Engineers</td>
<td>0</td>
</tr>
<tr>
<td>EGR 103</td>
<td>Engineering Innovation</td>
<td>2</td>
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<tr>
<td>EGR 150</td>
<td>Enrichment Workshop I</td>
<td>0</td>
</tr>
<tr>
<td>EGR 151</td>
<td>Enrichment Workshop II</td>
<td>0</td>
</tr>
<tr>
<td>EGR 200</td>
<td>Professional Development Seminar</td>
<td>0</td>
</tr>
<tr>
<td>or COP 200</td>
<td>Introduction to Engineering Cooperative Education</td>
<td></td>
</tr>
<tr>
<td>EGR 201</td>
<td>Engineering Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>EGR 202</td>
<td>Engineering Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>EGR 203</td>
<td>Electrical &amp; Electronic Circuits</td>
<td>3</td>
</tr>
<tr>
<td>EGR 203L</td>
<td>Electrical and Electronic Circuits Lab</td>
<td>1</td>
</tr>
<tr>
<td>ENG 100</td>
<td>Writing Seminar I</td>
<td>6</td>
</tr>
<tr>
<td>&amp; ENG 200</td>
<td>and Writing Seminar II</td>
<td></td>
</tr>
<tr>
<td>or ENG 114</td>
<td>First-Year Writing Seminar</td>
<td></td>
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<tr>
<td>or ENG 198</td>
<td>Honors Writing Seminar</td>
<td></td>
</tr>
<tr>
<td>HST 103</td>
<td>The West &amp; the World</td>
<td>3</td>
</tr>
<tr>
<td>or HST 198</td>
<td>History Scholars’ Seminar</td>
<td></td>
</tr>
</tbody>
</table>

MEE 101 | Introduction to Mechanical Engineering II | 0
MEE 104L | Solid Modeling in Design | 2
MEE 300 | Professional Development for Juniors | 0
MEE 308 | Fluid Mechanics | 3
MEE 312 | Engineering Mechanics I & Materials Laboratory | 4
MEE 314 | Computational Methods | 3
MEE 321 | Theory of Machines | 3
MEE 341 | Engineering Experimentation | 3
MEE 400 | Professional Development for Seniors | 1
MEE 410 | Heat Transfer | 4
MEE 427 | Mechanical Design I | 3
or MEE 425 | Aerospace Design | 3
MEE 431L | Multidisciplinary Design I | 2
MEE 432L | Multidisciplinary Design II | 3
MEE 439 | Dynamic Systems & Controls | 4
or MEE 440 | Flight Vehicle Performance | 3
MEE 460 | Engineering Analysis | 3
MTH 168 | Analytic Geometry & Calculus I | 4
MTH 169 | Analytic Geometry & Calculus II | 4
MTH 218 | Analytic Geometry & Calculus III | 4
MTH 219 | Applied Differential Equations | 3
PHL 103 | Introduction to Philosophy | 3
PHY 206 | General Physics I - Mechanics | 3
PHY 207 | General Physics II - Electricity & Magnetism | 3
REL 103 | Introduction to Religious and Theological Studies | 3

Select one course from:

MEE 344 | Manufacturing Processes | 3
MEE 401 | Aerodynamics | 3
MEE 478 | Energy Efficient Manufacturing | 12

Electives

MEE 101 | Introduction to Mechanical Engineering II | 0
MEE 104L | Solid Modeling in Design | 2
MEE 300 | Professional Development for Juniors | 0
MEE 308 | Fluid Mechanics | 3
MEE 312 | Engineering Mechanics I & Materials Laboratory | 4
MEE 314 | Computational Methods | 3
MEE 321 | Theory of Machines | 3
MEE 341 | Engineering Experimentation | 3
MEE 400 | Professional Development for Seniors | 1
MEE 410 | Heat Transfer | 4
MEE 427 | Mechanical Design I | 3
or MEE 425 | Aerospace Design | 3
MEE 431L | Multidisciplinary Design I | 2
MEE 432L | Multidisciplinary Design II | 3
MEE 439 | Dynamic Systems & Controls | 4
or MEE 440 | Flight Vehicle Performance | 3
MEE 460 | Engineering Analysis | 3
MTH 168 | Analytic Geometry & Calculus I | 4
MTH 169 | Analytic Geometry & Calculus II | 4
MTH 218 | Analytic Geometry & Calculus III | 4
MTH 219 | Applied Differential Equations | 3
PHL 103 | Introduction to Philosophy | 3
PHY 206 | General Physics I - Mechanics | 3
PHY 207 | General Physics II - Electricity & Magnetism | 3
REL 103 | Introduction to Religious and Theological Studies | 3

Total Hours 132

1. Select from list approved by the Mechanical and Aerospace Engineering Department.
2. Select from list approved by the Mechanical and Aerospace Engineering Department.

Concentration in Aerospace Engineering (AEC)

This concentration is open only to mechanical engineering majors. The program provides a strong background for career specialization in the fields of aircraft and aerospace engineering.

MEE 225 | Introduction to Flight | 3
MEE 401 | Aerodynamics | 3
MEE 409 | Aerospace Structures | 3
MEE 425 | Aerospace Design | 3
### Concentration in Energy Systems-Mechanical (MRS)

This concentration is open to all engineering students.

Select two courses from:

- **ASI 320** Cities & Energy
- **CEE 390** Environmental Pollution Control
- **CEE 434** Water & Wastewater Engineering
- **ECO 435** Economics of the Environment
- **PHL 321** Environmental Ethics
- **PHY 220** Energy & Environmental Physics
- **POL 371** Environmental Policy
- **SEE 301** Global Change & Earth Systems
- **SEE 401** Sustainability Research I
- Any approved Arts and Science energy/sustainability related elective

Select four courses from:

- **AEE 566** Combustion Theory
- **MEE 413** Propulsion
- **MEE 420** Energy Efficient Buildings
- **MEE 456** Energy Systems Engineering
- **MEE 457** Building Energy Informatics
- **MEE 461** Solar Energy Engineering
- **MEE 462** Geothermal Energy Engineering
- **MEE 464** Sustainable Energy Systems
- **MEE 471** Design of Thermal Systems
- **MEE 472** Design for Environment
- **MEE 473** Renewable Energy Systems
- **MEE 478** Energy Efficient Manufacturing
- **MEE 493** Honors Thesis
- **MEE 565** Fundamentals of Fuels & Combustion
- **RCL 507** Materials Advanced Energy Applications
- **RCL 511** Advanced Thermodynamics
- **RCL 524** Electrochemical Power
- **RCL 533** Biofuel Production Processes
- **RCL 556** Energy Systems Engineering
- **RCL 557** Building Energy Informatics
- **RCL 561** Solar Energy Engineering
- **RCL 562** Geothermal Energy Engineering
- **RCL 563** Wind Energy Engineering
- **RCL 564** Sustainable Energy Systems
- **RCL 568** Internal Combustion Engines
- **RCL 569** Energy Efficient Buildings
- **RCL 571** Design of Thermal Systems
- **RCL 572** Design for Environment
- **RCL 573** Renewable Energy Systems
- **RCL 578** Energy Efficient Manufacturing
- **RCL 583** Advanced Photovoltaics
- **RCL 590** Special Problems in Renewable & Clean Energy
- **RCL 595** Renewable & Clean Energy Project
- **RCL 599** Renewable & Clean Energy Thesis
- Any approved engineering energy/sustainability related elective

Total Hours: 19

### Minor in Aerospace Engineering (AAE)

This minor is open to chemical, civil, and mechanical engineering majors. The program provides a strong background for career specialization in the fields of aircraft and aerospace engineering.

Select four courses from:

- **AEE 558** Computational Fluid Dynamics
- **MEE 225** Introduction to Flight
- **MEE 401** Aerodynamics
- **MEE 409** Aerospace Structures
- **MEE 425** Aerospace Design
- **MEE 440** Flight Vehicle Performance
- **MEE 413** Propulsion
- Approved AEE related elective

Total Hours: 12

### Minor in Human Movement Biomechanics (HMB)

This minor focuses on the theory and techniques in the field of biomechanical engineering to understand the kinematics and kinetics of human motion. Courses in the minor will prepare students to apply mechanical engineering concepts to solve clinical, occupational, and sports biomechanics problems.

- **MEE 230** Introduction to Biomechanics
- **MEE 430/530** Biomechanical Engineering
- **HSS 305** Human Anatomy
- **or BIO 475** Human Anatomy
- **or HSS 206** Fundamentals of Human Anatomy and Physiology

Select one:

- **MEE 450** Experimental Methods in Biomechanics
- **MEE 531** Experimental Methods in Biomechanics
- Approved minor elective

Total Hours: 12

### Minor in Mechanical Systems (MES)

This area concentrates on the study of design and analysis as well as modeling and control of mechanical systems. The activities in this area include, but are not limited to, computer-aided design, kinematic synthesis and analysis, acoustics and structural dynamics, noise and vibrations control, system modeling and identifications, and dynamics systems and control.

Required:

- **MEE 203** Intro to Mechanical Innovation
- **or MEE 204** Introduction to Robot Design

Total Hours: 12
Minor in Robotic Systems (RBS)

This minor focuses on the theory and techniques in the field of robotics and mechanical systems. Courses in the minor will prepare students to apply kinematics, mechatronics, machine design, and controls to robotic and autonomous systems. The minor requires MEE 204, MEE 438 and two other courses from the following list or approved by the Department Chair.

Required Courses

MEE 204  Introduction to Robot Design  3
MEE 438  Robotics & Flexible Manufacturing  3

Select two (2) additional courses from the following list:  6

MEE 437  Autonomous Systems
MEE 428  Mechanical Design II
MEE 520  Theoretical Kinematics
MEE 521  Kinematic Principles in Design
MEE 545  Computational Methods for Design
MEE 577  Robotics & Numerically Controlled Machines

Total Hours  12

Total credit hours: 132
MEE 114L. Introduction to Programming. 1 Hour
Introduction to applications and use of computer programs for mechanical engineers with concentration on spreadsheets, plotting, data manipulation and basic programming.

MEE 198. Research & Innovation Laboratory. 0-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis, and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

MEE 200. Professional Development for Sophomores I. 0 Hours
Exposure to breadth of Mechanical Engineering and opportunities available to students including minors and concentrations, research, and student organizations. Registration required for all MEE sophomores. Prerequisite(s): MEE 101.

MEE 201. Professional Development for Sophomores II. 0 Hours
Exposure to breadth of Mechanical Engineering and opportunities available to students including minors and concentrations, research, and student organizations. Registration required for all MEE sophomores.

MEE 203. Intro to Mechanical Innovation. 3 Hours
Application of the innovation process with emphasis on detailed mechanical design techniques, standards and guidelines. Experience is gained by completing individual and team design projects, and generating integrated CAD models. Prerequisite(s): EGR 103, MEE 104L.

MEE 204. Introduction to Robot Design. 3 Hours
Mechanical design aspects of robotic and automation systems. Employing the innovation process as applied to automation systems with an emphasis on detailed mechanical design techniques, standards and guidelines. Experience is gained by completing individual and team design projects. Prerequisite(s): EGR 103 and MEE 104L.

MEE 205. Mechatronics. 3 Hours
This course provides an introduction to the cross-disciplinary topic of Mechatronics, a blend of Mechanical, Electrical, and Computer Engineering. Topics include principles of linear circuit analysis and problem solving techniques (both analytical and computer solutions) associated with analog circuits containing both passive and active components. Students are introduced to DC, AC, and transient circuit analyses. In addition to these fundamentals, the "mechatronics emphasis" involves practical experience in creating robotic and automated systems. Related to its integrative component within CAP, students discuss and reflect on the social impact such technology has within their lives, their future profession, and the world as a whole. Ultimately, students scaffold their knowledge through a series of microprocessor programming modules which culminate in student teams designing, fabricating, and programming autonomous robotic vehicles for a class-wide competition. Prerequisite(s): MTH 168.

MEE 214. Programming for Mechanical Engineers. 3 Hours
Detailed introduction to solving engineering problems through computational methods. Fundamentals of programming in MATLAB involving arrays, functions, decision making, loops, and graphing. Emphasis on numerical methods that are applied in engineering. Prerequisite(s): MTH 169.

MEE 225. Introduction to Flight. 3 Hours
An introductory course designed to provide students with a basic understanding of the multitude of disciplines that comprise the aeronautical engineering profession. A background and brief history of flight are covered. Foundational knowledge of aerodynamics, propulsion, aerostructures, aircraft performance and aerospace vehicle design. Laboratory included. Prerequisite(s): PHY 206.

MEE 230. Introduction to Biomechanics. 3 Hours
Introduction to the field of biomechanical engineering with an emphasis on human movement. Application of engineering concepts to solve clinical, occupational, and sports biomechanics problems with a focus on experimental data analysis, kinematics, research, product design, and technical reporting. Corequisite(s): EGR 201 or permission of instructor. Prerequisite(s): PHY 206 or permission of instructor.

MEE 298. Research & Innovation Laboratory. 0-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis, and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

MEE 300. Professional Development for Juniors. 0 Hours
Presentations on contemporary mechanical engineering subjects by students, faculty, and engineers in active practice; student involvement in professional and service activities. Registration required of all MEE juniors. Prerequisite(s): MEE 200 or COP 200 or EGR 200.

MEE 308. Fluid Mechanics. 3 Hours

MEE 312. Engineering Materials I. 3 Hours
Atomic structure, bonding, and arrangement in solids. Mechanical and physical properties of solids, phase equilibria, and processing of solids. Strengthening methods in solids, principles of material selection, and characteristics of non-ferrous alloys, polymers, ceramic composites, and construction materials. Corequisite(s): EGM 303; MEE 312L.

MEE 312L. Materials Laboratory. 1 Hour
Conducting mechanical and physical tests on solids including, but not limited to tension, compression, bending, hardness, and impact. Metallographic examination of surfaces. Test standards, data reduction, analysis, interpretation, and written and oral communication of test results. Corequisite(s): EGM 303; MEE 312.

MEE 314. Computational Methods. 3 Hours
Detailed introduction to solving engineering problems through programming in the Matlab technical computing software package. Fundamentals of algorithms, including iterative processes, arrays and logic operations. Graphing of 2D and 3D functions. Graphical user interfaces. Focus on engineering applications that utilize the mathematical techniques of linear algebra, statistics and numerical methods. Prerequisite(s): MTH 169.
MEE 321. Theory of Machines. 3 Hours
Analysis and synthesis of mechanisms using analytical and computer-based techniques. Applications include cams, gears, and linkages such as four-bar, slider-crank, and quick-return mechanisms. Gear train specification and force analysis. Position, velocity, and acceleration analysis and mechanical advantage of a wide variety of linkage systems. Prerequisites: EGR 201. Corequisites: MEE 214 or MEE 314 or ECE 203.

MEE 341. Engineering Experimentation. 3 Hours
Basic sensors and instrumentation, design of experiments, data acquisition and processing, and uncertainty and statistical analysis of data. Measurement of strain, motion, pressure, temperature, flow and sound. Measurement applications to engineering phenomena or systems. Course will utilize a mix of lecture, laboratory experiments, and demonstrations. Also a term project to provide design of experiment experience. Corequisite(s): EGR-203 or MEE-205 or ECE-201.

MEE 344. Manufacturing Processes. 3 Hours
Casting processes including casting defects and design of castings; metal working processes such as extrusion, forging, rolling and wire drawing; sheet metal forming; welding processes; powder metallurgy and design principles for P/M parts, metal removal processes; forming and shaping plastics and composite materials; rapid prototyping. Design principles for manufacturability. Includes laboratory. Prerequisite(s): MEE 312.

MEE 398. Research & Innovation Laboratory. 0-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis, and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

MEE 400. Professional Development for Seniors. 1 Hour
Presentations on contemporary mechanical engineering subjects by students, faculty, and engineers in active practice; student involvement in professional and service activities. Registration required of all MEE seniors. Prerequisite(s): MEE 300.

MEE 401. Aerodynamics. 3 Hours
Fundamentals of steady and inviscid aerodynamic flows. Emphasis on force and moment determination for airfoils and finite wings. Prerequisite(s): MEE 308.

MEE 409. Aerospace Structures. 3 Hours
Structural properties of wing and fuselage sections. Nonsymmetrical bending of skin-stringer wing sections. Shear stresses in thin-walled and skin-stringer multiple-celled sections. Deflection by energy methods. Introduction to finite element stiffness method. Prerequisite(s): MEE 308.

MEE 410. Heat Transfer. 3 Hours
Fundamentals of conduction, convection, and thermal radiation energy transfer. Conduction of heat in steady and unsteady state. Principles of boundary layer theory applicable to free and forced convection heat transfer for internal and external flows. Radiation analysis with and without convection and conduction. Prerequisite(s): MEE 308.

MEE 410L. Thermo-Fluids Laboratory. 1 Hour
Hands-on opportunities for students to gain knowledge of instrumentation used for temperature, flow, heat, and pressure measurement and to visualize thermo-fluids phenomena in a rich problem solving context. Phenomena to be studied include: boundary layer and separation phenomena, internal flow characteristics, hydraulics, conduction, convection, and combustion. Corequisite(s): MEE 410.

MEE 413. Propulsion. 3 Hours
Principles of propulsive devices, aerothermodynamics, diffuser and nozzle flow, energy transfer in turbo-machinery; turbojet, turbo-fan, prop-fan engines; turbo-prop and turboshaft engines. RAM and SCRAM jet analysis and a brief introduction to related materials and air frame-propulsion interaction. Prerequisite(s): MEE 308.

MEE 415. Professional Development I. 0 Hours
Presentations on contemporary mechanical engineering subjects by students, faculty, and engineers in active practice; student involvement in professional and service activities. Registration required of all MEE juniors.

MEE 416. Professional Development II. 1 Hour
Presentations on contemporary mechanical engineering subjects by students, faculty, and engineers in active practice; student involvement in professional and service activities. Registration required of all MEE seniors.

MEE 417. Internal Combustion Engines. 3 Hours
Combustion and energy release processes. Applications to spark and compression ignition, thermal jet, rocket, and gas turbine engines. Emphasis on air pollution problems caused by internal combustion engines. Idealized and actual cycles studied in preparation for laboratory testing of I. C. engines. Prerequisite(s): EGR 202 or permission of instructor.

MEE 420. Energy Efficient Buildings. 3 Hours
Provides knowledge and skills necessary to design and operate healthier, more comfortable, more productive, and less environmentally destructive buildings. A specific design target of E/3 (typical energy use divided by three) is established as a goal. Economic, thermodynamic, and heat transfer analyses are utilized. Extensive software development. Prerequisite(s): MEE 410.

MEE 425. Aerospace Design. 3 Hours
Capstone Air Vehicle Design project that involves both individual and team-based conceptual and preliminary design and sizing. This course integrates the knowledge acquired from the disciplinary subjects already taken (aerodynamics, aerospace structures, propulsion, flight dynamics and intro to flight) in order to size an air vehicle based on a set of requirements. Prerequisite(s): (MEE 225, MEE 401) or permission of instructor. Corequisite(s): MEE 409.

MEE 427. Mechanical Design I. 3 Hours
Stress and deflection analysis of machine components; theories of failure; fatigue failure of metals. Design and analysis of mechanical components such as gears, shafts, bearings and springs. Prerequisite(s): EGM 303; MEE 321.

MEE 428. Mechanical Design II. 3 Hours
Advanced topics in stress and deflection analysis; analysis and design of mechanical elements such as gears, journal and ball bearings, belts, brakes, and clutches; principles of fracture mechanics; failure analysis; machinery construction principles. Contemporary design methods and issues associated with the product development cycle. Prerequisite(s): MEE 427.

MEE 430. Biomechanical Engineering. 3 Hours
Application of engineering principles to clinical, occupational, and sports biomechanics topics. The course focuses on biomechanical analysis, particularly kinematics and kinetics of human movement, with emphasis on both research and product design.
MEE 431L. Multidisciplinary Design I. 2 Hours
Application of engineering fundamentals to sponsored multidisciplinary-team design projects. In a combination of lecture and lab experiences, students learn the product realization process and project management. Product realization topics include idea generation, proposal development, design specifications, conceptualization and decision analysis. Project management topics include cost estimation and intellectual property management. Design projects progress to the proof of concept and prototype development stages. Prerequisites: MEE Students: EGM 303 and MEE 321, ECE students: ECE 304 or ECE 314. Corequisites: (MEE 344 or MEE 478 or RCL 578 or MEE 401 or MEE 409).

MEE 432L. Multidisciplinary Design II. 3 Hours
One hour lecture and five hours of lab per week. Detailed evaluation of the Product Realization Process focusing on conceptual design, embodiment design, final design and prototyping is taught. Analysis of the design criteria for safety, ergonomics, environment, cost and sociological impact is covered. Periodic oral and written status reports are required. The course culminates in a comprehensive written report and oral presentation. Prerequisite(s): MEE majors: MEE 431L; CPE majors: ECE 431L and (ECE334 or CPS444); ELE majors: ECE431L and (ECE 401 or ECE415).

MEE 433. Project Management & Innovation. 1 Hour
Introduces students and teams to project management, entrepreneurship, and innovation. Topics include project management, cost estimating, time value of money, patent law, marketing, finance, and business plan development. Prerequisite(s): Junior status.

MEE 434. Mechatronics. 3 Hours
Emphasis on the integration of sensors, micro-controllers, electromechanical actuators, and control theory in a 'smart' system for a semester long design project. Topics include: sensor signal processing, electromechanical actuator fundamentals, interfacing of sensors and actuators to micro-controllers, digital logic, and programming of micro-controllers, programmable logic controllers and programmable logic devices. Equal mix of lecture and laboratory. Prerequisite(s): (ECE 201 or EGR 201) and (ECE 201L or EGR 203L).

MEE 437. Autonomous Systems. 3 Hours
At the intersection of mechanical engineering, electrical engineering, and computer science, autonomous systems involve the implementation of mechatronic technologies which operate independently (autonomously) from human intervention. This course emphasizes the practical implementation of modern control systems for the purposes of creating fully-or semi-autonomous systems. Topics include programming syntax and structure, integration of peripherals (sensors and actuators) with controllers, and data communications both within and external to the systems. Equal mix of lecture and laboratory with significant time dedicated to design projects. Prerequisite(s): (ECE 201 or EGR 203) and (ECE 201L or EGR 203L) or MEE 205.

MEE 438. Robotics & Flexible Manufacturing. 3 Hours
Overview of industrial robots; physical configuration, operation, and programming of robots; actuators, drive mechanisms, sensors, vision systems, controls, and control methods for robots; economic considerations; and automated factory concept. Prerequisite(s): MEE 321.

MEE 439. Dynamic Systems & Controls. 4 Hours
Dynamic systems modeling with special emphasis on mechanical systems (one and two degrees of freedom). Covers both transfer function and state space modeling techniques. Analogues drawn between mechanical, electrical, fluid, and thermal physical domains. System nonlinearities and model linearization methods are discussed. Analytical solutions of linear ordinary differential equations using Laplace transformation and state space theory. Feedback control theory, including root locus and frequency response techniques. Prerequisite(s): EGM 202; MTH 219.

MEE 440. Flight Vehicle Performance. 4 Hours
This course is intended to introduce the student to the flight mechanics of aerospace vehicles. Some familiarity with aircraft performance, static stability and control is assumed, but not required. We will use modern analysis methods to develop the topical details including: 1) a study of aerodynamics involved in flight vehicle motion to obtain an understanding of influence coefficients; 2) use of linear algebra to develop a rational approach to modeling aircraft dynamics; 3) an introduction to modern control theory methodology; and 4) problems and examples that illustrate the use of desktop computational tools currently available. Prerequisite(s): (EGM 202; MEE 401, MEE 225; MTH 219) or permission of instructor.

MEE 450. Experimental Methods in Biomechanics. 3 Hours
This course is focused on developing and applying advanced experimentation skills with a specific focus on techniques associated with the study of human movement. Emphasis on equipment and technology, data analysis and interpretation, statistical methods, and technical reporting. Prerequisite(s): MEE 341 Engineering Experimentation or permission of instructor.

MEE 456. Energy Systems Engineering. 3 Hours
This course is aimed at providing fundamental knowledge of thermodynamics, fluid mechanics, and heat transfer in context of Energy Systems Engineering. A Just-in-Time approach to learning and applying these topics will be used. Projects will anchor all class activities. In addition to providing knowledge and experience of thermodynamics, fluid mechanics, and heat transfer, this course seeks to provide students the analysis skills necessary to determine the importance of energy conversion technologies, with special emphasis on energy efficiency and renewable energy (tidal, hydroelectric, wind, solar and geothermal). Corequisite(s): MEE 410.

MEE 457. Building Energy Informatics. 3 Hours
The focus of the course is the collection and analysis of energy data sets to reduce energy consumption and/or energy demand. Students will typically utilize monthly energy data from multiple buildings, real time energy data, and building energy audit data. Students will disaggregate/aggregate data to develop energy use benchmarks, identify priority buildings/actions for energy reduction, identify problems, and estimate savings. Programming in Matlab and an introduction to sql dbase management are covered. Corequisite(s): MEE 410.

MEE 460. Engineering Analysis. 3 Hours
Case study approach to engineering problem solving. Emphasis on breaking down problems to tractable parts, modeling physical systems and selection of solution techniques. Problems related to thermal, fluid, structural, and dynamic systems. Problems typically involve solution of ordinary and partial differential equations, Fourier analysis of periodic behavior, simulation, optimization and/or statistical analysis. Analytical and numerical solution techniques, with an emphasis on selecting the most appropriate technique and understanding the limitations of the analysis. Prerequisite(s): MEE 410.
MEE 461. Solar Energy Engineering. 3 Hours
This course will cover the theory, design and application of two broad uses of solar energy: (i) direct thermal and (ii) electrical energy generation. The majority of the course will focus on thermal applications, with emphasis on system simulation and design for buildings and other systems. This course will expose students to the development and use of solar design and simulation tools. Most of the tools will be implemented in Excel and TRNSYS, but students are welcome to use other software tools such as Engineering Equation Solver (EES) or MATLAB. Some of the class time will be devoted to demonstrate the development and use of these tools to solve homework problems. Corequisite(s): MEE 410.

MEE 462. Geothermal Energy Engineering. 3 Hours
This course will cover the theory and design of three broad uses of geothermal energy: (i) heat pump applications, (ii) direct uses, and (iii) electrical energy generation. The majority of the course will focus on heat pump applications, with emphasis on ground heat exchanger simulation and design for buildings and other systems. Closed-loop, open-loop, and hybrid geothermal heat pump systems will be examined. Heating, cooling, and electricity generating applications using hot geothermal reservoirs will also be discussed. This course will expose students to the development and use of geothermal design and simulation tools. Most of the tools will be implemented in Excel, but students are welcome to use other software tools such as Engineering Equation Solver (EES) or MATLAB. The course notes explain the development and use of these tools, which will be used to solve homework problems. Corequisite(s): MEE 410.

MEE 463. Wind Energy Engineering. 3 Hours
Introduction to wind energy engineering, including wind energy potential and its application to power generation. Topics include wind turbine components; turbine fluid dynamics and aerodynamics; turbine structures; turbine dynamics, wind turbine controls; fatigue; connection to the electric grid; maintenance; web site assessment; wind economics; and wind power legal, environmental, and ethical issues. Corequisite(s): MEE 410.

MEE 464. Sustainable Energy Systems. 3 Hours
Survey of conventional fossil-fuel and renewable energy with an emphasis on system integration. Basic concepts of climate physics will be addressed along with estimates of fossil resources. Corequisite(s): MEE 410.

MEE 471. Design of Thermal Systems. 3 Hours
This course integrates thermodynamics, heat transfer, engineering economics, and simulation and optimization techniques in a design framework. Topics include design methodology, energy analysis, heat exchanger networks, thermal-system simulation and optimization techniques. Prerequisite(s): MEE 410.

MEE 472. Design for Environment. 3 Hours
Emphasis on design for environment over the life cycle of a product or process, including consideration of the mining, processing, manufacturing, use, and post-life stages. Course provides knowledge and experience in invention for the purpose of clean design, life cycle assessment strategies to estimate the environmental impact of products and processes, and cleaner manufacturing practices. Course includes a major design project.

MEE 473. Renewable Energy Systems. 3 Hours
Introduction to the impact of energy on the economy and environment. Engineering models of solar thermal and photovoltaic systems. Introduction to wind power. Fuel cells and renewable sources of hydrogen.