Academic Year 2010 - 2011

Departments of:

Electrical and Computer Engineering &
Mechanical and Materials Engineering

School of Engineering and Computer Science

BSCPE
Computer Engineering

BSEE
Electrical Engineering

BSEE-MSE
Concentration in Mechatronic Systems Engineering

BSME
Mechanical Engineering

BS/MS

BS/MBA
DEGREE PROGRAMS

Four-Year Programs
Bachelor of Science in Computer Engineering (BSCPE)
Bachelor of Science in Electrical Engineering (BSEE)
Bachelor of Science in Electrical Engineering with a Concentration in Mechatronics Systems Engineering (BSEE-MSE)
Bachelor of Science in Mechanical Engineering (BSME)

Five-Year Programs
Five-Year Dual-Degree Programs with a BS in Math, Science or Engineering and MS in Engineering (CPE, EE, ME or Mechatronic Systems Engineering)

Five-Year Coordinated Programs with the Daniels College of Business (BSCPE/MBA, BSEE/MBA, BSME/MBA)
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I. MISSION AND OBJECTIVES

Mission
The mission of the Electrical and Computer (ECE) and the Mechanical and Materials (MME) Engineering Departments of the University of Denver at the undergraduate level is: to offer programs that support and complement the mission of the University of Denver; to provide a general undergraduate education in mechanical, computer, and electrical engineering that prepare students for either employment or graduate study; to include interdisciplinary engineering work in all programs; to encourage the professional status of the faculty, and to foster the professional awareness of the students. This statement concisely sums up the goals and objectives of our programs.

Educational Objectives
In order that we and our undergraduates attain these goals, we have developed a distinctive set of engineering programs. These undergraduate programs stress the development of fundamental concepts, ideas, and design processes. The educational objectives for the computer, electrical and mechanical engineering programs are:

I. Graduates will apply broad industry relevant communication and teamwork skills that will enable their career and professional accomplishments.
II. Graduates will demonstrate strong abilities in the fundamentals of engineering.
III. Graduates will apply the knowledge from their undergraduate education to creatively and systematically solve engineering problems using the appropriate tools and technology.
IV. Graduates will apply the design (including interdisciplinary systems) and laboratory skills expected of practicing engineers.
V. Graduates will flourish professionally in an increasingly global, dynamic and competitive marketplace and work environment.

Program Components
All of our engineering programs have several components:
1. The University of Denver’s Common Curriculum, which includes First-year Seminar, Writing and Rhetoric, Ways of Knowing, and Advanced Seminar;
2. Basic sciences and mathematics, including chemistry, physics, and mathematics;
3. A common engineering background, with contributions from basic material in Computer, Electrical, and Mechanical Engineering;
4. A four-year integrated engineering sequence, stressing engineering design and project work, much of which is interdisciplinary and involves constructive teamwork;
5. An engineering discipline (Computer Engineering, Electrical Engineering, Mechanical Engineering);
6. A specialization giving the discipline more depth, or complementing it, according to the student’s individual interests.

Engineering Design
The feature of engineering programs which most differentiates them from programs in basic or applied science and mathematics is engineering design, which is both an art and a science. Our programs feature a four-year stem of course work required of all students, regardless of curriculum, which emphasizes design, project work, team-work, and the application of scientific and technical knowledge and design skills already acquired to the solution of interdisciplinary engineering problems. As the student progresses in the curriculum, more and more reliance is placed on previous work, and more realistic constraints and considerations are required for success. The sequence culminates in a three-quarter capstone design project carried out in the final year. Additional design work is contained in specialized courses.

Assessment of Programs
Integral to the improvement of our programs is the concept of assessment. We regularly evaluate how well our students are meeting the eight outcomes we aim for via student work, student evaluations, student performance on
two examinations [one administered by us at the end of the second year, and the national Fundamentals of Engineering Examination (requirement of Mechanical Engineering students) taken in the final year of study], student exit interviews, polling of recent alumni on the degree to which they feel we have met our goals, and other indicators (such as employer satisfaction, scholarships, awards, acceptance for graduate study, etc.). We then use this information to improve our programs to meet changing needs and circumstances.

Accreditation
The University of Denver is accredited by the Higher Learning Commission of the North Central Association of Colleges and Schools.

The Computer, Electrical, and Mechanical engineering bachelor degrees are accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700).

The Daniels College of Business is accredited by the Association to Advance Collegiate Schools of Business (AACSB) International.
II. ENTRANCE REQUIREMENTS AND ADVISING

First Year Students
Students should be prepared to take Calculus and University Physics in the first year. Students unprepared to take Calculus in the Autumn quarter should take MATH 1750 in the Autumn, followed by the regular Calculus sequence in the remaining two quarters, and the first quarter of the second year. Students should start the University Physics sequence (PHYS 1211, 1212, 1214) in the Winter quarter and finishing in the Autumn quarter of the second year. Delaying any of these basic science and mathematics courses may add an extra year to the student’s program of study.

Transfer Students
After acceptance to the University, engineering transfer students should submit a transcript to the appropriate engineering department to receive credit for engineering courses taken elsewhere. All engineering course work must be validated by the appropriate engineering department before it can be transferred. It should be noted that some engineering courses do not transfer for some of the following reasons:

1. There is no equivalent course offered at the University of Denver.
2. The content of the course differs significantly from the apparently equivalent course offered at the University of Denver.
3. No course having a grade less than “C” can be transferred to the University of Denver. No more than 138 quarter hours may be transferred from four-year institutions or 90 quarter hours, from two-year institutions.
4. Courses taken as part of an engineering technology program often do not transfer even if titles are similar, as the theoretical background required in technology courses is usually quite different from that required in engineering courses.

Advising of transfer students will be an effort coordinated between the student’s advisor and a faculty member in the specific area of study.

A transfer student may be asked to submit a detailed course syllabus and a copy of the text used to aid in determination of the transfer of credit for a course. If it is determined that the student has completed much of the topical material of the course, but is missing an essential component, such as a laboratory or significant project work, the student may be permitted to take only the missing component under ENGR 3991, Independent Study, and may not be required to take the entire course.

Laptop Requirements
With the considerations of hardware, software, and lab workbench space, the engineering departments highly recommend ALL incoming engineering students purchase the Dell Latitude E4300 or E4310. For more detailed requirements, please refer to the laptop requirements link on the University Technology Services website at http://www.du.edu/uts/laptops/purcheng.html.

The engineering faculty has tested this particular laptop model with all of the required software and laboratory hardware which your laptop will need to communicate. If you have a laptop which is not recommended by the engineering departments, you will mostly likely encounter difficulties with operating some of the software and/or interfacing with some of the hardware. When this occurs you will need to make other arrangements with the instructor for completing the assignments.

AP Credits
The University of Denver accepts AP credits. Some AP credits apply towards engineering program requirements. Among the most common are:

- **English**: An AP score of 5 gives 8 credit hours exemption including WRIT 1122; a score of 4 gives 4 credit hours exemption from WRIT 1122; and a score of 3 allows for Advanced Standing in the First-Year English sequence.
- **Calculus (BC)**: An AP score of 5 gives 12 credit hours exemption from MATH 1951, 1952 and 1953; a score of 4 gives 8 credit hours exemption from MATH 1951, 1952; and a score of 3 gives 4 credit hours including exemption from MATH 1951.

Entrance Requirements and Advising 2010-11
Calculus (AB): An AP score of 5 gives 8 credit hours exemption from MATH 1951, MATH 1952; and a score of 4 gives 4 credit hours exemption from MATH 1951.

Chemistry: An AP score of 5 gives 12 credit hours exemption including CHEM 1010/1610 and 1040 and 8 quarter hours of Chemistry electives; and a score of 4 gives 8 credit hours exemption from CHEM 1010/1610 and 1040 and 4 quarter hours of Chemistry electives.

Physics: An AP score of 4 or 5 gives 10 quarter hours exemption.

**IB Credits**
The University of Denver accepts IB credits. Some IB credits apply towards engineering program requirements. Among the most common are:

**English:** An IB score of 7, 6 or 5 gives 4 credit hours exemption from WRIT 1122 and a score of 4 allows for Advanced Standing in the First-Year English sequence.

**Chemistry:** An IB score of 7 or 6 gives 12 credits hours including exemption from CHEM 1010 and 1040 and 8 quarter hours of Chemistry electives and a score of 5 gives 12 credits hours exemption including exemption from CHEM 1010 and 1040 and 4 quarter hours of Chemistry electives.

**Physics:** IB score of score of 7, 6 or 5 gives 10 credit hours including exemption from PHYS 1111 and 1113.

**Advising**
Entering **First-Year students** all have Faculty Mentors who also teach their First-Year Seminar course. These faculty members assist students in adjusting to the university setting and provide academic advising. This Faculty Mentor is assigned as the first-year student’s academic advisor. Even though most of these Faculty Mentors are not Engineering Advisors, all Faculty Mentors will be informed of courses that engineering students should take before registration advising begins. In addition, you will also be assigned a faculty advisor from one of the engineering departments. Your progress through the program will be monitored by your engineering faculty advisor to determine if you are registering for the correct courses during the first year.

A helpful tool in determining your progress through the engineering curriculum is the Academic Progress Report (APR). This report is available to the student through webCentral or myWeb. Students can track their progress year-by-year and find out all of the required courses for graduation.

If a student decides to study engineering after the start of autumn quarter, they should talk to one of the Engineering Associate Chairs to process a change of major. **Transfer students** also need to talk to an Associate Chair of the appropriate department to obtain advice on curriculum planning.

At the beginning of each advising period, each student must contact his/her advisor about which courses to register. The advisor will then delete the alternate personal identification number (PIN) assigned to that student so that he/she can register for courses. If the student is unsure who their advisor is, he/she should either contact one of the engineering departments to find out the name of the advisor or locate this information through webCentral.

Upon completion of the first-year engineering curriculum, students are assigned to an engineering advisor. The second year is the year in which the student should explore the engineering opportunities available, and make a decision on which engineering discipline best fits his or her individual interests and abilities. The student’s engineering advisor can help the student’s decision on an engineering discipline.

At the end of the second year, once the decision on a specific program (BSCPE, BSEE, BSME) has been made, an advisor from that program will be assigned; this will most likely be the student’s advisor for the remainder of the program. Students admitted into the coordinated programs with the Daniels College of Business (DCB) will have a co-advisor from DCB. Students who are admitted to the 5-year BS and MS program in engineering will have advisors for both programs. Students should feel free to contact their advisor throughout the year to discuss any areas of interest or concern. We pride ourselves on having one of the best academic advising systems at the University of Denver.

**Minors for Engineering Students**
A minor (20-25 quarter hours) is a program of courses in a secondary area of concentration. Individual departments establish requirements for a minor and these are listed in the Undergraduate Bulletin. Not all of the possible majors
at DU offer minors, some programs are only offered as minors, and not all minor are available to engineering students. Please consult the Undergraduate Bulletin for a list of available minors.

Since there are many courses outside of engineering that are required of engineering students, there are several minors that an engineering student can obtain without taking any extra courses or with just a few extra courses. Most engineering students will be able to qualify for a minor in math without needing to take any additional courses. Students who get D’s in more than one required math course will not be able to meet the minimum requirement for a minor since the D’s are not counted for a minor. A minor in physics can be obtained by taking six additional quarter hours. Other minors that have reduced requirements for engineering students are chemistry and computer science.

Engineering curricula have only minimal opportunities for taking extra courses. Unless a student comes into DU with AP, IB or transfer credit or is willing to take summer courses, adding a minor may mean that additional time is required to complete the degree.

**Minor in Computer Engineering**

A student in Electrical or Mechanical Engineering can get a minor in Computer Engineering. Computer Engineering minor requires at least 20 credit hours of ENCE courses numbered 2000 or higher. With prior approval of the department, courses outside of the discipline can be applied to the minor. ENCE courses that are required of all engineering students do not count towards a minor in Computer Engineering.

**Minor in Electrical Engineering**

A student in Computer or Mechanical Engineering can get a minor in Electrical Engineering. Electrical Engineering minor requires the student take ENEE 2222 Advanced Electronics, ENEE 3111 Signals and Systems, and an additional 12 credit hours of ENEE courses numbered 2000 or higher. With prior approval of the department, courses outside of the discipline can be applied to the minor. ENEE courses that are required of Computer or Mechanical Engineering students do not count towards a minor in Electrical Engineering.

**Minor in Mechanical Engineering**

A student in Computer or Electrical Engineering can get a minor in Mechanical Engineering. Mechanical Engineering minor requires the student take ENME 2410 Materials Science I or ENME 2651 Fluid Mech/Heat Transfer I and an additional 17 credit hours of ENME courses numbered 2000 or higher. With prior approval of the department, courses outside of the discipline can be applied to the minor. ENME courses that are required of all engineering students do not count towards a minor in Mechanical Engineering.
III. PROGRAM DESCRIPTIONS AND CURRICULA

Degree Programs
The ECE and MME Departments at the University of Denver offer programs leading to the following degrees in 4 years of study: the Bachelor of Science in Computer Engineering (BSCPE); the Bachelor of Science in Electrical Engineering (BSEE); the Bachelor of Science in Electrical Engineering (BSEE) with a concentration in Mechatronic Systems Engineering (MSE); the Bachelor of Science in Mechanical Engineering (BSME).

The ECE and MME Departments offer Five-Year Dual-Degree Programs with a BS in Computer Science or an engineering discipline and a MS in any of the engineering disciplines. The ECE and MME Departments and the Daniels College of Business also offer programs leading to an engineering degree and a Master of Business Administration (MBA) in 5 years of study.

Course of Study
Engineering curricula are highly structured; acquisition of certain knowledge and skills must precede acquisition of more advanced ones. There is thus very little flexibility in the order in which courses must be completed, and there are few electives. Most engineering courses are offered only once a year, so an omission or deletion can add a year to the time required to complete the degree program. Although a high percentage of our students graduate in four years, it should be noted that, nationwide, nearly half of all engineering graduates take more than four years to complete their degrees, so students should not become discouraged if this is needed. The additional year may also be used to acquire additional expertise.

Engineering Common Curriculum: The curricula in all programs are the same for the first two years; a student can delay choosing an engineering major until the beginning of the third year.

Advanced Curriculum (Four Year Program):
The curricula for the last two years have several components:
1. Advanced work in the engineering discipline chosen;
2. Integrated engineering project work and design;
3. Development of a specialized area (details of the areas of specialization for each degree program are given later in this booklet);
4. Completion of the University of Denver Common Curriculum

Advanced Curriculum (Five-Year Duel-Degree (BS/MS) Program):
The curricula for the last three years have several components:
1. Advanced work in the engineering discipline chosen;
2. Integrated engineering project work and design;
3. Completion of the University of Denver Common Curriculum;
4. Completion of the requirements for the MS in the engineering discipline.

Advanced Curriculum (Five-Year Program with MBA):
The curricula for the last three years have several components:
1. Advanced work in the engineering discipline chosen;
2. Integrated engineering project work and design;
3. Completion of the University of Denver Common Curriculum;
4. Completion of the requirements for the MBA.

It should be noted that these five-year curricula are highly intensive, and there is little opportunity to develop a specialization without further study.

Special Requirements for Dual Engineering Degrees (BSCPE, BSEE, BSME and MS) Programs
Prior to entering the fourth year of study, the student must take the Graduate Record Exam (GRE), and apply to be admitted to the Graduate Engineering Program. Prior to completing the graduate application, the student must work with an engineering advisor or advisors (for the case of different disciplines) to develop a plan for completing both degrees. The curriculum plan is to be submitted along with the application. A minimum GPA of 3.2 is required for admission to the program.
The MS degree requires 45 credit hours and up to 9 of these hours can be counted toward the technical elective requirement of the undergraduate engineering degree. As a result the minimum number credit hours required to complete both degrees is 228 (192 - 9 + 45) for the BSME, 234 (198 – 9 + 45) for the BSEE and BSCpE, and 238 (202 – 9 + 45) for the BSEE with a concentration in Mechatronic Systems Engineering.

Special Requirements for the Coordinated Engineering/MBA Programs

Prior to entering the fourth year of study, the student must take the Graduate Management Admission Test (GMAT), and apply and be admitted to the Graduate School of the Daniels College of Business. Typically, a minimum score of at least 590 on the GMAT is required for admission, as well as a 3.00+ grade point average over the previous two years of study. It is strongly recommended that students take the GMAT and apply prior to March 15 of the third year to assure admission for the following fall. An orientation is required just prior to entrance into the MBA Program. For students entering in the Autumn Quarter, this session occurs the weeks just preceding the Autumn Quarter and for the Spring Quarter it is held during Spring Break.

The MBA requires 64 credit hours with 20 credits to fulfill the Daniels Compass courses and 44 credits for the MBA core. A student can get a concentration by fitting in an extra 16 credits. The degrees are awarded concurrently upon completion of the requirements for both. For purposes of financial aid, the student is considered an undergraduate while completing both degrees. A student can complete the requirements for both degrees in a total of five years because an MBA engineering student can count a total of 16 graduate credit hours toward the undergraduate degree.

As these programs must meet the standards of two different accrediting agencies, there may be changes made to the curricula as stated in this booklet. Students must check with advisors in both engineering and the Graduate School of the Daniels College of Business during preregistration periods to ensure that they are taking the required courses for both degrees.
Degree Plans
### Bachelor of Science in Computer Engineering (BSCpE)

#### Sample Schedule:

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<tr>
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<th>Fall</th>
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<td>FSEM 1111 - First Year Seminar</td>
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<td>4 MATH 1953 - Calculus III</td>
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<td>ENGR 1521 - Engineering Connections II</td>
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<td>ENGR 1621 - Engr Concepts &amp; Practice II</td>
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<td>COMP 1571 - Procedural Programming I</td>
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<td>COMP 1572 - Procedural Programming II</td>
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<td>PHYS 1214 - Univ Physics III for Engineers</td>
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<td>MATH 2070 - Intro to Diff. Equations</td>
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<td>ENME 2510 - Engineering Mechanics I</td>
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<td><strong>Third Year</strong></td>
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<td>ENCE 3100 – Advanced Digital Design</td>
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<td>ENEE 2211 – Electronics</td>
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<td>ENCE 3210 - Microprocessor Systems I</td>
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<td>ENEE 3111 - Signals and Systems</td>
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<td>ENCE 3241 – Comp. Organization &amp; Arch</td>
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<td>ENGR 3610 - Engineering Analysis</td>
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<td>ENGR 2610 - Engineering Integration I</td>
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### Fourth Year

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<td>ENGR 3323</td>
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<td>ENGR 3333</td>
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<td>ENCE 3261</td>
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<td>COMP 3361</td>
<td>Operating Systems I</td>
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<td>ENGR 3951</td>
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<td>ENCE 3501</td>
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<td>LGST XXXX</td>
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<td>ENGR 3970</td>
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**Required Total Hours** 198 QH

*NOTES

**University Common Curricula**  These may be taken in any order. They must have 2 courses with attributes of analytical inquiry: society and 2 courses attributes of scientific inquiry: society.

**ASEM 2XXX - Advanced Seminar**  Engineering students are required to take a writing-intensive advanced seminar. Junior standing is also required.

**OOOO - Math Elective.**  The Math Elective may be any course offered in which the student has an interest and which is at the 2000 level or above.

**XXXX - Technical Elective.**  Technical Electives are used to complete specializations for the degree. Only technical courses may be used, and these must carry Upper-Division credit. Prior approval by the advisor is required.

**These hours can vary based on Technical Electives.**
BSCPE Specializations

A specialization is required for the BSCPE. The student must complete a minimum of 10 quarter hours from one of the following specializations:

**Communications, DSP and Networking**
- ENEE 3130 Principles of Comm Systems 3 QH
- ENEE 3141 Digital Communications 3 QH
- ENEE 3150 Communication Systems Lab 3 QH
- ENEE 3670 DSP 4 QH
  
  *Special Topics or Independent Study as appropriate for this option*

**Robotics, Embedded Systems and Instrumentation**
- COMP 3501 Intro to Artificial Intelligence 4 QH
- COMP 3801 Introduction Computer Graphics 4 QH
- ENCE 3231 Embedded Microprocessors 3 QH
- ENCE 3620 Computer Vision 4 QH
- ENCE 3630 Pattern Recognition 4 QH
- ENGR 3721 Controls 3 QH
- ENGR 3730 Robotics 3 QH
  
  *Special Topics or Independent Study as appropriate for this option*

**Computer Systems Engineering**
- COMP 3352 Elements of Compiler Design 4 QH
- COMP 3694 Advanced Computer Architecture 4 QH
- ENCE 3231 Embedded Microprocessors 3 QH
  
  *Special Topics or Independent Study as appropriate for this option*

**Individualized Option**
Eight quarter hours of upper division technical courses selected with advisor’s approval. A letter signed by the student’s advisor giving the reason for the courses selected must be on file in the student’s records.
# Bachelor of Science in Computer Engineering / MBA (BSCpE/MBA)

**Sample Schedule:**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENCE 3261 Fault Tolerant Computing</td>
<td>ENGR 3323 Engineering Design Project II</td>
<td>ENGR 3333 Engineering Design Project III</td>
</tr>
<tr>
<td>ENCE 3501 VLSI Design</td>
<td>COMP 3361 Operating Systems I</td>
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<tr>
<td>ENGR 3313 Engineering Design Project I</td>
<td>FIN 4630 Managerial Finance</td>
<td>MGMT 4620 Organizational Dynamics</td>
</tr>
<tr>
<td>STAT 4610 Quantitative Methods</td>
<td>MKTG 4610 Marketing Strategy</td>
<td>MBA Elective</td>
</tr>
<tr>
<td>ACTG 4610 Financial Accounting</td>
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<td>15 QH</td>
</tr>
<tr>
<td><strong>Fourth Year</strong></td>
<td><strong>Fifth Year</strong></td>
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<tr>
<td>ENCE 3xxx Technical Elective</td>
<td>BUS 4620 Ethics - 21st Century Professional</td>
<td>ENGR 3951 Engineering Assessment II</td>
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<td>ACTG 4660 Strategic Cost Management</td>
<td>MGMT 4690 Strategic Management</td>
<td>BUS 4630 Creating Sustainable Enterprise</td>
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<td>BUS 4610 The Essence of Enterprise</td>
<td>MBA Elective</td>
<td>ITEC 4610 Information Technology Strategy</td>
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<td>MGMT 4630 Strategic Human Resources</td>
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</table>

*NOTES*

**University Common Curricula** These may be taken in any order. They must have 2 courses with attributes of analytical inquiry: society and 2 courses attributes of scientific inquiry: society.

**ASEM 2XXX - Advanced Seminar** Engineering students are required to take a writing-intensive advanced seminar. Junior standing is also required.

**XXXX - Technical Elective.** Technical Electives are used to complete specializations for the degree. Only technical courses may be used, and these must carry Upper-Division credit. Prior approval by the advisor is required.
# Bachelor of Science in Electrical Engineering (BSEE)

**Sample Schedule:**

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<tr>
<th>Semester</th>
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<th>Winter</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td><strong>First Year</strong></td>
<td></td>
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<td><strong>Total</strong></td>
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<td>COMP 1571 - Procedural Programming</td>
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<td>ENEE 2011 - Circuits I</td>
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<td><strong>Total</strong></td>
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<td><strong>Total</strong></td>
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<tr>
<td><strong>Third Year</strong></td>
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<tr>
<td>ENEE 2211 - Electronics</td>
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<td>ENEE 2611 - Engineering Electromagnetics</td>
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<td>ENCE 3210 - Microprocessor Systems I</td>
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<td>ENGR 3530 - Intro to Power and Energy Sys</td>
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<td>ENGR 2610 - Engineering Integration I</td>
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<td><strong>Total</strong></td>
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*Enrollment restrictions apply. Check with your academic advisor for details.*
### Fourth Year

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<tr>
<th>Course Code</th>
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<td>ENGR 3725 - Digital Control Systems</td>
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<td>ENGR 3323 - Engineering Design Project II</td>
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<td>XXXX - Technical Elective*</td>
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<td>ENGR 3970 - Engineering Entrepreneurship</td>
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<td>ENGR 3951 - Engineering Assessment II</td>
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</table>

**Total Hours:** 198 QH

*NOTES

**University Common Curricula**  These may be taken in any order. They must have 2 courses with attributes of analytical inquiry: society and 2 courses attributes of scientific inquiry: society.

**ASEM 2XXX - Advanced Seminar**  Engineering students are required to take a writing-intensive advanced seminar. Junior standing is also required.

**OOOO - Open Elective.**  The Open Elective may be any course offered in which the student has an interest and which is at the 1000 level or above.

** XXXX - Technical Elective.**  Technical Electives are used to complete specializations for the degree. Only technical courses may be used, and these must carry Upper-Division credit. Prior approval by the advisor is required. A total of 12 QH of technical electives is required.

** These hours can vary based on Technical Electives.**
BSEE Specializations

An area of specialization is required for the BSEE. The student must complete one of the specializations listed below:

**Communications Systems and Digital Signal Processing**

Required:
- ENEE 3141 Digital Communications 4 QH

And two of the following:
- ENCE 3321 Network Design 3 QH
- ENEE 3150 Communications Systems Lab 3 QH
- ENEE 3620 Optical Fiber Communications 4 QH
- ENEE 3630 Antennas 4 QH
- ENEE 3646 CAD of Microwave Circuits 4 QH
- ENEE 3670 DSP 4 QH

Special topics or Independent Study as appropriate for this option

**Robotics**

Three of the following
- ENCE 3100 Advanced Digital Systems Design 4 QH
- ENCE 3231 Embedded Microprocessors 3 QH
- ENGR 3730 Robotics 3 QH
- ENME 3545 Mechanisms 4 QH
- ENME 3555 Advanced Dynamics 3 QH
- ENMT 3220 Mechatronics II 4 QH
- ENGR 3100 Data Acq and Inst 4 QH
- ENCE 3620 Computer Vision 4 QH

(Students should note that ENME 2530, Engineering Mechanics III, is a prerequisite for both ENME 3545 and ENME 3555.)

Special topics or Independent Study as appropriate for this option

**Electronics, Photonics, and Microsystems**

At least two of the following:
- ENEE 3030 Optoelectronics 4 QH
- ENEE 3035 Photonics 4 QH
- ENEE 3620 Optical Fiber Communications 4 QH
- ENGR 3220 Intro. MEMS and Microsystems 4 QH
- ENGR 3210 Intro. NEMS 4 QH
- ENGR 3215 NEMS Lab 4 QH
- ENGR 3520 Intro to Power Electronics 4 QH
- ENGR 3525 PE and renewable energy lab 1 QH

Special topics or Independent Study as appropriate for this option

**Power and Energy**

One of the following:
- ENGR 3525 PE and renewable energy lab 1 QH
- ENGR 3535 Electric Power Engineering Lab 1 QH

and two of the following:
- ENCE 3231 Embedded Microprocessors 3 QH
- ENGR 3520 Intro to Power Electronics 4 QH
- ENGR 3550 Intro to Machine Drive Control 4 QH

Special topics or Independent Study as appropriate for this option

**Individualized Option**

Nine quarter hours of upper division technical courses selected with advisor’s approval. A letter signed by the student’s advisor giving the reason for the courses selected must be on file in the student’s records.
# Bachelor of Science in Electrical Engineering / MBA (BSEE/MBA)

## Sample Schedule:

<table>
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<tr>
<th></th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
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<tbody>
<tr>
<td><strong>First three years are same as the BSEE, above.</strong></td>
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<tr>
<td><strong>Fourth Year</strong></td>
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<td></td>
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<tr>
<td>ENGR 3510 – Renewable and Eff Pwr Sys</td>
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<td>ENGR 3323 - Engineering Design Project II</td>
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</tr>
<tr>
<td>ENGR 3725 - Digital Control Systems</td>
<td>4</td>
<td>ENGR 3333 - Engineering Design Project III</td>
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</tr>
<tr>
<td>ENGR 3313 - Engineering Design Project I</td>
<td>2</td>
<td>FIN 4630 - Managerial Finance</td>
<td>4</td>
</tr>
<tr>
<td>ACTG 4610 - Financial Accounting</td>
<td>4</td>
<td>MKTG 4610 - Marketing Strategy</td>
<td>4</td>
</tr>
<tr>
<td>STAT 4610 - Quantitative Methods</td>
<td>4</td>
<td>XXXX - MBA Elective*</td>
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<td></td>
<td>18 QH</td>
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<tr>
<td><strong>Fifth Year</strong></td>
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</tr>
<tr>
<td>XXXX - Technical Elective*</td>
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<td>XXXX - MBA Elective*</td>
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<td>BUS 4610 - The Essence of Enterprise</td>
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<td>ENGR 3951 - Engineering Assessment II</td>
<td>0</td>
</tr>
<tr>
<td>ACTG 4660 - Strategic Cost Management</td>
<td>4</td>
<td>BUS 4620 - Ethics 21st Century Professional</td>
<td>4</td>
</tr>
<tr>
<td>MGMT 4630 - Strategic Human Resources</td>
<td>4</td>
<td>MBA 4610 - Business Law &amp; Public Policy</td>
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</tr>
<tr>
<td></td>
<td>16 QH</td>
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<tr>
<td>Required Total Hours</td>
<td></td>
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<td>246 QH</td>
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*NOTES*

**University Common Curricula**  These may be taken in any order. They must have 2 courses with attributes of analytical inquiry: society and 2 courses attributes of scientific inquiry: society.

**ASEM 2XXX - Advanced Seminar**  Engineering students are required to take a writing-intensive advanced seminar. Junior standing is also required.

**XXXX - Technical Elective**  Technical Electives are used to complete specializations for the degree. Only technical courses may be used, and these must carry Upper-Division credit. Prior approval by the advisor is required.

**XXXX - MBA Elective**  Must be upper-division business course.
**BS Electrical Engineering with a Concentration in Mechatronic Systems Engineering**  
(BSEE-MSE)

**Sample Schedule:**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Year</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSEM 1111 - First Year Seminar</td>
<td>WRIT 1122 - Academic Writing</td>
<td>WRIT 1133 - Writing and Research</td>
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<td>PHYS 1212 - University Physics II</td>
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<td>ENGR 1531 - Engineering Connections III</td>
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<td>ENGR 1611 - Engr Concepts &amp; Practice I</td>
<td>ENGR 1621 - Engr Concepts &amp; Practice II</td>
<td>ENGR 1631 - Engr Concepts &amp; Practice III</td>
</tr>
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<td>17 QH</td>
<td>17 QH</td>
</tr>
</tbody>
</table>

| **Second Year**                                           |                                          |                                              |
| University Common Curricula*                             | University Common Curricula*             | CHEM 1610 - Chemistry for Engineers          |
| COMP 1571 - Procedural Programming                        | COMP 1572 - Procedural Programming II    | CHEM 1040/1240 - Gen. Chemistry Lab          |
| PHYS 1214 - Univ Physics III for Engineers                | MATH 2070 - Intro to Diff. Equations     | MATH 2080 - Calculus of Several Variables    |
| ENEE 2011 - Circuits I                                    | ENEE 2021 - Circuits II                  | ENCE 2101 - Digital Design                   |
| ENEE 2015 - Engineering Applications I                    | ENEE 2025 - Engineering Applications II  | ENGR 2035 - Engineering Applications III     |
| 18 QH                                                     | 18 QH                                    | 17 QH                                        |

| **Third Year**                                            |                                          |                                              |
| ENEE 2211 Electronics                                     | University Common Curricula*             | ENCE 3220 Microprocessor Systems II          |
| ENEE 2611 Engineering Electromagnetics                    | ENCE 3210 Microprocessor Systems I       | ENCE 2530 Engineering Mechanics III          |
| ENEE 3111 Signals and Systems                             | ENEE 2222 Advanced Electronics           | ENGR 3100 Instrumentation and Data Acq       |
| ENGR 3610 Engineering Analysis                            | ENGR 3721 Controls                       | ENGR 2620 Engineering Integration II         |
| ENGR 3530 Intro to Power and En Sys                       | ENGR 3722 Controls Lab                   | ASEM 2xxx Advanced Seminar                   |
| 18 QH                                                     | 18 QH                                    | 18 QH                                        |
### Fourth Year

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
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<td>LGST XXXX - Legal Studies</td>
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<td>Digital Control Systems</td>
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<td>ENGR 3730</td>
<td>Robotics</td>
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<td>ENGR 3970</td>
<td>Engineering Entrepreneurship</td>
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</table>

| **Total**                 |                                   | **16 QH**|
| **Required Total Hours**  |                                   | **202 QH**|

**NOTES**

**University Common Curricula**  These may be taken in any order. They must have 2 courses with attributes of analytical inquiry: society and 2 courses attributes of scientific inquiry: society.

**ASEM 2XXX - Advanced Seminar**  Engineering students are required to take a writing-intensive advanced seminar. Junior standing is also required.

**XXXX - Technical Elective.**  Technical Electives are used to complete specializations for the degree. Only technical courses may be used, and these must carry Upper-Division credit. Prior approval by the advisor is required. At minimum total of 12 QH of technical electives is required.
BSEE with a concentration in Mechatronic Systems Engineering Specializations

An area of specialization is required for the BSEE-MSE. The student must complete one of the specializations (Mechanical or Computer) listed below. The remaining technical elective course (for a minimum total of 12 QH) must be taken from the other specialization (Computer or Mechanical).

Mechanical Systems
Three of the following:
- ENME 2541 Mechanics of Materials 3QH
- ENME 3511 Machine Design 3QH
- ENME 2810 Mech Engineering Laboratory I 3QH
- ENME 2820 Mech Engineering Laboratory II 3QH
- ENME 2545 Mechanisms 4QH

Special topics or Independent Study as appropriate for this option

Computer Systems
Three of the following:
- ENCE 3231 Embedded Microprocessors 3QH
- ENME 3555 Advanced Dynamics 3QH
- ENCE 3261 Fault Tolerant Computing 3QH
- ENCE 3241 Computer Org & Architecture 3QH

Special topics or Independent Study as appropriate for this option

Individualized Option
Nine quarter hours of upper division technical courses selected with advisor’s approval. A letter signed by the student’s advisor giving the reason for the courses selected must be on file in the student’s records.
**BS Electrical Engineering with a Concentration in Mechatronic Systems Engineering / MBA (BSEE-MSE/MBA)**

**Sample Schedule:**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>First three years are the same as the BSEE-MSE, above.</td>
<td></td>
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</tbody>
</table>

**Fourth Year**

| ENGR 3510 Renewable and Eff Pwr Sys | 4 | ENGR 3730 Robotics | 3 | ENGR 3333 Engineering Design Project III | 3 |
| ENGR 3313 Engineering Design Project I | 2 | ENGR 3731 Robotics Lab | 1 | ASEM 2XXX Advanced Seminar | 4 |
| STAT 4610 Quantitative Methods | 4 | ENGR 3323 Engineering Design Project II | 3 | MGMT 4620 Organizational Dynamics | 4 |
| ACTG 4610 Financial Accounting | 4 | FIN 4630 Managerial Finance | 4 | XXXX - MBA Elective | 4 |
|  |  | MKTG 4610 Marketing Strategy | 4 |
|  |  |  |  |  |  |
| 14 QH | 15 QH | 15 QH |

**Fifth Year**

| ENGR 3725 Digital Control Systems | 4 | BUS 4620 Ethics - 21st Century Professional | 4 | ENGR 3951 Engineering Assessment II | 0 |
| ACTG 4660 Strategic Cost Management | 4 | XXXX - MBA Elective | 4 | ENMT 3220 Mechatronics II | 4 |
| MGMT 4630 Strategic Human Resources | 4 | MGMT 4690 Strategic Management | 4 | BUS 4630 Creating Sustainable Enterprise | 4 |
| BUS 4610 The Essence of Enterprise | 4 | MBA 4610 Business Law and Public Policy | 4 | ITEC 4610 Information Technology Strategy | 4 |
|  |  |  |  | MBA 4690 Enterprise Solutions | 4 |
|  |  |  |  |  |  |
| 16 QH | 16 QH | 16 QH |

**Required Total Hours**

250 QH

---

**NOTES**

**University Common Curricula**  These may be taken in any order. They must have 2 courses with attributes of analytical inquiry: society and 2 courses attributes of scientific inquiry: society.

**ASEM 2XXX - Advanced Seminar**  Engineering students are required to take a writing-intensive advanced seminar. Junior standing is also required.

**XXXX - MBA Elective**  Must be upper-division business course.
### Bachelor of Science in Mechanical Engineering Curriculum (BSME)

#### Sample Schedule:

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<th></th>
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<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSEM 1111 - First Year Seminar</td>
<td>4</td>
<td>WRIT 1122 - Academic Writing</td>
<td>4</td>
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<tr>
<td>MATH 1951 - Calculus I</td>
<td>4</td>
<td>MATH 1952 - Calculus II</td>
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<tr>
<td>University Common Curricula*</td>
<td>4</td>
<td>PHYS 1211 - University Physics I</td>
<td>5</td>
</tr>
<tr>
<td>ENGR 1511 - Engineering Connections I</td>
<td>1</td>
<td>ENGR 1521 - Engineering Connections II</td>
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<tr>
<td>ENGR 1611 - Engr Concepts &amp; Practice I</td>
<td>4</td>
<td>ENGR 1621 - Engr Concepts &amp; Practice II</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17 QH</strong></td>
<td><strong>17 QH</strong></td>
<td><strong>17 QH</strong></td>
</tr>
</tbody>
</table>

|                |                       |                    |                            |
| **Second Year**|                       |                    |                            |
| University Common Curricula*  | 4 | University Common Curricula* | 4 | CHEM 1610 - Chemistry for Engineers | 3 |
| COMP 1571 - Procedural Programming | 3 | COMP 1572 - Procedural Programming II | 3 | CHEM 1040/1240 – Gen. Chemistry Lab | 1 |
| PHYS 1214 - Univ Physics III for Engineers | 4 | MATH 2070 - Intro to Differential Equations | 4 | MATH 2080 - Calculus of Several Variables | 4 |
| ENEE 2011 - Circuits I         | 3 | ENEE 2021 - Circuits II      | 3 | ENCE 2101 - Digital Design      | 3 |
| ENEE 2015 - Engineering Applications I | 1 | ENEE 2025 - Engineering Applications II | 1 | ENGR 2035 - Engineering Applications III | 3 |
| ENME 2510 - Engineering Mechanics I | 3 | ENME 2520 - Engineering Mechanics II | 3 | ENGR 2950 - Engineering Assessment I | 0 |
|                      |                       |                    | ENME 2710 - Engr. Thermodynamics I | 3 |
| **Total**            | **18 QH**             | **18 QH**          | **17 QH**                  |

|                |                       |                    |                            |
| **Third Year**  |                       |                    |                            |
| MATH 2060 - Elements of Linear Algebra | 4 | University Common Curricula* | 4 | ENGR 2620 - Engineering Integration II | 3 |
| ENGR 3610 - Engineering Analysis      | 3 | ENGR 2610 - Engineering Integration I | 3 | ENGR 2910 - Economics for Engineers | 3 |
| ENME 2720 - Engr. Thermodynamics II   | 3 | ENME 3511 - Machine Design          | 3 |                                    |   |
| **Total**            | **16 QH**             | **16 QH**          | **12 QH**                  |
### Fourth Year

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASEM 2XXX</td>
<td>Advanced Seminar*</td>
<td>4</td>
</tr>
<tr>
<td>ENGR 3313</td>
<td>Engineering Design Project I</td>
<td>2</td>
</tr>
<tr>
<td>ENME 2671</td>
<td>Fluid Mech/Heat Transfer III</td>
<td>3</td>
</tr>
<tr>
<td>XXXX</td>
<td>Technical Elective*</td>
<td>4</td>
</tr>
<tr>
<td>ENGR 3323</td>
<td>Engineering Design Project II</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 3721</td>
<td>Controls</td>
<td>3</td>
</tr>
<tr>
<td>ENME 2810</td>
<td>Mech Engr. Laboratory I</td>
<td>3</td>
</tr>
<tr>
<td>XXXX</td>
<td>Technical Elective*</td>
<td>4</td>
</tr>
<tr>
<td>ENGR 3333</td>
<td>Engineering Design Project III</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 3951</td>
<td>Engineering Assessment II</td>
<td>0</td>
</tr>
<tr>
<td>ENME 2820</td>
<td>Mech Engr. Laboratory II</td>
<td>3</td>
</tr>
</tbody>
</table>

**Required Total Hours:** 192 QH

*NOTES

**University Common Curricula**  These may be taken in any order. They must have 2 courses with attributes of analytical inquiry: society and 2 courses attributes of scientific inquiry: society.

**ASEM 2XXX - Advanced Seminar**  Engineering students are required to take a writing-intensive advanced seminar. Junior standing is also required.

**OOOO - Open Elective.**  The Open Elective may be any course offered in which the student has an interest and which is at the 1000 level or above.

**XXXX - Technical Elective.**  Only technical courses may be used, and these must carry Upper-Division credit. Prior approval by the advisor is required.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 3951</td>
<td>Engineering Assessment II</td>
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<tr>
<td>ENME 2820</td>
<td>Mech Engr. Laboratory II</td>
<td>3</td>
</tr>
<tr>
<td>XXXX</td>
<td>Technical Elective*</td>
<td>4</td>
</tr>
</tbody>
</table>

13 QH 17 QH 14 QH
**BSME Specializations**

Although a specialization is not required for the BSME, a student desiring to achieve some depth in a special area may do so by taking several Technical Electives in the same area. A minimum of 12 quarter hours of Technical Electives are required. Areas available at this time include:

**Materials**
- ENEE 3011 Physical Electronics 4 QH
- ENGR 3630 Finite Element Methods 4 QH
- ENME 3230 Intro to Non-Destructive Eval 4 QH
- ENME 3540 Continuum Mechanics 4 QH
- MTSC 3010 Mech Behavior of Materials 4 QH
- MTSC 3110 Thermodynamics of Solids 3 QH
- MTSC 3020 Composite Materials I 4 QH
- MTSC 3430 Diffraction & Structure I 3 QH
- MTSC 3450 Fracture Mechanics 4 QH

**Bioengineering**
- ENBI 3100 Bioengineering System Design 1 QH
- ENBI 3500 Biofluids 4 QH
- ENBI 3510 Biomechanics 4 QH

**Robotics**
- ENGR 3730 Introduction to Robotics 3 QH
- ENGR 3731 Introduction to Robotics Lab 1 QH
- ENME 3545 Mechanisms 4 QH
- ENME 3555 Advanced Dynamics 4 QH

**Environmental Systems - Geographic Information Systems (GIS)**
- GEOG 3100 Introduction to GIS 4 QH
- GEOG 3130 Advanced GIS 4 QH
- GEOG 3200 Remote Sensing 4 QH

**Environmental Chemistry**
- CHEM 2240 Environmental Chemistry 4 QH
- CHEM 2451 Organic Chemistry 3 QH
- CHEM 2461 Organic Chemistry Lab 1 QH

**General Environmental Systems**
- ENVI 3000 Environmental Law 4 QH

Any of the courses listed above along with any special topics or technical Independent Study.

Students must consult their advisors concerning the suitability of courses used as Technical Electives. A memo of approval of the Technical Electives taken, signed by the advisor, must be placed in the student’s file prior to graduation. All Technical Electives must be in technical areas and must carry upper-division credit.
# Bachelor of Science in Mechanical Engineering / MBA

**(BSME / MBA)**

**Sample Schedule:**

<table>
<thead>
<tr>
<th></th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>First two years are the same as the BSME, above.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Third Year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 2060 - Elements of Linear Algebra 4</td>
<td>University Common Curricula* 4</td>
<td>XXXX – Technical Elective* 3</td>
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</tr>
<tr>
<td>ENGR 3610 - Engineering Analysis 3</td>
<td>ENGR 2610 - Engineering Integration I 3</td>
<td>ASEM 2XXX - Advanced Seminar* 4</td>
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<tr>
<td>ENME 2410 - Materials Science I 3</td>
<td>ENME 2421 - Materials Science II 3</td>
<td>ENGR 2620 - Engineering Integration II 3</td>
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<tr>
<td>16 QH</td>
<td>16 QH</td>
<td>16 QH</td>
<td></td>
</tr>
<tr>
<td><strong>Fourth Year</strong></td>
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<td></td>
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<tr>
<td>ENGR 3313 - Engineering Design Project I 2</td>
<td>ENGR 3323 - Engineering Design Project II 3</td>
<td>ENGR 3333 - Engineering Design Project III 3</td>
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<tr>
<td>ACTG 4610 - Financial Accounting 4</td>
<td>FIN 4630 - Managerial Finance 4</td>
<td>MGMT 4620 - Organizational Dynamics 4</td>
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<tr>
<td>STAT 4610 - Quantitative Methods 4</td>
<td>MKTG 4610 - Marketing Strategy 4</td>
<td>MBAX - MBA Elective* 4</td>
<td></td>
</tr>
<tr>
<td>OOOO – Open Elective 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 QH</td>
<td>14 QH</td>
<td>14 QH</td>
<td></td>
</tr>
<tr>
<td><strong>Fifth Year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUS 4610 - The Essence of Enterprise 4</td>
<td>ENGR 3721 – Controls 3</td>
<td>ENGR 3951 - Engineering Assessment II 0</td>
<td></td>
</tr>
<tr>
<td>ACTG 4660 - Strategic Cost Management 4</td>
<td>BUS 4620 - Ethics 21st Century Professional 4</td>
<td>BUS 4630 Creating Sustainable Enterprise 4</td>
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<tr>
<td>MGMT 4630 - Strategic Human Resources 4</td>
<td>MBA 4610 - Business Law and Public Policy 4</td>
<td>ITEC 4610 - Information Tech. Strategy 4</td>
<td></td>
</tr>
<tr>
<td>MBAX - MBA Elective* 4</td>
<td>MGMT 4690 - Strategic Management 4</td>
<td>MBA 4690 - Enterprise Solutions 4</td>
<td></td>
</tr>
<tr>
<td>16 QH</td>
<td>15 QH</td>
<td>12 QH</td>
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</tr>
</tbody>
</table>

**Required Total Hours**

240 QH

*NOTES*

**University Common Curricula**  These may be taken in any order. They must have 2 courses with attributes of analytical inquiry: society and 2 courses attributes of scientific inquiry: society.

**ASEM 2XXX - Advanced Seminar**  Engineering students are required to take a writing-intensive advanced seminar. Junior standing is also required.

**MBAX - MBA Elective**-  Must be upper-division business course.

**XXXX - Technical Elective.**  Technical Electives are used to complete specializations for the degree. Only technical courses may be used, and these must carry Upper-Division credit. Prior approval by the advisor is required.
IV. COURSE DESCRIPTIONS

Engineering (General)

ENGR 1511 Engineering Connections I (1 qtr. hr.)
This is the first course in a 3 course sequence designed to help students bridge the gap from high school to a college environment in a very challenging major. Topics and activities include academic success strategies; interviewing engineering alumni; the ethics of the profession; visits to industry sites; seminars by industry and academic experts; establishing the relationships between math, science, and engineering courses with design projects; critical and creative thinking activities; tours of the research labs of the engineering professors; disseminating information on the dual degree programs, the MBA programs, the honor code, and engineering program structures; and readings from and discussions about articles from professional publications. Membership in a professional society is a required course component. Prerequisites: None

ENGR 1521 Engineering Connections II (1 qtr. hr.)
This is the second course in a 3 course sequence designed to help students bridge the gap from high school to a college environment in a very challenging major. Topics and activities include academic success strategies; interviewing engineering alumni; the ethics of the profession; visits to industry sites; seminars by industry and academic experts; establishing the relationships between math, science, and engineering courses with design projects; critical and creative thinking activities; tours of the research labs of the engineering professors; disseminating information on the dual degree programs, the MBA programs, the honor code, and engineering program structures; and readings from and discussions about articles from professional publications. Membership in a professional society is a required course component. Corequisite: ENGR 1621 or permission of the instructor.

ENGR 1531 Engineering Connections III (1 qtr. hr.)
This is the third course in a 3 course sequence designed to help students bridge the gap from high school to a college environment in a very challenging major. Topics and activities include academic success strategies; interviewing engineering alumni; the ethics of the profession; visits to industry sites; seminars by industry and academic experts; establishing the relationships between math, science, and engineering courses with design projects; critical and creative thinking activities; tours of the research labs of the engineering professors; disseminating information on the dual degree programs, the MBA programs, the honor code, and engineering program structures; and readings from and discussions about articles from professional publications. Membership in a professional society is a required course component. Corequisite: ENGR 1631 or permission of the instructor.

ENGR 1611 Engineering Concepts & Practice I (4 qtr. hrs.)
Introduction to concepts and practices in computer, electrical and mechanical engineering, including engineering ethics. Engineering problem-solving as it applies to engineering analysis, synthesis and design. Students practice structured teamwork and program management skills in the context of projects. Emphasis on computer tools with immediate application to engineering practice. Prerequisite for ENGR 1621.

ENGR 1621 Engineering Concepts & Practice II (3 qtr. hrs.)
Introduction to concepts and practices in computer, electrical and mechanical engineering including engineering ethics. Engineering problem solving as it applies to engineering analysis, synthesis and design. Students practice structured teamwork and program management skills in the context of projects. Emphasis is on computer tools with immediate application to engineering practice. Prerequisite: ENGR 1611.

ENGR 1631 Engineering Concepts & Practice III (3 qtr. hrs.)
Concepts III provides first-year engineering students the opportunity to explore fundamental computer engineering concepts. Lectures include the fundamentals of digital electronics. In the laboratory students use logic circuits to build an analog to digital converter and program a microprocessor in assembly language to use signals from ultrasound sensors to control an autonomous vehicle. A report including a detailed analysis of the vehicle control system, flow charts, and program documentation is required.

ENGR 1700 Machine Shop Practice (1 qtr. hr.)
Introduction to concepts and practice in basic machine tool work (mill, lathe, welding etc.). The course provides the necessary information for majors and non-majors to gain access to the DU Engineering Machine Shop. Class size is limited to 5 students per quarter. Enrollment priority will be given to engineering majors.
ENGR 1911 Introduction to Engineering I (2 qtr. hrs.)
This course is intended mainly for transfer students who have had an introduction to engineering, but who need to learn certain techniques and software typically dealt with in ENGR 1611, including engineering ethics.

ENGR 1921 Introduction to Engineering II (1 qtr. hr.)
This course is intended mainly for transfer students who have had an introduction to engineering, but who need to learn certain techniques and software typically dealt with in ENGR 1621, including engineering ethics.

ENGR 1931 Introduction to Engineering III (1 qtr. hr.)
This course is intended mainly for transfer students who have had an introduction to engineering, but who need to learn certain techniques and software typically dealt with in ENGR 1631, including engineering ethics.

ENGR 2035 Engineering Applications III (3 qtr. hrs.)
Topics from computer, electrical and mechanical engineering demonstrating the interdependence of the disciplines, including engineering ethics. Principles and use of transducers and data acquisition systems. Techniques for signal conditioning and analysis of experimental data. Prerequisites: ENEE 2021, ENME 2520, COMP 1572. Corequisites: ENCE 2101, ENME 2710 or instructor’s permission.

ENGR 2610 Engineering Integration I (3 qtr. hrs.)
Interdisciplinary course combining topics from computer, electrical and mechanical engineering, including engineering ethics, with emphasis on laboratory experience and the design, analysis and testing of interdisciplinary systems. Manufacture of mechanical systems and/or circuit boards. Team project work on interdisciplinary "design-and-build" projects. Prerequisites: ENGR 2035 and junior standing in the appropriate engineering discipline. Corequisite: enrollment in appropriate junior-level engineering courses.

ENGR 2620 Engineering Integration II (3 qtr. hrs.)
Interdisciplinary course combining topics from computer, electrical and mechanical engineering, including engineering ethics, with emphasis on laboratory experience and the design, analysis and testing of interdisciplinary systems. Manufacture of mechanical systems and/or circuit boards. Team project work on interdisciplinary "design-and-build" projects. Prerequisites: ENGR 2035, ENGR 2610. Corequisite: enrollment in appropriate junior-level engineering courses.

ENGR 2910 Engineering Economics (3 qtr. hrs.)
This course focuses on the practical application of economics to engineering. It explains concepts in accounting and finance and applies them to engineering situations. Topics that are discussed include: economic decision making, engineering cost and estimates, interest, inflation, depreciation, income taxes, minimum attractive rate of return, economic viability of projects, and the economic advantages of "green" technology. Prerequisites: MATH 1953.

ENGR 2950 Engineering Assessment I (0 qtr. hrs.)
Examination covering basic mathematics, science and sophomore-level engineering topics. Must be taken prior to obtaining senior status in engineering. Prerequisites: ENEE 2021, ENME 2520, COMP 1572. Corequisites: ENGR 2035, ENCE 2101, ENME 2710.

ENGR 3100 Instrumentation and Data Acquisition (4 qtr. hrs.) (course is a technical elective and required for MSE)
This course will examine different instrumentation techniques and describe how different measurement instruments work. Measurement devices will include: length, speed, acceleration, force, torque, pressure, sound, flow, temperature, and advanced systems. The course will examine the acquisition, processing, transmission and manipulation of data. Prerequisite: PHYS 1214.

ENGR 3200 Introduction to Nanotechnology (4 qtr. hrs.) (course is a technical elective)
In this highly interdisciplinary series of lectures spanning engineering, physics, chemistry and biology, an introduction to the subject of nanotechnology in several disciplines are discussed. The most important recent accomplishments in the application of nanotechnology in several disciplines are discussed. Then a brief overview of the most important instrumentation systems used by nanotechnologists is provided. The nature of nanoparticles, nanoparticle composites, carbon nanostructures, including carbon nanotubes and their composites, is subsequently discussed. The course also deals with nanopolymer, nanobiological systems, and nanoelectronic materials and devices. The issues of modeling of nanomaterials and nanostructures are also covered in this class. Multiscale modeling based on finite element simulations, Monte Carlo methods, molecular dynamics and quantum mechanics
calculations are briefly addressed. Most important, students should obtain appreciation of developments in nanotechnology outside their present area of expertise. Prerequisite: ENME 2410

**ENGR 3210 Introduction to Nano-Electro-Mechanics (4 qtr. hrs.) (course is a technical elective)**

Familiarizes science and engineering students with the electromechanical aspects of the emerging field of nanotechnology (NEMS). NEMS is a relatively new and highly multidisciplinary field of science and technology with applications in the state-of-the-art and future sensors, actuators, and electronics. Starting with an overview of nanotechnology and discussion on the shifts in the electromechanical behavior and transduction mechanisms when scaling the physical dimensions from centimeters to micrometers and then down to nanometers. Several electromechanical transduction mechanisms at the micro and nanoscale are presented and discussed in an application-based context. New electromechanical interactions appearing in the nano and molecular scale, such as intramolecular forces and molecular motors, are discussed. A detailed discussion and overview of nanofabrication technologies and approaches are also provided. Prerequisite: CHEM 1010 or equivalent, PHYS 1214 or permission of instructor, must be an engineering or science major of at least junior standing.

**ENGR 3215 NEMS and Nanofabrication Lab (4 qtr. hrs.) (course is a technical elective)**

This course provides science and engineering students with comprehensive hands-on experience in design, fabrication and characterization of Nanoscale Electromechanical Systems (NEMS). This laboratory-based course starts with a number of sessions including brief lectures reviewing the fundamentals and theories followed by pre-designed lab experiments. The students are then provided with a choice of different comprehensive design and implementation projects to be performed during the quarter. The projects include design, layout, fabrication, and characterization of the devices potentially resulting in novel findings and publications. Prerequisites: ENGR 3210 or ENGR 3220.

**ENGR 3220 Introduction to Micro-Electro-Mechanical Systems (4 qtr. hrs.) (course is a technical elective)**

This course will introduce students to the multi-disciplinary field of Micro-Electro-Mechanical Systems (MEMS) technology. MEMS and Microsystem technology is the integration of micro-scale electro-mechanical elements, sensors, actuators, and electronics on a common substrate or platform through semiconductor microfabrication technologies. The course will give a brief overview of the involved physical phenomena, electromechanical transduction mechanisms, design principles, as well as fabrication and manufacturing technologies. Prerequisites: Must be Engineering and Science majors at junior level or higher.

**ENGR 3313 Engineering Design Project I (2 qtr. hrs.)**

Planning, development and execution of an engineering design project. The project may be interdisciplinary, involving aspects of computer, electrical and mechanical engineering. Projects have economic, ethical, social, and other constraints, as appropriate. Design activities include: 1) preparation and presentation of proposals in response to requests-for-proposals from “customers,” including problem description, quantitative and qualitative criteria for success, alternate designs and project plans; 2) generation and analysis of alternate designs, and choice of best design; 3) formulation of test procedures to demonstrate that the design chosen meets the criteria for success and testing of the completed project where feasible; 4) reporting on the design and testing. Prerequisite: senior standing in engineering.

**ENGR 3314 Honors Thesis I (2 qtr. hrs.)**

Honors equivalent of ENGR 3313. Required of students in the Honors Program and of students graduating summa cum laude, in place of ENGR 3313.

**ENGR 3323 Engineering Design Project II (3 qtr. hrs. each)**

Planning, development and execution of an engineering design project. The project may be interdisciplinary, involving aspects of computer, electrical and mechanical engineering. Projects have economic, ethical, social, and other constraints, as appropriate. Design activities include: 1) preparation and presentation of proposals in response to requests-for-proposals from “customers,” including problem description, quantitative and qualitative criteria for success, alternate designs and project plans; 2) generation and analysis of alternate designs, and choice of best design; 3) formulation of test procedures to demonstrate that the design chosen meets the criteria for success and testing of the completed project where feasible; 4) reporting on the design and testing. Prerequisite: ENGR 3313.

**ENGR 3324 Honors Thesis II (3 qtr. hrs.)**

Honors equivalent of ENGR 3323. Required of students in the Honors Program and of students graduating summa cum laude, in place of ENGR 3323.
ENGR 3333 Engineering Design Project III (3 qtr. hrs.)
Planning, development and execution of an engineering design project. The project may be interdisciplinary, involving aspects of computer, electrical and mechanical engineering. Projects have economic, ethical, social, and other constraints, as appropriate. Design activities include: 1) preparation and presentation of proposals in response to requests-for-proposals from “customers,” including problem description, quantitative and qualitative criteria for success, alternate designs and project plans; 2) generation and analysis of alternate designs, and choice of best design; 3) formulation of test procedures to demonstrate that the design chosen meets the criteria for success and testing of the completed project where feasible; 4) reporting on the design and testing. Prerequisite: ENGR 3323.

ENGR 3334 Honors Thesis III (3 qtr. hrs.)
Honors equivalent of ENGR 3333. Required of students in the Honors Program and of students graduating summa cum laude, in place of ENGR 3333. In addition to the requirements given above for ENGR 3333, the student must submit a copy of the final report on the project to the Mechanical and Materials and Electrical and Computer Engineering Departments.

ENGR 3350 Reliability (4 qtr. hrs.) (course is a technical elective)
An overview of reliability-based design. Topics include: fundamentals of statistics, probability distributions, determining distribution parameters, design for six sigma, Monte Carlo simulation, first- and second-order reliability methods (FORM, SORM); Most Probable Point (MPP) reliability methods, sensitivity factors, probabilistic design.

ENGR 3510 Renewable and Efficient Power and Energy Systems (4 qtr. hrs.)
This course introduces the current and future sustainable electrical power systems. In this course fundamentals of renewable energy sources and storage systems will be discussed. Interfaces of the new sources to the utility grid will be covered. Prerequisite: ENEE 2021, Circuits II.

ENGR 3520 Introduction to Power Electronics (4 qtr. hrs.) (course is a technical elective)
This course covers fundamentals of power electronics. It will discuss various switching converters topologies. Basic knowledge of Efficiency and small-signal modeling for the DC-DC switching converters are covered in this course. Furthermore, magnetic and filter design will be introduced in this course. Prerequisite: ENEE2211 Electronics, and ENGR3721 Controls.

ENGR 3525 Power Electronics and Renewable Energy Laboratory (1 qtr. hr.) (course is a technical elective)
In this course the fundamentals of switching converters and power electronics in a real laboratory set-up is covered. The course incorporates hardware design, analysis, and simulation of various switching converters as a power processing element for different energy sources. The energy sources are power utility, batteries and solar panels. Prerequisite: ENGR3520 Introduction to Power Electronics.

ENGR 3530 Introduction to Power and Energy Conversion Systems (3 qtr. hrs.)
Basic concepts of AC systems, single-phase and three-phase networks, electric power generation, transformers, transmission lines, and electric machinery. Prerequisite: ENEE 2021, Circuits II.

ENGR 3535 Electric Power Engineering Laboratory (1 qtr. hr.) (course is a technical elective)
In this laboratory the magnetic circuits, single phase transformers, power quality and harmonics, synchronous machines, Induction machines and DC machines are studied and tested in a real physical set-up. Prerequisite: ENGR3530 Intro to Power and Energy Conversion.

ENGR 3550 Introduction to Machine Drive Control (4 qtr. hr.) (course is a technical elective)
This course provides the basic theory for the analysis and application of adjustable-speed drive systems employing power electronic converters and ac or dc machines. Prerequisite: ENGR3520 Introduction to Power Electronics, and ENGR3530 Introduction to Power and Energy Conversion Systems

ENGR 3610 Engineering Analysis (3 qtr. hrs.)
Applied mathematics for engineers. Generalized Fourier analysis, complex variables, vector calculus, introduction to Bessel functions, and applied probability and statistics. Prerequisites: MATH 2070, MATH 2080.

ENGR 3620 Advanced Engineering Mathematics (4 qtr. hrs.)
ENGR 3630 Finite Element Methods (4 qtr. hrs.) *(course is a technical elective)*
Introduction to the use of finite element methods in one or two dimensions with applications to solid and fluid mechanics, heat transfer and electromagnetic fields; projects in one or more of the above areas. Prerequisite: COMP 1572, ENGR 3610 or equivalent.

ENGR 3721 Controls (3 qtr. hrs.) *(course is a technical elective for CpEs)*
Modeling, analysis and design of linear feedback control systems using Laplace transform methods. Techniques and methods used in linear mathematical models of mechanical, electrical, thermal and fluid systems are covered. Feedback control system models, design methods and performance criteria in both time and frequency domains. A linear feedback control system design project is required. Prerequisites: ENEE 2021, ENGR 3610 or instructor’s permission.

ENGR 3725 Digital Control (4 qtr. hrs.) *(required course for all Electrical Engineers)*
The course introduces and studies computer-controlled systems following the state variable approach and the z-transform approach. Sampling theory is presented, along with its effect on digital control design. Feedback computer controlled systems, components of digital control systems; system models on the z-domain (z-transfer functions) and on the time domain (state variable representations) are examined. Digital controller design from the state space and frequency domain points of view is included. System design and evaluation of system performance are considered. Several discrete-time controllers are presented, state and output feedback controllers, reconstruction of states using observers. Prerequisites: ENEE 3111, ENGR 3610, permission of the instructor. Students must have knowledge of MATLAB, ENGR 3721 (recommended).

ENGR 3730 Introduction to Robotics (3 qtr. hrs.) *(course is a technical elective)*
Introduction to the analysis, design, modeling and application of robotic manipulators. Review of the mathematical preliminaries required to support robot theory. Topics include forward kinematics, inverse kinematics, trajectory control and planning, and kinetics. Prerequisites: ENME 2520 and MATH 2060 or MATH 2200 or instructor’s permission.

ENGR 3731 Introduction to Robotics Laboratory (1 qtr. Hr.) *(course is a technical elective)*
Laboratory that complements the analysis, design, modeling and application of robotic manipulators. Implementation of the mathematical structures required to support robot operation. Topics include forward kinematics, inverse kinematics, motion kinematics, trajectory control and planning, and kinetics. Applications include programming and task planning of a manufacturing robot manipulator. Corequisites: ENGR 3730 or instructor’s permission.

ENGR 3800 Special Topics (ENGR) (1-5 qtr. hrs.) *(these courses are usually technical electives)*
Special topics in engineering as announced. May be taken more than once. Prerequisite: varies with offering.

ENGR 3900 Engineering Internship (1-4 qtr. hrs.)
Students in engineering may receive elective credit for engineering work performed for engineering employers with the approval of the chair or associate chair of the department. At the end of the term, a student report on the work is required, and a recommendation will be required from the employer before a grade is assigned. Junior, senior or graduate status in engineering is normally required. May not be used to satisfy technical requirements. May be taken more than once for a maximum of 6 quarter hours. Corequisite: Must be working as an intern.

ENGR 3951 Engineering Assessment II (0 qtr. hrs.)
Students in Mechanical Engineering must register for and take the Fundamentals of Engineering Examination (FE). All students must complete an engineering exit interview and other assessment-related tasks. To be taken in the spring quarter of attendance.

ENGR 3970 Engineering Entrepreneurship (4 qtr. hrs.)
The course will present an overview of fundamentals of understanding entrepreneurship and entrepreneurial characteristics; the focus will be on aspects of engineering entrepreneurship, technology-based innovation and new product development. Topics to be covered: learning an industry, recognizing and creating opportunities; new product development process, phases and cycle, risks and benefits; ‘testing’ of an engineering-focused business concept; marketing, organizational plan strategies and financing for new start ups. Special attention will be given to technological innovation, considering both incremental or routine innovation, and more radical or revolutionary changes in products and processes. Prerequisites: ENGR 3610 or permission of the instructor.
ENGR 3991 Independent Study (0-5 qtr. hrs.) *(this course can be taken as a technical elective)*
Topics in engineering investigated under faculty supervision. May be taken more than once. Students must obtain and complete an Independent Study form from the Office of the Registrar. This course prepares students to participate in a capstone engineering design project. They will learn the ethical treatment of patients, identify and survey the needs of a patient population, identify leading projects, form a design team, discuss human factors issues and develop an initial strategy for project design. Prerequisite: instructor’s permission.

**Bioengineering**

ENBI 3100 Bioengineering System Design (1 qtr. hrs.) *(course is a technical elective)*
This course will prepare students to participate in a capstone engineering design project. They will learn the ethical treatment of patients, identify and survey the needs of a patient population, identify leading projects, form a design team, discuss human factors issues, and develop an initial strategy for project design.

ENBI 3500 Biofluids (4 qtr. hrs.) *(course is a technical elective)*
The application of fluid dynamics theory and design to problems within the biomedical community. Specific topics include the mechanics of inhaled therapeutic aerosols, basic theory of circulation and blood flow, foundations in biotechnology and bioprocessing, and controlled drug delivery.

ENBI 3510 Biomechanics (4 qtr. hrs.) *(course is a technical elective)*
An introduction to the mechanical behavior of biological tissues and systems. Specific topics include: analysis of the human musculoskeletal system as sensors, levers and actuators; joint articulations and their mechanical equivalents; kinematic and kinetic analysis of human motion; introduction to modeling human body segments and active muscle loading for analysis of dynamic activities; mechanical properties of hard and soft tissues; mechanical and biological consideration for repair and replacement of soft and hard tissue and joints; orthopedic implants. Prerequisites ENME 2410, ENME 2520, ENME 2541.

ENBI 3800 Special Topics (Bioengineering) (1-5 qtr. hrs.) *(these courses are technical electives)*
Special topics as announced. May be taken more than once. Prerequisite: varies with offering.

**Computer Engineering**

ENCE 2101 Digital Design (3 qtr. hrs.)
Basic logic concepts. Boolean algebra, truth tables and logic diagrams. Karnaugh maps; programmable devices including ROM’s, PLA’s, and PAL’s; data selectors and multiplexors; flip-flops, and memory design of sequential logic circuits. State diagrams, counters, latches and registers; realization of sequential and arbitrary counters; monostable multivibrators. Laboratory. Prerequisite: ENEE 2021 or instructor’s permission.

ENCE 3100 Advanced Digital Systems Design (4 qtr. hrs.)
Design of logic machines. Finite state machines, gate array designs, ALU and control unit designs, microprogrammed systems. Hardware design of digital circuits using SSI and MSI chips. Introduction to probability and statistics. Application of probability and stochastic processes for cache and paging performance. Laboratories incorporate specification, top-down design, modeling, implementation and testing of actual digital design systems hardware. Simulation of circuits using VHDL before actual hardware implementation. Laboratory. Prerequisite: ENCE 2101.

ENCE 3210 Microprocessor Systems I (4 qtr. hrs.)
Introduction to microprocessors and to the design and operation of computer systems. A study of the microprocessor and its basic support components. Analysis of CPU architectures of modern computers. Assembly language programming. Use of an assembler and other development tools for programming and developing microprocessor-based systems. Laboratory. Prerequisite: ENCE 2101.

ENCE 3220 Microprocessor Systems II (4 qtr. hrs.)
Introduction to microprocessors and to the design and operation of computer systems. A study of the microprocessor and its basic support components. Analysis of CPU architectures of modern computers. Assembly language programming. Use of an assembler and other development tools for programming and developing microprocessor-based systems. Laboratory. Prerequisite: ENCE 3210.
ENCE 3231 Embedded Systems Programming (4 qtr. hrs.) (course is a technical elective)
Design, construction and testing of microprocessor systems. Hardware limitations of the single-chip system. Includes micro-controllers, programming for small systems, interfacing, communications, validating hardware and software, microprogramming of controller chips, design methods and testing of embedded systems. Prerequisite: ENCE 3220.

ENCE 3241 Computer Organization and Architecture (3 qtr. hrs.)

ENCE 3250 HDL Modeling & Synthesis (3 qtr. hrs.)
Introduction to Hardware Design Language (HDL). Language syntax and synthesis. Applications related to digital system implementation are developed. Project. Prerequisites: ENCE 2101 or instructor's permission.

ENCE 3261 Fault Tolerant Computing (3 qtr hrs)

ENCE 3321 Network Design (4 qtr. hrs.)
Introduction to network components. Layering of network architecture. Analysis of Local Area Network (LAN) concepts and architecture based on IEEE standards. Design principles including switching and multiplexing techniques, physical link, signal propagation, synchronization, framing and error control. Application of probability and statistics in error detecting and control. Ethernet, Token-ring, FDDI (Fiber Distributed Data Interface), ATM (Asynchronous Transfer Mode), ISDN (Integrated Service Data Networks). Prerequisites: ENEE 3111, ENCE 2101 or instructor’s permission.

ENCE 3501 VLSI Design (3 qtr. hrs.) (course is a technical elective)
Design of Very Large Scale Integration integrated systems. Examination of layout and simulation of digital VLSI circuits using a comprehensive set of CAD tools in a laboratory setting. Studies of layouts of CMOS combinational and sequential circuits using automatic layout generators. Fundamental structures of the layout of registers, adders, decoders, ROM, PLA’s, counters, RAM and ALU. Application of statistics and probability to chip performance. CAD tools allow logic verification and timing simulation of the circuits designed. Prerequisite: ENCE 3220.

ENCE 3610 Multimedia Systems (3 qtr hrs) (course is a technical elective)
Interactive multimedia technologies include hardware, software, standards, concepts and issues, compression, decompression, user interface design, query by content, multimedia indexing, and distributed multimedia.

ENCE 3620 Computer Vision (4 qtr. hrs.) (course is a technical elective)
This course is an introduction to the basic concepts in image processing and computer vision. First, an introduction to low-level image analysis methods, including radiometry and geometric image formation, edge detection, feature detection, and image segmentation will be presented. Then, geometric based image transformations (e.g., image warping and morphing) for image synthesis will be presented in the course. Furthermore, methods for reconstructing three-dimensional scenes including, camera calibration, Epipolar geometry, and stereo feature matching will be introduced. Other important topics include optical flow, shape from shading, and three-dimensional object recognition. In conclusion, students will learn and practice image processing and computer vision techniques that can be used in other areas such as robotics, pattern recognition, and sensor networks. Prerequisites: Signals and Systems (ENEE 3111)

ENCE 3630 Pattern Recognition (4 qtr. hrs.) (course is a technical elective)
This class provides an introduction to classical pattern recognition. Pattern recognition is the assignment of a physical object or event to one of several prescribed categories. Applications include automated object recognition in image and videos, face identification, and optical character recognition. Major topics include: Bayesian decision theory, Parametric estimation and supervised learning, Linear discriminant functions, Nonparametric methods, Feature extraction for representation and classification, Support Vector Machines. The course assumes previous programming experience and some familiarity with linear algebra and statistics (normally obtained through undergraduate coursework).
ENCE 3830 Special Topics (CPE) (1-5 qtr. hrs.) *(these courses are technical electives)*  
Special topics in computer engineering as announced. May be taken more than once. Prerequisite: varies with offering.

ENCE 3991 Independent Study (1-5 qtr. hrs.) *(this course can be taken as technical elective)*  
Topics in computer engineering investigated under faculty supervision. May be taken more than once. Students must obtain and complete an Independent Study form from the Office of the Registrar. Prerequisite: instructor’s permission.

**Electrical Engineering**

ENEE 2011 Circuits I (3 qtr. hrs.)  
(Co-listed with PHYS 2011) An introduction to electrical circuits analysis and design. Emphasis is on definitions of basic variables, passive circuit components and the ideal operational amplifier. DC analysis of circuits and circuit theorems are stressed. AC signals are introduced. Computer analysis software is integrated throughout the course. A relevant topic in engineering ethics is also explored. Co-requisites: PHYS 1213/1214, MATH 1953, ENEE 2015 or instructor’s permission.

ENEE 2015 Engineering Applications I (1 qtr. hr.)  
(Co-listed with PHYS 2012) Laboratory program introduces electronic test equipment, verifies circuit theorems and practices elementary interface circuit design. Co-requisite: ENEE 2011 or instructor’s permission.

ENEE 2021 Circuits II (3 qtr. hrs.)  
(Co-listed with PHYS 2021) AC analysis of linear circuits to include circuit theorems via classical and transform techniques. Emphasis is placed on the Laplace transform, including use of pole-zero and Bode diagrams to analyze and design circuits, including multiple filters (single-pole cascade, Butterworth, Chebyshev), and step response circuits. Phasors applications to sinusoidal steady state analysis and AC power. Computer analysis software is used as an aid to circuit design. A relevant topic in engineering ethics is also explored. Co-requisites: ENEE 2011, 2015. Co-requisites: MATH 2070, ENEE 2025.

ENEE 2025 Engineering Applications II (1 qtr. hr.)  
(Co-listed with PHYS 2025) Laboratory program practicing time and frequency domain analysis and design techniques on step response and filter problems. Applications to instrumentation and circuits. Prerequisites: ENEE 2011, 2015. Co-requisites: ENEE 2021 or instructor’s permission.

ENEE 2211 Electronics (4 qtr. hrs.)  
Circuit behavior of semiconductor devices. Bipolar and field-effect transistors and their models; basic physical explanation of the functioning of these devices; large- and small-signal analysis of practical circuits; electronic design using both hand and computer methods of calculation and design; biasing methods for amplifier circuits; power supplies and current-source circuits. Design laboratory. Prerequisites: ENEE 2021, 2025.

ENEE 2222 Advanced Electronics (3 qtr. hrs.)  
High-frequency transistor models and determination of parameters; Laplace and Fourier analyses of common amplifier circuits; design and analysis of broad-band amplifiers and multistage amplifiers. Basic feedback topologies; Nyquist, root-locus and Bode plot investigations of stability; introduction to amplifier noise; active filter design; sinusoidal oscillators. Prerequisite: ENEE 2211.

ENEE 2611 Engineering Electromagnetics (4 qtr. hrs.)  
The study of Maxwell’s equations and their experimental and theoretical foundations. Topics include Static electromagnetic fields, time-varying electromagnetic fields, wave propagation, transmission lines, and antennas. Prerequisites: PHYS 1213/1214, ENGR 3610 or permission of instructor.

ENEE 3011 Physical Electronics (4 qtr. hrs.)  
The basic physical concepts of electronics, electrons and holes in semiconductors, transport and optical processes. Concentration on device concepts, including material synthesis and device processing, P-N junction diodes, junctions with other materials, bipolar transistors, field effect transistors (JFET, MESFET, MOSFET) and optoelectronic devices (lasers, detectors). Prerequisites: CHEM 1010/1610 or equivalent, PHYS 1213/1214 or permission of instructor.
ENEE 3030 Optoelectronics (4 qtr. hrs.) (course is a technical elective)
The active and passive optical elements. Includes principles of light, optical sources (LED, LASER, Fiber Laser), optical fibers, photodetectors (APD, PIN, MSM) and practical optical transmitter and receivers. Laboratory. Prerequisite: ENEE 3011 or ENEE 2211 or permission of instructor.

ENEE 3035 Photonics (4 qtr. hrs.) (course is a technical elective)
Theory and techniques for the application of the optical electromagnetic spectrum from infrared to ultraviolet to engineering problems in communications, instrumentation and measurement. May include lasers, optical signal processing, holography, nonlinear optics, optical fiber communications, optical behavior of semiconductors and similar topics in modern optics, depending on the interests and requirements of the students. Prerequisite: ENEE 2611 or instructor’s permission.

ENEE 3111 Signals & Systems (4 qtr. hrs.)
Introduces continuous time and discrete time linear system analysis, Fourier series, Fourier and Laplace transforms. Specific engineering tools for discrete time linear system analysis include discrete time convolution, Z-transform techniques, discrete Fourier transform and fast Fourier transform (DFT/FFT), and the design and analysis of analog and digital filters for real-world signal-processing applications. Prerequisites: ENEE 2021, MATH 2070.

ENEE 3130 Principles of Communication Systems (3 qtr. hrs.)
Introduction to the theory and analysis of communication systems. Emphasis on analog systems; application of probability and statistics, modulations and demodulations; noise and signal-to-noise ratio analysis; the measure of information, channel capacity, coding and design factors. Prerequisites: ENEE 3111, ENGR 3610 or instructor’s permission.

ENEE 3141 Digital Communications (3 qtr. hrs.) (course is a technical elective)
Introductory course on modern digital communication systems. Basic communication system theory, probability and random processes, baseband digital data transmission, coherent and non-coherent digital modulation techniques and analysis of bit error probability. Bandwidth efficiency and transmission of digital data through band-limited channels. Prerequisites: ENEE 3111, ENGR 3610 or instructor’s permission.

ENEE 3150 Communications Systems Lab (3 qtr. hrs.) (course is a technical elective)
Communication systems experiments demonstrating classical and applied features of digital and analog communication principles. Includes digital and analog modulation techniques. A consolidated laboratory experience for students in the communication sequence with a capstone design of a complete communications process, including source coding, channel coding, transmission over media, reception and decoding, followed by a detailed performance analysis of the reliability of the sequence of processes. Co-requisites: ENEE 3130, ENEE 3141.

ENEE 3611 Antennas and Antenna Arrays (4 qtr. hrs.) (course is a technical elective)
Maxwell’s equations applied to antenna analysis and design. Topics include fundamental parameters of antennas, radiation integrals and auxiliary potential functions, analysis and design of linear wire antennas, loop antennas, arrays, broadband antennas, frequency independent antennas, aperture antennas and horns. Integrated lab included. Prerequisite: ENEE 2611.

ENEE 3620 Optical Fiber Communications (4 qtr. hrs.) (course is a technical elective)
A comprehensive treatment of the theory and behavior of basic constituents, such as optical fibers, light sources, photodetectors, connecting and coupling devices, and optical amplifiers. The basic design principles of digital and analog optical fiber transmission links. The operating principles of wavelength-division multiplexing (WDM) and the components needed for its realization. Descriptions of the architectures and performance characteristics of complex optical networks for connecting users who have a wide range of transmission needs (SONET/SDH). Discussions of advanced optical communication techniques, such as soliton transmission, optical code-division multiplexing (optical CDMA) and ultra-fast optical time-division multiplexing (OTDM). Laboratory. Prerequisite: ENEE 3030 or instructor’s permission.

ENEE 3641 Electromagnetic Compatibility (4 qtr. hrs.) (course is a technical elective)
The study of the design of electronic systems so that they operate compatibly with other electronic systems and also comply with various governmental regulations on radiated and conducted emissions. Topics may include: electromagnetic compatibility (EMC) requirements for electronic systems, non-ideal behavior of components, radiated emissions and susceptibility, conducted emissions and susceptibility, shielding and system design for EMC. Includes integrated lab. Prerequisites: ENEE 3111, 2620, 2222.
ENEE 3646 CAD of Microwave Circuits (4 qtr. hrs.) (course is a technical elective)
Microwave network analysis; analysis and design of planar transmission lines, impedance matching and tuning; analysis and design of two-, three-, and four-port passive networks; analysis and design of active microwave circuits; introduction to microwave systems. The lab incorporates software for analysis, design and optimization of passive and active. Prerequisite: ENEE 2620 or instructor’s permission.

ENEE 3660 Communications Systems Design (4 qtr. hrs.) (course is a technical elective)
Design and performance evaluation of terrestrial and space communications systems; error correction coding; spread spectrum communication; link budget analysis and environmental effects. System design considerations include engineering judgment decisions to implement optimum communication configurations such as data rates, bandwidth, modulation schemes and operating frequencies. Prerequisite: ENEE 3130.

ENEE 3670 Digital Signal Processing (4 qtr. hrs.) (course is a technical elective)
Introduction to the theory and applications of digital signal processing. Special attention is paid to the fast Fourier transform and convolution and to the design and implementation of both FIR and IIR digital filters. Prerequisite: ENEE 3111.

ENEE 3810 Special Topics (EE) (1-5 qtr. hrs.) (these courses are technical electives)
Various topics as announced. May be taken more than once. Prerequisite: varies with offering.

ENEE 3991 Independent Study (1-5 qtr. hrs.) (this course can be taken as technical elective)
Topics in electrical engineering investigated under faculty supervision. May be taken more than once. Students must obtain and complete an Independent Study form from the Office of the Registrar. Prerequisite: instructor’s permission.

**Mechanical Engineering**

ENME 2410 Materials Science I (3 qtr. hrs.)
Atomic structure, bonding and crystal structures in solids. Diffusion and crystal defects. Thermodynamics and phase equilibria in one-, two- and three-component systems, binary phase diagrams. Kinetics and phase transformations. Specific microstructure and mechanical properties of metals, glasses, ceramics, polymers and composites. Electrical conduction: energy levels and bands, charge carriers and insulators. Semiconductors of intrinsic and extrinsic types. Prerequisite: PHYS 1212, CHEM 1610, MATH 1953 or instructor’s permission.

ENME 2421 Materials Science II (3 qtr. hrs.)

ENME 2510 Engineering Mechanics I (3 qtr. hrs.)
(Co-listed with PHYS 2510)
Statics of particles and rigid bodies, equivalent systems of forces, frames and machines, friction, centroids and centers of mass, moments of inertia, virtual work. Kinematics of particles, Newton’s second law, energy and momentum methods for particles and systems of particles, angular momentum, impulsive motion, kinematics and motion of rigid bodies in two and three dimensions; accelerated frames of reference; mechanical vibrations. A relevant topic in engineering ethics is also explored. Prerequisite PHYS 1211.

ENME 2520 Engineering Mechanics II (3 qtr. hrs.)
(Co-listed with PHYS 2520) Statics of particles and rigid bodies, equivalent systems of forces, frames and machines, friction, centroids and centers of mass, moments of inertia, virtual work. Kinematics of particles, Newton’s second law, energy and momentum methods for particles and systems of particles, angular momentum, impulsive motion, kinematics and motion of rigid bodies in two and three dimensions; accelerated frames of reference; mechanical vibrations. A relevant topic in engineering ethics is also explored. Prerequisite: ENME 2510. Co-requisite: MATH 2070.
ENME 2530 Engineering Mechanics III (3 qtr. hrs.)
(Co-listed with PHYS 2530) Statics of particles and rigid bodies, equivalent systems of forces, frames and machines, friction, centroids and centers of mass, moments of inertia, virtual work. Kinematics of particles, Newton’s second law, energy and momentum methods for particles and systems of particles, angular momentum, impulsive motion, kinematics and motion of rigid bodies in two and three dimensions; accelerated frames of reference; mechanical vibrations. A relevant topic in engineering ethics is also explored. Prerequisites: ENME 2520, ENGR 3610 or instructor’s permission.

ENME 2541 Mechanics of Materials (3 qtr. hrs.)
Normal and shear stress and strain; elasticity, mechanical properties of materials, principal stresses; torsion, beams, deflection of beams under loads, methods of superposition, failure theory, columns. Prerequisite: ENME 2520.

ENME 2651 Fluid Mechanics/Heat Transfer I (3 qtr. hrs.)
Course series provides students with the basic skill levels required to solve fluid mechanics and heat transfer problems. Topics include hydrostatics, dimensional analysis, incompressible and compressible flows, conduction, convection and radiation. Students explore a variety of solution techniques such as control volume, differential analysis, boundary layer analysis, finite differencing and resistance network analogies. Prerequisite: ENME 2520.

ENME 2661 Fluid Mechanics/Heat Transfer II (3 qtr. hrs.)
Course series provides students with the basic skill levels required to solve fluid mechanics and heat transfer problems. Topics include hydrostatics, dimensional analysis, incompressible and compressible flows, conduction, convection and radiation. Students explore a variety of solution techniques such as control volume, differential analysis, boundary layer analysis, finite differencing and resistance network analogies. Prerequisite: ENME 2651.

ENME 2671 Fluid Mechanics/Heat Transfer III (3 qtr. hrs.)
Course series provides students with the basic skill levels required to solve fluid mechanics and heat transfer problems. Topics include hydrostatics, dimensional analysis, incompressible and compressible flows, conduction, convection and radiation. Students explore a variety of solution techniques such as control volume, differential analysis, boundary layer analysis, finite differencing and resistance network analogies. Prerequisite: ENME 2661.

ENME 2710 Engineering Thermodynamics I (3 qtr. hrs.)

ENME 2720 Engineering Thermodynamics II (3 qtr. hrs.)

ENME 2810 Mechanical Engineering Lab I (3 qtr. hrs.)
Engineering experiments illustrating selected topics in heat transfer, fluid mechanics, solid mechanics, thermodynamics, measurement and control. Use of microcomputers in experimentation and control. This course encourages the development of laboratory experimentation skills, design skills and technical writing skills. Prerequisites: ENME 2651, ENME 2720, ENME 2541 or instructor’s permission.

ENME 2820 Mechanical Engineering Lab II (3 qtr. hrs.)
Engineering experiments illustrating selected topics in heat transfer, fluid mechanics, solid mechanics, thermodynamics, measurement and control. Use of microcomputers in experimentation and control. This course encourages the development of laboratory experimentation skills, design skills and technical writing skills. Prerequisites: ENME 2810 or instructor’s permission.

ENME 3230 Introduction to Nondestructive Evaluation (3 qtr. hrs.) (course is a technical elective)
Principles of nondestructive evaluation, including ultrasonic, radiographic, magnetic, electrical, penetrant, acoustic emission, etc. Covers expected results for flaw and materials characterization. Current literature approaches are examined. Prerequisite: ENGR 3610.
ENME 3310 Computational Methods for Mechanics and Materials (4 qtr. hrs.) *(course is a technical elective)*
An introductory course for the general-purpose computational methods in advanced multiscale materials and mechanics. Students will learn the fundamentals on the numerical methods used in mechanical and materials engineering.

ENME 3400 Fatigue (4 qtr. hrs.) *(course is a technical elective)*
A detailed overview of fatigue. Topics include: stress life and strain life approaches, fracture mechanics, constant amplitude and spectrum loading, life prediction, fatigue at notches, microstructural effects, environmentally assisted fatigue, retardation and acceleration, multi-axial fatigue, design against fatigue and reliability. Prerequisites: ENME 2421, ENME 2541.

ENME 3511 Machine Design (3 qtr. hrs.)
Application of statics, dynamics, mechanics of materials, and manufacturing processes to the design of machine elements and systems. Properties of materials and design criteria. Synthesis and analysis of a machine design project. Prerequisites: ENME 2520, ENME 2541.

ENME 3540 Introduction to Continuum Mechanics (4 qtr. hrs.) *(course is a technical elective)*
Kinematics of deformation, measures of stress, equations of motion for deformable solids; constitutive relations for elastic, viscoelastic, and elastic-plastic materials; work and energy. Prerequisites: ENME 2530, ENME 2541.

ENME 3545 Mechanisms (4 qtr. hrs.) *(course is a technical elective)*
Synthesis, analysis and use of mechanisms. Mechanisms studied include cams, gears and planar linkages, with an emphasis on planar linkages. Prerequisites: ENME 2530, COMP 1572.

ENME 3550 Mechanical Vibrations (4 qtr. hrs.) *(course is a technical elective)*
Basic mechanical vibrations including: dynamics, periodic motion, energy methods and Rayleigh’s principle, forced periodic motion, initial conditions and transient vibration, damping, damped forced vibrations, several degrees of freedom, torsional vibration, discrete and distributed systems. Prerequisites: ENME 2530, ENGR 3610.

ENME 3555 Advanced Dynamics (4 qtr. hrs.) *(course is a technical elective)*
Introduction to variational principles of mechanics. Lagrangian mechanics, three-dimensional rigid body mechanics and other topics. Applications. Prerequisites: ENME 2530, ENGR 3610 or permission of instructor.

ENME 3560 Advanced Mechanisms & Machinery (3 qtr. hrs.) *(course is a technical elective)*
Advanced topics in the design and analysis of mechanisms. Topics may include: force analysis of mechanisms, force and moment balancing, flywheels, flexible mechanisms. Prerequisite: ENME 3545 or permission of instructor.

ENME 3651 Computational Fluid Dynamics (4 qtr. hrs) *(course is a technical elective)*
Introduction to principles and applications of computational methods in fluid flow and topics chosen from heat transfer, mass transfer or two phase flow. The conservation equations, their discretization and solution are presented. Convergence and validity of solutions along with computational efficiency are explored. Students learn to apply these techniques using the latest software packages. Prerequisite: ENME 2671.

ENME 3731 Advanced Engineering Thermodynamics (4 qtr. hrs.) *(course is a technical elective)*
Advanced topics in thermodynamics. Introduction to statistical thermodynamics. Prerequisites: ENME 2720, ENGR 3610 or permission of instructor.

ENME 3820 Special Topics (ME) (0-5 qtr. hrs.) *(these courses are technical electives)*
Mechanical engineering topics as announced. May be taken more than once. Prerequisite: varies with offering.

ENME 3860 Introduction to Air Pollution (3 qtr. hrs.) *(course is a technical elective)*
The thermodynamics, kinetics and photochemistry of air pollution. Origins and effects of particulate pollution, including light scattering. Effects of meteorology on air pollution. Prerequisite: MATH 1953.

ENME 3991 Independent Study (0-5 qtr. hrs.) *(this course can be taken as technical elective)*
Topics in mechanical engineering investigated under faculty supervision. May be taken more than once. Students must obtain and complete an Independent Study form from the Office of the Registrar. Prerequisite: Permission of instructor.
Mechatronic Systems

ENMT 3210 Mechatronics I (4 qtr. hrs.) *(course is a technical elective)*
This course provides basic concepts from electrical, mechanical and computer engineering as applied to mechatronic systems; and is intended to serve as a foundation course for further exploration in the area of mechatronics. Prerequisite: senior or graduate standing in engineering.

ENMT 3220 Mechatronics II – Real-Time Systems (4 qtr. hrs.) *(course is a technical elective)*
Real-time systems require timely response by a computer to external stimuli. This course examines the issues associated with deterministic performance including basic computer architecture, scheduling algorithms, and software design techniques including data flow diagrams, real-time data flow diagrams, state transition diagrams, and petri nets. In the lab portion of this class, students will program a microcontroller to interact with mechatronic devices. Prerequisites: ENMT 3210, ENCE 3210 or COMP 3354.

ENMT 3800 Special Topics (Mechatronics) (1-5 qtr. hrs.) *(these courses are technical electives)*
Various topics in Mechatronic Systems Engineering as announced. May be taken more than once. Prerequisite: varies with offering.

Materials Science

MTSC 3010 Mechanical Behavior of Materials (4 qtr. hrs.) *(course is a technical elective)*
Effects of microstructure on mechanical behavior of materials (metals, polymers, ceramics and composites); emphasis on recent developments in materials science, modulus, fracture (fracture toughness and brittle strength), fatigue, creep, wear, corrosion, stress rupture, rupture and deformation. Prerequisite: ENME 2421.

MTSC 3020 Composite Materials I (4 qtr. hrs.) *(course is a technical elective)*
An introduction to composite materials. Properties of fibers and matrices, fiber architecture, elastic properties of laminae and laminates, interface in composites. Prerequisites: MATH 2060, ENME 2410, ENME 2541.

MTSC 3110 Thermodynamics of Solids (3 qtr. hrs.) *(course is a technical elective)*
Relations among thermodynamic quantities, thermodynamics of phase transformations, chemical reactions, solutions, alloys and phase diagrams. Applications to solid state properties of materials. Prerequisites: ENME 2710, ENME 2421.

MTSC 3430 Diffraction & Structure I (3 qtr. hrs.) *(course is a technical elective)*
Properties of X-rays, geometry of crystals, calculation of directions and intensities of diffracted beams from polycrystalline samples, experimental methods including computerized data acquisition and data reduction, detector characteristics, search/match methods for phase identification and determination of crystal structure (indexing). Laboratory exercises illustrating the above. Prerequisite: ENME 2410.

MTSC 3450 Fracture Mechanics (4 qtr. hrs.) *(course is a technical elective)*
Topics include stress field at a crack tip, linear elastic fracture mechanics, energy release rate, stress intensity factors, plastic zones, plane stress, plane strain, fracture toughness, airy stress functions, elastic-plastic fracture mechanics, J integral, crack tip opening displacements, experimental testing, fatigue, life prediction, crack closure, weight functions, failure analysis. Prerequisites: ENME 2421, ENME 2541

Chemistry

CHEM 1040 Introductory General Chemistry Lab (1 qtr. hr.)
Laboratory to accompany CHEM 1010. For students with no high school chemistry background or who feel they do not have adequate preparation in chemistry form high school. First half, fundamental concepts of chemistry, presented as series of tutorial exercises. Second half, experiments intended to illustrate certain principles in CHEM 1010. Co-requisite: CHEM 1010.

CHEM 1240 General Chemistry Lab (1 qtr. hr.)
Laboratory to accompany CHEM 1060. For students with a good ground in high school chemistry. Experiments illustrate aspects of atomic structure, chemical bonding, and thermodynamics. Co-requisite: CHEM 1610.
CHEM 1610 Chemistry for Engineers (3 qtr. hrs.)
Lecture course for engineering majors and other science majors with strong background in chemistry. Topics covered include atomic and molecular structure, reactions in solution, thermochemistry and thermodynamics, electrochemistry and intermolecular forces. Co-requisite: CHEM 1240.

Computer Science

COMP 1571 Applied Procedural Programming (3 qtr. hrs.)
The C programming language is used to introduce fundamental procedural programming including engineering applications. Programming topics include an overview of computers and programming languages, variables and data types, arithmetic operators, input/output, comments, control structures, user-defined functions, scope, constants, file I/O, and pointers. Prerequisite: High School Algebra.

COMP 1572 Applied Procedural Programming II (3 qtr. hrs.)
The Java programming language is used to introduce object-oriented programming. Topics include fundamental object-oriented concepts, class design and implementation, inheritance, polymorphism, exceptions, and event-driven programming. Prerequisite: COMP 1571.

COMP 2370 Introduction to Algorithms & Data Structure (4 qtr. hrs.)
Performance analysis of algorithms; data structures and their physical storage representation; recursive techniques; stacks, queues, lists, trees, sets, graphs; sorting and searching algorithms. Prerequisites: MATH 2200, COMP 2673.

COMP 3361 Operating Systems I (4 qtr. hrs.)
Operating systems functions and concepts; processes, process communication, synchronization; processor allocation, memory management in multiprogramming, time sharing systems. Prerequisites: COMP 1672 and 3693.

Mathematics

MATH 1951 Calculus I (4 qtr. hrs.)
Differentiation of functions of one variable. Use of a laptop computer and a computer algebra system is an integral component of the course. Students with high school trigonometry should enter sequence in fall quarter. Others should complete prerequisite MATH 1750 and enter sequence in winter quarter. Prerequisite: MATH 1750 or equivalent.

MATH 1952 Calculus II (4 qtr. hrs.)
Differentiation and integration of functions of one variable. Use of a laptop computer and a computer algebra system is an integral component of the course. Prerequisite: MATH 1951.

MATH 1953 Calculus III (4 qtr. hrs.)
Integration of functions of one variable, infinite sequences and series. Use of a laptop computer and a computer algebra system is an integral component of the course. Prerequisite: MATH 1952.

MATH 2060 Elements of Linear Algebra (4 qtr. hrs.)
Matrices, systems of linear equations, vectors, eigenvalues and eigenvectors; idea of a vector space; applications in the physical, social, engineering, and life sciences. Prerequisite: MATH 1750 or equivalent.

MATH 2070 Introduction to Differential Equations (4 qtr. hrs.)
Solution of linear differential equations; special techniques for nonlinear problems; mathematical modeling of problems from physical and biological sciences. Prerequisite: MATH 1953 or MATH 1963.

MATH 2080 Calculus of Several Variables (4 qtr. hrs.)
Multivariable processes encountered in all sciences; multiple integration, partial differentiation and application; algebra of vectors in Euclidean three-space; differentiation of scalar and vector functions. Prerequisite: MATH 1953 or MATH 1963.

MATH 2200 Introduction to Discrete Structures (4 qtr. hrs.)
Introduction to theory of sets; relations and functions; logic, truth tables and propositional calculus; proof techniques; introduction to combinatorial techniques. Prerequisite: high school algebra.
Physics

PHYS 1211 - University Physics I (5 qtr. hrs. each)
First of a three-quarter sequence. Kinematics, vectors, force, energy and work, linear momentum, rotation of rigid bodies. Required for all physics and engineering majors and recommended for all science majors who are also required to take calculus. The course includes a rigorous calculus-based laboratory that exposes students to a broad range of the real physical phenomena studied in the lecture course. Through the use of experimental apparatus, computerized instrumentation and data acquisition, data analysis and graphical representation, students use the observed phenomena to exemplify the laws of physics. Physics theory and other relevant background information are explored individually by students in weekly prelab exercises. Students learn to write introductory-level laboratory reports and become familiar with good laboratory technique. Emphasis for this lab is on mechanics. Corequisite(s): MATH 1951.

PHYS 1212 - University Physics II (5 qtr. hrs. each)
Second of a three-quarter sequence. Gravitation, fluids; oscillatory motion; waves; thermal physics. Required for all physics and engineering majors and recommended for all science majors who are also required to take calculus. The lab portion of this course is a continuation of the PHYS 1211 lab portion and builds on laboratory skills and knowledge from that course. Emphasis for this lab is on waves, oscillations, sound, fluids and thermodynamics. Prerequisite(s): PHYS 1211. Corequisite(s): MATH 1952.

PHYS 1214 University Physics III for Engineers (4 qtr. hrs.)
This is the third course of a 3-quarter sequence and is for Engineers only; this is equivalent to PHYS 1213, but does not include lab component. Electrodynamics, electric circuits, magnetism and electromagnetism; electromagnetic waves, geometrical and physical optics. Required for all engineering majors. Prerequisite: PHYS 1212. Corequisite: MATH 1953

MBA Business Courses

Note that the Daniels College of Business often revises its MBA curriculum, so the courses listed and the sequences given here may not be the ones in place in 2011. One should consult the DCB website for updates.

ACTG 4610 Financial Accounting and Reporting (4 qtr. hrs.)
The purpose of this course is to provide you with an understanding of financial statements issued by companies to external parties, such as shareholders, creditors, and government agencies such as the Securities and Exchange Commission (SEC). To achieve this purpose, the course will: 1) introduce students to the most important issues relating to the assets, liabilities, and stockholders' equity accounts reported on the balance and income statement reporting issues; 2) provide students with sufficient understanding of the reporting mechanics to locate and interpret relevant information in the financial statements; 3) assist students in developing skills that can be used in analyzing financial information provided by companies; and 4) examine major transaction categories and accounting policies of business firms and their financial statement implications. Upon completion of the course, students should be able to appreciate both the usefulness and the limitations of accounting information. The perspective of the course is at all times that of the USER, rather than a PREPARERE, of financial statements.

ACTG 4660 Strategic Cost Management (4 qtr. hrs.)
Strategic cost management methods and practices focus on how to help the firm succeed in contemporary business. Topics in the course include balanced scorecard, cost-volume-profit analysis, target costing, standard costing, and management control. The course will enable students to apply strategic thinking to management planning, decision-making, and management reporting. Prerequisite: ACTG 4610

BUS 4610 The Essence of Enterprise (4 qtr. hrs.)
Today's business environment is increasing characterized by complex questions without clear black and white answers that span well beyond the historically narrow focus on the enterprise. Managers of tomorrow must be equipped with analytical and conceptual skills that allow them to see connections between social and environmental challenges and opportunities from local to global levels and how they interact and influence enterprise level value creation and innovation in a responsible manner. This course provides a perspective - i.e. worldview - that appropriately places the enterprise in the context of an interconnected world where success, organizationally and personally, is determined by how well one applies the necessary functional skills and organizational understanding to opportunities and challenges framed by globalization,
both shared and disparate values, and the need for creativity, innovation, and entrepreneurial spirit. This course draws on the history of business practice and leadership to provide a foundation for personal self discovery and professional direction.

**BUS 4620 Ethics - 21st Century Professional (4 qtr. hrs.)**
A fundamental purpose is to engage students in ongoing reflection and dialogue about their responsibilities as managers and leaders. Of particular emphasis are the ethical, professional and social responsibilities of managers and leaders, especially as it relates to numerous stakeholders and communities. This course focuses on the idea of "community" and the social relationships of managers and business organizations in their communities. Roles and responsibilities of managers and business firms will be examined by analyzing a variety of issues that managers will face during their careers. These specific issues will be examined in terms of their legal, public policy, and ethical dimensions. The goal is to provide students with generalized understanding and skills that can be employed in dealing with other issues that may emerge in their business careers.

**BUS 4630 Creating Sustainable Enterprise (4 qtr. hrs.)**
A sustainable enterprise is defined as any human endeavor with integrity in three interconnected dimensions - environmental, cultural, and economic - and whose collective actions meet the needs of the enterprise and its stakeholders today without compromising the ability of future generations to meet their needs. The fundamental purpose of this course is to help prepare students for careers in which success requires a worldview that extends beyond the enterprise level in order for managers to create sustainable cultural, social, and financial value for the organization and society in a responsible manner.

**FIN 4630 Managerial Finance (4 qtr. hrs.)**
Analytical skills and tools of finances; theoretical concepts and practical applications. Topics include ratio analysis, breakeven analysis and leverage, securities valuation, capital budgeting, financial forecasting, and working capital management.

**ITEC 4610 Information Technology Strategy (4 qtr. hrs.)**
Businesses run on information, organized data about customers, markets, competition, and environments. Information systems (interconnected computers, data, people, and processes) are critical to capture, organize, and disseminate that information in ways that provide stakeholder value. This course is designed to help managers, technical and non-technical alike, to explore how to derive greater value and satisfaction, both personally and professionally, from information systems.

**MBA 4610 Business Law and Public Policy (4 qtr. hrs.)**
This course is designed as a survey to cover a broad scope of basic concepts, along with their application to three major policy areas in the final weeks of the course. The course begins with an exploration of the role of business in the public policy environment. The course then examines the legal environment of business, including key elements of private law (contracts, agency, torts, and business organization law) and public law (employment law, administrative law, antitrust law, environmental law, and intellectual property law). In so doing, the course finally applies basic concepts from law and public policy, along with some concepts from economics, to examine three crucial policy areas related to business: regulatory policy, competition policy, and natural resource policy.

**MBA 4690 Enterprise Solutions (4 qtr. hrs.)**
A practical application of key business and managerial knowledge, skills, and competencies designed to integrate all graduate program elements and provide students with a distinctive advantage in career development.

**MGMT 4620 Organizational Dynamics (4 qtr. hrs.)**
In this course, you will: (1) understand and develop a set of management and leadership skills critical for effectiveness in high performance work environments; (2) develop the ability to analyze organizations and environments from multiple perspectives; (3) explore policies and practices for facilitating organizational change; (4) become a valued and effective member of a work team; and (5) learn how to incorporate effective communication, critical thinking, creative problem solving, and technology, into organizational behaviors and processes.

**MGMT 4630 Strategic Human Resources Management (4 qtr. hrs.)**
This course advances the argument that effective human resource policies will create sustained competitive advantage. To that end, this course will address the effective management of human resources in various policy areas: staffing, diversity, training and development, voice and influence, performance appraisal, and reward systems.
Rather than taking a traditional, staff personnel perspective, we will discuss human resource management from the strategic perspective of a general manager. Prerequisite: MGMT 4620.

MGMT 4690 Strategic Management (4 qtr. hrs.)
This course builds from the premise that managers make decisions that influence the overall success of their organizations. We will concentrate on how top managers create and maximize value for their stakeholders. You will learn about how companies compete against each other in the quest of achieving high performance and market victories. You will learn about how and why some companies are successful while others are not. This course is about strategy. The primary task of strategy is the allocation and commitment of critical resources over relatively long periods of time in pursuit of specific goals and objectives. Strategic decisions take account of the conditions that prevail within the industry environment, both positive and negative, and the resources and capabilities available to managers for meeting environmental challenges. Strategy also requires establishing and managing an internal organizational system that creates and sustains strategic value.

MKTG 4610 Marketing Strategy (4 qtr. hrs.)
This course covers the foundations of marketing as well as the process of developing, assessing, and implementing marketing strategy. The foundations are grounded in an understanding of customers' wants and needs and a commitment to satisfying those needs within the resources of the organization, the long-term benefits of society and the economy, and the highest ethical and moral standards. From this foundation, students learn the process of formulating and assessing marketing strategies, including qualitative and quantitative analyses.

STAT 4610 Quantitative Methods (4 qtr. hrs.)
This course introduces students to basic analytical tools in statistics and operations and provides the initial theoretical concepts and skills that are building blocks for future courses. The approach is to present students with a "corporate" view of how quantitative tools and concepts are used to analyze data and facilitate business decision-making. Students will familiarize themselves with all of the statistical and operations models presented in the course and will demonstrate knowledge in applying the appropriate techniques and models to various decision modeling, with an interpretation of the results of the analysis. Appropriate software will be used in all places where it facilitates the analysis and modeling, allowing students to become more proficient overall in using Microsoft Excel and to place their emphasis on applications to core business disciplines, quantitative reasoning, model building, proper interpretation of results, and managerial decision-making.
VI. STUDENT ORGANIZATIONS AND OPPORTUNITIES

Engineering Club and Other Engineering Student Organizations

The Engineering Club is a University and Department sponsored student organization to which all engineering students are encouraged to belong. It coordinates the activities of the numerous student professional societies and clubs and organizes other activities, such as the annual Industry Reception (where local industry representatives meet with students to discuss careers, internships and jobs), the Engineering Mentoring Program (which pairs a student with a practicing engineer from a local company) and social activities, such as picnics and get-togethers. It is an excellent opportunity to make friends, become involved and to practice leadership.

As part of the Engineering Club, there are student chapters or branches for numerous specialized interests, most of which are connected to national engineering organizations. Cost of student membership in each is moderate and well worth the return. Most of these have programs in which one can take part on a local, regional or national level; some offer competitive scholarships to outstanding students. Student chapters or branches of national societies: ASME (American Society of Mechanical Engineers), IEEE (Institute of Electrical and Electronics Engineers), SAMPE (Society for the Advancement of Materials Processing Engineering), AIAA (American Institute of Aeronautics and Astronautics), NSBE (National Society of Black Engineers), SHPE (Society of Hispanic Professional Engineers), SWE (Society of Women Engineers) and ACM (Association for Computing Machinery). There is also a local club: ASEC (Asian Science and Engineering Club). Joining and participating in one or more of these is an excellent way to become involved, learn more about a field of interest and develop leadership skills. Details about these can be obtained through the Engineering Club.

The Order of the Engineer is an association for graduate and professional engineers in the United States that emphasizes pride and responsibility in the engineering profession. It is a common presence in American engineering schools. Before joining, members must take an oath to abide by a code of ethics called The Obligation of an Engineer. Members are given a stainless steel ring called the Engineer's Ring that is worn on the little finger of the working hand. This ring is given at the end of the student’s senior year, prior to graduation.

PINS and Undergraduate Research Assistantships

Students wishing to participate in faculty research projects may be eligible for participation in PINS (Partners in Scholarship) or Undergraduate Research Assistantships (URA’s). PINS is a University-wide program in which a student performs research in conjunction with a faculty member. More information on PINS is available at http://www.du.edu/urc/. URA’s work directly with faculty, often for compensation, on current research efforts. Students can read about faculty research interests on the ECE (http://www.ece.du.edu) and MME (http://www.mme.du.edu) web sites. Such work enhances the student’s ability to compete for scholarships, internships, entrance to graduate study and permanent employment. A limited number of these are available and are typically restricted to upper-division students with good academic backgrounds. An agreement with a specific faculty member is required and the URA is requested by, and granted to, the faculty member.

Summer Jobs and Internships

The Office for Career Counseling receives notices about summer job openings and summer internships. Some of those jobs and internships are forwarded to the appropriate engineering department and are placed in an internship notebook inside the ECE or MME Offices. Check this notebook frequently, and if interested, contact the person named on the announcement. A limited number of jobs for juniors and seniors may also be available in ECE or MME. Summer PINS programs are also available. The engineering departments also are contracted directly by companies that are interested in hiring interns and these postings are place in the notebooks.

Study Abroad

The University of Denver strongly encourages students to participate in Study Abroad Programs, particularly the Cherrington Global Scholars Program; more information about which can be found at: http://www.du.edu/intl/abroad/

The engineering curricula have been structured so that advantage can be taken of this opportunity in the Autumn Quarter of the Senior year, rather than in the Autumn Quarter of the Junior Year, as is more usual in other DU programs. There are many advantages to this.
1. As planning for the Study Abroad experience must begin early in the preceding year, it is to the student’s advantage to have decided firmly on the degree program to be pursued, which is not done in engineering until after completion of the first two years;
2. More opportunities for expanding the scope and focus of one’s engineering education are available at this time, as the student will have completed many of the required disciplinary courses, and can take advantage of technical electives which may not be offered at the University of Denver;
3. By the end of the Junior year, it is possible to plan the entire Senior year fully;
4. As it is, in general, not possible to complete the dual-degree programs in five years if Study Abroad is also included, the student is better prepared to make this choice at that time.

In general, the following considerations should be kept in mind if the student desires to graduate “on time” and wishes to take part in the Study Abroad experience:

1. The student will need to be “on track” with the chosen degree program at the time of studying abroad;
2. The host institution must offer appropriate courses which may be required for the engineering program followed;
3. It is also highly advisable to select an institution in which the language of instruction is English unless the student is a native speaker.
4. For participation in the Cherrington Global Scholars program, a minimum GPA of 3.0 is required.

Engineering students must be especially careful in planning this experience because of the highly restrictive and sequential nature of engineering curricula. It should also be noted that the sites at which the required courses can be found are very limited, vary depending on degree, and may change from one year to the next. Drs. Daniel Armentrout and Ron DeLyser are the department contacts for students interested in the Cherrington Global Scholar Program.

Scholarships, Honors and Awards

Departmental Scholarships
The engineering departments have endowed scholarships from several different donors which are strictly for engineering students. Since the donors desire to have scholarship go only to engineering students, students who change registration from the engineering curriculum will most likely lose the engineering scholarship. There is no application form for these scholarships because every engineering student is automatically considered. Scholarships are awarded based primarily on need as determined by the Free Application for Federal Student Aid (FAFSA) and merit (Engineering GPA and Math Science GPA). Individual donors have placed restrictions on how their scholarship can be awarded. Because there is currently a disproportionate amount of scholarship funds available to female engineering students, more scholarship money is awarded to female students.

Honor Societies
Engineering students are eligible for a number of Honor Societies at the University, including: Golden Key (general), Pi Mu Epsilon (Mathematics), Sigma Pi Sigma (Physics), Alpha Lambda Delta (First-Year students) and Mortar Board (Third-Year students). Some students who show exceptional ability and interest in the humanities, social sciences and natural sciences may also be considered for election to Phi Beta Kappa (Liberal Arts and Sciences).

University Honors Program
Students accepted as members of the University Honors Program have numerous opportunities to enhance their educational experiences. Students graduate with University Honors upon satisfaction of the following requirements:

- completion of the Honors sequence of courses
- maintenance of a 3.5 GPA
- satisfaction of all requirements for distinction in the major, including a thesis or culminating project
Students in the Honors Program take ENGR 3314, 3324 and 3334 (Honors Thesis I, II & III) in place of ENGR 3313, 3323 and 3333 (Senior Design Project I, II & III). In addition to the requirements for Honors Thesis I, II & III, the student must also fulfill the requirements for Graduation with Distinction discussed below.

The above is only a general indication of requirements; for a complete set, students should contact the Honors Program.

**Graduation with Distinction**

Graduation with Distinction provides a mechanism to recognize those students who have made significant academic achievements in an area of engineering during their undergraduate careers at DU.

The requirements for Graduation with Distinction are:

1. Cumulative GPA exceeding 3.3
2. Successful completion of an undergraduate research project, including a Research Paper and presentation.

The undergraduate research project is an individual project in an engineering-related discipline. The emphasis of the undergraduate research project should be on making a novel research contribution, which differs significantly from a senior design capstone project. Unusual cases in which a student has made a significant individual research contribution in an area related to a senior design project may be considered.

Graduation with Distinction will appear on the student’s transcript and in the commencement program. Eligible students and their faculty advisors should complete an application form.

**Degrees with Honors**

The University of Denver awards baccalaureate degrees with honors. These are designated as cum laude (minimum DU GPA 3.75), magna cum laude (minimum DU GPA 3.85), and summa cum laude (minimum DU GPA 3.95). A thesis is required for the designation of summa cum laude, and an engineering student must take ENGR 3314, 3324 & 3334 (Honors Thesis I, II & III) in order to qualify for this designation. Further requirements on numbers of hours taken at the University of Denver for each of these designations may be found in the University Bulletin. These designations appear on the diploma and on the final transcript.

**All-University Awards**

The University gives awards for the Outstanding Student and Distinguished Students from each undergraduate class. These are based upon academic achievement, contributions to the University and community service. Students are eligible for consideration for these upon nomination. Pioneer Awards are given for particularly distinguished service to the University.

**Departmental Awards**

Both the ECE and MME departments annually give awards to graduating students for academic excellence and for service to the departments.

**Colorado Engineering Council Awards**

Each year the Colorado Engineering Council selects an outstanding graduating engineering student from each of the colleges and universities in the state of Colorado offering accredited engineering programs to receive a Colorado Engineering Council Silver Medal. The award recognizes engineering excellence and potential for outstanding engineering work in the future. The silver medal recipient is selected from the top three graduating engineering students of the year selected by the engineering faculty. The other two candidates who do not receive the silver medal receive Certificates of Merit from the Colorado Engineering Council.
VII. ACADEMIC REQUIREMENTS AND PROCEDURES

Curriculum Requirements
All courses listed in a student’s specific curriculum must be completed in order to receive the degree(s), and all GPA requirements must be met.

Grade Point Average (GPA)
The University of Denver requires students to maintain an overall GPA of 2.0 (on a 4 point scale) to remain in academic good standing. Students whose GPA falls below 2.0 are placed on probation and eventual suspension. The University Bulletin contains details on this process.

A Major GPA of 2.0 or greater is also required for graduation. In Engineering, all courses with prefixes ENBI, ENCE, ENEE, ENGR, ENME, ENMT, and MTSC are Major courses. The procedure for calculating the Major GPA is the same as that used by the University in calculating the overall GPA. All courses in the curriculum must be passed, and all required Major courses must be passed with a grade of C- or better. The student’s academic progress report (APR) has a calculation of the overall and major GPAs.

Students in a dual-degree program are required to have a graduate GPA of 3.0 or better. Repeated courses are still counted in the GPA but the student only receives the credit hours for taking the course once. Only courses taken at the University of Denver are considered in the calculation of the overall, Major, and MBA GPA’s.

Class Standing in Engineering
Some courses in engineering require junior or senior standing in engineering. This is distinct from junior or senior standing in the University which is determined solely on the basis of credit hours completed. Engineering students are determined to have junior or senior standing in engineering based on the following:

Junior Standing in Engineering
A student must have completed required courses in the common 2-year curriculum to obtain junior standing in engineering. Failure to have done so may result in not being permitted to enroll in ENGR 2610, 2620, Engineering Integration I, II.

Senior Standing in Engineering
A student must have completed all courses in the common 2-year curriculum, the junior engineering integration sequence (ENGR 2610, ENGR 2620) and most of the courses required for the particular degree in the discipline. Failure to have done so may result in not being permitted to enroll in ENGR 3313, 3323 & 3333 Engineering Design Project I, II & III or in ENGR 3951, Engineering Assessment II.

Application for Graduation
The student should apply for graduation three quarters prior to the expected date of graduation. This can be done either by completing a form available from the Office of the Registrar or on-line at http://www.du.edu/registrar/graduation/grad-app2.html.

Students in a dual-degree program must also apply separately for graduation from the second degree. Please contact your advisor for the second degree for details on applying for graduation.

Prerequisites and Co-requisites
Course descriptions list all prerequisite and co-requisite courses. All prerequisite courses listed must be taken and passed before a course may be attempted; all co-requisite courses must either have already been completed or must be taken concurrently. Failure to do this will usually result in a student being excluded from the course. If a student drops one course, then any co-requisite courses must be dropped as well. Grades of D-, D, D+ are considered to be “passing” for purposes of fulfilling prerequisites to a course. Note, however, that if these grades are obtained in a required engineering course, that course must be repeated until a grade of C- or above is obtained in order to satisfy Major requirements.
Fundamentals of Engineering (FE) Examination and Enrollment as an Engineer-Intern (EI)

As an essential part of our assessment program, all mechanical engineering students in our ABET/EAC accredited curricula must register for and take the FE exam before graduation. It is also highly recommended that all ECE students register for and take the FE exam before graduation.

The FE exam is a national 8-hour examination administered by NCEES (National Council of Examiners for Engineering and Surveying) in conjunction with the Colorado State Board for Professional Engineers and Land Surveyors. Students must have senior standing in engineering to apply to take the FE exam, for which a fee is charged. For more information please contact Dr. Armentrout.

In order to be enrolled as an EI, the student must pass the FE exam and send a final transcript recording the receipt of an engineering degree to the Colorado State Board for Professional Engineers and Land Surveyors. This is a nationally recognized designation and enrollment as an EI in Colorado (or any other state) is recognized by all others when the individual later applies for registration as a Professional Engineer (PE). Typically, the requirements for registration as a PE beyond those required for the EI are: 4 years of engineering experience with increasing engineering responsibility and passing the PE examination.
VIII. FACULTY

Electrical and Computer Engineering Faculty

PROFESSOR
K. Valavanis, PhD, Rensselaer Polytechnic Institute, Troy, NY, Department Chair.

ASSOCIATE PROFESSORS
R.R. DeLyser, PhD, University of Colorado, Boulder, Department Associate Chair.
D.W. Gao, PhD, Georgia Institute of Technology.
M.A. Matin, PhD, University of Nottingham, UK.
R.E. Salters, PhD, University of New Mexico.
R.M. Voyles, PhD, Carnegie Mellon University.

ASSISTANT PROFESSORS
M. Mahoor, PhD, University of Miami, Florida.
S. Pourkamali, PhD, Georgia Institute of Technology.
V. Yousefzadeh, PhD, University of Colorado, Boulder.

SENIOR LECTURERS AND LECTURERS
R.K. Whitman, PhD, University of Colorado, Boulder.

ADJUNCT FACULTY
G.R. Edelstein, MS, Hunter College.

JOINTLY APPOINTED FACULTY
C.S. Lengsfeld, PhD, University of California, Irvine.
R.A. Shoureshi, PhD. Massachusetts Institute of Technology/Dean.
Y. Yi, PhD, University of Michigan.

LAB MANAGER
G.R. Edelstein, MS, Hunter College.

EMERITUS or EMERITA FACULTY
A.J. Rosa, PhD, University of Illinois, Urbana-Champaign.
Mechanical and Materials Engineering Faculty

PROFESSORS
M.S. Kumosa, PhD, University of Wroclaw.
R.A. Shoureshi, PhD. Massachusetts Institute of Technology/Dean.
J.C. Wilson, PhD, University of Minnesota.

ASSOCIATE PROFESSORS
P.J. Laz, PhD, Purdue University.
C.S. Lengsfeld, PhD, University of California, Irvine.
P.K. Rullkoetter, PhD, Purdue University.

ASSISTANT PROFESSORS
B.S. Davidson, PhD, Virginia Tech-Wake Forest University.
Y. Yi, PhD, University of Michigan.

SENIOR LECTURERS AND LECTURERS
D.L. Armentrout, PhD, University of Denver, Department Interim Chair.

JOINTLY APPOINTED FACULTY
S. Pourkamali, PhD, Georgia Institute of Technology.
R.M. Voyles, PhD, Carnegie Mellon University.

LAB MANAGER
J. Buckley, University of Denver.

EMERITUS or EMERITA FACULTY
J.B. Calvert, PE, PhD, University of Colorado, Boulder.
M.A. Hamstad, PE, PhD, University of California, Berkeley.
P.K. Predecki, PhD, Massachusetts Institute of Technology.
E.R. Tuttle, PE, PhD, University of Colorado, Boulder.