Mechanical Engineering

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The Department of Mechanical Engineering at Florida International University (FIU) offers a curriculum which is designed to give the student a thorough understanding of the basic laws of science and to simultaneously stimulate and develop creative thinking, a professional attitude, economic judgement and environmental consciousness. The aim is to develop the student’s potential to the fullest, to prepare the student for superior performance as a mechanical engineer, foster lifelong learning and to provide the student with the fundamental principles necessary for pursuing advanced study in the diverse fields of engineering, science and business.

A graduate of the Mechanical Engineering program should possess:

1. Broad and in-depth knowledge of engineering science and principles in the following five major branches of Mechanical Engineering: (1) Fluids/Thermal Sciences and Energy Systems, (2) Mechanics and Materials, (3) Design and Manufacturing, and (4) Biomechanics and Biomedical Engineering for effective engineering practice, professional growth and as a base for lifelong learning.

2. Hands-on experience with state-of-the-art instruments and laboratory techniques to bridge classroom learning with practical "real-life" problems.

3. The ability to utilize analytical and experimental methods and modern computer technology for decision making, engineering design, and to solve realistic engineering problems.

4. The ability to work effectively with others in a team while simultaneously maintaining independent and creative thought.

5. The ability to articulate technical matters using verbal, written and graphic techniques.

6. An adequate background to pursue graduate studies in engineering and other fields.

7. A sense of professional and social responsibility, including a commitment to protect both occupational and public health and safety, developed through consideration of moral, social, and ethical paradigms related to the engineering profession and practice.

The academic program provides a well-balanced curriculum in the following three major areas of Mechanical Engineering:

- Fluid/Thermal Science
- Mechanics and Materials Design and Manufacturing
- Further specializations in any of the following areas may be obtained by the proper choice of electives: Environmental and Waste Management
- Energy Systems
- Heating, Ventilation, and Air Conditioning
- Mechanics and Material Sciences
- Biomechanics and Bioengineering Manufacturing Robotics Design
- Computer-Aided Engineering

The courses in the Manufacturing Methods area and Robotics are offered by both the Mechanical and the Industrial Engineering Departments. Biomechanics and Biomedical Engineering are interdisciplinary studies with courses offered by both the Mechanical and Electrical and Computer Engineering Departments. The courses in the Environmental and Waste Management area are offered by the Mechanical and Civil Engineering Departments.

A Bachelor’s degree in Mechanical Engineering provides students with the background suitable for immediate employment in engineering industries, as well as excellent preparation for graduate studies in Engineering, Medicine, Law, or Business Administration.

Bachelor of Science in Mechanical Engineering

Common Prerequisites

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM 1045</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>CHM 1045L</td>
<td>General Chemistry Lab I</td>
</tr>
<tr>
<td>MAC 2311</td>
<td>Calculus I</td>
</tr>
<tr>
<td>MAC 2312</td>
<td>Calculus II</td>
</tr>
<tr>
<td>MAC 2313</td>
<td>Multivariable Calculus</td>
</tr>
<tr>
<td>MAP 2302</td>
<td>Differential Equations</td>
</tr>
<tr>
<td>EGM 3311</td>
<td>Analysis of Engineering Systems</td>
</tr>
<tr>
<td>PHY 2048</td>
<td>Physics with Calculus I</td>
</tr>
<tr>
<td>PHY 2048L</td>
<td>General Physics Lab I</td>
</tr>
<tr>
<td>PHY 2049</td>
<td>Physics with Calculus II</td>
</tr>
<tr>
<td>PHY 2049L</td>
<td>General Physics Lab II</td>
</tr>
</tbody>
</table>

Degree Program Hours: 128

The qualifications for admissions to the Department of Mechanical Engineering are the same as for admission to the School of Engineering.

The academic program is designed to satisfy the criteria outlined by the Accreditation Board for Engineering and Technology (ABET), as well as to meet the State of Florida’s articulation policy. Entering freshmen at FIU should seek advisement from the Undergraduate Studies Office as well as from the Mechanical Engineering Department’s office of advisement.

Lower Division Preparation

Lower division requirements include at least 60 hours of pre-engineering credits (see the Undergraduate Studies portion of this catalog for specific requirements). These courses include Software for Mechanical Design, Calculus I, II, III, Differential Equations, Chemistry I and Lab, Calculus based Physics I & II and labs, 2 semesters of English and 2 other Gordon rule writing courses. (Engineering Graphics is a required prerequisite unless previously taken in high school). A minimum grade of a “C” is required in all writing courses, all calculus courses Differential Equations, both Physics classes and Chemistry. In addition, both transfer students and FIU Freshman must take a combination of social sciences and
humanities that fulfill the state general education requirements and whose topics also complement the goals and objectives of the College of Engineering (including economic, environmental, political, and/or social issues. See semester-by-semester sample program for courses that fulfill this requirement). In addition, students may transfer a pre-approved engineering Statics course as long as they meet the proper prerequisites for the course (speak to an FIU engineering advisor to see if your community college offers an acceptable statics course). Students must make up any missing prerequisites before they will be allowed to begin taking certain engineering courses (see course listing for required pre/co-requisites).

Other Requirements
Students must meet the University Foreign Language Requirement. Students must pass the CLAST or have it waived. Students who enter the university with fewer than 36 semester hours must satisfy a summer residency requirement by taking a minimum of 9 credit hours during the summer semester while at FIU. Students must meet all of the state and university requirements in order to graduate.

The minimum requirements for graduation in Mechanical Engineering consist of two parts: 1) Mathematics, Basic Sciences, Humanities and Social Science requirements, and 2) Engineering Sciences, Engineering Design, Laboratory and Elective requirements.

Mechanical Engineering Curriculum
Engineering Science, Engineering Design, Laboratory and Elective semester credit hours requirements:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGN 1100</td>
<td>Introduction to Engineering</td>
<td>2</td>
</tr>
<tr>
<td>EML 2030</td>
<td>Software for Mechanical Design</td>
<td>3</td>
</tr>
<tr>
<td>EGN 3311</td>
<td>Statics</td>
<td>3</td>
</tr>
<tr>
<td>EGN 3321</td>
<td>Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>EGN 3365</td>
<td>Materials in Engineering</td>
<td>3</td>
</tr>
<tr>
<td>EMA 3702</td>
<td>Mechanics and Material Science</td>
<td>3</td>
</tr>
<tr>
<td>EMA 3702L</td>
<td>Mechanics and Materials Science Lab</td>
<td>1</td>
</tr>
<tr>
<td>EML 3126</td>
<td>Transport Phenomena Lab</td>
<td>1</td>
</tr>
<tr>
<td>EML 3126L</td>
<td>Transport Phenomena Lab</td>
<td>1</td>
</tr>
<tr>
<td>EGN 3343</td>
<td>Thermodynamics I</td>
<td>3</td>
</tr>
<tr>
<td>EML 3101</td>
<td>Thermodynamics II</td>
<td>3</td>
</tr>
<tr>
<td>EML 3262</td>
<td>Kinematics &amp; Mechanism Design</td>
<td>3</td>
</tr>
<tr>
<td>EML 4220</td>
<td>Mechanical Vibrations</td>
<td>3</td>
</tr>
<tr>
<td>EIN 3354</td>
<td>Engineering Economy</td>
<td>3</td>
</tr>
<tr>
<td>EML 4312</td>
<td>Automatic Control Theory</td>
<td>3</td>
</tr>
<tr>
<td>EML 4140</td>
<td>Heat Transfer</td>
<td>3</td>
</tr>
<tr>
<td>EIN 3390</td>
<td>Manufacturing Processes</td>
<td>2</td>
</tr>
<tr>
<td>EIN 3390L</td>
<td>Manufacturing Processes Lab</td>
<td>1</td>
</tr>
<tr>
<td>EEL 3003</td>
<td>Electrical Engineering I</td>
<td>3</td>
</tr>
<tr>
<td>EEL 3111L</td>
<td>Circuit Lab</td>
<td>1</td>
</tr>
<tr>
<td>EML 3301L</td>
<td>Instrumentation &amp; Measurement Lab</td>
<td>1</td>
</tr>
<tr>
<td>EML 4906L</td>
<td>Mechanical Lab I</td>
<td>1</td>
</tr>
<tr>
<td>EML 3500</td>
<td>Mechanical Design I</td>
<td>3</td>
</tr>
<tr>
<td>EML 4501</td>
<td>Mechanical Design II</td>
<td>3</td>
</tr>
<tr>
<td>EML 4706</td>
<td>Design of Thermal and Fluid Systems</td>
<td>3</td>
</tr>
<tr>
<td>EML 4551</td>
<td>Design Project Organization*</td>
<td>1</td>
</tr>
<tr>
<td>EML 4905</td>
<td>Senior Design Project # 3</td>
<td>3</td>
</tr>
<tr>
<td>EEM 4905</td>
<td>Engineering Electives</td>
<td>8</td>
</tr>
<tr>
<td>EML 4501</td>
<td>Math/Statistics Elective*</td>
<td>3</td>
</tr>
</tbody>
</table>

The elective areas offer the following additional laboratories: Air Conditioning and Refrigeration, Biomedical Engineering, Material Sciences, Computer/Aided Design, and Computer/Integrated Manufacturing.

Electives
Four concentrations available within the Mechanical Engineering program with some of their elective offerings are listed below.

Fluids-Thermal Sciences and Energy Systems

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGN 4350</td>
<td>Finite Element Analysis in Mechanical Design</td>
<td>3</td>
</tr>
<tr>
<td>EML 4503</td>
<td>Production Machine Modeling and Design</td>
<td>3</td>
</tr>
<tr>
<td>EML 4525</td>
<td>Mechanical Design Synthesis and Analysis</td>
<td>3</td>
</tr>
<tr>
<td>EML 4535</td>
<td>Mechanical Computer Aided Design</td>
<td>3</td>
</tr>
<tr>
<td>EML 4561</td>
<td>Introduction to Electronic Packaging</td>
<td>3</td>
</tr>
<tr>
<td>EML 4585</td>
<td>Design of Biomedical Systems and Devices</td>
<td>3</td>
</tr>
<tr>
<td>EML 4603</td>
<td>Air Conditioning Design</td>
<td>3</td>
</tr>
<tr>
<td>EML 5509</td>
<td>Mechanical Design Optimization</td>
<td>3</td>
</tr>
<tr>
<td>EML 5519</td>
<td>Fault-Tolerant System Design</td>
<td>3</td>
</tr>
<tr>
<td>EIN 4395</td>
<td>Computer Integrated Manufacturing</td>
<td>3</td>
</tr>
<tr>
<td>STA 3033</td>
<td>Introduction to Engineering Data</td>
<td>3</td>
</tr>
</tbody>
</table>

Students who are dismissed for the first time from the University due to low grades may appeal to the Dean for reinstatement. A second dismissal results in no possibility of reinstatement.
Mechanics, Materials and Design
EGM 3311 Analysis of Mechanical Systems 3
EGM 4610 Introduction to Continuum Mechanics 3
EGM 4350 Finite Element Analysis in Mechanical Design 3
EGM 5315 Intermediate Analysis of Mechanical Systems 3
EGM 5615 Synthesis of Engineering Mechanics 3
EGN 5367 Industrial Materials and Engineering Design 3
EMA 3066 Polymer Science and Engineering 3
EMA 4121 Physical Metallurgy 3
EMA 4121L Materials Laboratory 1
EMA 4223 Mechanical Metallurgy 3
EMA 5295 Principles of Composite Materials 3
EMA 5507C Analytical Techniques of Material Sciences 3
EMA 5935 Advanced Topics in Materials Engineering 3
EML 3222 System Dynamics 3
EML 3301C Instrumentation 3
EML 4260 Dynamics of Machinery 3
EML 4525 Mechanical Design Synthesis and Analysis 3
EML 4535 Mechanical Computer-Aided Design 3
EML 4561 Introduction to Electronic Packaging 3
EML 5125 Classical Dynamics 3
EML 5385 Identification Techniques of Mechanical Systems 3
EML 5530 Intermediate CAD/CAE 3
EML 5562 Advanced Electronic Packaging 3

Biomechanics and Biomedical Engineering
EE 5071 Bioelectrical Models 3
EE 5085 Bioradiation Engineering 3
EGM 4580 Principles of Bioengineering 3
EGM 4580L Biomedical Engineering Lab 1
EGM 4581 Biomechanics of Cardiovascular Systems 3
EGM 4582 Engineering Hemodynamics 3
EGM 4583 Orthopaedic Biomechanics 3
ELR 4202C Medical Instrumentation Design 4
EML 4585 Design of Biomedical Systems & Devices 3

Manufacturing and Robotics
EIN 3600 Introduction to Robotics 2
EIN 4391 Product Design for Manufacturing and Automation 3
EIN 4395 Computer-Integrated Manufacturing 3
EML 4535 Mechanical Computer-Aided Design 3
EML 4561 Introduction to Electronic Packaging 3
EML 4806 Modeling and Control of Robots 3
EML 5562 Advanced Electronic Packaging 3

Students are required to complete eleven credit hours of technical electives, three of which are approved design credits.

Students with special needs may take other elective courses (not listed above) with permission of the Mechanical Engineering Advisor. Students are not restricted to these four areas but may choose courses, with the advisor’s consent, that will form a coherent concentration area. Special topics may be counted as an elective.

Areas of Specialization
Air Conditioning and Refrigeration
Applied Mechanics
Bioengineering/Biomechanics
Computer-Aided Engineering
Computer-Integrated Manufacturing and Design
Energy Systems

Environmental and Waste Management
Finite Element Analysis
Fluid Mechanics
Heat Transfer
Material Sciences
Robotics
Thermal Science

In order to specialize in manufacturing, students need to collaborate with the faculty of the Industrial Engineering Department.

Options in Mechanical Engineering

The following options are available:

Heating, Ventilation and Air Conditioning Design Option
EML 4601 Refrigeration and Air Conditioning 3
EML 4601L Refrigeration and Air Conditioning Lab 1
EML 4603 Air Conditioning Design Option
EML 4608 Mechanical Systems in Environmental Control 3
EIN 3235 Evaluation of Engineering Data 3
STA 3033 Probability and Statistics for Computer Science 3
EML 4535 Mechanical Computer-Aided Design 3
EIN 3390L Manufacturing Lab 1

Biomechanical/Biochemical Option
EIN 3235 Evaluation of Engineering Data 3
STA 3033 Probability and Statistics for Computer Science 3
EML 4585 Design of Biomedical Systems and Devices 3
EGM 4581 Biomechanics of Cardiovascular Systems 3
EGM 4582 Engineering Hemodynamics 3

Mechanical Engineering Program Requirements—Freshman to Senior

First Semester: (17)
MAC 2311 Calculus I 4
CHM 1045 General Chemistry I 3
CHM 1045L General Chemistry I Lab 1
ENC 1101 Freshman Composition I 3
ARH 2050 Art History I 3
or
ARH 2051 Art History II 3
or
THE 2000 Theatre Appreciation I 3
or
CRW 2001 Creative Writing I 3
or
MUH 1011 Music Appreciation I 3
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EGN 1100  Introduction to Engineering  2
SLS 1501  Freshman Experience Seminar  1

Second Semester: (17)
MAC 2312  Calculus II  4
PHY 2048  Physics I with Calculus  4
PHY 2048L  General Physics Lab  1
ENC 1102  Literary Analysis  3
EGN 3365  Materials in Engineering  3
EML 2013  Principles of Macroeconomics  3
or
EML 2023  Principles of Microeconomics  3
or
EVR 1017  Society and Global Environment  3

Third Semester: (17)
MAC 2313  Multivariable Calculus  4
PHY 2049  Physics with Calculus II  4
PHY 2049L  General Physics Lab  1
EGN 3311  Statics  3
EIN 3390  Manufacturing Processes  2
EIN 3390L  Manufacturing Processes Lab  1
EML 2030  Software for Mechanical Design  3

Fourth Semester: (17)
MAP 2302  Differential Equations  3
EGN 3321  Dynamics  3
EEL 3003  Electrical Engineering I  3
EEL 3111L  Circuits Lab  1
EGN 3343  Thermodynamics I  3
EMA 3702  Mechanics and Materials Science  3
EMA 3702L  Mechanics and Materials Science Lab  1

Fifth Semester: (14)
EIN 3354  Engineering Economy  3
EML 3101  Thermodynamics II  3
EML 3126  Transport Phenomena Lab  1
EML 3126L  Transport Phenomena Lab  1
EML 3262  Kinematics and Mechanism Design  3
EML 3301L  Instrumentation and Measurement Lab  1

Sixth Semester: (15)
EML 4220  Mechanical Vibrations  3
EML 4140  Heat Transfer  3
EML 3500  Mechanical Design I  3
Math/Statistics Elective  3
ANT 4273  Law & Culture (SS)  3
or
ECS 3003  Comparative Economic Systems (SS)  3
or
HUM 4191  Cultural Heritage &

Sixth Semester
Measurement Lab 1

Fifth Semester
SLS 1501  Freshman Experience Seminar  1

Fourth Semester
PHY 2048  Physics I with Calculus  4
EML 3262  Kinematics and Mechanism Design  3
EML 3126L  Transport Phenomena Lab  1

Third Semester
MAC 2313  Multivariable Calculus  4
EGN 3311  Statics  3
EML 2030  Software for Mechanical Design  3

Second Semester
MAC 2312  Calculus II  4
EGN 3365  Materials in Engineering  3
MAC 2311  Calculus I  4
MAC 2312  Calculus II  4
MAC 2313  Multivariable Calculus  3

Sixth Semester
Or
ECS 3003  Comparative Economic Systems (SS)  3
or
HUM 4191  Cultural Heritage &

Students enrolled in the program may count up to 6 credit hours of ME graduate courses toward the elective engineering BSME requirements as well as toward the MSME degree. Only graduate lecture courses can be counted for both degrees.

Admission to the combined BSME/MSME program by the department does not automatically qualify students for admission to the MSME degree program. To enroll in the MSME degree program, students must meet the graduate admission requirements.

Bachelor of Science in Chemical Engineering

Common Prerequisites
CHM 1045  General Chemistry I
CHM 1045L  General Chemistry Lab I
MAC 2311  Calculus I
MAC 2312  Calculus II
MAC 2313  Multivariable Calculus
MAP 2302  Differential Equations
or
EGM 3311  Analysis of Engineering Systems
PHY 2048  Physics with Calculus I
PHY 2048L  General Physics Lab I
PHY 2049  Physics with Calculus II
PHY 2049L  General Physics Lab II

Degree Program Hours: 128

The Chemical Engineering curriculum is designed to prepare graduates to apply the principles of chemical engineering to the design and operation of chemical process systems. Proper selection of electives allows a graduate to develop background in physiology as preparation for a career in biochemical applications to the field of biomedical engineering.

Lower Division Preparation
It is required that FIU undergraduates complete the common prerequisite courses listed above with a 2.5 GPA. In addition, FIU undergraduates must meet all lower division requirements to include: CLAST, two Gordon Rule courses, two English composition courses and 16 hours of humanities/social science. Progress toward the baccalaureate degree is facilitated by the completion of the General Chemistry sequence (second course with laboratory) as well as the two course sequence in Organic Chemistry with laboratories.
### Foreign Language Requirement
Students must meet the University foreign language requirement. Refer to the Catalog's section on General Information for Admissions and the Office of the Registrar.

### Upper Division Program
The upper division program includes continuation of the science component of the program with a two course sequence in Physical Chemistry (with laboratories) with the option of substituting an elective course in the biological science for the second course in the Physical Chemistry sequence. The remaining 38 credits of required courses include a senior design project and an additional 11 credits of technical elective. The latter permits students to develop their programs in areas of specific interest.

Students must maintain and achieve a grade point average of 2.0 or better in those engineering courses to be used to satisfy BSChE degree requirements. This "major GPA" is computed in the manner of the overall GPA. Courses that are excluded from the calculation of the overall GPA will also be excluded from the calculation of the major GPA. Students failing to maintain a major GPA of 2.0 will be placed on major GPA probation, suspension, or dismissed from the program according to the same criteria that are utilized with the overall GPA.

Students who are dismissed for the first time from the University due to low grades may appeal to the Dean for reinstatement. A second dismissal results in no possibility of reinstatement.

### Chemical Engineering Program Requirements

#### First Semester: (17)
- **MAC 2311**  Calculus I  4
- **CHM 1045**  General Chemistry I  3
- **CHM 1046L**  General Chemistry I Lab  1
- **ENC 1101**  Freshman Composition  3
- **ARH 2050**  Art History  3
- **THE 2000**  Theatre Appreciation  3
- **CRW 2001**  Creative Writing  3
- **MUH 1011**  Music Appreciation  3
- **EGN 1100**  Introduction to Engineering  2
- **EGN 1110C**  Engineering Drawing  0

#### Second Semester: (17)
- **MAC 2312**  Calculus II  4
- **CHM 1046**  General Chemistry II  3
- **CHM 1046L**  General Chemistry II Lab  1
- **CGS 2423**  C Programming for Engineers  3
- **ENC 1102**  Literacy Analysis  3
- **ECO 2013**  Principles of Macroeconomics  3
- **ECO 2023**  Principles of Microeconomics  3
- **EVR 1017**  Society and Global Environment  3

#### Third Semester: (16)
- **MAC 2313**  Multivariable Calculus  4
- **PHY 2048**  Physics with Calculus I  4
- **PHY 2048L**  Physics with Calculus I Lab  1
- **CHM 2210**  Organic Chemistry I  4
- **CHM 2210L**  Organic Chemistry I Lab  1
- **ANT 4273**  Law & Culture(SS)  3
- **ECS 3003**  Comparative Economic Systems(SS)  3
- **HUM 4191**  Cultural Heritage & Cultural Change  3
- **INR 4283**  International Relations, Development, and the Third World(SS)  3

#### Fourth Semester: (15)
- **MAP 2302**  Differential Equations  3
- **PHY 2049**  Physics with Calculus II  4
- **PHY 2049L**  Physics with Calculus II Lab  1
- **CHM 2211**  Organic Chemistry II  4
- **CHM 2211L**  Organic Chemistry Lab II  1
- **EML 3343**  Thermodynamics  3

#### Fifth Semester: (16)
- **CHM 3410**  Physical Chemistry I  4
- **CHM 3410L**  Physical Chemistry I Lab  1
- **ECH 3123**  Thermo II for Chem Engineers  3
- **EML 3126**  Transport Phenomena  3
- **EML 3126L**  Transport Phenomena Lab  1
- **EEL 3003**  Electrical Engineering I  3
- **EEL 3111L**  Circuits Lab  1

#### Sixth Semester: (16 or 14)
- **CHM 3411**  Physical Chemistry II  4
- **CHM 3411L**  Physical Chemistry Lab II  2
- **BCH 1010**  General Biology  3
- **BCH 1010L**  General Biology Lab I  1

#### Seventh Semester: (15 or 17)
- **ECH 4641**  Design of Chemical Engineering Processes  3
- **ECH 4242L**  Chemical Engineering Lab I  2
- **EML 4312**  Automatic Control Theory  3
- **ECH 4643**  Design Project I  1
- **EIN 3354**  Engineering Economy  3
- **Technical Elective**  3 or 5

#### Eighth Semester: (16)
- **EML-4xxxL**  Chemical Engineering Lab II  2
- **ECH 4645**  Design Project II  3
- **Technical Elective**  5
- **SSI 3240**  World Prospect and Issues  3
- **WOH 2001**  World Civilization  3

1For students entering the university with at least 36 semester hours, refer to the “General Education Requirements” section and select courses that satisfy the Writing Requirement and the Humanities and Social Science requirements.

2These are four contact hours courses that include a one-hour non-credit tutorial.

3The Design Project is taken in two consecutive semesters during the senior year. The project is initiated during Design Project I and is completed during the Design Project II.

(No new admits at this time)

### Course Descriptions

#### Definition of Prefixes
- **ECH** – Chemical Engineering
- **EGM** – Engineering Mechanics;
- **EGN** – Engineering; General;
- **EMA** – Engineering; Materials;
- **EML** – Engineering: Mechanical

#### EAS 4105 Introduction to Flight Mechanics (3). An introductory level course on the fundamentals of aerospace engineering with emphasis on aerodynamics and airplane performance. Prerequisite: EML 3126.

#### ECH 3123 Chemical Engineering Thermodynamics II (3). Properties of single component systems using corre-
sponding states, non-reacting mix-
tures, phase equilibrium in mixtures,
chemical reactions and thermodynamic
equilibrium in reacting systems. Prere-
quise: EGN 3343 and CHM 1046.

**ECH 3704 Principles of Industrial
Electrochemistry (3).** This course
provides a discussion of the basic principles underlying various
electrochemical processes. The
emphasis is on theoretical principles
involved in plating, refining, winning;
aqueous and fused salts, primary,
secondary and fuel cells. Prerequisite:
CHM 3411.

**ECH 4242 Chemical Engineering
Lab I (1).** Demonstrates thermo-
dynamic, heat, mass and momentum
transport principles through experi-
mental practice. Prerequisite: ECH
3123 and EML 4140.

**ECH 4243L Chemical Engineering
Lab II (1).** Demonstrates reactor
design and control and mass transfer by
diffusion and convection. Prerequisite:
ECH 4242L.

**ECH 4416 Design of Separation
Processes (3).** The design of processes
and systems for the purpose of
separating one or more components
from a mixture. This is to be done by
processes such as distillation,
dehumidification, drying, desorption or
stripping, solvent extraction, leaching
and crystallization. Prerequisites: ECH
3123 and EML 4140.

**ECH 4522 Chemical Reaction Engi-
neering (3).** The design of commercial
reactors considering the influence of
kinetics and transport phenomena
under batch, plug flow and well-stirred
conditions as well as residence time
limited reactors. Prerequisites: ECH
3123, EML 3126, and CHM 3410.

**ECH 4641 Design of Chemical Engi-
neering Process (3).** Specification,
simulation and optimization of process
flow sheets. Component specification
and design considering operability,
environmental impact, safety and
economic viability. Prerequisites: ECH
3123, EML 3126, and CHM 3410.

**ECH 4643 Design Project I (1).**
Design project organization to include
objectives, concept selection, prelimi-
ary and detail design, prototype
development and testing. Oral and
written presentation of design plan by
project team.

**ECH 4645 Design Project II (3).**
Continuation of design project from
Senior Design I. Final Design Report
and presentation. Prototype construc-
tion, performance evaluation, demon-
stration and presentation. Prerequisite:
ECH 4643.

**ECH 4706 Engineering Application
of Electrochemistry (3).** The application of the electrochemical
engineering principles to the analysis of
industrial processes. Emphasis is
placed on electrolysis in aqueous solutions
and in fused salts; electodeposition, electrowinning, and
refining; electrochemical power
systems. Prerequisite: ECH 3704.

**ECH 4826 Corrosion Control (3).**
Various forms of corrosion, including
pitting, stress, crevice, galvanic and
microbial induced corrosion, are
presented. The problems of material
selection, failure analyses and
corrosion control are discussed.
Prerequisites: EGN 3365 and CHM
3411

**EGM 3311 Analysis of Engineering
Systems (3).** Analysis of engineering
problems, from modeling principles to
their solution via linear and nonlinear
differential equations. Lumped para-
meter analysis and numerical methods
available for solutions. Prerequisites:
EGN 3321 and MAC 2313.

**EGM 3503 Applied Mechanics (3).**
Statics and dynamics of solids and
fluids. Science of engineering materi-
als. Open to non-mechanical engineer-
ing students only. Prerequisite: Per-
mission of the instructor.

**EGM 4350 Finite Element Analysis
in Mechanical Engineering (3).** Finite
Element Analysis is developed as a
means to determine stress and de-
formation levels as well as temperature
and heat flux levels in solids. Applica-
tion by means of commercial software.
Prerequisites: CGS 2420 or CGS 2423,
EML 4140 and EMA 3702.

**EGM 4580 Principles of Bioengineer-
ing (3).** Medical instrumentation and
design, regulations for medical devices,
application of computers in medicine,
biomaterials, biocommunications, arti-
ficial implants; clinical engineering.
Prerequisite: Permission of the instruc-
tor.

**EGM 4580L Biomedical Engineering
Lab (1).** Introduction to the principles
of biological signal measurements,
biological data acquisition and image
processing. Prerequisite: Permission of
the instructor.

**EGM 4581 Biomechanics of Cardio-
vascular Systems (3).** Functional
cardiovascular physiology and anat-
omy; analysis and computation of
cardiovascular flow; constitutive pro-
erties of tissue; coronary and systemic
circulation; flow and stress considera-
tions in cardiovascular assist devices.
Prerequisites: EMA 3702 and EML
3126.

**EGM 4582 Engineering Hemody-
namics (3).** Fluid Mechanics of the
circulatory system, rheology of blood,
lubrication mechanics. Prerequisites:
EML 3126 and EML 3126L.

**EGM 4583 Orthopaedic Biomechan-
ic (3).** Introduction to the funda-
amentals of human musculo-skeletal
physiology and anatomy and computa-
tion of mechanical forces as it applies
to orthopaedic biomechanics. Prerequi-
sites: EGN 3321 and EMA 3702.

**EGM 4610 Introduction to Contin-
uum Mechanics (3).** Introduction to
modern continuum mechanics, mathe-
matical preliminaries, stress and equili-
rium, deformations and compatibility,
constitutive equations, balance laws,
problem solution strategies. Prereq-
usites: EMA 3702

**EGM 5315 Intermediate Analysis of
Mechanical Systems (3).** First course
at the graduate level in the analysis of
mechanical systems. Modeling of the
system and analytical and numerical
methods of solution of the governing
equations will be studied. Fluid and
thermodynamic systems will be
emphasized in this course. Prerequi-
sites: EGM 3311, MAP 2302, or
permission of the instructor.

**EGM 5346 Computational Engineer-
ing Analysis (3).** Application of comput-
tational methods to mechanical
engineering problems of translational,
rotational, control, thermal and fluid
systems employing linear/nonlinear
system elements. Prerequisites: EML
2030 or CGS 2420 or CGS 2423, MAP
2302 or EGM 3311, and EML 3222, or
permission of the instructor.

**EGM 5354 Finite Element Method
Applications in Mechanical Engin-
eering (3).** Utilize the finite element
method to solve problems in heat
transfer, fluid dynamics, diffusion,
acoustics, vibrations, and electromag-
netism, as well as the coupled inter-
action of these phenomena. Prerequi-
EGN 5990 Fundamentals of Engineering (3). A mid-level course addressing the selection of engineering materials based on static and dynamic loadings, environmental analysis and the experimental analysis of mechanical systems. Emphasis on metals and composite materials. Prerequisite: EGN 3311.

EMA 3702 Mechanics and Materials Science (3). A mid-level course covering reactive and nonreactive phase diagrams and reactions within solid materials. Prerequisite: CHM 1045, MAC 2311 and PHY 2048.

EGN 5367 Industrial Materials and Engineering Design (3). Industrial materials, material selection, and engineering design process, including synthesis, analysis, optimization, and evaluation.


EMA 3066 Polymer Science and Engineering (3). Introduction to molecular structure; property relationships; preparation, processing and applications of macromolecular materials. Prerequisite: EGN 3365.

EMA 3702 Mechanics and Materials Science (3). A mid-level course addressing the selection of engineering materials based on static and dynamic loadings, environmental analysis and the experimental analysis of mechanical systems. Emphasis on metals and composite materials. Prerequisite: EGN 3311.


EMA 4121 Physical Metallurgy (3). Correlation of properties; structural, mechanical, and thermal history and service behavior of various metals and their alloys. Prerequisite: EGN 3365.

EMA 4121L Materials Laboratory (1). Laboratory techniques in materials, including metallography, mechanical testing, heat treatment and non-destructive testing techniques. Prerequisite: EGN 3365.

EMA 4223 Mechanical Metallurgy (3). Fundamentals of plastic deformation of crystalline solids: elementary theory of statics and dynamics of dislocations; applications to deformation of single crystals and polycrystals; fracture of metals. Prerequisites: EGN 3365 and EMA 3702.

EMA 5295 Principles of Composite Materials (3). The mechanical behavior of composite materials used in the automotive, aircraft and sporting goods industries. Material and laminar properties; design of composites; failure analysis; and environmental effects. Prerequisite: EGM 5615 or permission of the instructor.

EMA 5507C Analytical Techniques of Materials Sciences (3). Fundamental theories and techniques of the analytical methods for materials including: X-ray diffraction, scanning and transmission electron microscopy, thermal and surface analysis, and vacuum systems. Prerequisite: EGN 3365.

EMA 5584 Biomaterials Science (3). Materials used in prostheses for skin and soft tissue, vascular implant devices, bone repair, and artificial joints. Structure-property relationships for biological tissue. Prerequisites: EGN 3365, and EMA 3702.

EMA 5935 Advanced Topics in Materials Engineering (3). Topics include thermodynamics of solids, principles of physical metallurgy, including phase transformation and diffusion and analytical methods in materials engineering. Prerequisites: EGN 3343 and EGN 3365.

EMC 5415 Digital Control of Mechanical Systems (3). Discrete modeling of mechanical systems. Digital feedback with emphasis on hydraulic, pneumatic and electro-mechanical devices. Prerequisite: EML 4312.

EML 2030 Software for Mechanical Design (3). Students will use software to develop solid models and a mathematical software package to solve mechanical engineering problems. A programming language will be used to define input parameters. Prerequisite: EGN 1100 or EML 3006, Corequisite: MAC 2313.

EML 3006 Concepts of Engineering (2). Provide a broad exposure, “birdseye” view, of the engineering profession to junior and senior transfer students. To be completed within two terms after admission to the ME program.

EML 3101 Thermodynamics II (3). Continuation of Thermodynamics I covering reactive and nonreactive
mixtures and various thermodynamic cycles. Prerequisite: EGN 3343.

**EML 3126 Transport Phenomena (3).** Fundamental principles of transport phenomena; Governing Equations; Compressible Flow. Prerequisite: EGN 3321 or EGN 3343, and MAP 2302 or EGM 3311.

**EML 3126L Transport Phenomena Laboratory (1).** Experiments illustrating the principles of transport phenomena: wind tunnel, shock tubes, airfoils. Prerequisite: EGN 3321, Corequisite: EML 3126.

**EML 3222 System Dynamics (3).** Introduction to modeling of mechanical systems; derivation of system equations and response of fluid, thermal, and vibrational systems. Available solution methods will be discussed. Prerequisites: EGN 3321, EMA 3702, and EML 2030 or CGS 2420 or CGS 2423.

**EML 3262 Kinematics and Mechanism Design (3).** Fundamentals of kinematics and mechanism design; study of the mechanisms used in machinery and analysis of their motion. Two and three dimensional analytical and numerical methods of computer application. Design is emphasized. Prerequisites: EGN 3321, EML 2030 or CGS 2420 or CGS 2423.

**EML 3301C Instrumentation (3).** A practical study of common instrumentation techniques. The use of instrumentation and measurement methods to solve problems is emphasized. Prerequisite: EEL 3003 or EEL 3111.

**EML 3301L Instrumentation and Measurement Laboratory (1).** A practical study of common instrumentation elements and measurement systems used in mechanical and electro-mechanical applications. Prerequisite: EEL 3111L.

**EML 3450 Energy Systems (3).** Review of theory and engineering aspects of conventional energy conversion systems, fuels and combustion, fossil fuels, and nuclear power plants. Aspects of direct energy conversion. Prerequisite: EML 3101.

**EML 3500 Mechanical Design I (3).** Design of basic machine members including shafts, springs, belts, clutches, chains, etc. Prerequisites: EGN 3321, EMA 3702, and EGN 3365.

**EML 4140 Heat Transfer (3).** Study of the fundamentals of heat transfer including conduction, convection, and radiation. Computer applications and design problems emphasized. Prerequisites: EML 2030 or CGS 2420 or CGS 2423, EGN 3343, EML 3126, and MAP 2302 or EGM 3311.

**EML 4220 Mechanical Vibrations (3).** Theory and application of mechanical vibrations. Includes damped and undamped vibrations with one or more degrees of freedom. Computer methods emphasized. Prerequisites: EGN 3321, EMA 3702, and EML 2030 or CGS 2420 or CGS 2423.

**EML 4246 Tribological Design for Machines and Elements (3).** Introduction to friction and wear, analysis of tribological systems, and applications of Tribological Principles to machine and machine element design. Prerequisite: EML 4501 or permission of the instructor.

**EML 4260 Dynamics of Machinery (3).** Acceleration and force analysis of reciprocating and rotating mechanisms and machines. Dynamic balancing of idealized systems. Torsional and lateral critical speeds of a rotor and self-excited instability. Prerequisite: EML 3262.

**EML 4312 Automatic Control Theory (3).** Feedback control systems; stability analysis; graphical methods. Applications with emphasis on hydraulic, pneumatic and electro-mechanical devices. Prerequisites: EGN 3321, MAP 2302 or EGM 3311, EML 2030 or CGS 2420 or CGS 2423.

**EML 4410 Combustion Processes (3).** Introduction to combustion pro cesses, thermochemistry, chemical kinetics, laminar flame propagation, detonations and explosions, flame-mobility and ignition, applications in IC engines and gas turbines. Prerequisites: EML 3101 and EML 4140.

**EML 4419 Propulsion Systems (3).** Basics of air breathing and rocket engines used in flight systems, gas turbine and ramjet fundamentals. Introduction to compressor and turbine design. Propulsion performance. Unconventional means of propulsion in space. Prerequisites: EML 3101 and EML 3126.


**EML 4501 Mechanical Design II (3).** Continuation of design analysis of elementary machine elements, including lubrication bearings, and gearings. Introduction to advanced analysis techniques. Prerequisite: EML 3500.

**EML 4503 Production Machine Modeling and Design (3).** The modeling of metal removing, forming, and polymer processing operations will be introduced. The design of production machines will be discussed based on the models. Prerequisites: EGN 3365, EMA 3702, and EIN 3390.

**EML 4535 Mechanical Computer Aided Design (3).** Introduction to the use of computers in the design process. Course emphasizes the use of interactive computing and computer graphics in developing CAD applications. Programming project is required. Prerequisite: EML 2030.

**EML 4551 Design Project Organization (1).** Design project organization to include objectives, concepts selection, preliminary and detail design, prototype development and testing. Oral and written presentation of design plan by project team. Prerequisite: EML 3301L, Corequisites: EML 4501, EML 4706, and EIN 3354.

**EML 4561 Introduction to Electronic Packaging (3).** Introduction to mechanical packaging of electronic systems. Integrates concepts in mechanical engineering to the packaging of electronic systems, such as hybrid microelectronics. Prerequisites: EEL 3003 or EEL 3111, and EEL 3111L.

**EML 4585 Design of Biomedical Systems and Devices (3).** Mechanical design and material choices of various biomedical systems and devices such as cardiovascular assist devices, total artificial heart, pulmonary assist devices, total hip prostheses and other orthopaedic devices. Prerequisites: EGN 3365, EMA 3702, EML 3126 or permission of the instructor.

**EML 4601 Refrigeration and Air Conditioning (3).** Application of principles of Heating, Ventilation, Refrigeration, and Air Conditioning to design problems. Prerequisite: EML 3101 or permission of the instructor.
EML 4601L Refrigeration and Air Conditioning Lab (1). Experiments in Air Conditioning and Refrigeration applications. Corequisite: EML 4601.

EML 4603 Air Conditioning Design (3). Psychrometry comfort; mechanical refrigeration; heat pumps, load calculations; cooling coil performance; heating and humidification; distribution duct and fan design. Prerequisites: EML 3101 and EML 4140 or permission of the instructor.

EML 4608C Mechanical Systems in Environmental Control (3). Analysis of refrigeration, heating and air distribution systems. Synthesis of environmental control systems. Prerequisite: EML 3101.

EML 4702 Fluid Dynamics (3). A mid-level course on ideal fluid flow, compressible flow and viscous flow. Analysis and numerical techniques of continuity and Navier-Stokes equation for incompressible and compressible flow. Prerequisite: EML 3126.

EML 4706 Design of Thermal and Fluid Systems (3). Design of thermal and fluid systems and components. Piping networks, duct works. Selection of pumps and fittings. Basic design of heat exchangers, turbomachinery, pumps, and fans. Prerequisites: EML 3101 and EML 4140.

EML 4711 Gas Dynamics (3). Basic equations of motion for the flow of a compressible fluid, isentropic flow, normal and oblique shock waves, linearized flows method of characteristics and supersonic thin-airfoil theory. Prerequisites: EML 3126 and EGN 3343.

EML 4804 Introduction to Mechatronics (3). This course will introduce computer controlled precise motion generation in smart machines. Prerequisite: EML 3301L.


EML 4823 Introduction to Sensors and Signal Processing (3). This course will introduce the basic sensors and signal processing techniques for design and development of smart products. Prerequisite: EML 3301L.

EML 4905 Senior Design Project (3). Project course introducing methods of research; a survey, analysis, or apparatus project in mechanical engineering or research on a current problem in engineering. Prerequisites: EML 3301L and permission of the advisor. Co-requisites: EML 4501, EML 4706.

EML 4906L Mechanical Lab (1). Experiments with various types of mechanical equipment including engines, fans, boilers, pumps, motions and mechanics. Prerequisites: EGN 3343 and EML 3126.

EML 4930 Special Topics/Projects (1-3). Individual conferences, assigned readings, and reports on independent investigations selected by the students and professor with approval of advisor.

EML 4949 Co-op Work Experience (3). Supervised full-time work experience in engineering field. Limited to students admitted to the co-op program with consent of advisor. Evaluation and reports required.

EML 5103 Intermediate Thermodynamics (3). Thermodynamic approach to processes and engines; alternative formulations and legendre transformations; maxwell relations, first and second order phase transitions. Prerequisite: EML 3101.

EML 5104 Classical Thermodynamics (3). Mathematical analysis of the laws of classical reversible and irreversible thermodynamics. Applications to mechanical, electro-magnetic, and chemical systems. Prerequisite: EML 3101.


EML 5385 Identification Techniques of Mechanical Systems (3). FFT, time series analysis and neural networks are introduced. Applications of these techniques are discussed for identification of mechanical structures and machine diagnostics. Prerequisite: EML 4312.

EML 5412 Combustion Processes (3). Introduction to combustion processes, thermochemistry, chemical kinetics, laminar flame propagation, detonations and explosions, flammability and ignition, applications in IC engines and gas turbines. Prerequisites: EML 3101 and EML 4140.

EML 5509 Mechanical Design Optimization (3). Finite element analysis and sensitivity analysis combined with numerical optimization techniques to optimize design. Prerequisite: EGM 5354 or permission of the instructor.

EML 5505 Smart Machine Design and Development (3). Design of independently operating smart electromechanical systems (most consumer products) which monitor their environment, give decisions, and create motion. Prerequisite: EML 4312 or consent of the instructor.


EML 5519 Fault-Tolerant System Design (3). Fault tolerance in mechanical, manufacturing, computer, and aerospace systems. Basic stages of fault isolation. Fault tolerance measures, architectures, and mechanical system design methodologies. Prerequisite: EML 3500.

EML 5528 Digital Control of Mechanical Systems (3). Discrete modeling of mechanical systems. Digital feedback systems. Computer interface with mechanical systems. Controller design with emphasis on hydraulic, pneumatic and electromechanical devices. Prerequisite: Permission of the instructor.

kinematic systems will be emphasized. Prerequisite: EML 4535 or permission of the instructor.

EML 5562 Advanced Electronic Packaging (3). Advanced topics in electronic packaging. Evaluation of first through fourth level assembly. Applications of computer layout design, thermal management and mechanical stability analysis. Prerequisite: EML 4561 or permission of the instructor.

EML 5599 Heat Pipe Theory and Applications (3). Heat pipe theory, heat pipe design and its applications, especially in the areas of energy conversion and conservation. Prerequisites: EML 3101 and EML 4140.

EML 5606C Advanced Refrigeration and Air Conditioning Systems (3). The various methods used in the thermal design and analysis of both refrigeration and heat pump systems are investigated. Various methods of producing heating and cooling are examined including vapor compression, absorption, air cycle, steam jet, thermoelectric, solar heating and cooling systems. Prerequisite: EML 4601.

EML 5615C Computer-Aided Design in Air Conditioning (3). Software will be used to demonstrate heating, ventilating and air conditioning design concepts and sizing equipment & determining performance parameters. Project design is required. Prerequisites: EML 2030 or CGS 2420 or CGS 2423, and EML 4601.

EML 5708 Advanced Design of Thermal and Fluid Systems (3). Advanced designs of pumps, compressors, heat exchangers, HVAC systems and thermal and fluid control devices. Prerequisite: EML 4706.

EML 5709 Intermediate Fluid Mechanics (3). Basic concepts and scope of fluid dynamics; non-inertial reference frames. Two-dimensional potential theory. Applications to airfoils. The Navier-Stokes equations; selected exact and approximate equations. Prerequisite: EML 3126.

EML 5748 Boundary Layer Theory (3). Advanced fluid dynamic analysis of the Navier-Stokes equations, using boundary layer assumptions. Focus will be on solutions of thermal and fluid boundary layers. Prerequisite: EML 3126.


EML 5825 Sensors and Applied Machine Intelligence (3). Sensors, signal analysis techniques, and error compensation methods will be introduced for machine intelligence. Prerequisites: EML 4312, EML 4503, or equivalent, or permission of the instructor.