Faculty of Engineering and Architecture (FEA)

Officers of the Faculty

Peter F. Dorman  President of the University
Ahmad Dallal  Provost, ex-officio
Makram Suidan  Dean
Fadl Moukalled  Associate Dean
Moueen Salameh  Registrar, ex-officio
Salim Kanaan  Director of Admissions, ex-officio
Lokman Meho  University Librarian, ex-officio

Faculty Administrative Support

Ghada Kamar Najm  Executive Officer
Alia Kazma Serhal  Student Services Officer
Lara Touma  Financial Officer

Historical Background

As early as 1913 the University recognized the need for engineering education and training in the Middle East, and courses in this field were offered in the School of Arts and Sciences. By 1944 sufficient additional courses had been added to permit the granting of the degree of Bachelor of Science in Civil Engineering. The last class in this program graduated in June 1954. In 1951 a separate School of Engineering was established and curricula were initiated in civil engineering, mechanical engineering, electrical engineering, and architectural engineering. The years from 1951 to 1954 were a transitional period of continuous development toward the new curricula, established in 1954. In 1963 a program leading to the degree of Bachelor of Architecture was introduced, replacing the bachelor of architectural engineering program, the last class of which graduated in June 1966. In that year the school was renamed the Faculty of Engineering and Architecture. Since then curricula have been under constant review with changes introduced as necessary to keep pace with modern technology, to conform to sound developments in engineering and architecture education, and to meet the evolving needs of the region. In 1986 a new undergraduate major in computer and communications engineering was added within the Department of Electrical and Computer Engineering. In 1992 a new major in graphic design was added within the Department of Architecture and Design. In 2006 the name of the degree was changed to Bachelor of Fine Arts in Graphic Design. In 2006 the name of the Electrical Engineering degree was changed to Electrical and Computer Engineering. In 2009 two new programs offering BS and BE degrees were added to the FEA. A Construction Engineering Program in the CEE department and a Chemical Engineering Program currently housed in the Mechanical Engineering Department.
Accreditation
The American University of Beirut, Bachelor of Engineering (BE) programs in civil engineering, computer and communications engineering, electrical and computer engineering, and mechanical engineering have been accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012. This is one of the most respected and internationally renowned accreditation organizations in the USA. ABET accreditation demonstrates a program’s commitment to providing its students with a quality education.

Mission
The Faculty of Engineering and Architecture (FEA) at the American University of Beirut is a leading professional school in the Middle East. The FEA offers educational programs of the highest standards, advances knowledge through research and scholarly creative work of its faculty and students, and provides services to the community at large, while addressing the needs of Lebanon and the region. The FEA undergoes continuous improvement to maintain a challenging and intellectually stimulating environment, and prepares its students to be lifelong learners, innovators, and professionals capable of being leaders in their chosen careers, committed to personal integrity, and civic responsibility.

Undergraduate Programs
The Faculty of Engineering and Architecture offers programs of study leading to the degrees of Bachelor of Architecture (BArch), Bachelor of Fine Arts in Graphic Design (BFA), and the degree of Bachelor of Engineering (BE), with majors in civil engineering, computer and communications engineering, electrical and computer engineering, mechanical engineering, and chemical engineering. The curriculum of the BArch degree extends over 14 terms (ten 16-week semesters and four eight-week summer terms), totaling 192 weeks. Although the program is completed in five calendar years, it is equivalent to a program of six academic years that does not include summers. The curriculum of the BE degree and that of the BFA degree is each divided into 11 terms (eight 16-week semesters and three eight-week summer terms), totaling 152 weeks. This duration is equivalent to five academic years, without summers, but the program is completed in four calendar years. There is a short break after each term and a one-month vacation between summer and fall terms. The Faculty also offers a Bachelor of Science (BS) degree in Construction Engineering and a Bachelor of Science (BS) degree in Chemical Engineering. The curriculum of both BS degree programs require the completion of 110 credit hours, after the freshman year, of coursework over three years, including two summer terms.

The Faculty reserves the right to make changes in the curriculum, course content, and regulations as it deems appropriate, and without prior notice.

Admissions

Admission to First Year
Admission is by the selection of a limited number of the most promising, eligible applicants. All candidates for admission to the Faculty of Engineering and Architecture must have completed the pre-professional educational requirements of the candidate’s country and the approved freshman program in the Faculty of Arts and Sciences of this University as described in this catalogue, or a program recognized as equivalent. The certificates, recognized for admission to the first year in the Faculty of Engineering and Architecture, are listed under Secondary Certificates in the section on Admissions in this catalogue. Holders of the technical baccalaureate (BT) are eligible for admission only to the same major as that of the BT.

More specifically, to be eligible for admission to the first year in the Faculty of Engineering and Architecture, a candidate must

- Demonstrate an acceptable level of proficiency in English, as specified under Admissions in this catalogue
- Sit for the required SAT I tests as specified in the relevant section in Admissions in this catalogue
- Satisfy the Faculty of Engineering and Architecture requirements on character recommendation, as well as academic grounds

Students admitted to the first year are required to take all the major engineering, architecture, or graphic design courses specified in their respective programs.

Admission of Transfer Students
Students attending recognized institutions of higher learning, including AUB, may apply for transfer to any of the engineering, architecture, or graphic design majors in the FEA. These students are eligible for consideration for admission to any of Terms I through VI (Term VIII for architecture) depending on availability of places and subject to the following conditions. Students will not be admitted to the architecture or graphic design programs in the middle of the academic year. Students must

- Have completed the equivalent of the sophomore class at the college or university from which they are transferring
- Have attained a minimum cumulative average of 2.7 out of 4.0 (75 out of 100 for AUB students)
- Have taken at least 12 credits of math and basic science courses at the sophomore level or higher and attained a total average in these courses of at least 3.0 out of 4.0 (77 out of 100 for AUB students) This applies to engineering and architecture majors only
- Have satisfied the university English requirements for admission
- Students from outside AUB applying for transfer to the architecture or graphic design majors are required to submit portfolios of their work; students from within AUB applying for transfer to the architecture or graphic design majors are encouraged to submit portfolios of their work.

Applications of transfer students are evaluated and approved by the departments and the Admissions Committee of the Faculty. The term in which the student is placed, and the complete program of study in the major in which s/he is admitted, are determined by the department concerned depending on the number of credits completed at the institution from which the student is transferring.

Non-degree Students
Refer to page xx in this catalogue.
Students working for Dual Degree

Students may, upon approval of the Faculty concerned, complete the requirements for a second degree while registered in another Faculty at AUB (or in the same faculty if there are two different degree structures). In such a case, a student will be granted two degrees at the same time of graduation. If tuition differs, students will pay the higher of the tuitions. Information about deadlines and applications are available on the following link: www.aub.edu.lb/registrar/Documents/pdfdoc/dualdegree.pdf

Students working for a Double Major

Students may, upon the approval of the faculty, earn more than one major in the same degree structure within the faculty of engineering (both BS or BE degrees) which means that the student earns one degree with a double major. In such case, one diploma will be issued with both majors indicated. Students enrolled in a double major must satisfy requirements of both majors and must satisfy at least 15 credit hours over and above the requirements of both majors. Information about deadlines and applications are available on the following link: www.aub.edu.lb/registrar/Documents/pdfdoc/doublemajor-application.pdf

Residence Requirements

Students of the Faculty of Engineering and Architecture must meet the following minimum residence requirements:

- **Engineering or Graphic Design Majors:** A student must register in residence at the Faculty of Engineering and Architecture for the last four regular semesters and should complete at least 50 credits during this period.
- **Architecture Major:** A student must register in residence at the Faculty of Engineering and Architecture for the last five regular semesters and should complete at least 65 credits during this period.

Academic Rules and Regulations

For information on Categories of Students, Correct Use of Language, Grading System, Graduation with Distinction and High Distinction, and Placement on the Dean's Honor List, see pages xx–xx in this catalogue.

General Education Program Requirements

Students in the CCE, ECE and ME departments are expected to satisfy the following distribution requirements of humanities/social sciences courses:

- Two English courses, one of them English 206 (6 credits)
- One Arabic Communications Skills course as determined by the Arabic Placement Test (3 credits)
- One course on ethics (3 credit humanity course)
- Three humanities courses (9 credits)
- Two social sciences courses (6 credits)

FEA students must select humanities/social science elective courses from the approved GE program course list on the Registrar's homepage.

Graduation Requirements

To be eligible for graduation with the bachelor's degree, a student must have passed all the required courses and the approved experience:

- attained a minimum cumulative course average of 70
- attained a cumulative average of 70 or more in major courses as specified by the department
- met the residence requirements
- satisfied the faculty as to the adequacy of the student's professional development and conduct

Class Status

The class status of students is as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year</td>
<td>Terms I and II</td>
</tr>
<tr>
<td>Second Year</td>
<td>Terms III, IV, and V</td>
</tr>
<tr>
<td>Third Year</td>
<td>Terms VI, VII, and VIII</td>
</tr>
<tr>
<td>Fourth Year</td>
<td>Terms IX, X, and XI</td>
</tr>
<tr>
<td>Fifth Year (architecture)</td>
<td>Terms XII, XIII, and XIV</td>
</tr>
</tbody>
</table>

A student's status is changed to that of a higher year if his/her cumulative number of failed, withdrawn or unregistered credits from the regular credit hour requirements does not exceed seven.

Change of Major within the Faculty

All changes of major are subject to approval by the department to which the change is requested. The receiving departments will determine the new study plans for students accepted to a new major.

Minor in Applied Energy

The minor in applied energy is open to all FEA students who are interested in the energy domain and in renewable energy applications. Students seeking professional careers that will focus on energy, the environment, sustainable applications in buildings, and energy systems may find this minor attractive. The minor in applied energy is offered by the Faculty of Engineering and Architecture rather than by an individual department.

Students who have completed at least 60 credits at the sophomore level and higher, and who have a cumulative average of 70 or more, may apply by completing a minor application form available in the Dean's Office. The minor will be indicated on the transcript of the student who completes all the requirements described below. A minimum grade of 70 is required for a course to count toward the fulfillment of the minor.
Applied Energy Minor Program Structure

The applied energy minor has two components. The first is a core of courses that provides a foundation for the understanding of energy science and technology. The second component is a customized series of electives and labs, selected by each student in close consultation with a special faculty advisor for the applied energy minor. A student wishing to complete the minor is required to complete a minimum of 20 credits: 9 credits from the list of core courses, and 11 credits from the list of elective courses.

Required Core Courses (9 credits)

The core courses include courses from three domains related to energy studies: one course in fundamental energy science, one course in energy technologies, and one course in energy management and economy as follows:

Fundamental Energy Science Course
MECH 310  Thermodynamics I  3 cr.
or CIVE 340  Fluid Mechanics and Laboratory  3 cr.
or CHEM 217  Thermodynamics and Chemical Dynamics  3 cr.

Energy Technologies Course
EECE 675  Renewable Energy Systems  3 cr.

Energy Management and Economy Course
ECON 333  Energy Economics and Policy  3 cr.

Elective Courses (Minimum of 11 credits)

Elective courses are selected from two lists. List A includes technical courses from chemical, mechanical, and electrical engineering majors at the undergraduate and master’s levels. List B includes courses in management, sciences, and the social sciences. The student must take a minimum of five credits from List A and a minimum of three credits from List B.

List A: Energy in Engineering Context
CHEN 417  Reaction Engineering and Reactor Design  3 cr.
CHEN 411  Heat and Mass Transfer Operations  3 cr.
CHEN 470  Chemical Process Design  3 cr.
CHEN 570  Process Synthesis and Optimization  3 cr.
CHEN 571  Chemical Product Design  3 cr.
CIVE 450  Water and Wastewater Treatment and Laboratory  3 cr.
CIVE 654  Solid Waste Management I  3 cr.
CIVE 656  Air Pollution and Control I  3 cr.
CIVE 658  Industrial/Hazardous Waste Management  3 cr.
CIVE 659  Environmental Impact Assessment  3 cr.

List B: Energy Management and Economics
ARCH 065  Climate Responsive Design  3 cr.
ENMG 640  Sustainable Development Management  3 cr.
ENMG 642  Lean Engineering Concepts  3 cr.
LDEM 203  The Environment and Sustainable Development  3 cr.
PSPA 317 (ENSC 657) Environmental Regulation and Legislation  3 cr.
PSPA 316 (ENSC 650) International Environmental Policy  3 cr.

Table 1 shows the number of credits that students will have to take outside their engineering major. Engineering students will have to take a minimum of 9 credits outside their major.

Table 1: Minimum number of credits taken by engineering students outside their major

<table>
<thead>
<tr>
<th>Major</th>
<th>CEE</th>
<th>CHEN</th>
<th>ECE and CCE</th>
<th>MECH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain</td>
<td>Credits in Major</td>
<td>Credits Outside Major</td>
<td>Credits in Major</td>
<td>Credits Outside Major</td>
</tr>
<tr>
<td>Core</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MECH 310</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
or CIVE 340 |
| EECE 675 | 3 | 3 | 3 | 3 |
| ECON 333 | 3 | 3 | 3 | 3 |
Minor in Biomedical Engineering

The minor in Biomedical Engineering is open to all AUB students. Students who have completed at least 60 credits at the sophomore level and higher, and who have a cumulative average of 70 or more, may apply by completing a minor application form available in the ECE department. The minor will be indicated on the transcript of the student who completes all the requirements described below, and who obtains an average in the minor courses of 70 or more.

The minor requirements are divided into a set of core courses and a set of elective courses.

Core Courses

For engineering students:
• EECE 401 (1 cr.)
• BIOL 201 (4 cr.)
• BIOL 202 or PHYS 246 (4 cr.)
• One core course (3 cr.) chosen from EECE 601, EECE 603, or MECH 633
• One elective course from list A below (3 cr.)
• One elective course from list A, B, or C below (3 cr.)

Minimum number of credits: 18

For biology students:
• EECE 401 (1 cr.)
• BIOL 201 (4 cr.)
• BIOL 202 (4 cr.)
• PHYS 228 (3 cr.) and PHYS 228L (1 cr.) or equivalent, and EECE 601 (3 cr.) or CIVE 210 (3 cr.) or equivalent, and MECH 634 (3 cr.)
• One elective course from list A or B below (3 cr.)

Minimum number of credits: 19

For all other students:
• EECE 401 (1 cr.)
• BIOL 201 (4 cr.)
• BIOL 202 or PHYS 246 (6 cr.)
• PHYS 228 (3 cr.) and PHYS 228L (1 cr.) or equivalent, and EECE 601 (3 cr.) or (CIVE 210 (3 cr.) or equivalent, and MECH 634 (3 cr.)
• One elective course from list A, B, or C below (3 cr.)

Minor in Chemical Engineering

The minor in chemical engineering, currently offered in the Mechanical Engineering Department, is open to all engineering students in majors other than chemical engineering.

Minor Program Requirements (21 credits)

Student taking the minor are required to complete 21 credits of course work: 15 credits of core courses, and six credits of elective courses from the list given below.

Required Core Courses (15 credits)
• MECH 310 Thermodynamics I 3 cr.
• CHEN 311/MECH 314 Introduction to Fluids Engineering 3 cr.
• CHEN 312 Separation Processes 3 cr.
• CHEN 411 Heat and Mass Transfer Operations 3 cr.
• CHEN 417 Reactor Engineering and Reactor Design 3 cr.

Elective Courses (6 credits) selected from the following courses
• CHEN 314 Chemical Engineering Thermodynamics 3 cr.
• CHEN 451 Process Instrumentation and Measurements 3 cr.
• CHEN 470 Chemical Process Design 3 cr.
• CHEN 480 Safety and Loss Prevention 3 cr.
• CHEN 515 Mechanical Unit Operations 3 cr.
• CHEN 531 Principles of Corrosion 3 cr.
• CHEN 570 Process Synthesis and Optimization 3 cr.
• CHEN 571 Chemical Product Design 3 cr.
• CHEN 612 Desalination 3 cr.
• CHEN 672 Polymer Science 3 cr.
• CHEN 673 Engineering of Drug Delivery Systems 3 cr.

Minimum number of credits: 19

Elective Courses

List A: EECE 601, EECE 602, EECE 603 (unless the student takes EECE 694, in which case either EECE 694 or 603 counts toward the minor), EECE 604, EECE 605, MECH 633, MECH 634

List B: MECH 532, MECH 606, MECH 607, MECH 624, MECH 631, MECH 641/EECE 661, EECE 693, EECE 694 (unless the student takes EECE 603, in which case either 694 or 603 counts toward the minor)

List C: BIOL 202, BIOL 223, BIOL 225, BIOL 244, BIOL 263, BIOL 268, PHYL 202, PHYL 246
Minor in Engineering Management

The Engineering Management Program offers a minor in engineering management that can be pursued by undergraduate engineering and architecture students, as well as by students from related majors, starting as early as the fall semester of their third year of enrollment. Only students who have a cumulative average of 70 or more are eligible to apply for the minor. To satisfy the requirements of the minor, a student must earn 18 credits of course work from the engineering management course offerings.

- At least nine of the total requirement of 18 credits must be fulfilled from the six undergraduate courses offered by the program, which must include ENMG 400: Engineering Economy. These nine credits must also include either ENMG 500: Engineering Management I, or ENMG 501: Engineering Management II.
- The other nine credits can be satisfied by taking courses either from the list of undergraduate courses or from the elective graduate courses offered by the program.

A minimum grade of 70 is required for a course to count toward the fulfillment of a minor in engineering management. Additionally, a cumulative average of 75 or above in all the minor courses is required.
Department of Architecture and Design

Chairperson: Musfy, Leila
Graduate Coordinator: Fawaz, Mona
Architecture Coordinator: Najjar, Karim
Binladen Chair for Architecture in the Islamic World
Professors: Al-Harithy, Howayda; Damluji, Salma Samar; Musfy, Leila; Saliba, Robert
Associate Professors: Arbid, George; Fawaz, Mona; Ghaibeh, Lina; Harb, Mona; Maasri, Zeina; Sadek, Walid; Shorto, Sylvia
Assistant Professors: Abedini, Reza; Aramouny, Carla; Gharbieh, Ahmad; Haddad, Rana; Najjar, Karim
Visiting Assistant Professor: Graef, Alexander
Senior Lecturers: Assi, Naji; Freiji, Mayda; Haddad, Walid; Hajjar, Majdi; Hassan, Sinan; Jamal, Sany; Kodor, Selim; Kosermelli, Simone; Nader, Marc; Samara, Rana; Serof, Gregoire; Yeretzian, Aram
Lecturers: Abboud, Rania; Alamuddin, Hana; Baki, Fadi; Boyadjian, Rafi; El-Souri, Amer; Feschfesch, Antoine; Kadi, Salim; Hallaj, Omar; Imam, Hatem; Kanaan, Joy; Kerbaj, Mazen; Mahmoud, Samir; Mallat, Bernard; Moukhaiber, Carole; Nader, Karim; Najm, Wagih; Nasrallah, Maha; Richani, Sandra; Saikali, Maya; Salem, Carla; Shuayb, Itab; Traboulsi, Jana; Zahreddine, Hassan
Instructors: Abi Hanna, Margheritta; Apelian, Khajag; Azar, Samia; Bou Akli, Hicham; Hachem, Pascal; Haidar, Mazen; Kahwagi, Bassam; Youssef, Shawki; Zoghbi, Pascal

The Department of Architecture and Design offers programs at both the undergraduate and graduate levels. The undergraduate level programs are in architecture and graphic design. The architecture program leads to the professional degree of Bachelor of Architecture (BArch). The graphic design program leads to the professional degree of Bachelor of Fine Arts in Graphic Design (BFA).

Architecture

Mission Statement

The bachelor of architecture program offers students a first professional degree that qualifies them to practice architecture. The program aims to graduate well rounded intellectuals, critical thinkers, and skilled professional architects who are committed to the advancement of the field and the practice; and who have a sense of responsibility for the built environment and the natural resources. Design is approached as a research-oriented process that is culturally grounded, theoretically informed and technically advanced so as to enable graduates to become lifelong learners and to take a leading role in the professional practice both in Lebanon and the region.
# Program Description

The architecture program comprises a total of 174 credit hours normally taken over five years. The curriculum is structured as follows: 1) Two foundation years, first and second, with core requirements in design, technical, and history courses which offer students basic skills and knowledge in design and related areas. 2) Two advanced years, third and fourth, with core requirements in advanced design, technical, history and theory courses, reinforced by the distribution electives. Two of the design studios at this level are thematic vertical studios. 3) Final year, fifth year, with a one-year design thesis and project and advanced electives.

The degree requirements in architecture consist of the following:

- 129 credit hours of mandatory core courses
- 15 credit hours of approved ArD/FEA field electives
- 3 credit hours in Category A: Representation
- 6 credit hours in Category B: History and Theory
- 6 credit hours in Category C: Technology and Professional Practice
- 6 credit hours of free electives in consultation with the academic adviser

To meet the General Education Requirements of AUB (24 credits must be taken outside the department)

- 6 credit hours of English including ENGL 206
- 3 credit hours of Arabic Communication Skills course as per placement test
- 6 credit hours of approved electives in humanities
- 3 credit hours of an approved elective in social sciences
- 3 credit hours of an approved elective in natural sciences
- 3 credit hours of an approved elective in quantitative thought

## Curriculum for the Degree of Bachelor of Architecture

### First Year

<table>
<thead>
<tr>
<th>Fall Semester</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARCH 100 Basic Design</td>
<td>4</td>
</tr>
<tr>
<td>ARCH 111 Technical Drawing</td>
<td>4</td>
</tr>
<tr>
<td>ARCH 121 History of Ancient Art and Architecture: From Caves to Catacombs</td>
<td>3</td>
</tr>
<tr>
<td>ARCH 151 Statics and Mechanics of Solids</td>
<td>4</td>
</tr>
<tr>
<td>ENGL 206 (or English as required) Technical English</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total 18</strong></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring Semester</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ARCH 101 Architecture Design I</td>
<td>7</td>
</tr>
<tr>
<td>ARCH 112 Descriptive Drawing</td>
<td>3</td>
</tr>
<tr>
<td>ARCH 122 History of Medieval Art and Architecture</td>
<td>3</td>
</tr>
<tr>
<td>ARCH 152 Analysis and Design of Structures I</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total 17</strong></td>
<td></td>
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</table>

### Second Year

<table>
<thead>
<tr>
<th>Summer Semester</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARCH 241 Surveying Regional Architecture</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fall Semester</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ARCH 202 Architecture Design II</td>
<td>7</td>
</tr>
<tr>
<td>ARCH 223 History of Post-Medieval Art and Architecture</td>
<td>3</td>
</tr>
<tr>
<td>ARCH 253 Analysis and Design of Structures II</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total 17</strong></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Spring Semester</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ARCH 203 Architecture Design III</td>
<td>7</td>
</tr>
<tr>
<td>ARCH 224 History of Modern Art and Architecture: 1760–1945</td>
<td>3</td>
</tr>
<tr>
<td>ARCH 242 Building Construction I</td>
<td>3</td>
</tr>
<tr>
<td>ARCH 213 Computer Aided Design</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total 16</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Third Year

<table>
<thead>
<tr>
<th>Summer Semester</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARCH 373 Training in CAD</td>
<td>0 b.</td>
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</table>

<table>
<thead>
<tr>
<th>Fall Semester</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARCH 065 Climate Responsive</td>
<td>3</td>
</tr>
<tr>
<td>ARCH 304 Architecture Design IV</td>
<td>7</td>
</tr>
<tr>
<td>ARCH 325 Contemporary Architecture</td>
<td>3</td>
</tr>
<tr>
<td>ARCH 343 Building Construction II</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total 16</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring Semester</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARCH 305 Vertical Studio I</td>
<td>7</td>
</tr>
<tr>
<td>ARCH 354 Building Services</td>
<td>4</td>
</tr>
<tr>
<td>ARCH 061 Architectural Programming</td>
<td>3</td>
</tr>
<tr>
<td>ENMG 502 Construction Management</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total 17</strong></td>
<td></td>
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</tbody>
</table>

* b. stands for billing
**Course Descriptions**

**Mandatory Core Courses**

Each of the following courses is required for the degree in architecture. Students should pay careful attention to the prerequisite structure, which must be observed. There is a grade average requirement for: ARCH 202, 304, 406, and 508; an average of 70 must be attained in the two preceding design courses in each case. Non-majors must secure the approval of the department and the instructor concerned to enroll in any of the courses listed below.

**ARCH 100  Basic Design**  
4 cr.  
Basic Design is an introductory studio course that provides an initial practical involvement in issues pertaining to design and architecture. The student is introduced and called upon to engage in thinking through applied practices about various questions concerning pictorial space, urban space, representation, physical gesture, objects and structures of organization. The aim of the projects is to expose students to basic design principles and train them in foundation studio skills.

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<table>
<thead>
<tr>
<th>Fourth Year</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer Semester</td>
<td>Credits</td>
</tr>
<tr>
<td>ARCH 474</td>
<td>Training in Execution Drawings</td>
</tr>
<tr>
<td>Fall Semester</td>
<td>Credits</td>
</tr>
<tr>
<td>ARCH 406</td>
<td>Architecture Design V</td>
</tr>
<tr>
<td>ARCH 431</td>
<td>Urbanism</td>
</tr>
<tr>
<td>3 Field/Free Electives or General Education Requirements</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total 19</strong></td>
<td></td>
</tr>
</tbody>
</table>

| Spring Semester | Credits |
| ARCH 407 | Vertical Studio II | 7 |
| 3 Field/Free Electives or General Education Requirements | 9 |
| **Total 16** |  |

<table>
<thead>
<tr>
<th>Fifth Year</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer Semester</td>
<td>Credits</td>
</tr>
<tr>
<td>ARCH 575</td>
<td>Approved Experience</td>
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<td>ARCH 508</td>
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| Spring Semester | Credits |
| ARCH 509 | Final Year Design Thesis II | 7 |
| 3 Field/Free Electives or General Education Requirements | 9 |
| **Total 16** |  |

**ARCH 101  Architecture Design I – Architecture and Place**  
7 cr.  
This studio centers on the dialectic of architecture and place. Through exercises, notions of habitation, site, and place are explored. Initial introduction to simple structural systems, low-tech sustainable strategies and site analysis are conducted. Though the studio navigates within fairly simple assignments, it nonetheless pursues the full range of scales and complexities of a complete architecture project; it is the opportunity to clearly set the pace of what a complete project of architecture requires and engages. The final exercise is thus comprehensive and should be developed with appropriate drawings and models. In addition, precedent analysis plays a central role in articulating the exercises and bridging over the history sequence.  
**Prerequisite:** ARCH 100.

**ARCH 111  Technical Drawing**  
4 cr.  
This is a course in descriptive geometry and graphic communication in architecture. Students learn to use drawing tools. They acquire techniques of representation of 3D and space on 2D surfaces, including orthogonal (plans, sections, and elevations), paraline (axonometrics and isometrics), and perspective drawings. Applications cover construction of shades and shadows.

**ARCH 112  Descriptive Drawing**  
3 cr.  
This studio course is an introduction to the visual representation of the built environment. Students learn the skills of pictorial conventions and are introduced to the historical specificity and theoretical assumptions that underlie them.

**ARCH 121  History of Ancient Art and Architecture: From Caves to Catacombs**  
3 cr.  
The first course in the History of Art and Architecture sequence surveys the origins and development of architecture, artifacts, and urbanism from prehistoric times to the end of the third century CE. We question meanings of the term art through objects associated with the activities of daily life and with the practices of kingship and religion, especially beliefs and rituals surrounding death and burial. While considering formal development, we also look at artifacts in their cultural context, relating them to myth, literature, and the development of technology. Local field trips are an important component of the class.

**ARCH 122  History of Medieval Art and Architecture**  
3 cr.  
This course is the second in the History of Art and Architecture sequence required for students in Architecture and Graphic Design. It covers medieval art and architecture from the fourth to the fourteenth centuries, including Byzantine, Ummayyad, Abbasid, Fatimid, Romanesque, Gothic, Ayyubid, and Mamluk art. The course is an analytic study of major developments, artists, and monuments. It emphasizes processes of cultural productions, their ideological framework, and socio-political significance.  
**Prerequisite:** ARCH 121 or consent of instructor.

**ARCH 151  Statics and Mechanics of Solids**  
4 cr.  
An introduction to vector forces and moments; equilibrium of rigid bodies in 2-D and 3-D; free body diagrams; frames and machines; centers of gravity and moments of inertia; design of trusses, beams with shear and moment diagrams; introduction to material properties; stresses, strains, and their relationship; normal, shearing stresses. The course also provides an introduction to indeterminate structures.
ARCH 152 Analysis and Design of Structures I 4 cr.
Review of normal and shearing stresses and combined stresses; an introduction to column
design and buckling; cable design; physical properties of various materials used in construction:
timber, steel, aluminum, copper, and others; and the deformation of structural elements
under loads using moment area and conjugate beam method; indeterminate structures by
approximate methods and Moment Distribution method; design and selection of the structural
elements according to loads applied with practical assignments: selection of materials and pre-
dimensioning the structure elements. Prerequisite: ARCH 151.

ARCH 202 Architecture Design II 7 cr.
Mid-Density Housing and Tectonic
This studio focuses on applying and developing concepts acquired in the first year into larger,
more complex programs and sites with an introduction to mid-density urban dynamics and low-
rise, multi-unit housing building. While basic structural and low-tech sustainable strategies are
addressed, the focus is placed on exploring diverse materials and assembly methods, in
relation to their tectonic language and implication. Prerequisites: ARCH 101 and a combined
grade average of 70 in ARCH 100 and ARCH 101.

ARCH 203 Architecture Design III 7 cr.
Mid-Density Public Building and Structural Strategies
This studio introduces the definition of public buildings (museum, theater, school, etc.) within
mid-density urban conditions. Questions of private to public scales are addressed. While site
planning, tectonics, low/high tech sustainable strategies are integrated into design process,
particular focus is placed on structural strategies. Students are introduced to historical urban
analysis and documentation. Prerequisite: ARCH 202.

ARCH 213 Computer Aided Design 3 cr.
This course is an introduction to the CAD world and its 2D implementation in the architectural
field. Students learn the tools and techniques to translate their hand drawn design sketches
into digital format, from basic conceptual diagrams to fully loaded architectural drawings,
meeting the high standards of design-firm expectations.

ARCH 223 History of Post-Medieval Art and Architecture 3 cr.
The course is a study of art and architecture during the post-medieval period with a special
emphasis on the fifteenth and sixteenth century Mediterranean world. It is the third in the
history of art and architecture sequence required for students in architecture and graphic
design. The post-Medieval period covered by the course includes the Italian Renaissance and
the Ottoman Empire with emphasis on cultural encounters and exchange between East and
West. Prerequisites: ARCH 121, ARCH 122 or consent of instructor.

ARCH 224 History of Modern Art and Architecture: 1760–1945 3 cr.
The last course of the History of Art and Architecture sequence surveys the development of
Western art and architecture from 1760 to 1945. Thinking beyond the established canon,
the course critically addresses the political, aesthetic, institutional, and cultural forces
that have contributed to shaping this canon. Problems we encounter when we acknowledge
that art is a cultural product include the uneasy fit of style-period categories or the isms of
art, gender, historical definitions of the avant-garde, the consumption and display of art;
and the status of the artist in society. Prerequisites: ARCH 121, ARCH 122 and ARCH 223 or
consent of instructor.

ARCH 241 Surveying Regional Architecture 6 cr.
The course is organized in two successive formats. The first introduces the students to
topographic mapping and route surveying. The second involves the tools and methods of
architectural surveying. Fieldwork is applied to surveying, documentation, and the analysis of
factors contributing to the distinctive aspects of Lebanese regional architecture: vernacular,
traditional, and modern. Prerequisite: ARCH 111.

ARCH 242 Building Construction I 3 cr.
A course on the response of building envelopes to surrounding environmental factors; covering
detail in the components of the envelope: floors, walls, doors, windows, and roofs of all types.
This course is also an introduction to construction detailing.

ARCH 243 Building Construction II 3 cr.
This is the third course in the sequence of building construction courses. It is a combined
lecture and studio course that examines recent building technologies, materials, finishing work
and structures. Prerequisite: ARCH 242.

ARCH 253 Analysis and Design of Structures II 4 cr.
Concrete mechanical properties: design of continuous beams in flexure and in shear, columns,
different types of footings, basement walls, retaining walls, structural walls, one way solid
slab, one way ribbed slab, introduction to two way slabs, staircase; design of a multi-story
building with a detailed project. Prerequisite: ARCH 152.

ARCH 304 Architecture Design IV 7 cr.
Mixed-Use Housing and City Dynamics
This studio centers on large mixed-use housing project typologies within dense urban fabrics.
Projects address complex urban situations, negotiation between private/public issues, accessibility,
codes, public agencies, and market forces. Urban in its nature and scale, this studio formulates
strategies to consider architectural production within the building and the transformation of cities.
Prerequisites: ARCH 203 and a combined grade average of 70 in ARCH 202 and ARCH 203.

ARCH 305 Vertical Design Studio I 7 cr.
Vertical studios are offered to 3rd and 4th year students in the spring semester. Each studio
follows one of the assigned themes as a specialized orientation. While particular projects may
vary from one semester to another, the themes are maintained as guidelines and inform the
particular focus of given projects. Students can choose the orientation they wish to engage
with, though cannot repeat the same thematic twice. Prerequisite: ARCH 304.

ARCH 325 Contemporary Architecture 3 cr.
The contemporary condition of architecture was shaped by a series of events and movements
that followed the rise of Modernism. As a logical continuation of the History of Art and
Architecture sequence, this class surveys the main architectural movements from 1945 on in
order to better understand the state of architecture today and as a way for students to shape
enlightened opinions about contemporary practices and discourses. Through lecture classes,
critical readings and seminar sessions, students are encouraged to voice their thoughts and
opinions on reviewed projects or discourses and are invited to explore a particular area of
interest that is relevant to current and emerging practices. Prerequisite: ARCH 224.

ARCH 343 Building Construction III 3 cr.
This is the third course in the sequence of building construction courses. It is a combined
lecture and studio course that examines recent building technologies, materials, finishing work
and structures. Prerequisite: ARCH 242.
ARCH 344  Construction Documents  3 cr.
The third course in the sequence of Building construction courses. It is focused on methods, contents and representation of professional construction documents including execution drawings, details and schedules. **Prerequisites: ARCH 242 and ARCH 343.**

ARCH 354  Building Services  4 cr.
The objectives of the course are to introduce the art, science, and practice of building services engineering to the future architect in all aspects of design, installation, and maintenance associated with building services. Included are: air-conditioning, heating and ventilating, water services, sanitary works, energy management systems, solar collectors, electrical distribution systems, electrical equipment, materials, lighting, and lifts.

ARCH 373  Training in CAD  0 b.
This is a non-credit training course in which students work in local architectural offices on CAD applications. Reports on work completed are evaluated for level of involvement and quality of achievement.

ARCH 406  Architecture Design V  7 cr.
**Public Equipment and Structural Systems**
This studio centers on large public building, equipment, or infrastructure within dense urban fabrics. Projects address complex urban situations, traffic flows, and transportation; focusing specifically on structural strategies for large scale buildings. Students taking this studio will define part of, or the entire program. **Prerequisites: ARCH 305 and a combined grade average of 70 in ARCH 304 and ARCH 305.**

ARCH 407  Vertical Design Studio II  7 cr.
See description of ARCH 305. **Prerequisite: ARCH 406.**

ARCH 421  Urbanism  3 cr.
This is an introductory course to contemporary debates in the field of urban studies within the social sciences and their implications for the practices of architecture, urban design and urban planning. Special emphasis is placed on understanding processes of place-making (that is looking at the forces behind the production of space) and the influence of place on its dwellers (that is seeing how places/spaces influence/dictate how people act). The relevance of these theoretical debates to the local/regional geographic context is closely investigated. **Prerequisite: ARCH 224.**

ARCH 474  Training in Execution Drawings  0 b.
This is a non-credit course that consists of professional training in architectural offices, where students develop their knowledge of execution drawings.

ARCH 508  Final Year Design Thesis I  7 cr.
In this course, students start a year-long design investigation of an architecture issue of their choice. This issue is argued and supported by readings and case-studies, and developed into a proposed architecture design intervention. By the end of the semester, students defend their design statement and their preliminary design proposal. In addition to their argument, their presentation includes a completed site analysis as well as defined user groups, architectural program(s) and systems. **Prerequisites: Four vertical design studios and a combined grade average of 70 in ARCH 406 and ARCH 407.**

ARCH 509  Final Year Design Thesis II  7 cr.
This is the second half of a year-long design thesis and the culmination of the design studio training. In this course, students complete the investigation of the selected architecture issue they began in ARCH 508 making it into a full-fledged design intervention that articulates in all its details their design statement. By the end of the term, all the components making up their architecture project are thoroughly developed and clearly presented: argument, site analysis, user groups, architectural programs and systems. **Prerequisite: ARCH 508.**

ARCH 575  Approved Experience  1 b.
This is an eight-week professional training course at a recognized architectural design office, in Lebanon or abroad. Students are expected to engage in a capacity that ensures that they apply their knowledge and acquire professional experience in the field of architecture.

**Field Electives**
The elective courses in the architecture program, offered within the Department of Architecture and Design are distributed in three main categories and are subject to change as new electives are introduced every year.
- Category A: Representation (01)
- Category B: History (02) and Theory (03)
- Category C: Technology (04), Engineering (05) and Professional Practice (06)

**Category A: Representation**

ARCH 010  Photography  3 cr.
This course aims at providing architecture students with a comprehensive understanding of the basics of black and white and color photography, its techniques, and aesthetics. Students learn how to use their cameras and light meters and are taught, through hands-on practice, the fundamentals needed in traditional black and white printing in the darkroom. The course includes slide lectures and discussions around the works of classic masters and contemporary experts of the medium, field trips, as well as presentations by well-established photographers specializing in architectural photography.

ARCH 012  The Black Box  3 cr.
The Black Box is a workshop and seminar open to architecture, graphic design and other students. Class meets once a week. Metaphorically, the black box stands for a hiding device that creates a feeling of curiosity and triggers imagination. This seminar is an exploration, interaction and experimentation with the concept of the black box through the three sub-themes of Desire, Imagination and the Unseen. Students are invited to respond to contemporary artistic works (cinema, architecture, literature) as well as to present their own through the media of photography, script-writing and projection. **Prerequisite: Advanced standing.**

ARCH 014  Pages From An Autobiography  3 cr.
The goal of this class is to explore, practice and theorize the form of the portfolio (more broadly understood as the work of creative individuals representing themselves) in order to gain a certain level of mastery of the process of presentation and representation of previously produced work. Through a theoretical, analytical and practical process of reading, looking, and producing visual, textual and multi-media material, students will gain an exposure to the global culture of the making of portfolios and a practical knowledge in the production of such (physical or online) representational artifacts. Ultimately, this workshop will raise and investigate the complex and never-ending issue of self-representation, the portfolio being, obviously, an autobiography of sorts.
ARCH 016  Digital Tools: 3D Studio Max 3 cr.
The beginning of the millennium traces of traditional drawing in architecture are replaced by digitized layouts. With computer software exponentially evolving, a new vision of architecture is now possible. From schematic design, visual construction, to final renderings, software tools have proven to be of the utmost efficiency, 3DMax is one of the best of these. Combined with a simple presentation tool such as MS PowerPoint it creates a powerful impact. This course is essentially aimed toward today’s architecture students, providing them with everything needed to complete the construction, rendering, and presentation of architectural ideas.

For Graphic Design representation courses refer to Graphic Design section.

Category B: History and Theory

ARCH 020  Beirut Modern 3 cr.
The course investigates modern architecture in Lebanon, mainly in the 1950s and 1960s, shedding light on a vibrant period that produced a distinctive local version of modernism. The course covers aspects such as architectural education, the organization of the profession, patronage, competitions, collaborations, and the various meanings given to modernity and tradition.

ARCH 021  The Imperial Image 3 cr.
Images are constants, but the ideas they legitimize take on different forms and values. This seminar explores the relationship between the visual arts and the ideologies of empire, looking at art produced in, and relating to, the sites of colonial, imperial, and mandatory control that comprised the European colonial project from the 16th to the mid-20th centuries.

ARCH 022  Building the Colonies: Colonialism 3 cr.
Imperialism, and Local Modernities
Colonialism and imperialism can be interpreted as part of larger ideological and sociopolitical systems that continue to inform changing cultural values today. This seminar uses sites of colonial urbanism to investigate ways that spatial organization produces historical knowledge. We consider alterations made to pre-existing cities as well as new city plans, both built and projected, in the Americas, in Asia, and around the Mediterranean Rim.

ARCH 023  From Urban Design to Landscape Urbanism 3 cr.
The distinction between urban, suburban and rural is increasingly blurred. New patterns of physical urbanization and growing environmental concerns are challenging the conventional approach of urban design in thinking about and shaping city space. Emerging disciplines such as landscape design and landscape urbanism are providing alternative ways of conceptualization that stress ecology over morphology, network surface over urban form, and the confluence of architecture, landscape, city and infrastructure. This course explores the changing conception of city space examining the shifts in urban design theory and practice. The course will appeal to students in architecture, landscape architecture and urbanism who are interested in crossing the boundaries between disciplines and exploring new potentialities in design thinking.

ARCH 024  Hybrid Beirut: Morphogenesis of the Contemporary City 3 cr.
Subjected to colonialism, Beirut was able to develop its own response to early modernization through the assimilation and domestication of Western urban and architectural trends. The resulting cultural hybridity and townscape diversity is understood by exploring the transitional years from a Medieval Arab-Islamic town in the 1840s to a showcase of the French Mandate in the 1920s and 30s. This course is an attempt to read the contemporary city through its recent colonial past and to trace the continuity and change in its social, economic and cultural conditions as mirrored in building typologies and spatial urban structure.

ARCH 025  House and Home: Histories of Domesticity 3 cr.
This seminar/practicum takes two contrasting but complementary approaches, historical understanding and phenomenological experience, to explore definitions of what we mean by the word home. Both planned and informal domestic architecture in the region are investigated as central case studies.

ARCH 026  The Cities of Delhi: Urban Form and the Transmission of Meaning 3 cr.
New Delhi, capital of the Republic of India, encompasses the vestiges of many older cities, built over a thousand-year period by disparate cultural groups. In this course, case histories of buildings and neighborhoods are used as a way of reading the processes of hybridization that result from the overlay of city upon city.

ARCH 027  Museum/Store 3 cr.
This course will offer a critique of the role and practices of the Museum of Modern Art (MoMA) in New York City at a time when the institution is seeking to redefine itself. MoMA, the first major institutional collector of 20th-Century art, now has what is arguably the most important concentration of modern painting and sculpture, film and media art in the world. This will be used as a focal point and a case study for exploring the evolution and history of museum architecture and museum practices as they change in the emerging 21st Century. Within a seminar format, students will explore the histories of a range of topics that relate to the role of museums today.

ARCH 030  Architecture and Culture: Regional and Vernacular Design 3 cr.
The course will analyse cultural disciplines, attitudes and practice in regional architecture from classic to contemporary works. A number of integrated themes relevant to architecture in its wider context of the region (e.g. Andalusia, North Africa, Arabia, Iraq, Iran across to India) will be covered. Recognising the paradigms of Islamic architecture, the role of geometry in design and quarter planning, attention will be drawn towards a better understanding and discussion of the creative process and influences. ‘Sustainable vernacular’ architecture, earth construction methods and materials, will be investigated in parallel with the international debate generated in urban heritage and culture.

ARCH 031  Theories of Conservation and Reconstruction 3 cr.
The course explores different theories of architectural conservation and reconstruction. In addition to the conservation of ancient monuments, students will also be introduced to theories of post-war reconstruction and urban conservation. Topics will include: memory in architecture, authenticity, historical consciousness and the conservation of modern architecture. These themes will be presented through a series of case studies, many of which focus on Lebanon and the Middle East.

ARCH 032  Theorizing Ornament: Art, Architecture and Nature 3 cr.
The study of ornament has a long and important history in art and design, but with the advent of modernism, ornament was deemed ethically suspect and inimical to art’s higher purposes. Such a low estimate of ornament thereby relegated non-Western artistic traditions such as Islamic Art, which is overwhelmingly ornamental, to a merely decorative art.

ARCH 034  Questions of Representation in Arab Documentary 3 cr.
Documentary has a rich tradition of dialogue between theory and practice. This involves philosophical and ethical questions about the relation between reality, representation and ways of engaging in the world. We will explore how Arab documentaries engage with the issue of representing people and the spaces they inhabit and what form this takes on. Arab filmmakers...
often question notions of territory, identity, home, exile and frontiers. Their inquiry expands from a dialogue between: past/present, private/public, and home/exile. This has led them to question the medium itself, to explore the frontiers between documentary and fiction, to develop experimental and poetic forms of expression and engage in digital media.

**ARCH 036/ URPL 637 Illegal Cities**  
3 cr.

The seminar is designed as an introduction for students enrolled in architecture, urban planning and policy, and urban design to the ongoing debates about the relationship between law and the building process, specifically by looking at its actual materialization in illegal/informal settlements. It is based on a combination of lecture/seminar sessions in which various theorizations of the city/law nexus are explored and on field studies/class discussions in which the applications of these theories are investigated using a local case study.

**ARCH 037/ URDS 631 Cities after War: Rebuilding the Past, Projecting the Present**  
3 cr.

This course explores cities after war by investigating the evolution of reconstruction interventions on devastated landscapes in the US, Europe and the Middle East from WWI till the present. The focus will be on Lebanon as a primary laboratory of postwar reconstruction in the 1990s and 2000s, to explore, evaluate, and generalize from. The two poles of investigation are: morphologies of destruction and dialectics of reconstruction, emphasizing four generic geospatial contexts: 1) urban central district restoration; 2) suburban neighborhood rebuilding; 3) refugee camp reconstruction; and 4) rural landscape recovery.

**Category C: Technology, Engineering, and Professional Practice**

**Technology**

**ARCH 040 Making It**: Models and Prototypes of Complex Structures  
3 cr.

Design and technology studies in schools of architecture are based on the making of things, how they perform in the environment, the experience of the results, and its cognitive interpretation. The scientific knowledge and technical expertise available for architecture are extensive and their rate of change is substantial. The course seeks to develop the ability to learn how to learn, a vital necessity for innovation. The teaching focus is on craftsmanship, innovation, conceptual and lateral thinking, new technologies, construction, interdisciplinary work, and collaboration with industries.

**ARCH 041 Lighting Design**  
3 cr.

The course is one of the requisite tools of design. An architect or environmental designer has the ability to render the architectural form with light and to use lighting distribution, intensity, color and modulation to conceive a desired effect. Additionally, light can set the mood for a space - a critical step in the design process.

**ARCH 045 Building Systems Technology**  
3 cr.

This course provides an introduction to building systems technology. The course will focus mainly on the behavior of buildings as systems, and where possible will provide additional material for the design of buildings against extreme conditions such as fires, explosions, rare earthquakes and wind. All the above concepts will be introduced with minimum (if any) recourse to mathematical equations, as emphasis will be placed on understanding the behavior of different structural systems under various loading scenarios.

**Professional Practice**

**ARCH 061 Architectural Programming**  
3 cr.

The course deals with Architectural Programming as a design process that does not precede design, but works with it. The intent is to delineate a design methodology based on academic research and practical knowledge to synthesize and translate a project brief – client requirements, legal regulations, spatial needs, etc. – to design strategies and solutions, through the collaboration of multiple participants and decision-makers. The course is envisioned to be given in close collaboration with design studios to strengthen the bridge between theory and practice.

**ARCH 062/ URPL 665 Development and Planning Policies**  
3 cr.

The course examines development and spatial planning projects and policies. It investigates policy governance and institutional setup, the role of professional expertise, and the spatial impacts on the built and un-built environments, as well as the social and environmental impacts. Using case-study analysis of selected cities and towns, the course investigates how policies are elaborated through the use of chosen models, approaches, strategies, and tools; privileging certain sectors; and for specific ends.

**ARCH 063 Algorithm and Iteration**  
3 cr.

Using Grasshopper/Rhino3d as the main software platform, the course explores the concepts, tools and ways in which parametric programming can lead to greater integration of concept and execution in architectural design.

**ARCH 065 Climate Responsive Design**  
3 cr.

This course addresses the subject of climate-responsive architecture. The course's content starts with an introduction to the broad issue of sustainability, continues with the analysis of vernacular examples in architecture and moves on to develop the subjects of climate, people and buildings. The course consists of a series of lectures and short design applications that will enhance the students' understanding of the subject matter.

**ARCH 066 Conservation and Adaptation of Modern Buildings in Lebanon**  
3 cr.

This course provides students with effective and efficient tools to deal with conservation within the flawed framework of current Lebanese legislation. Students will be introduced to problems that are frequently encountered in the practice of architecture in Lebanon. These problems include: the seeming necessity of over-saturating the building site; adapting existing builds to modern exigencies; and the ethical responsibility of preserving historical buildings. Focusing on a particular case study in Beirut, the course will examine different sustainable solutions in response to these themes.

**ARCH 068 Law and the Built Environment**  
3 cr.

This course explores the relations between the rules that govern the production of the built environment, building practices, and the shape of the city. Rules include the complex set of state legislated regulations (e.g. building law, zoning regulations, urban planning law) as well as socially sanctioned norms (e.g. privacy regulations). Investigated building practices are mostly those of the professional architectural practice and should inform the future role of the students as designers. The course is based on a critical approach to the understanding of law, how it is legislated, how it is actualized, how it intersects with other norms in the context where it is implemented, and how it affects building practices.
Graphic Design

Mission Statement

The Graphic Design Program answers to the developments and needs of Lebanon and the region as it strives to meet globally required proficiency. The curriculum focuses on a solid training in the theoretical, practical and technical aspects of Graphic Design. It is the goal of the program to help students perceive and adapt to the changing demands of culture and therefore to the continuous change in the design field. Students develop an intellectual background, critical thinking and contribute to the continuum of aesthetic and technological innovations by generating ideas and solutions to a wide range of design problems. The program is committed to its involvement in the Arab world: its multitude of languages and cultures. It is the Program’s mission to address these issues in a challenging creative teaching and learning environment.

Program Description

The Graphic Design Program is comprised of a total of 139 credit hours normally taken over four years. The curriculum is structured as follows: 1) Two foundation years, first and second, with core requirements in design, typography, representation techniques, digital media, history and theory courses which offer students basic skills and knowledge in design and related areas. 2) One advanced year, third year, with core requirements in advanced design, digital media, history and theory courses, reinforced by the field/free electives and general education requirements. 3) Final year, fourth year, with a one-year design project and advanced electives.

The degree requirements in Graphic Design consist of the following:

- 97 credit hours of mandatory core courses
- 12 credit hours of approved ArD/FEA field electives:
  - 3 credit hours in Category A: Representation
  - 6 credit hours in Category B: History, theory, and methodology
  - 3 credit hours in Category C: Digital media, typography, and professional practice
- 3 credit hours of free electives in consultation with the academic adviser

To meet the AUB General Education Requirements (27 credits must be taken outside the department):

- 6 credit hours of English including English 204
- 3 credit hours of Arabic, as per placement test
- 6 credit hours of approved electives in humanities
- 3 credit hours of approved electives in social sciences
- 6 credit hours of approved electives in natural sciences
- 3 credit hours of approved electives in quantitative thought

Curriculum for the Degree of Bachelor of Fine Arts in Graphic Design

First Year

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<td>Drawing</td>
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<td>GRDS 231</td>
<td>Introduction to Visual Theory</td>
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</table>
GRDS 112  Color  3 cr.
A study of the dynamic interaction of color and its applications for designers and artists. This course includes an introduction to the physics of color, color composition and the three dimensions of color, hue, value, and chroma, as well as the color wheel.

GRDS 113  Photography  3 cr.
A course aimed at providing graphic design students with a thorough understanding of the basic techniques and aesthetics of both black and white and color photography, through hands-on assignments and darkroom practice.

GRDS 114  Illustration  3 cr.
This course introduces students to illustration techniques and styles with the aim of strengthening their representation and visualizing skills to enrich the graphic design process and its outcomes. Assignments cover various themes while exploring a wide range of media and approaches. Prerequisites: GRDS 111 and GRDS 112.

GRDS 141  Computer Graphics I  3 cr.
This course is divided into three sections. The first introduces students to the Macintosh platform and the MacOS, covering all aspects such as file management, activating fonts, accessing network, and printing. The second section deals with the basic features of Adobe Illustrator®, the industry-standard and most professional vector-based illustration software; the last part covers the basic features of Adobe Photoshop®, where students learn basic image creation and manipulation.

GRDS 202  Graphic Design II  6 cr.
This studio focuses on principles of identity design through investigations in symbolic graphic representation; logo design; and the development of identity systems using various modes of image making and typography. Prerequisites: GRDS 101 and a combined grade average of 70 in ARCH 100 and GRDS 101.

GRDS 203  Graphic Design III  6 cr.
This studio addresses graphic design as a cultural practice. It focuses on processes of visual communication where issues of meaning production and exchange are emphasized and critically examined in their relation to particular social contexts and localities. Methodologies of arriving at meaningful graphic solutions—image-type relationships, visual narratives, info-graphics, and complex information organization— are explored through diverse theme-based projects and loose-sheet printed formats of public dissemination (posters, book covers, leaflets, maps). Prerequisite: GRDS 202.

GRDS 242  Computer Graphics II  3 cr.
This course is the second in the series following the first computer course (GRDS 212). It is also divided into three sections. The first deals with the advanced features of Adobe Illustrator®. Advanced Adobe Photoshop® constitutes the second section of the semester, where students learn advanced image creation and editing techniques for print and web applications. The last section covers Adobe InDesign®, the professional electronic desktop publishing software for the creation of any form of publication, from simple single page to complex multicolor documents. In addition, cross-compatibility issues between the above-mentioned software are tackled at the end of the semester. Prerequisite: GRDS 141.

1 b. stands for billing
GRDS 251  Typography I 3 cr.
The course introduces students to Arabic and Latin type and typography, providing the necessary historical, theoretical and technical knowledge, in combination with applied exercises and projects, which aim to enrich the graphic designer's typographic skills. The course is focused on the micro aesthetics of typography and its communicative potential; it begins with building an understanding and sensitivity to the formal and structural characteristics of letters, type styles and related classification, and gradually moves to basics of choosing, combining and working with type to enhance composition, meaning and readability.

GRDS 252  Typography II 3 cr.
The course is a sequel to Typography I (GRDS 251). It builds on the basic skills and knowledge already acquired to move to more advanced applications of Arabic and Latin typography for the design of different kinds of text-based information. New aspects are investigated while maintaining attention to the aesthetic and communicative potential of typography: type setting, color, texture, direction, flow, readability and context. Prerequisite: GRDS 251.

GRDS 231  Introduction to Visual Theory 3 cr.
An introduction to the various debates concerning visual representation aimed towards an investigation of the visual as a social practice and as part of an aesthetic discourse.

GRDS 304  Graphic Design IV 6 cr.
The course covers the design of printed publications in their various formats and audiences, ranging from mass media (newspapers, magazines etc.) to special interest publications (fanzines, limited edition books etc.), where processes of art direction and the design of layout systems for multi-page prints will be covered. While learning to materialize editorial concepts and content into graphic form, students also develop advanced skills in organizing complex information, and devising appropriate compositional, typographic and image solutions. Prerequisites: GRDS 203 and a combined grade average of 70 in GRDS 202 and GRDS 203.

GRDS 305  Graphic Design V 6 cr.
The course covers package design, installation art, and an interactive process between them. Research and analysis are conducted in each individual project. Projects are distributed into experimental and commercial ‘real’ situation types. Students will develop an understanding and ability to manipulate two-dimensional graphics to three dimensional objects and environments; understand the needs of the market through market research; apply regulations where appropriate; carry the given projects from concept development to a final stage [real situation scenario]; and experiment with acquired [design] language and vocabulary. Prerequisites: GRDS 203 and a combined grade average of 70 in GRDS 202 and GRDS 203.

GRDS 325  History of Graphic Design 3 cr.
Starting with Gutenburg's 42 line bible as the first specimen of movable type printing, the course will cover a period of time from the 15th century till today. The course is conceived of thematically with the intention to address the conceptualization of Graphic Design as a discipline directed by various interpretative inquiries into the History and Theory of graphic communication. The course is formulated in a way that enables the students to take part in the current debate around graphic design theory and practice. Prerequisite: ARCH 224.

GRDS 343  Motion Graphics 3 cr.
This course provides the student with the basics of designing for digital media and the moving image. The course covers animation in its various forms, studying the process in depth from animation principles to concepts and storyboarding, to the final output edited with the soundtrack. Students will be exposed to and use various techniques of animation, from the classical hand drawn animation, flip books, and experimental Stop Motion Animation, to computer based animation, motion graphics for TV and movie titles. Prerequisite: GRDS 242.

GRDS 361  Professional Practice 3 cr.
This course prepares students to face the REAL WORLD of the graphic design profession. Lectures, readings and field research along with hands-on assignments, are given to assist students in writing their CVs and preparing their portfolios, learning about basic business practices (public relations, client handling, invoicing and billing, time management, work flow…), in addition to building knowledge about pre-press production and production techniques essential to the design practice. Prerequisite: GRDS 203.

GRDS 444  Interactive Media Design 3 cr.
This is a course where students learn to design for interactive media. The course will cover the principles, methods and tools to plan organize and implement interactive content. Students will acquire an understanding of information architecture and the proper integration for elements of text, image (still and moving), audio, and video to create and deliver an interactive experience. They will also receive a firm foundation and familiarity with basic programming language and software used by the industry. Prerequisites: GRDS 242 and GRDS 334.

GRDS 406  Final Project Design and Research I 6 cr.
In this course, students start a year-long design investigation of an issue of their choice. The process begins with the submission of a proposal at the start of the term in which the student begins to identify the project's design problematic, define its framework and set its aims. Throughout the term students, with the guidance of a panel of advisers, will conduct the necessary research, reflection, sketching, and experiments that will enable them to refine their initial proposals, respond to its questions, and argue their positions; to arrive at a well-defined design concept statement and a concrete design proposal. The successful completion of the latter, synthesized in a research document submitted at the end of the term, allows the student to move to the design implementation phase in the following term. Prerequisites: GRDS 305 and GRDS 304, and a combined grade average of 70 in GRDS 304 and GRDS 305.

GRDS 407  Final Project Design and Research II 6 cr.
This is the second half of a year-long design project and the culmination of the design studio training. Students integrate and synthesize acquired knowledge and skills, and elaborate, through concrete design experimentations and implementations, the design proposal developed in GRDS 406, with the aim of arriving at a completed graphic design output by the end of the term. Students work independently and in consultation with a chosen adviser from the faculty. Work in progress is presented and discussed with a panel of advisers over the course of the semester. The completed projects are presented for evaluation to a jury of faculty members and invited professionals. Prerequisite: GRDS 406.

GRDS 462  Approved Experience 1 b.
This is an eight-week professional training period at a recognized graphic design studio or graphic design department within a web design, television station, advertising agency, publishing house, or other approved workplace in Lebanon or abroad. The training should ensure that the student applies his/her knowledge and acquires professional experience in the field of graphic design.

For other mandatory core courses such as ARCH 100, ARCH 121, ARCH 122, ARCH 223, and ARCH 224 please refer to the architecture core course descriptions.
Field Electives

The elective courses in the Graphic Design Program are offered within the Department of Architecture and Design and some are open to students in all faculties. They are distributed into three categories:

Category A: Representation Skills (01); Category B: History (02), Theory and Methodology (03); Category C: Digital Media (04), Typography (05), and Professional Practice (06). Electives are chosen in consultation with the assigned adviser, and in accordance with the load distribution (mentioned earlier under program description).

The following list of courses is subject to change as new electives are introduced every year.

Category A: Representation Skills

GRDS 011 Contested Land: New Landscapes of Lebanon 3 cr.

Following WJT Mitchell’s claim that ‘landscape is not simply an object to be seen or text to be read, but a central tool in the creation of national and social identities’, students learn how to dig under the surface of landscape and to critically use it as an effective representational tool. Students are asked to produce a series of landscapes of Lebanon and to use them to create a set of posters that will be exhibited and collected in a book at the end of the semester. Prerequisite: GRDS 203, or ARCH 203; or permission of instructor.

GRDS 012 Silkscreen 3 cr.

This course teaches students the fundamental principles of silkscreen printing and to be creative in their approach to printmaking. Silkscreen, one of the most versatile and widely used methods of printmaking, will be fully explored in this studio class through demonstrations and self-initiated projects. Students will be encouraged to experiment with multiple techniques and combinations of traditional and contemporary methods of serigraphy; and search for solutions that best translate the nature of their work to the medium. Prerequisites: GRDS 214, or ARCH 112, or FAAH 202 and FAAH 234.

GRDS 014 Engraving and Etching 3 cr.

This course is an introduction to the fundamentals of intaglio printmaking processes. It covers the non-acid methods such as engraving, dry point and mezzotint and acid methods like etching (hard and soft ground) and aquatint. This studio art course covers the needed technical information; however emphasis will not only be placed on the technical production of art works but also on the content and concepts of printmaking. Prerequisite: GRDS 214, or ARCH 112, or FAAH 202.

GRDS 015 The Artist Book 3 cr.

This course will examine how books have become a recognized way of making art and introduces students to techniques of making books-by-hand through incorporating traditional techniques like letterpress, etching, relief, stenciling, stamping, and photo etching to make their texts and images. This course will also introduce students to different techniques of book-binding in order to produce an artist book. Prerequisite: GRDS 214 or FAAH 202.

GRDS 016 Advanced Photography 3 cr.

This course takes the student a significant leap further into the understanding and use of the photography medium in both analog and digital format. It addresses the aesthetics of picture making at an advanced level of technical, artistic, and creative development. Major emphasis is placed on developing a thoughtful approach toward the seeing and making of meaningful photographs that communicate with the viewer. Prerequisite: GRDS 113 or ARCH 010.

Category B: History, Theory, and Method

GRDS 020 Signs of Conflict and Resistance 3 cr.

The course addresses the deployment of political rhetoric in graphic design, historically and in contemporary practice. It examines those particular moments of political conflict - war, resistance, and revolt - where visual artifacts in different print formats become important vehicles through which ideological constructions are graphically materialized and diffused. The course uses a case study the graphic production by Lebanese political parties and movements during the civil war (1975-1990) while covering other significant cases that enrich and inform this main investigation.

GRDS 030 Proximity and Imminence 3 cr.

The course is open to all senior undergraduates across AUB departments with no prerequisites. This elective course approaches texts written at the limit of representation when the pressing onslaught of the here and now precludes any access to reflective and contemplative thought. It also proposes a close reading of texts written after the event, when a catastrophe has occurred but can only later be experienced as contemporary.

GRDS 032 Mediated Spectacles (new theories and cases) 3 cr.

A seminar course that engages students in the activity of analysis and critical assessment of the role of mediated images in modern everyday life. It takes as case studies the production and circulation of images in Arab popular culture and media, ranging from modern leisure and commodity poster advertisements to contemporary music videos and other image-potent cultural forms. It addresses the paradoxical relation between a cosmopolitan someliness brought by increasingly global cultural flows, and an alterity negotiated in and through the production of cultural localities and social identities. The seminar is directed through theoretical approaches and methodological tools of investigation that address the mechanism of the ‘image’, in terms of its signifying practices, social imaginaries and power relations in which it is embedded.

GRDS 034 The Valley of the Shadow of Death 3 cr.

Through close readings of texts, monuments, artworks, and films; the seminar invites students to grapple with the lingering consequences of unfinished violence, with the aftermath, namely— and in following the etymology of that term—the second crop that follows a first one violently mowed.

GRDS 035 Time and Time Again: The Triptych in Theory and Practice 3 cr.

This elective course approaches the historical art form of the triptych as a relevant contemporary form open to thinking and visualizing heterogeneous temporal configurations. As is well known, a triptych is a painted three-leaved construction of two hinged panels flanking a central panel. Historically, the painted and occasionally carved triptych was often used as altarpiece in Byzantine, Catholic and Celtic churches. The Christian religious triptych, as that of The Mystic Marriage of St. Catherine painted by Hans Memlinc in 1475-9, is notable for visualizing layered multi-directional temporalities functioning within and under the overriding principle of a divine teleological time. It is accordingly a rich tradition which stands to be reconsidered and re-opened to thinking time and temporality, and to extending this religious tradition onto other non-teleological and non-sequential configurations.

GRDS 036 Seeing Rude and Erudite 3 cr.

This seminar proposes an investigation of seeing, understood both as an authoritative discourse and as an embodied physical sensation. The aim and ambition of this seminar is to question the authority of the visual and to identify what is unrecognized in the act of seeing.
GRDS 037 Grain and Pixel: Readings in the History and Theory of the Reproducible Image 3 cr.

This elective course offers close readings of seminal texts culled from the rich history and theory of the reproducible photographic image.

Category C: Digital Media, Typography, and Professional Practice

Digital Media

GRDS 040 3D Animation 3 cr.
3D animation is an advanced course designed for students who are well versed in both concepts and technical research. The course builds the fundamental understanding of 3D computer modeling, texture mapping, lighting, and camera rendering in order to develop 3D animated sequences. The course then introduces students to advanced 3D character modeling, rigging, and animation. Student projects combine 3D animation and different output formats, like interactive techniques and motion design. Prerequisite: GRDS 343 or permission of instructor.

GRDS 042 Rough Cuts: An Introduction to Video 3 cr.
Filmmaking is used here as an umbrella term, rather than referring to the actual process of shooting on film, and is used to connote the mixed media bag of filmic narrative, including video, sound, animation and stills. All of these can come together in the making of a film. With the democratization of audio/video editing from an elite, exclusive and expensive art to a popular and commonplace tool, the art of filmmaking has become within reach of everyone with a computer. Filmmaking itself has mutated into a variety of different forms depending on the vessel, be it YouTube, cell phone video and soap operas, CCTV surveillance footage, webcams, satellite imagery, video installations, etc. The ubiquity of footage is a testament to our current audio/visual culture and the digital revolution gives everyone the access to produce work within this culture. Prerequisite: GRDS 203 or ARCH 203.

GRDS 043 Advanced Digital Animation
Building upon the foundations of the Motion Graphics course, this elective will explore the impact of time-based media on visual communication by focusing on three areas commonly dealt with in the field: The translation of information datasets into time-based media, and how the mapping of this visual information can be augmented through time and motion sequences. Creating “hero characters” within sequential narrative. Identifying the characteristics of the lead elements (humanoid or design-based) and rendering these “personalities” in the way they move.

GRDS 045 If Walls Could Talk/ Talking Walls: Urban Graffiti Animations 3 cr.
A course offered to Architecture and Graphic Design students covering the techniques, principles and processes of stop motion animation, particularly focusing on painting on walls and urban surfaces. Students are encouraged to explore the relationship of the method of expression and techniques employed with the concepts, themes and issues, using alternate interpretations beyond the literal and classical narrative constraints. Students will be examining motion, tempo, rhythm, depth, color, texture, form, matter and spatial representation and relation. By the end of the course the students will produce a complete edited stop motion animation short film that will be publicly screened in the original setting. Prerequisite: GRDS 305, or permission of instructor for students in Architecture.

Typography

GRDS 050 Introduction to Arabic Type Design 3 cr.
This is an advanced course in typography introducing students to the creation of Arabic fonts. In addition to providing necessary knowledge on the history of Arabic calligraphy and the modern developments of Arabic type, the course consists of two main approaches to learning the skills and methods of designing Arabic typefaces. The first consists of hands-on exercises dealing with basics of Arabic type design, including hand drawing and workshops in calligraphy. The second involves learning the computer-based techniques needed to digitize typefaces and generate working Arabic Open Type fonts, the latter will be facilitated through introductory lectures and applied exercises. Prerequisite: GRDS 251.

GRDS 053 Advanced Arabic Typography 3 cr.
In addition to a new and summarized historical overview, the study of Arabic calligraphy involves dealing with the problems facing this traditional art in its efforts at modernization, innovation, and adaptation to new technologies. This consists of two approaches to the subject, one that looks at the Arabic script as an art by itself: calligraphy; and the other that ponders its reformist and media function, or its applications in modern life. Prerequisite: GRDS 252.

Professional Practice

GRDS 060 Critical Mapping 3 cr.
The course aims to introduce students to the possibilities of mapping as a research method and a tool of visual representation. A critical understanding of the history of cartography and mapping practices combined with a theoretical positioning of the map as a socio-political product supports and informs the practical dimensions of the course. Prerequisite: GRDS 203 or ARCH 203.

GRDS 061 GraFix in the Environment 3 cr.
We are bombarded daily with visual clutter, noise, buildings, people, beggars, cigars, clothes, shops, garbage, cars, horns, broken sidewalks you name it! Then there are signage, posters, and billboards! All are components of our GraFix in the Environment! This course is based on research, presentations, and a series of small projects illustrating the various aspects of ‘GraFix.’ Prerequisite: GRDS 203 or permission of instructor for architecture students.

GRDS 062 Brand Inc. 3 cr.
This course offers an in-depth examination of branding—an increasingly common and central specialization in the contemporary graphic design profession. While looking at the history of the practice and the ways it has been (and is being) critically theorized, students will engage in a series of practical assignments, investigating and addressing existing local cases. In addition to the brand design component and its visual and verbal manifestations, the assignments will cover more fundamental operations of the brand: including brand research and assessment, brand positioning and strategy, brand architecture, brand planning and management, among other less obvious but equally crucial components of the brand development life cycle.

GRDS 065 Visual Inquiries: Investigations of the Everyday 3 cr.
In this course, we will be investigating diverse methodologies of visual exploration through a series of exercises, games and projects. As innovative contributions to the discipline, students will be invited to develop their own design research methods, valuable for varied authored and commissioned design projects, through both practical and theoretical examinations. Focus will be on sketching/drawing/making as integral to the design research processes.
GRDS 066  Alternative Comics: The Study and Making of Graphic Narratives  3 cr.
Through this course the student will explore the language of comic art: building a textual and visual narrative, developing the word image relationship, investigating temporal translations and expanding the concept of time. They will explore comics as a storytelling art form where emphasis is placed on narrative concepts as well as advanced technical and media skills. Students will explore ways in which images can tell a full story independent of the written word, through tone, pace, time, and implied dialogue, thereby expanding the storytelling range.
Department of Civil and Environmental Engineering

Chairperson: El Fadel, Mutasem
Professors: Ayoub, George; Basha, Habib; El Fadel, Mutasem; Hamad, Bilal; Harajli, Mohamed; Kaysi, Isam; Mabsout, Mounir; Sadek, Salah; Suidan, Makram
Professor Emeritus: Iliya, Raja
Associate Professor: Chehab, Ghassan
Assistant Professors: Abou Najm, Majdi; Abou Zeid, Maya; Alameddine, Ibrahim; El-Khoury, Hiam; Hamzeh, Farook; Hantouche, Elie; Najjar, Shadi; Saad, George; Salam, Darine
Part time Senior Lecturer: Azar, Kamal; Basha, Hisham; Fawwaz, Youssef
Part time Lecturers: El Souri, Amer; Hatem-Moussallem, Manal; Inglessis, Constantine; Nader, Halim; Nasreddine, Khaldoun
Laboratories: El Khatib, Helmi

Undergraduate Programs

The Department of Civil and Environmental Engineering (CEE) offers the degrees of Bachelor of Engineering (BE): major, Civil Engineering (CE); and Bachelor of Science (BS): major, Construction Engineering (ConsE).

The mission of the undergraduate programs of the CEE department is to provide a stimulating and supportive environment for high-standard education; to prepare graduates for a lifelong productive career in addressing problems in a rapidly changing world, while instilling in them an appreciation of leadership qualities, professionalism, and ethics; to provide professional services of the highest quality to the community; and to contribute to expanding the knowledge and technological base in civil and environmental engineering.

Bachelor of Engineering (BE), Specialization: Civil Engineering

Program Educational Objectives

The objectives of the CE program are to see our graduates move on to become:

- Engineers who hold central positions in various sub-disciplines of civil engineering in local, regional, and international practice;
- Graduates who are admitted and successfully completing advanced degrees in leading universities around the world;
- Leaders in their profession and in the service of their community.
### Curriculum

#### Term I (Fall) Credits
- CIVE 200 Introduction to Civil Engineering 2
- CIVE 210 Statics 3
- MATH 201 Calculus and Analytical Geometry III 3
- CHEM 2nn Chemistry Elective 3
- CHEM 203 Introductory Chemical Techniques 2
- ARAB 2nn Arabic Elective 3

**Total 16**

#### Term II (Spring) Credits
- CIVE 201 Engineering Drawings and Tools 3
- CIVE 310 Mechanics of Materials 3
- MATH 202 Differential Equations 3
- PHYS 210 Introductory Physics II 3
- PHYS 210L Introductory Physics Laboratory II 1
- Humanities Elective I 3

**Total 16**

#### Term III (Summer) Credits
- CIVE 301 Surveying 2
- STAT 230 Introduction to Probability and Random Variables 3
- Humanities Elective II 3

**Total 8**

#### Term IV (Fall) Credits
- CIVE 370 Construction Materials and Technologies 3
- CIVE 410 Theory of Structures 3
- EECE 231 Introduction to Programming with C++ and MATLAB 3
- ENGL 206 Technical English 3
- MATH 2nn Mathematics Elective 3
- Humanities Elective III 3

**Total 18**

#### Term V (Spring) Credits
- CIVE 340 Fluid Mechanics and Laboratory 3
- ENMG 400 Engineering Economy 3
- MATH 251 Numerical Computing 3
- BIOL 2nn Biology Elective 3
- ENMG 504 Engineering Ethics 3
- Social Science Elective I 3

**Total 18**

#### Total Credit Hours: 143

### Term VI (Summer) Credits
- GEOL 2nn Geology Elective 3
- ENGL 2nn English Elective 3
- Social Science Elective II 3

**Total 9**

#### Term VII (Fall) Credits
- CIVE 413 Concrete Design I 3
- CIVE 430 Soil Mechanics and Laboratory 3
- CIVE 440 Hydraulics and Laboratory 3
- CIVE 550/551 Water Treatment/Wastewater Treatment and Laboratory 3
- CIVE 460 Transportation Engineering and Laboratory 3

**Total 15**

#### Term VIII (Spring) Credits
- CIVE 4nn Indeter. Structural Analysis/Steel Design/Concrete Design II 3
- CIVE 431 Foundation Engineering 3
- CIVE 541/542 Engineering Hydrology/Urban Hydrology 3
- CIVE 55n Waste Management and Treatment/Environmental Biotech/Air Quality Management 3
- CIVE 461 Highway Engineering 3

**Total 15**

#### Term IX (Summer) Credits
- CIVE 400 Approved Experience 1

**Total 1**

#### Term X (Fall) Credits
- CIVE 401 Final Year Project I 3
- CIVE 421 Construction Management 3
- CIVE CEE Technical Elective I 3
- CIVE CEE Technical Elective II 3
- CIVE CEE Technical Elective III 3
- CEE | FEA Technical Elective 3

**Total 15**

#### Term XI (Spring) Credits
- CIVE 402 Final Year Project II 3
- CIVE CEE Technical Elective IV 3
- CIVE CEE Technical Elective V 3
- CEE | FEA Technical Elective 3

**Total 12**

**Total Credit Hours: 143**
Bachelor of Science (BS), Specialization: Construction Engineering

Program Educational Objectives

The objectives of the Construction Engineering program are to see our graduates move on to become:

- Engineers who hold central positions in local, regional, and international construction engineering practice;
- Engineers who are involved in landmark projects and who contribute to the advancement of the local and regional construction industry;
- Leaders in their profession and in the service of their community.

Curriculum

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<tr>
<td>CIVE 200</td>
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<td>MATH 201</td>
<td>Calculus and Analytical Geometry III</td>
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<td>Introduction to Environmental Chemistry</td>
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<tr>
<td>ENMG 400</td>
<td>Engineering Economy</td>
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<tr>
<td><strong>Total 15</strong></td>
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<tr>
<th>Term VIII Spring</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CIVE 461</td>
<td>Highway Engineering</td>
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<tr>
<td>CIVE 521</td>
<td>Construction Methods and Safety</td>
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<tr>
<td>CIVE 522</td>
<td>Building Construction and Estimating</td>
</tr>
<tr>
<td>CIVE 523</td>
<td>Construction Planning and Scheduling</td>
</tr>
<tr>
<td>ECON 212</td>
<td>Elementary Macroeconomic Theory</td>
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<tr>
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<tr>
<th>Term IX Summer</th>
<th>Credits</th>
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<tr>
<td>CIVE 500</td>
<td>Approved Experience</td>
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<tr>
<td><strong>Total 1</strong></td>
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**Total Credit Hours: 110**

Elective Courses

- List of Biology Elective Courses: BIOL 201, 202, 250, 252, 255, 258, 259, CIVE 252
- List of Chemistry Elective Courses: CHEM 202, CIVE 251
- List of Geology Elective Courses: GEOL 201, 211 CIVE 330
- List of Mathematics Elective Courses: MATH 211, 212, 218, 281
Course Descriptions

Common Courses

CIVE 200 Introduction to Civil Engineering 2 cr.
An introductory course to the world of civil and environmental engineering including significant developments in the field, both current and future. The course gives an overview of the profession covering aspects of concept, design, and execution through: seminars, case studies, competitions, field trips, lab experimentation, literature searches, and hands-on group projects.

CIVE 201 Engineering Drawings and Tools 3 cr.
An introductory course to introduce students to the basics of engineering drawing and mapping through the use of Autodesk’s Revit and ESRI’s ArcGIS software packages.

CIVE 301 Surveying 2 cr.
A course on the theory of measurements and errors; linear measurements; surveying instruments; leveling; angles, bearings, and azimuths; stadia measurements; traversing–field aspects; traverse computations and adjustment; topographic surveying; triangulation. Prerequisites: CIVE 201, CIVE 210.

CIVE 400 Approved Experience 1 cr.
Students are placed for eight full weeks at a recognized consulting and/or contracting firm in Lebanon or abroad, in a capacity that ensures they apply their knowledge and acquire professional experience in the field of Civil Engineering. Prerequisite: E4 Status.

CIVE 401 Final Year Project I 3 cr.
A chosen design topic and preparation of a detailed execution program for CIVE 402, through comprehensive research with the guidance and approval of the faculty. Prerequisite: CIVE 400.

CIVE 402 Final Year Project II 3 cr.
A supervised project in groups of normally three students aimed at providing practical design experience in a civil and environmental engineering application. Prerequisite: CIVE 401.

CIVE 403 Special Topics in Civil and Environmental Engineering 3 cr.

CIVE 501 Computer Methods in Civil Engineering 3 cr.
A course on the use of computers for analysis, design, and decision making in civil engineering, including programming, numerical, and CAD methods and applications. Prerequisites: EECE 231.

CIVE 600 Seminar in Civil Engineering 0 cr.
A seminar that consists of current research or applied projects presented by faculty members, students, or invited speakers.

CIVE 601 Introduction to Geographic Information Systems 3 cr.
An introductory course on Geographic Information Systems (GIS) and their applications in the planning and engineering fields, data concepts and tools, network data management and planning applications, and implementation issues.

CIVE 602 Experimental Design and Statistical Analysis for Engineers 3 cr.
A course that covers the main steps required to efficiently plan, conduct, analyze, and interpret the results from experiment and observational studies. The course focuses on statistical inference and modeling. Topics covered include ANOVA, t-tests, regression models, and non-parametric tests. The course involves working within a statistical modeling environment.

CIVE 603 Numerical Modeling 3 cr.
A course that deals with ordinary differential equations: initial-, boundary-, and characteristic-value problems; partial differential equations: steady state, time dependent, and oscillatory problems; techniques: Runge-Kutta, shooting, iterative, and finite difference methods. Prerequisite: MATH 251.

Structural Sequence

CIVE 210 Statics 3 cr.
A course outlining vector mechanics of forces and moments; free-body diagrams; equilibrium of particles and rigid bodies in two & three dimensions; plane & space trusses; frames & machines; axial, shear, moment diagrams of beams & simple frames; friction; center of gravity & centroid; area moment of inertia; computer applications. Pre- or corequisite: MATH 201.

CIVE 310 Mechanics of Materials 3 cr.
A course on stresses, strains, and stress-strain relationships; temperature; axial bars in tension and compression; torsion of circular bars; bending and shear stresses in beams; combined stresses; stress transformation and Mohr’s circle; and computer applications. Prerequisite: CIVE 210.

CIVE 410 Theory of Structures 3 cr.
A course covering review of principles of statics; analysis of statically determinate plane frames; deflection of statically determinate beams; Introduction to indeterminate structural analysis; Influence lines; Computer applications; a Project on Building modeling and assessment. Prerequisites: CIVE 310, MATH 202, PHYS 210.

CIVE 411 Indeterminate Structural Analysis 3 cr.
A course covering review of basic concepts of structural analysis; equilibrium, stability, indeterminacy and degrees of freedom; indeterminate analysis of trusses; Indeterminate analysis of beams and frames; influence lines for statically Indeterminate structures. Prerequisite: CIVE 410.

CIVE 412 Steel Design 3 cr.
A course that examines loads on structures; philosophies of design: LRFD versus ASD; behavior, analysis, and design (according to AISC) of tension members, bolted connections, welded connections, welding fundamentals and groove welds, compression members, and beams. Prerequisite: CIVE 410.

CIVE 413 Concrete Design I 3 cr.
A course that covers the mechanical properties of concrete materials; ultimate strength theory of flexure and shear; flexural and shear design of beams; service load behavior; bond properties of reinforcing bars; design of solid and ribbed one-way slabs. Prerequisite: CIVE 410.

CIVE 414 Concrete Design II 3 cr.
A course that covers continuous beams, short columns, tension columns, and axially loaded columns; wall footings; concentrically loaded single column footings, and combined footings; staircases; bearing walls; cantilever retaining. Prerequisite: CIVE 413.

CIVE 610 Numerical Methods in Structural Analysis 3 cr.
A course that introduces the matrix approach for the modeling and analysis of structural systems; computer modeling/analysis using specialized software (SAP2000); computer implementation and code development; nonlinear analysis of frames. Prerequisites: CIVE 411; EECE 231.
CIVE 611 Bridges 3 cr.
A course that discusses types of bridges; influence lines; loads and their distribution on bridges; serviceability of bridges; methods of design of bridge deck, superstructure, and substructure. Prerequisite: CIVE 410.

CIVE 612 Advanced Steel Design 3 cr.
A course that investigates stability; column strength, beam-columns, composite steel-concrete construction, plate buckling, plate girders, torsion, and combined torsion and bending, eccentrically loaded connections, influence of connection stiffness on moment demand, and general moment connection. Prerequisite: CIVE 412.

CIVE 613 Prestressed Concrete 3 cr.
A course on material characteristics; prestress losses; working strength design procedures; composite construction; ultimate flexural strength and behavior; shear design; continuous prestressed concrete members. Prerequisite: CIVE 413.

CIVE 614 Special Topics in Concrete 3 cr.
A course that reviews reinforced concrete (R/C) design; torsion in R/C members; wind load on structures; earthquake load and seismic design of structures; design of shear walls; design of corbels, brackets and deep girders; circular and rectangular water tanks; and spherical. Prerequisite: CIVE 414.

CIVE 615 Strengthening and Rehabilitation of Concrete Structural Systems 3 cr.
A course on assessment of materials and structural deficiency using field test or analytical methods; repair and strengthening materials; strengthening and repair techniques; strengthening of structural members in flexure, shear and axial load; and upgrading of gravity load-designed buildings for earthquake load resistance. Prerequisites: CIVE 410 and CIVE 413.

CIVE 616 Earthquake Engineering 3 cr.
A course that examines the nature of earthquake ground motion; seismic hazard evaluation in engineering practice; response analysis of structures and effect of soil conditions on structural response and behavior under earthquake ground motion; design of structures under earthquake loading.

CIVE 710 The Finite Element Method 3 cr.
A course that introduces basic elements; interpolation and shape functions; variational formulation methods; Galerkin and weighted residual Methods; isoparametric elements; numerical integration; error estimation and modeling issues; finite elements in structural dynamics. Prerequisite: CIVE 610.

CIVE 711 Advanced Mechanics of Solids 3 cr.
A course that covers theories of stress and strain; generalized Hook’s law; modes of failure, failure criteria; energy principles and applications; torsion; beams on elastic foundations; introduction to the theory of plates; thin-wall and thick-wall cylinder.

CIVE 712 Structural Dynamics 3 cr.
A course on analysis of vibration of single degree, multi-degree, and infinite degree of freedom systems; free and forced vibration response; analysis of dynamic response by approximate methods; introduction to earthquake engineering.

CIVE 713 Behavior of Reinforced Concrete Members 3 cr.
A course on building codes; limit state design; mechanical characteristics of concrete and steel reinforcement; creep and shrinkage; flexure: moment-curvature and force-deformation relationships; columns: axial force-moment-curvature relationships; shear: mechanisms of shear resistance, and truss analogy; bond and anchorage of reinforcement. Prerequisite: CIVE 414.

Construction Sequence

CIVE 421 Construction Management 3 cr.
A course that seeks to impart in students a sound understanding of the construction company and project organization, pre-construction activities, estimating and bidding, staffing for construction, macro-level planning and scheduling, and quality control.

CIVE 521 Construction Methods and Safety Management 3 cr.
A course that exposes students to the tools needed for estimating, planning and directing operations in building construction and heavy civil projects. The course addresses equipment, methods, productivity, ownership, operating costs, and safety management. Prerequisite: CIVE 370.

CIVE 522 Building Construction and Estimating 3 cr.
A course that exposes students to building systems and how to integrate them by choosing the best materials and methods (concrete, masonry, steel, thermal and moisture protection, mechanical and electrical, etc. The presentation of professional construction documents including execution drawings, details, and specifications will also be covered.

CIVE 523 Construction Planning and Scheduling 3 cr.
A course on CPM, precedence network, schedule control, codes, collaborative planning, resource management, priority rules and leveling, earned value, schedule reduction, PERT, line of balance scheduling, the Last Planner System, Primavera P6, Microsoft Project, and VICO control.

CIVE 620 Construction Systems Analysis and Simulation 3 cr.
A course that covers planning and simulation modeling of construction operations, design of efficient processes, construction productivity and resource use considerations, production system design, construction supply chain management, and analysis of construction systems.

CIVE 621 Infrastructure Construction and Rehabilitation 3 cr.
A course on urban requirements and engineering technologies and procedures for construction of infrastructure facilities including: roads and pavements, bridges, water and sanitary networks, electric power lines, and telephone/communication lines; as well as their applications to urban and rural areas, while focusing on QA/QC, environment, and safety.

CIVE 622 Advanced Construction Scheduling 3 cr.
A course that provides advanced techniques in construction scheduling. It examines monitoring, updating, and controlling the project schedule; impact of scheduling on productivity, operational planning and scheduling, and use of scheduling software. Prerequisite: CIVE 523.

CIVE 623 IT Applications in Construction 3 cr.
A course that covers computing tools impacting the construction industry such as mobile computing and information systems to support field engineering tasks; computerized systems applications to perform specific functions, such as estimating, scheduling, cost control; emerging sensing and instrumentation technologies to solve construction problems and case studies.
CIVE 624 Building Information Modeling 3 cr.
A course that covers Building Information Model (BIM) use and benefits in design and construction. It addresses collaborative design, clash detection, level of development (LOD), BIM contracts, automated code checking, simulation, BIM and lean applications, and integrated project delivery.

CIVE 625 Construction Business Management 3 cr.
A course that covers the principles of business management of construction companies - theory as well as international and regional practice; an overview of construction business operations including strategic planning, organizational structure, accounting, financing, risk analysis, and quality; and the principles and sources of construction funding for contracting firms and projects.

CIVE 626 Lean Construction Methods and Applications (Blended) 3 cr.
A course on lean theory, production control, value stream mapping, process improvement, project definition, lean design, integrated project delivery, advanced lean scheduling, risk assessment, budget under uncertainty, and project monitoring. Prerequisite: CIVE 421.

CIVE 627 Construction Technology for Tall Buildings 3 cr.
A course on the latest construction practices and processes for tall buildings from foundation to roof. It covers advanced methods, materials, equipment, and systems used for the construction of tall buildings, as well as principles of sustainable construction.

CIVE 628 Design of Temporary Support Structures 3 cr.
A course that covers design and construction of temporary support structures used in the construction industry, including concrete formwork, scaffolding, caissons, cofferdams, and dewatering systems.

CIVE 629 Construction Decisions under Uncertainty 3 cr.
A course that covers construction project and organization decisions for the uncertain future. The selection of construction method, equipment, contract, markup, and financing alternatives having the highest expected values; uses decision theory, competitive bid analysis, probabilistic modeling and simulation, and multiple regression analysis in managing construction.

CIVE 720 Advanced Construction Safety 3 cr.
A course that exposes students to the real world of construction and the complexity of managing machines, material and people. The course content includes the selection of construction equipment and material based on applications, methods, and production requirements for earthmoving, heavy and building construction.

CIVE 721 Legal Aspects of Construction 3 cr.
A course that covers legal problems and liability issues in the area of construction contracts, torts, and insurance.

CIVE 722 Sustainable Design and Construction 3 cr.
A course that covers principles of sustainable design and construction, including life-cycle cost analysis, evaluation of economic and environmental impacts, state-of-the-art technology, and so on.

Geotechnical Sequence

CIVE 330 Engineering Geology 3 cr.
A course that discusses the composition and properties of rocks; geologic processes; geologic hazards; geologic structure and engineering consequences; terrain analysis and geologic mapping; interpretation and use of geologic maps; application of geology to engineering practice.

CIVE 430 Soil Mechanics and Laboratory 3 cr.
A course on soil classification and index properties; soil structure and moisture; compaction; seepage; effective stress concept; compressibility and consolidation; stress and settlement analysis; shear strength; and laboratory experiments. Prerequisites: CIVE 310, CIVE 330.

CIVE 431 Foundation Engineering 3 cr.
A course that covers site investigations; evaluation of data from field and laboratory tests; estimation of stresses in soil masses; applications of principles of soil mechanics to determination of bearing capacity and settlement of spread footings, mats, single piles, and pile groups. Prerequisite: CIVE 430.

CIVE 631 Applied Foundation Engineering 3 cr.
A course on braced excavations, retaining structures, deep foundations, slope stability, and computer applications. Prerequisite: CIVE 431.

CIVE 632 Soil Behavior 3 cr.
A course on soil mineralogy, soil formation, and composition; influence of geological factors on properties; colloidal phenomena in soils; soil structure; analysis of conduction phenomena (hydraulic, diffusive, thermal, and electrical); compressibility, strength, and deformation properties. Prerequisite: CIVE 430.

CIVE 633 Soil and Site Improvement 3 cr.
A course that covers compaction, admixture stabilization, foundation soil treatment, reinforced soil and composite materials, and material sites reclamation.

CIVE 634 Shear Strength of Soils 3 cr.
A course that covers stresses within a soil mass, tests to measure stress strain properties, stress-strain relationships, shear strength, strained conditions, undrained, constitutive models, and failure criteria applications. Prerequisite: CIVE 430.

CIVE 635 Earth Dams 3 cr.
A course that examines hydraulic dams, roller earth dams, homogenous dams, thin core dams, filters, causes of dam failures, seepage control, and seismic stability of dams.

CIVE 636 Geotechnical Earthquake Engineering 3 cr.
A course on causative mechanisms and characteristics of earthquakes; evaluation dynamic soil properties local site response; seismic soil-structure interaction; evaluation and mitigation of soil liquefaction; seismic code provisions and additional current topics. Prerequisite: CIVE 430.

Water Resources Sequence

CIVE 340 Fluid Mechanics and Laboratory 3 cr.
A course that deals with fluid properties, fluid static, continuity equation, Bernoulli's equation, energy principle, momentum principle, laboratory experiments. Prerequisites: MATH 201, PHYS 210.

CIVE 440 Hydraulics and Laboratory 3 cr.
A course that covers flow in conduits, flow in open channels, flow measurements, design of basic hydraulic structures, and laboratory experiments. Prerequisites: CIVE 340, MATH 202, ENGL 206.

CIVE 541 Engineering Hydrology 3 cr.
A course outlining hydrologic principles, rainfall-runoff analysis, flood routing, frequency analysis, and ground water hydrology. Prerequisites: CIVE 340, MATH 202.
CIVE 542  Urban Hydrology  3 cr.
A course covering design rainfall, infiltration, overland flow, channel flow, storm sewer hydraulics, stormwater detention, and simulation models. Prerequisite: CIVE 440.

CIVE 640  Advanced Hydraulics  3 cr.
A course that covers closed conduit flow, water distribution systems, transient analysis, open channel flow, flood control, culvert hydraulics, design of various hydraulic structures. Prerequisite: CIVE 440.

CIVE 641  Surface Water Hydrology  3 cr.
A course on design storm, rainfall-runoff modeling, flood routing, reservoir routing, simulation models, and stochastic hydrology. Prerequisite: CIVE 441 or equivalent.

CIVE 642  Groundwater Hydrology  3 cr.
A course that deals with properties of groundwater, Darcy’s law, steady groundwater flow, unsteady groundwater flow, well hydraulics, unsaturated flow, sea-water intrusion, and numerical modeling. Prerequisite: CIVE 441.

CIVE 644  Coastal Engineering  3 cr.
A course on small-amplitude wave theory (linear theory); finite-amplitude wave theory (nonlinear theory); cnoidal wave theory; solitary wave theory; wave refraction, diffraction, and reflection; wave forces and interaction with man-made structures; and design of maritime structures e.g. breakwaters. Prerequisite: CIVE 440.

CIVE 645  Surface Water Quality Modeling & Management  3 cr.
An introductory course on surface water quality pollution problems in streams, rivers, lakes, reservoirs, and estuaries with a focus on both the quantitative modeling aspects of surface water quality and the management and policy aspects of it. Both mechanistic and empirical models for assessing the status of surface water bodies are introduced.

CIVE 647  Water Resource Systems: Planning and Management  3 cr.
A course that introduces principles demonstrating steps in engineering policy planning as it applies to water resources management. Emphasis will be placed on systems and socio-economics analysis, conflict management, and concepts in strategic assessment.

CIVE 648  GIS for Water Resources and Environmental Engineering  3 cr.
A course that introduces the concepts and principles of Geographic Information Systems (GIS) from the perspective of water resources and environmental engineering and sciences. It provides coverage of state-of-the-art GIS methods and tools: spatial and terrain analysis, geostatistical analysis, watershed delineation, time series analysis, and development of GIS integrated models.

CIVE 649  Climate Change and Water Resources  3 cr.
An introductory course on global climate change and its potential impacts on water resources and related sectors. It explores drivers of climate change, greenhouse gases emissions and mitigation efforts, and adaptation options with emphasis on Integrated Water Resources Management.

CIVE 740  Transport Phenomena in Surface and Subsurface Waters  3 cr.
A course on advection, diffusion, and dispersion of pollutants; transport in rivers and estuaries; transport in groundwater; numerical modeling; design of wastewater discharge system.

Environmental Sequence

CIVE 251  Environmental Chemistry  3 cr.
A course that introduces the basic principles of environmental chemistry and discusses example applications from the natural and engineered worlds.

CIVE 252  Environmental Microbiology  3 cr.
A course that introduces the basic principles of environmental microbiology. It discusses example applications from the natural and engineered worlds. The main goals of this course are to present an overview of important micro-organisms involved in environmental systems, their ecology, interactions with various pollutants, and beneficial or harmful effects on humans.

CIVE 550  Water Treatment and Laboratory  3 cr.
A course that examines the quality and principles of municipal and industrial water treatment processes and methods of testing for physical, chemical and biological parameters. Prerequisite: CIVE 251 or equivalent, or consent of instructor.

CIVE 551  Wastewater Treatment and Laboratory  3 cr.
A course that examines the quality and principles of municipal wastewater treatment processes and methods of testing for physical, chemical, and biological parameters. Prerequisite: CIVE 252 or equivalent, or consent of instructor.

CIVE 552  Waste Management and Treatment  3 cr.
A course on engineering principles, practices, and techniques for the management of solid wastes: sources, composition, properties, impacts, generation, storage, collection and transport, processing, resource recovery, and disposal.

CIVE 553  Environmental Biotechnology  3 cr.
A course designed to teach students the scientific and engineering principles of microbiological treatment technologies to clean contaminated environments and formulate effective solutions to problems in biochemical engineering. Prerequisites: CIVE 251, CIVE 252, or equivalent or consent of instructor.

CIVE 555  Air Quality Management  3 cr.
A course on the principles, practices, and techniques for the management of air pollution: Types, sources, properties, impacts, standards, control technologies, atmospheric dispersion, emissions, and indoor air quality.

CIVE 650  Water and Sewage Works Design  3 cr.
A course that examines the design of water and wastewater schemes, including design reports and a literature search on the development of conventional treatment processes. Prerequisites: CIVE 550 and CIVE 551 or consent of instructor.

CIVE 651  Processes in Water and Wastewater Treatment  3 cr.
A course on sedimentation, filterability, permeability and fluidization, ion exchange, aeration, flotation, membrane filtration, and aerobic digestion. Experimental applications of processes. Prerequisites: CIVE 251, CIVE 252, or equivalent or consent of instructor.

CIVE 652  Landfill Engineering Design  3 cr.
A course on solid waste disposal with emphasis on design development of landfill elements (site selection and characterization, gas extraction and management, leachate collection and management, liners, covers, closure and post-closure monitoring. Prerequisite: consent of instructor.
CIVE 653  Environmental Chemistry and Microbiology  3 cr.
A course that deals with organic, inorganic, and physical chemistry; chemical equilibrium; reaction kinetics; acidity, alkalinity; composition, morphology, and classification of microorganisms; energy, metabolism, and synthesis; growth, decay, and kinetics; and biological water quality indicators. Prerequisites: CIVE 251,CIVE 252, or equivalent or consent of instructor.

CIVE 654  Environmental Bioremediation  3 cr.
A course that discusses the application of biological treatment for the remediation of contaminated environments, and highlights current engineering methods/design used to enhance biodegradation. Prerequisites: CIVE 251, CIVE 252, or equivalent or consent of instructor.

CIVE 655  Air Pollution and Control  3 cr.
A course that examines processes and design equipment for the control of particulates and gaseous emissions. Prerequisite: consent of instructor.

CIVE 656  Environmental Impact Assessment  3 cr.
A course on procedures of assessing/preparing/reviewing/presenting environmental impacts of developmental projects/facilities: industrial facilities, waste management/disposal, wastewater treatment, transportation, dams and reservoirs, irrigation/drainage schemes, coastal zone developments, natural resource management, etc. Prerequisite: E4 status or consent of instructor.

CIVE 657  Methods of Environmental Sampling and Analysis  3 cr.
A course on sampling techniques and instrumental methods in environmental sciences; determination of pollutants in water, air, and soil; analytical techniques; adaptation of procedures to specific matrices; case studies. Prerequisite: CIVE 251, CIVE 252, or equivalent or consent of instructor.

CIVE 658  Industrial Waste Management  3 cr.
A course on engineering principles, practices, and techniques for the management of industrial-hazardous wastes: sources, generation, properties, impacts and auditing of industrial facilities. Basic treatment processes and disposal methods. Site remediation. Prerequisite: E4 status or consent of instructor.

CIVE 659  Environmental and Water Conflict Management  3 cr.
A course on the development of case studies in environmental and water conflict management taught under a framework of role play of opponents perspective and decision making thereof.

CIVE 751  Wastewater Reclamation and Reuse  3 cr.
A course that examines environmental issues in water reuse, risk assessment, water reclamation technologies, storage of reclaimed water, usage of reclaimed water, and planning of wastewater reclamation and reuse. Prerequisite: CIVE 551.

CIVE 755  Air Pollution Modeling  3 cr.
A course that deals with mathematical models, air pollution meteorology, plume rise, dispersion and atmospheric chemistry, meteorological models, as well as Gaussian, statistical, and other special application models. Prerequisite: CIVE 555 or consent of instructor.

Transportation Sequence

CIVE 460  Transportation Engineering and Laboratory  3 cr.
An introductory course to the field of transportation engineering through presenting the basics of traffic engineering, traffic flow theory, and airport planning. The laboratory component consists of field experiments that reinforce students' understanding of the academic concepts and principles. Prerequisites: STAT 230, ENGL 206.

CIVE 461  Highway Engineering  3 cr.
A course that examines road vehicle performance; principles of geometric design and highways; horizontal and vertical alignment; earthwork; intersections and interchanges; pavement design; parking facilities; and highway planning (travel demand forecasting). Prerequisites: CIVE 201, CIVE 301.

CIVE 661  Urban Transportation Planning I  3 cr.
An introductory course on methods and models used in transportation planning with emphasis on the urban context. Topics include travel patterns in urban areas; data requirements for planning and data collection techniques; transportation/land-use interaction; travel demand and network models; transport supply options; and evaluation techniques. Prerequisites: CIVE 460, CIVE 461.

CIVE 662  Traffic Engineering  3 cr.
A course outlining traffic engineering studies; traffic control of signalized and unsignalized intersections; signal control hardware and maintenance; arterial performance and operations; and network optimization. Prerequisite: CIVE 460.

CIVE 663  Transportation Systems Analysis  3 cr.
A course that introduces methods, models, and applications of transportation systems analysis focusing on both supply/performance and demand/economics. Prerequisites: CIVE 460, CIVE 461.

CIVE 664  Design and Management of Transport Operations  3 cr.
A course on probabilistic and optimization methods for designing efficient operations in freight carrier, airline, transit, and traffic modes. Topics include crew and vehicle scheduling in freight, airline, transit modes; vehicle routing and facility location problems in carrier systems; runway and air traffic operations; reliability in transit services. Prerequisites: CIVE 460, STAT 230 or equivalent.

CIVE 665  Transportation Economics  3 cr.
A course that investigates the application of economic principles to the evaluation of projects and policies in the transport sector such as transport project benefits, costs, and financing, and pricing in the transport sector. Prerequisite: CIVE 461.

CIVE 666  Public Transportation  3 cr.
A course on public transportation modes and services; single route, network, and strategic planning; tasks involved in system operations; management of public transportation organizations; privatization issues. Prerequisites: CIVE 460, CIVE 461.

CIVE 761  Urban Transportation Planning II  3 cr.
A course examining advanced topics in urban transportation planning; transportation systems management techniques; travel demand analysis; and discrete choice modeling of travel demand. Prerequisite: CIVE 661.
CIVE 683  Reliability Based Design of Civil Systems  3 cr.
A course that covers applications of reliability theory in assessing the safety and reliability of civil systems in the presence of uncertainty; decision making and risk analysis; definition of the probability of failure; modeling uncertainty in resistance and load; load and resistance factor design (LRFD) in structural and geotechnical engineering; basics of design code calibration.

CIVE 684  Environmental Geotechnics  3 cr.
A course on geotechnical practice in environmental protection and restoration; influence of physical and chemical processes in soils on the evaluation of contaminant distribution; design of waste containment systems, slurry walls, and soil stabilization; the applicability and use of geosynthetics; and technologies for site restoration and cleanup. Prerequisite: CIVE 430.

Special Courses

CIVE 690  Special Projects  3 cr.
CIVE 691  Special Topics in Civil and Environmental Engineering  3 cr.
CIVE 692  Advanced Topics in Civil and Environmental Engineering  3 cr.
CIVE 699  MS Thesis  6 cr.
CIVE 980  Qualifying Exam I: Comprehensive Exam  0 cr.
CIVE 981  Qualifying Exam II: Thesis Proposal Defense  0 cr.
CIVE 982  PhD Thesis  3 cr.
CIVE 983  PhD Thesis  6 cr.
CIVE 984  PhD Thesis  9 cr.
CIVE 985  PhD Thesis  12 cr.
CIVE 986  PhD Thesis  0 cr.
CIVE 987  PhD Thesis Defense  0 cr.

Materials Sequences

CIVE 370  Construction Materials and Technologies  3 cr.
An introductory course on the composition and properties of engineering materials such as asphalt, cement, concrete, geological materials, steel, polymers, and wood. Hands on laboratory experiments and demonstrations are part of the course, and are designed to familiarize the student with the materials, testing methods, equipment, and standards.

CIVE 670  Concrete Technology  3 cr.
A course that examines Portland cements; aggregates; pozzolans; proportioning normal concrete mixtures; pumping concrete; consolidating, finishing, and curing concrete; durability; testing hardened concrete; high-strength concrete; light and heavy weight concretes; and hot and cold weather concreting.

CIVE 671  Pavement Engineering  3 cr.
A course that examines highway and airport pavement design; flexible and rigid pavement types and wheel loads; stresses in flexible and rigid pavements; pavement behavior under moving loads; soil stabilization. The course covers empirical, mechanistic-empirical, and mechanistic design methodologies. Prerequisite: CIVE 461.

CIVE 672  Highway Materials and Construction  3 cr.
A course that covers various materials constituents in highway pavement structures with emphasis on asphalt concrete, aggregate-soil mixtures, geotextiles, and bituminous liquids. Materials properties, design, quality control and methods of construction will be described. Prerequisite: STAT 230.

CIVE 770  Viscoelastic Behavior of Construction Materials  3 cr.
A course that introduces students to viscoelastic behavior of construction materials, particularly asphalt concrete and polymer composites. The course covers basic concepts in material characterization, rheology, time-temperature superposition principles, in addition to linear and non-linear viscoelastic models. Prerequisite: STAT 230.

Multidisciplinary Courses

CIVE 481  Specifications and Cost Estimation  3 cr.
A course on the structure of construction documents and their interrelationships; bidding requirements; general and particular contract conditions; administrative and procedural requirements for construction; technical specifications; construction cost estimation processes; and unit rates determination and pricing.

CIVE 681  Evaluation of Cost Alternatives  3 cr.
A course that covers the principles of economic evaluations using concepts of time value of money to compare alternatives related to construction, design, and real property development.

CIVE 682  Infrastructure Systems Management  3 cr.
A course on modeling and optimization methods and their application to inspection, performance prediction and maintenance decision making for the management of infrastructure systems.
Department of Electrical and Computer Engineering

Chairperson: Chaaban, Farid
Professors: Al-Alaoui, Mohamad Adnan; Artail, Hassan; Chaaban, Farid; Chedid, Riad; Diab, Hassan; El-Hajj, Ali; Hajj, Ibrahim; Kabalan, Karim; Karaki, Sami; Kayssi, Ayman; Saade, Jean; Sabah, Nassir

Associate Professors: Abou-Faycal, Ibrahim; Akkary, Haitham; Bazzi, Louay; Chehab, Ali; Dawy, Zaheer; Elhajj, Imad; Hajj, Hazem; Jabr, Rabih; Karameh, Fadi; Mansour, Mohamed; Masri, Wassim

Assistant Professors: Awad, Mariette; Costantine, Joseph; Kanj, Rouwaida; Zaraket, Fadi

Adjunct Professor: Khoury, Shahwan

Senior Lecturers: Chahine, Hazem; Hamandi, Lama; Huijer, Ernst; Nasser, Youssef

Lecturers: Droubi, Ghashan; Mohtar, Taan; Moukalid, Ali

Instructors: Hijase, Basma; Kanafani, Zaher; Marmar, Ali; Rishani, Nadeen; Salim, Bassel

The Department of Electrical and Computer Engineering offers two undergraduate programs leading to the degree of Bachelor of Engineering, and a minor in Biomedical Engineering.

Undergraduate Programs

The Department of Electrical and Computer Engineering offers the degree of Bachelor of Engineering in two majors:

- Computer and Communications Engineering (CCE)
- Electrical and Computer Engineering (ECE)

The mission of the undergraduate programs is to impart a basic understanding of electrical and computer engineering built on a foundation of mathematics, physical sciences, and technology; to expose students to practical and major design experiences; and to provide students with a global perspective and an awareness of their leadership role in regional development. This preparation is augmented by the liberal arts education offered to all undergraduates at the American University of Beirut.

The Electrical and Computer Engineering program provides the students with options to explore, and specialize in, one or more areas of electrical and computer engineering.

The Computer and Communications Engineering program prepares its graduates for careers and graduate studies in information and communication technologies.

The department also offers one minor in Biomedical Engineering.

Computer and Communications Engineering Program

Program Educational Objectives

The objectives of the CCE program are to graduate students able to

- achieve their employment or post graduate educational goals and
- advance in their careers through leadership, life-long learning, innovation, critical thinking, integrity, and civic responsibility.

Program Requirements

- **Mathematics:** MATH 201, MATH 202, MATH 211 or CMPS 211, MATH 218 or 219, STAT 230, and one of MATH 210, 224, 227, 251, or 261.
- **Sciences:** PHYS 210, PHYS 210L, CHEM 201 or 202, CHEM 203 or 205, and one additional science elective.
- **General Education Requirements:** Please refer to the GE requirements as listed in the General University Academic Information or to the GE website. Students exempted from ENGL 203 should take ENGL 206 and another English course (excluding ENGL 204 and ENGL 208).
- **ENMG 400:** Engineering Economy
- **ENMG 504:** Engineering Ethics
- **ECE Core Courses:** EECE 200, EECE 210, EECE 230, EECE 290, EECE 310, EECE 311, EECE 320, EECE 321, EECE 330, EECE 340, EECE 350, EECE 380
- **ECE Laboratories:** EECE 310L, EECE 321L, EECE 410L, two additional laboratories: one laboratory restricted and one laboratory elective.
- **ECE Restricted Electives:** Four restricted elective courses from the list of CCE Focus Area courses with no more than three courses from any given area.
- **ECE Elective Courses:** Four restricted elective courses from any given area.
- **Undergraduate Elective Courses:** 6 credits of EECE 400 level courses
- **Technical Electives:** 18 credits of course work, at least six credits of which must be in ECE. No more than six credits may be taken from the same department, program, and/or track.
- **Approved Experience:** EECE 500
- **Final Year Project:** EECE 501 and EECE 502

The program requirements can be completed according to the following proposed schedule...
## Undergraduate Catalogue 2013–14

### Term I (Fall)
<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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</thead>
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<tr>
<td>EECE 200</td>
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### Term V (Spring)
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<td>EECE 321</td>
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### Term VI (Summer)
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### Term VII (Fall)
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### Term VIII (Spring)
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### Term IX (Summer)
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### Term X (Fall)
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<td>EECE xxx</td>
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<tr>
<td>EECE 502</td>
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<tr>
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### Term XI (Spring)
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<th>Course</th>
<th>Credits</th>
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<tr>
<td>EECE 502</td>
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<td>EECE xxx</td>
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<td>Humanities or Social Science Elective</td>
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<td><strong>Total</strong></td>
<td>16</td>
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</tbody>
</table>

**Total =143 credit hours**  

b. stands for billing
List of CCE Focus Area/Courses
- **Area 1: Computer Hardware Systems**: EECE 412, 421, 422, 425
- **Area 2: Communications and Networking**: EECE 442, 451, 455
- **Area 3: Software Systems**: EECE 430, 431, 432, 433, 434

List of CCE Restricted Labs
EECE 412L, 435L, 442L, 451L

List of Pre-approved Technical Electives
- Any EECE course with a number equal to, or greater than 400
- Any ENMG course with a number equal to, or greater than 500, with the exception of ENMG 504
- ACCT 210
- BIOL 201, 202, 210, 223, 224, 225, 243, 244, 247, 260, 268, 290
- CHEM 200, 201, 202, 206, 208, 211, 212, 215, 217, 218, 227, 228, 229
- CIVE 460, 461, 647, 652, 656, 657, 661, 662, 663, 664, 666, 667, 672
- DCSN 200, 210
- ENGL 220/ENMG 220, 225, 235
- FINA 210
- GEOL 201, 205, 212, 213, 219, 221
- MECH 310, 314, 320, 340, 550, 631, 633, 634, 641, 642
- MKTG 210, 225
- MNGT 218, 220, 229, 230
- PHYS 212, 217, 223, 225, 226, 235, 236, 249
- Any STAT course with a number equal to, or greater than 234

List of Science Electives
- BIOL 201, BIOL 202, BIOL 210, CHEM 201, CHEM 211, GEOL 201, GEOL 205, GEOL 211, PHYL 246, PHYS 212, PHYS 217, PHYS 223, PHYS 235, PHYS 236

**Electrical and Computer Engineering Program**

**Program Educational Objectives**
The objectives of the ECE program are to graduate students able to
- achieve their employment or post graduate educational goals and
- advance in their careers through leadership, life-long learning, innovation, critical thinking, integrity, and civic responsibility.

**Program Requirements**
- **Mathematics**: MATH 201, MATH 202, MATH 211 or CMPS 211, MATH 218 or 219, STAT 230, and one of MATH 210, 224, 227, 251, 261.
- **Sciences**: PHYS 210, PHYS 210L, CHEM 201 or 202, CHEM 203 or 205, and one additional science elective.
- **General Education Requirements**: Please refer to the GE requirements as listed in the General University Academic Information or to the GE website. Students exempted from ENGL 203 should take ENGL 206 and another English course (excluding ENGL 204 and ENGL 208).
- **ENMG 400**: Engineering Economy
- **ENMG 504**: Engineering Ethics
- **ECE Laboratories**: EECE 310L, EECE 321L, EECE 410L and two additional laboratories: one laboratory restricted and one laboratory elective.
- **ECE Restricted Electives**: Four restricted elective courses from the list of CCE Focus Area courses with no more than three courses from any given area.
- **Undergraduate Elective Courses**: 6 credits of EECE 400 level courses
- **Technical Electives**: 18 credits of course work, at least six credits of which must be in ECE. No more than six credits may be taken from the same department, program, and/or track. All technical electives must be from the list of pre-approved technical electives.
- **Approved Experience**: EECE 500
- **Final Year Project**: EECE 501 and EECE 502

The program requirements can be completed according to the following proposed schedule:

<table>
<thead>
<tr>
<th>Term I (Fall)</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECE 200 Introduction to Electrical and Computer Engineering</td>
<td>3</td>
</tr>
<tr>
<td>EECE 210 Electric Circuits</td>
<td>3</td>
</tr>
<tr>
<td>ENGL English Course</td>
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<tr>
<td>MATH 201 Calculus and Analytic Geometry III</td>
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</tr>
<tr>
<td>PHYS 210 Introductory Physics II</td>
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</tr>
<tr>
<td>PHYS 210L Introductory Physics Laboratory II</td>
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<td><strong>Total</strong></td>
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</table>

<table>
<thead>
<tr>
<th>Term II (Spring)</th>
<th>Credits</th>
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<tbody>
<tr>
<td>EECE 230 Introduction to Programming</td>
<td>3</td>
</tr>
<tr>
<td>EECE 290 Analog Signal Processing</td>
<td>3</td>
</tr>
<tr>
<td>MATH 202 Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>MATH 218/219 Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>MATH/CMPS 211 Discrete Structures</td>
<td>3</td>
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<tr>
<td><strong>Total</strong></td>
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</table>

**Total** 31
### Term III (Summer) Credits
- CHEM 201/202 Chemistry Course 3
- CHEM 203/205 Chemistry Laboratory 2
- Humanities or Social Science Elective 3

**Total 8**

### Term IV (Fall) Credits
- EECE 310 Electronics 3
- EECE 310L Electric Circuits Laboratory 1
- EECE 320 Digital Systems Design 3
- EECE 330 Data Structures and Algorithms 3
- EECE 370 Electric Machines and Power Fundamentals 3
- STAT 230 Introduction to Probability and Random Variables 3

**Total 16**

### Term V (Spring) Credits
- EECE 311 Electronic Circuits 3
- EECE 321 Computer Organization 3
- EECE 321L Computer Organization Laboratory 1
- EECE 340 Signals and Systems 3
- EECE 380 Engineering Electromagnetics 3
- Science Elective 3

**Total 16**

### Term VI (Summer) Credits
- ENGL English Course 3
- ARAB Arabic Course 3
- Humanities or Social Science Elective 3

**Total 9**

### Term VII (Fall) Credits
- EECE 4xx Restricted Elective 3
- EECE 4xx Restricted Elective 3
- EECE 4xx Restricted Elective 3
- MATH Math Elective 3
- ENMG 400 Engineering Economy 3

**Total 15**

### Term VIII (Spring) Credits
- EECE 4xx Restricted Elective 3
- EECE 4xx Restricted Elective 3
- EECE 4xx Restricted Elective 3
- EECE 410L System Integration Laboratory 1
- ENMG 504 Engineering Ethics 3

**Total 16**

**Total =143 credit hours**

### List of ECE Focus Area/Courses
- **Area 1: Computer Hardware Systems:** EECE 412, 421, 422, 425
- **Area 2: Power and Energy Systems:** EECE 471, 473, 474
- **Area 3: Control and Intelligence Systems:** EECE 460, 461, 463

### List of ECE Restricted Labs
- EECE 412L, 460L, 462L, 470L, 471L, 473L

### List of Pre-approved Technical Electives
- Any EECE course with a number equal to or greater than 400
- Any ENMG course with a number equal to, or greater than 500, with the exception of ENMG 504
- ACCT 210
- BIOL 201, 202, 210, 223, 224, 235, 243, 244, 247, 260, 268, 290
- CHEM 200, 201, 202, 206, 208, 211, 212, 215, 217, 218, 227, 228, 229
- CIVE 460, 461, 647, 652, 656, 657, 661, 662, 663, 664, 666, 667

* b. stands for billing
• DCSN 200, 205, 210
• ENTM 220/FINA 220, 225, 235
• FINA 210
• GEOL 201, 205, 211, 212, 213, 219, 221
• MECH 310, 314, 320, 340, 550, 631, 633, 634, 641, 642
• MKTG 210, 225
• PHYL 246
• PHYS 212, 217, 223, 225, 226, 235, 236, 249
• Any STAT course with a number equal to, or greater than 234

List of Science Electives
• BIOL 201, BIOL 202, BIOL 210, CHEM 201, CHEM 211, GEOL 201, GEOL 205, GEOL 211, PHYL 246, PHYS 212, PHYS 217, PHYS 223, PHYS 235, PHYS 236

Minor in Biomedical Engineering
The minor in Biomedical Engineering is open to all AUB students. Students who have completed at least 60 credits at the sophomore level and higher, and who have a cumulative average of 70 or more, may apply by completing the minor application form available in the ECE department. The minor will be indicated on the transcript of the student who completes all the requirements described below, and who obtains an average in the minor courses of 70 or more.

The minor requirements are divided into a set of core courses, and a set of elective courses.

For engineering students, the requirements are as follows:
• EECE 401 [1 cr.]
• BIOL 201 [4 cr.]
• BIOL 202 or PHYL 246 [4 cr.]
• One core course [3 cr.] chosen from EECE 601, EECE 603, or MECH 633 depending on the chosen track of Biomedical Equipment, Neuroengineering or Biomechanical, respectively.
• One elective course from list A below [3 cr.]
• One elective course from list B or C below [3 cr.]
• Maximum number of credits: 18

For biology students, the requirements are as follows:
• EECE 401 [1 cr.]
• BIOL 201 [4 cr.]
• BIOL 202 [4 cr.]
• EECE 210 [3 cr.] (or equivalent, such as PHYS 228 and PHYS 228L) and EECE 601 [3 cr.] for the Biomedical Equipment and Neuroengineering track or CIVE 210 [3 cr.] (or equivalent) and MECH 634 [3 cr.], for the Biomechanics track.
• One elective course from list A or B below [3 cr.]
• Minimum number of credits: 18

For other students, the requirements are as follows:

• EECE 401 [1 cr.]
• BIOL 201 [4 cr.]
• BIOL 202 or PHYL 246 [4 cr.]
• EECE 210 [3 cr.] (or equivalent, such as PHYS 228 and PHYS 228L) and EECE 601 [3 cr.] for the Biomedical Equipment and Neuroengineering tracks, or CIVE 210 [3 cr.] (or equivalent) and MECH 634 [3 cr.], for the Biomechanics track.
• One elective course from list A, B, or C below [3 cr.]
• Minimum number of credits: 18

E elective Courses
• List A: EECE 601, EECE 602, EECE 603 (unless the student takes EECE 694, in which case either EECE 694 or EECE 603 counts toward the minor), EECE 604, EECE 605, MECH 633, MECH 634
• List B: MECH 606, MECH 607, MECH 624, MECH 631, MECH 641/EECE 661, EECE 693, MECH 705, EECE 694 (unless the student takes EECE 603, in which case either EECE 694 or EECE 603 counts toward the minor)
• List C: BIOL 202, BIOL 223, BIOL 225, BIOL 244, BIOL 263, BIOL 268, PHYL 202, PHYL 246

Track in Control and Robotics
The ECE Track in Control and Robotics provides a coherent academic framework between the ECE and ME departments in the area of control, instrumentation, and robotics. This Track supports interested undergraduate ECE and ME students in pursuing additional control system modeling and design as given in either department based on their individual preferences. This track is open to all undergraduate ECE and ME students, and will be indicated on the transcript of participating students upon its completion.

ECE students interested in taking the Control and Robotics track must satisfy the following course requirements:
• EECE 460 (3 cr.)
• EECE 461 (3 cr.)
• EECE 460L (1 cr.)
• One elective from list A (Control)
• One elective from list B (Robotics)
• One elective from either list A, B or C

Total number of credits: 16

Elective Course
• List B Robotics: EECE 560/MECH 530, EECE 661/MECH 641, EECE 697/MECH 646, and EECE 698/MECH 650.
• List C Others: EECE 463/MECH 555, EECE 692/MECH642, and EECE 699/MECH 647.
Course Descriptions

EECE 200  Introduction to Electrical and Computer Engineering 3 cr.
This course covers the following topics: an overview of electrical and computer engineering; engineering as a profession; introduction to the different areas of ECE such as biomedical systems, circuits, communications, computer design, control, distributed systems, electromagnetics, energy, machines, and signal processing; basic computer tools such as SPICE, MATLAB, and LabVIEW; basic laboratory instruments; laboratory experiments and a design project.

EECE 210  Electric Circuits 3 cr.
A course on fundamentals of electric circuits; basic elements and laws; techniques of circuit analysis: node voltage, mesh current, Thévenin, Norton, and source transformation; inductors, capacitors, mutual inductance, and transformers; transient response of RC, RL, and RLC circuits; steady state AC circuits; power calculations; circuit simulation using SPICE.

EECE 230  Introduction to Programming 3 cr.
A course on the basic principles of programming and their application to the solution of engineering problems using a high level programming language. This course introduces structured and object-oriented programming, and covers the basic data types, control structures, functions, arrays, pointers, and classes. Weekly laboratory assignments are an integral part of this course.

EECE 290  Analog Signal Processing 3 cr.
A course on selected topics in circuit analysis; operational amplifiers; frequency responses; Butterworth and active filters; responses to periodic inputs; real, reactive, and complex power; maximum power transfer; responses to step, impulse, and switching operations; convolution; Laplace transform and its use in circuit analysis; Fourier transform; two-port circuits; and circuit simulation using SPICE. Prerequisite: EECE 210.

EECE 310  Electronics 3 cr.
A course on semiconductors; PN junctions; diodes and diode circuits; MOS transistor and applications such as amplifier and switch; bipolar junction transistor and applications such as amplifier and switch; and circuit simulation using SPICE. Prerequisites: EECE 290, and pre- or corequisite: EECE 200.

EECE 310L  Electric Circuits Laboratory 1 cr.
A laboratory course that covers passive electronic components; laboratory instruments; voltage-divider circuits; sources and Thevenin’s Theorem; RC lead-lag networks; series resonance; the transformer; op-amp circuits; single-phase rectifier circuits; LEDs; Zener diode regulator; diode clamping and clipping; BJT and MOSFET characteristics. Pre- or corequisite: EECE 310.

EECE 311  Electronic Circuits 3 cr.
A course on BJT amplifiers; MOSFET amplifiers; differential amplifiers; frequency response of amplifiers; feedback; operational amplifiers; oscillators; digital CMOS circuits; SPICE simulations. Prerequisite: EECE 310.

EECE 312  Electronics (for Mechanical Engineering students) 3 cr.
This course introduces the fundamentals of electronics and electronic circuits to non-majors. Its objectives are to provide a concise treatment of the basic concepts of electronic components and to introduce the student to the basic analog and digital electronic circuits. The course covers the fundamentals of semiconductor diodes, transistors, operational amplifiers and their applications, digital circuits and systems, and basic instrumentation. Prerequisites: EECE 210 and MATH 202.

EECE 312L  Circuits and Electronics Lab 1 cr.
A laboratory course for non-majors that covers passive electronic components, laboratory instruments, voltage-divider circuits, sources and Thevenin’s Theorem, diode rectifier circuits, BJT and FET applications, op-amp circuits, filters, digital circuits, and instrumentation. Pre- or corequisite: EECE 312.

EECE 320  Digital Systems Design 3 cr.
This course introduces digital systems design concepts. Topics include basic combinational building blocks and design methods to construct synchronous digital systems; alternative representations for digital systems; standard logic (SSI, MSI) vs. programmable logic (PLD, FPGA); finite state machine design; digital computer building blocks as case studies; introduction to computer-aided design software in VHDL. The course also includes a substantial design project. Prerequisites: EECE 210 and EECE 230.

EECE 321  Computer Organization 3 cr.
This course covers single-core microprocessor computer organization and basic input/output mechanisms. Students learn how to program microprocessors at the assembly level, and how to design the main core components of a von Neumann computer system, including its instruction set architecture, datapath, control unit, cache, and system buses. To consolidate the material, students work on a VHDL design project of a single-cycle MIPS microprocessor core. Prerequisite: EECE 320.

EECE 321L  Computer Organization Laboratory 1 cr.
A laboratory course with experiments in computer organization and interfacing techniques; digital hardware design using CAD tools and FPGAs; program-controlled and interrupt-driven I/O; memory organization; simple peripheral devices and controllers; bus interfaces; microcontroller-based designs. Pre- or corequisite: EECE 321.

EECE 330  Data Structures and Algorithms 3 cr.
This course covers fundamental algorithms and data structures that are used in software applications today. Particular emphasis is given to algorithms for sorting, searching, and indexing. Data structures such as linked lists, binary trees, heaps, B-Trees, and graphs will also be covered along with their associated algorithms. The course also covers basic algorithmic analysis techniques and seeks to promote student programming skills. Prerequisite: EECE 230.

EECE 340  Signals and Systems 3 cr.
The course covers basic concepts and methods related to continuous and discrete-time signals and systems. The course includes: signals and systems and their properties, linear time-invariant systems, stability analysis, sampling of continuous-time signals, z-transform, discrete Fourier transform, time and frequency domain representations of discrete-time signals and systems, and introductory concepts in communications. Prerequisite: EECE 290.

EECE 350  Computer Networks 3 cr.
A course that outlines data communications; wide area networks; circuit and packet switching; routing; congestion control; local area networks; communications architecture and protocols; internetworking. Prerequisites: EECE 330 and STAT 230.

EECE 370  Electric Machines and Power Fundamentals 3 cr.
The course covers three-phase circuits; magnetic circuits; transformers; ideal and real, construction, operation, autotransformers, and 3-phase transformers; fundamentals of AC machines: construction and basic concepts; synchronous generators: construction, equivalent circuits, testing and performance characteristics; induction motors construction, principle of operation, tests, power, and torque expressions. Prerequisite: EECE 210.
EECE 380 Engineering Electromagnetics  3 cr.
This course covers the fundamentals of electromagnetics. It deals with the study of static electric fields in vacuum and dielectrics, conductors, capacitance, electrostatic energy and forces; static magnetic fields, Blot-Savart law, Ampere's law, vector magnetic potential, inductance, Maxwell's equations for time varying fields, Faraday's law, plane wave propagation, in lossless media; transmission lines and their lumped-element model, transmission line input impedance. Prerequisites: EECE 210 and MATH 202.

EECE 401 Biomedical Engineering Seminar  1 cr.
Biweekly seminars given by members of the Faculty of Engineering and Architecture or by guest speakers. The seminars cover a range of biomedical engineering topics of theoretical and professional interest. Students are required to submit an assignment based on each seminar, which will be graded. The seminar is required of all students taking the Biomedical Engineering Minor. Prerequisite: EECE 601 or EECE 603, or MECH 633.

EECE 410L System Integrated Laboratory  1 cr.
A laboratory course that introduces students to a variety of electronic systems that will help them better realize a functional device. The laboratory covers a wide range of areas ranging from basic electronics, motor control, communication, micro-controllers, human machine interface, signal generation and measurement, and instrumentation. In addition to the mentioned topics, students are introduced to C language programming for embedded systems and techniques of circuit design and fabrication. Prerequisites: EECE 310L; pre- or corequisite: EECE 321L and EECE 311.

EECE 412 Digital Integrated Circuits  3 cr.
This course is an introduction to digital integrated circuits. Material covers CMOS devices and manufacturing technology, CMOS inverters and gates, propagation delay, noise margins, power dissipation, and regenerative logic circuits. Various design styles and architectures as well as issues designers face, such as technology scaling and the impact of interconnect, are investigated. The influence of interconnect parasitics on circuit performance are also treated. CAD Tools will be used for homework assignments, labs and projects. Prerequisites: EECE 310 and EECE 320.

EECE 412L VLSI Computer Aided Design Lab  1 cr.
This is VLSI design course that introduces students to the basics of integrated circuit (IC) designs using computer aided design (CAD) tools. The lab familiarizes students with the IC design flow using the industry-standard Cadence Design Systems tools. Custom design of basic ICs is covered at the physical layout, circuit, logic, and system levels. Lab assignments include design and simulation projects using CAD tools for physical layout design, schematic capture, place-and-route of standard cells, logic verification, circuit extraction, and simulation. Prerequisite: EECE 412.

EECE 420 Digital Systems Design II  3 cr.
This course focuses on principles and methodologies of digital logic design at the block and subsystem levels. It covers the design of relatively large and complex digital systems including arithmetic blocks, datapath subsystems, datapath controllers, programmable storage and logic devices, and memory buffers. Synchronous and asynchronous logic design principles are covered. Behavioral modeling and synthesis of combinational and sequential logic are discussed. The Verilog language is used. The course includes a design project using FPGAs. Prerequisite: EECE 320.

EECE 421 Computer Architecture  3 cr.
A course on the principles, techniques, and trade-offs used in designing modern processor core architectures. Topics include: benchmarking and performance evaluation; hardware instruction level parallelism techniques (pipelining, superscalar, out-of-order execution, branch prediction; software instruction level parallelism techniques (loop unrolling, software pipelining, predicated execution, EPIC architecture); virtual memory and high performance memory systems. Students will work on a VHDL design project of a 2-wide superscalar microprocessor core. Prerequisites: EECE 311 and EECE 340.

EECE 422 Parallel Computer Architecture and Programming  3 cr.
A course on high-performance computer architectures with emphasis on shared memory and distributed parallel architectures and programming models. Topics include: multiprocessor processors, SIMD processors, UMA, NUMA and COMA shared-memory multiprocessors, distributed multiprocessors, snappy and directory-based cache coherence protocols, memory consistency models, high performance synchronization methods, speculative lock elision, and transactional memory programming model. Students work on designing parallel programs using the OpenMP threading environment and MPI message passing programming standard. Prerequisite: EECE 321.

EECE 425 Embedded Microprocessor System Design  3 cr.
A course on embedded hardware and software design. Topics include 1) The embedded system design process: requirements, specification, system integration, testing; 2) Basic computing platform: hardware and software components, bus organization, DMA, interrupts, I/O, memory; 3) Program design and analysis: program models, compilation process, performance analysis, program level energy analysis, program testing 4) Real-time operating systems: multiple tasks and processes, context switching, task scheduling, interprocess communication; 5) System reliability. Students work on an embedded design project using Xilinx FPGA board and development tools. Prerequisite: EECE 320.

EECE 430 Software Engineering  3 cr.
A course that teaches the formal processes employed for carrying out software projects, including the analysis, design, development, testing, and deploying of practical software systems. The course requires the completion of a group-based real-life software project. Prerequisite: EECE 330.

EECE 431 Design and Analysis of Algorithms  3 cr.
This course covers techniques for the design and analysis of efficient algorithms. Topics include: sorting algorithms; median and order statistics; sorting lower bound; divide-and-conquer algorithms; dynamic programming; balanced search trees; hash tables; augmenting data structures; number-theoretic algorithms; greedy algorithms; graph algorithms; introduction to NP-completeness and intractability. Prerequisite: EECE 330.

EECE 432 Operating Systems  3 cr.
This course covers the principles of operating systems and systems programming. The topics discussed in class are processes, threads, concurrency and synchronization, scheduling, deadlocks, memory management, file systems, I/O devices, parallel and distributed systems, and security. The course will be accompanied with hands on assignments involving contemporary linux kernels. Prerequisites: EECE 321 and CMPS 272.
EECE 433  Database Systems  3 cr.
This course covers the nature and purposes of database systems and an introduction to data modeling: entity relationship model, relational model with relational algebra, relational calculus and SQL, integrity constraints, file organization and index files, and normalization. Prerequisite: EECE 330. Students cannot receive credit for both EECE 433 and CMPS 277.

EECE 434  Programming Language Design and Implementation  3 cr.
This course will provide an introduction to the design and implementation of various programming paradigms, namely object-oriented (Java, C++ and C#), functional (Haskell), and logic (Prolog). Compiler construction will be covered, including topics such as, virtual machines, intermediate languages, and concurrency. Prerequisite: EECE 330. Students cannot receive credit for both EECE 434 and CMPS 250, or for both EECE 434 and CMPS 274.

EECE 435L  Software Tools Laboratory  1 cr.
This course introduces software tools that enable engineers to become more effective and productive at writing quality code. Students are grouped into teams of two (or three) to undertake a software project. The project will reinforce object oriented programming concepts, and will involve software tools that expose students to source control, documentation, debugging, build automation, testing, profiling, configuration and deployment. Students have the choice of using Java or C++ to conduct their work. Prerequisite: EECE 330.

EECE 442  Communication Systems  3 cr.
This course introduces the students to the transmission and reception of analog signals; performance of analog communication systems in the presence of noise; analog to digital conversion and pulse coded modulation; transmission and reception of digital signals; performance of digital communication systems in the presence of noise and inter-symbol interference. Prerequisites: EECE 340 and STAT 230.

EECE 442L  Communications Laboratory  1 cr.
A laboratory course with experiments covering the following topics: AM and FM modulation/demodulation, sampling and quantization, digital modulation (PSK, FSK, MSK, GMSK), digital demodulation, and inter-symbol interference. Prerequisite: EECE 442.

EECE 451L  Internetworking Laboratory  1 cr.
This laboratory course covers the technologies and protocols of the Internet. The experiments cover IP, ARP, ICMP, UDP, TCP, DNS, routing protocols (RIP, OSPF, BGP), network address translation (NAT), dynamic host configuration (DHCP), SNMP, and IP multicast. Prerequisite: EECE 350 or EECE 450.

EECE 455  Cryptography and Networks Security  3 cr.
This course provides an overview of encryption and network security. The topics include: classical encryption techniques, block ciphers and the data encryption standard, public keys, digital signatures, authentication applications, Web security, email security, and IP security. Prerequisite: EECE 350 or EECE 450.
EECE 471L  Power Systems Laboratory  1 cr.
This lab course covers various aspects of power systems: measurement of the characteristics of a transmission line and an assessment of its voltage drop and losses; synchronization and operation of a generator connected to an infinite bus system; load characteristics of a synchronous motor and effect of field excitation; effect of voltage levels and load types on power transmission; load flow data preparation and system study; system analysis of symmetrical and unsymmetrical faults; Transient stability. **Prerequisite: EECE 471.**

EECE 473  Power Electronics  3 cr.
This lab course includes an overview of power electronics devices used and their desired characteristics: diode circuits and rectifiers, effect of source inductance, three-phase rectifiers; dc-dc switched mode converters, buck, boost, and buck-boost circuits, bridge converter; pulse-width modulated inverters, voltage control, harmonics, three-phase inverters; introduction to gate and base drive circuits, snubber circuits. **Prerequisites: EECE 210 and EECE 310, and MATH 218 or MATH 219.**

EECE 473L  Power Electronics and Drives Laboratory  1 cr.
This lab course includes experiments to study the following: induction motor torque-speed curve and starting characteristic, induction motor speed control through a 4-quadrant drive, single phase capacitor-start induction motor, ac to dc converter, dc to dc converters; buck, boost, and buck-boost regulators, dc to ac inversion, ac to ac converter. **Prerequisite: EECE 473.**

EECE 474  Electric Drives  3 cr.
A course that covers steady-state analysis of poly-phase induction motors, starting, and control; AC drives: solid-state control, dc link in adjustable speed drives, voltage and frequency controls, braking and plugging, affinity laws; dc motors, dc drives: rectifier and chopper drives, braking. Stepper motors: types, operational characteristics, control algorithms, power drive configurations. Special-purpose motors. **Prerequisite: EECE 370.**

EECE 475  Industrial Electrification  3 cr.
A course that outlines medium and low voltage installations; lighting, practical applications of electric machines, motor control centers; emergency power supplies; and auxiliary systems. **Prerequisite: EECE 370.**

EECE 476  Power System Protection and Switchgear  3 cr.
A course that covers current and voltage transformer theories, construction, and applications, electro-mechanical relay, solid state relay, and numeric relay; analogue to digital converter (ADC), digital to analogue converter (DAC), memories, protection systems for electric machines, transformers, bus bars, overhead and underground transmission lines; over-voltage protection system; and a brief introduction to data transmission. **Prerequisite: EECE 370.**

EECE 499  Undergraduate Research  3 cr.
This course requires participation, under supervision of a faculty member, in a research project. Before registering, the student must create a proposal regarding the nature of the research, the specific goals of the research, and the desired final report outcome; this proposal must be submitted to and approved by the supervising faculty member and the department before registering. **Prerequisites: Completion of 65 required credits in the major, and a cumulative average of 80.0 or above.**

EECE 500  Approved Experience  1 b.
This is an eight-week professional training course in electrical and computer engineering. **Prerequisite: EECE 410L.**

EECE 501  Final Year Project  3 cr.
A supervised project in groups of normally 3 students aimed at providing practical experience in some aspects of computer, communications and electrical engineering. Students are expected to define the project, state its objectives, complete a literature survey, set project specifications and select a design method. They are also expected to do some preliminary modeling and analysis and to acquire the necessary material needed for the completion of the project in the spring term. A professional report and an oral presentation are also required from the students. **Prerequisite: EECE 410L.**

EECE 502  Final Year Project  3 cr.
This is a continuation of EECE 501. Students are asked to deliver a product that has passed through the design, analysis, testing and evaluation stages. The course also requires the production of a professional report that includes a description of the design process, implementation and testing, verification and validation and a critical appraisal of the project. An oral presentation and a poster are also within the project deliverables. **Prerequisite: EECE 501.**

EECE 503  Special Topics in ECE  3 cr.

EECE 560/MECH 530  Mechatronics  3 cr.
A course that discusses mechatronics; data; numbering systems, architecture of the 8-bit Motorola MC68HC11 microcontroller, assembly language programming, A/D and D/A conversion; parallel I/O programmable timer operation, interfacing sensors and actuators, applications; a team project on design and implementation of a mechatronic system. **Prerequisites: EECE 312 and MECH 430 or EECE 461.**

EECE 601  Biomedical Engineering I  3 cr.
This course includes an introduction to: general instrumentation configuration, performance of instrument systems; types and characteristics of transducers; sources and characteristics of bioelectric signals; types and characteristics of electrodes; temperature regulation and measurement; cardiovascular system, measurements, and diagnostic equipment; blood instruments; patient care and monitoring; and electrical safety of medical equipment. **Prerequisites: EECE 210 and BIOL 210, or EECE 210 and BIOL 202 for students doing a minor in biomedical engineering, or consent of instructor.**

EECE 602  Biomedical Engineering II  3 cr.
This course covers respiratory system and measurements; nervous system and measurements; sensory and behavior measurements; biotelemetry; instrumentation for the clinical laboratory; x-rays and radiolotope instrumentation; magnetic resonance; and special surgical techniques. **Prerequisite: EECE 601 or consent of instructor.**

EECE 603  Biomedical Signal and Image Processing  3 cr.
Fundamentals of digital signal processing as implemented in biomedical applications. It provides a concise treatment of the tools utilized to describe deterministic and random signals as the basis of analyzing biological signals: data acquisition; imaging; denoising and filtering; feature extraction; modeling. The course is tightly coupled with a practical component through laboratory projects. Examples include the auditory system, speech generation, electrocardiogram, neuronal circuits, and medical imaging. Students should have reasonable software skills in Matlab. **Prerequisites: STAT 210 and EECE 340.**
EECE 604  Communications Engineering for Genetics and Bioinformatics 3 cr.
This course presents research topics with focus on how concepts and techniques from the field of communications engineering can be applied to problems from the fields of genetics and bioinformatics. The main topics covered include genomic data compression, mutual information for functional genomics, channel coding for gene expression modeling, genomic signal processing, and biological computation. Prerequisite: Senior standing.

EECE 605  Neuromuscular Engineering 3 cr.

EECE 612  Digital Integrated Circuits 3 cr.
A course on digital electronic circuits; models, current equations, and parasitics of CMOS transistors for digital design; study of CMOS inverter and logic gates, including analysis, design, simulation, layout, and verification; advanced circuit styles; sequential circuits; advanced topics: semiconductor memories, power grid, clocking strategies, datapath building blocks, deep-submicron design issues, interconnect. Prerequisites: EECE 310 and EECE 320.

EECE 613  Radio Frequency (RF) Circuits Design 3 cr.
The course focuses on the analysis and design of Radio Frequency circuits and components. RF design techniques using transmission lines, strip lines, microstrip and coplanar lines, the design of passive and active RF devices, including impedance transformers, amplifiers, oscillators and mixers, S-parameters and signal-flow graph analysis techniques. The course enables the student to get hands-on experience in RF circuit design through the use of computer-aided design tools Prerequisites: EECE 311, EECE 340, and EECE 380.

EECE 614  Computer-Aided Analysis and Design of VLSI Circuits and Systems 3 cr.
A course on circuit and logic simulation; timing analysis and verification; testing and fault simulation; logic and high-level synthesis; physical design automation. Prerequisite: EECE 311.

EECE 615  Computer Methods for Circuit and System Analysis 3 cr.
This course covers numerical methods and techniques for computer simulation of linear and nonlinear circuits and systems. This includes formulation methods, solution of linear equations and systems, time-domain solution, solution of large systems, and sensitivity analysis. Application areas include simulation of electronic integrated circuits, power systems, electro-mechanical systems, mechatronics, and systems. Prerequisites: EECE 210, MATH 202, and MATH 218 or MATH 219.

EECE 616  Advanced Digital Integrated Circuits 3 cr.
This course covers advanced concepts in circuit design for digital VLSI systems in state-of-the-art integrated circuits technologies. Emphasis is on circuit design and optimization techniques targeted for high-speed circuits, low-power circuits, or high-density circuits. The impact of scaling, deep submicron effects, interconnect, signal integrity, power distribution/ consumption, and timing on circuit design is investigated. Emerging challenges in low power/ low voltage design, process variations, and memory design in the nano-scale era are covered. Prerequisite: EECE 412 or EECE 612.

EECE 617  Reliability and Statistical Design 3 cr.
This course explores major aspects of statistical design methodologies with particular emphasis on electrical and computer engineering problems. It covers various topics in the domain of reliability, yield estimation, variance reduction methods for purposes of extreme statistics and rare fail event estimation, modeling and optimization. Case studies will be provided to analyze the manufacturability challenges of advanced circuits and the implications on low power design. Prerequisite: Senior Standing.

EECE 621  Advanced Computer Architecture 3 cr.
This course focuses on modern advancements in parallel computer architecture with emphasis on instruction level parallelism (ILP). Topics include: advanced branch prediction, data speculation, memory dependence prediction, trace caches, dynamic optimization, checkpoint architectures, latency-tolerant processors, simultaneous multithreading, speculative multithreading, and virtual machines. A key component of the course is a research project in which students use architecture performance simulator to investigate novel architecture techniques. Prerequisite: EECE 421.

EECE 622  VLSI for Communications and Signal Processing 3 cr.
This course introduces concepts in the design and implementation of digital signal processing systems using integrated circuits. Emphasis is on the architectural exploration, design and optimization of signal processing systems for communications. Algorithm, architecture, and circuit design techniques are introduced that enable joint optimization across the algorithmic, architectural, and circuit domains. A key component of the course is a project in which students investigate problems in the design and implementation of low-power and high-performance communication systems. Prerequisite: Senior or graduate standing.

EECE 623  Reconfigurable Computing 3 cr.
A course dealing with the design issues pertaining to the implementation of application specific computing systems using the reconfigurable computing paradigm allowing the same circuit to be reused in order to run different applications. Emphasis is on the systematic design of reconfigurable computing platforms that exploit a high degree of parallelism. Prerequisite: EECE 321.

EECE 624  Digital Systems Testing 3 cr.
This course covers an overview of digital systems testing and testable design; test economics, fault modeling, logic and fault simulation, testability measures, test generation for combinational circuits, memory test, delay test, IDDQ test, scan design, and boundary scan. Prerequisite: EECE 320.
EECE 625  Embedded Systems Design  3 cr.
A course on embedded hardware and software design. Topics include 1) The embedded system design process: requirements, specification, system integration, testing. 2) Basic computing platform: hardware and software components, bus organization, DMA, Interrupts, I/O, memory. 3) Program design and analysis: program models, compilation process, performance analysis, program level energy analysis, program testing. 4) Real-time operating systems: multiple tasks and processes, context switching, task scheduling, interprocess communication. 5) System reliability. Students work on an embedded design research project using Xilinx FPGA board and development tools. Prerequisite: EECE 320.

EECE 630  Distributed and Object Database Systems  3 cr.
Covers design techniques used for building distributed databases, and offers topics on fragmentation, replication, and allocation. The course also discusses strategies for executing distributed queries subject to performance-related criteria. Other covered topics include parallel database implementations and design of object database systems. The course includes a hands-on project for enabling students to get hands-on experience in designing distributed database systems. Prerequisite: EECE 433.

EECE 631  Advanced Topics in Algorithms  3 cr.
This is a second course on the general principles of algorithm design and analysis. The course is a continuation of EECE 431. Topics include: computability theory; complexity theory: time complexity, P versus NP, circuit complexity, and space complexity; randomized algorithms; linear programming; approximation algorithms; and selected topics. Prerequisite: EECE 431.

EECE 632  Cryptography and Computer Security  3 cr.
This course includes an overview of encryption and computer security; classical encryption techniques, block ciphers and the data encryption standard, finite fields, advanced encryption standard, confidentiality using symmetric encryption, public-key cryptography, key management, hash and MAC algorithms, digital signatures, authentication applications, email security, and Web security. Prerequisite: Senior standing.

EECE 633  Data Mining  3 cr.
This course is an introduction to data mining. Data mining refers to knowledge discovery from huge amounts of data to find non-trivial conclusions. Topics will range from statistics to machine learning to database, with a focus on analysis of large data sets. The course will target at least one new data mining problem involving real data, for which the students will have to find a solution. Prerequisite: EECE 433.

EECE 634  Introduction to Computational Arabic  3 cr.
The course discusses computational challenges specific to the Arabic language including representation, rendering, processing, structure, interface, and recognition. The course also discusses multilingual texts with Arabic, visits text processing techniques such as encoding, matching, tokenization, search, indexing, and pattern matching. The course reviews the state of the art in automating Arabic language understanding. Prerequisite: EECE 330.

EECE 636  Logic Verification and Synthesis  3 cr.
The course discusses the correctness of logic systems whether software or hardware, the basic representations of propositional logic, and first order logic. The course discusses how expressive and how realizable different logic theories are. The course covers tools that reason about the correctness of logic, and that automatically synthesizes logic into an implementation. Prerequisite: EECE 431.

EECE 637  Advanced Programming Practice  3 cr.
This is an advanced course on programming practices with a focus on verification. Teams will work in Agile and extreme programming environments, they will use formal specifications, design patterns, and aspect oriented programming. Projects will involve tools for source control, debugging, code building, documentation, dynamic and static verification. Prerequisite: EECE 330.

EECE 638  Software Testing  3 cr.
The course focuses on concepts, techniques and tools for testing software. It provides practical knowledge of a variety of ways to test software and an understanding of some of the tradeoffs between testing techniques. The topics include: software testing at the unit, module, and system level; functional and structural testing; regression testing; mutation testing; test suite minimization and prioritization; automatic test case generation. Prerequisite: Senior standing.

EECE 639  Advanced Techniques and Applications in Data Mining  3 cr.
A course that covers advanced topics in data mining and recent progress in this field. Discussions will include which techniques fit best for complex applications in data mining. Mining complex data will include general text mining, Arabic text mining, social network analysis, spatial data mining, mining of the World Wide Web, stream data, time-series data, and sequence data. We will also discuss recent application sectors and trends in data mining such as for the telecommunication, biological, and financial sectors. Prerequisites: EECE 330, and one of the following EECE 633, EECE 667, or EECE 693.

EECE 640  Wireless Communications  3 cr.
A course that covers the fundamentals of wireless communications with emphasis on wireless channel modeling; digital modulation in wireless channels; diversity techniques; channel coding and interleaving in fading channels; adaptive equalization; multistandard techniques; the cellular concept; overview of current wireless communications systems. Prerequisite: EECE 442.

EECE 640L  Wireless Communications Laboratory  1 cr.
A laboratory course that covers the following topics: basics of radio network planning and optimization, radio network planning for the GSM cellular system, radio network planning for the UMTS cellular system, GSM-UMTS co-existence and co-citing, radio network planning for the WiMAX broadband system, indoor GSM drive testing measurements and analysis, outdoor GSM drive testing measurements and analysis, UMTS drive testing measurements and analysis, and measurement-based wireless channel modeling. Prerequisite: EECE 640.

EECE 641  Information Theory  3 cr.
In this course students study "data transmission" through introducing the field of information theory. The theory is introduced in a gradual fashion and students study its applications to communications theory, computer science, statistics and probability theory. Covering all the essential topics in information theory, students are introduced to the basic quantities of entropy, relative entropy, and mutual information to show how they arise as natural answers to questions of data compression, channel capacity, rate distortion and large deviation theory. Prerequisite: STAT 230 or EECE 442.

EECE 642  Introduction to Coding Theory  3 cr.
This course introduces the theory of error-correcting codes with a focus on the asymptotic, algorithmic, and algebraic aspects. Topics include: background material from combinatorics and algebra; Shannon’s coding theorem; linear codes; coding bounds; classical algebraic codes: Hamming and Hadamard codes, Reed-Solomon codes and Justesen codes, and decoding algorithms; codes from graphs: low density parity check codes, expander codes, explicit constructions, and decoding algorithms; and an introduction to Turbo codes. Prerequisite: Senior standing.
EECE 643 RF System Engineering for Wireless Communications 3 cr.
This course introduces students to system blocks, system parameters, and architectures of RF systems for wireless communications. It focuses on the design of a radio system for transmission and reception of voice and data information: receivers and transmitters system topologies, key system blocks in a wireless system, determination of system parameters from radio requirements and system analysis, tradeoffs modulation and demodulation schemes and multiple-access techniques link budget analysis of RF radio links. Prerequisites: EECE 311, EECE 380, and EECE 442.

EECE 644 Stochastic Processes, Detection, and Estimation 3 cr.
This is a graduate-level introduction to the fundamentals of detection and estimation theory involving signal and system models in which there is some inherent randomness. The concepts that we develop are extraordinarily rich, interesting, and powerful, and form the basis for an enormous range of algorithms used in diverse applications. The material in this course constitutes a common foundation for work in the statistical signal processing, communication, and control areas. Prerequisites: STAT 230 and EECE 340.

EECE 645 Wireless Cellular Technologies 3 cr.
A course on the evolution of cellular technologies with focus on 2G GSM technology, 3G UMTS/HSPA technology, 4G LTE technology, and beyond. Topics include: cellular network fundamentals; standardization; transmitter and receiver link level designs; access and core network architectures; physical channels and signaling procedures; scheduling and radio resource management; radio network planning; multiple antenna techniques; emerging topics. Prerequisite: EECE 640.

EECE 646 Advanced Digital and Data Communications 3 cr.
A course that addresses digital communication principles and techniques aimed at achieving improved reliability. The course examines information measures such as entropy and mutual information for discrete and waveform channels, source coding, channel capacity and coding theorem, linear block and cyclic codes, hard and soft decision decoding, spread spectrum modulation. Prerequisite: Senior standing.

EECE 647 Queuing Theory 3 cr.
A course that covers Poisson counting and renewal processes; Markov chains and decision theory, branching processes, birth death processes, and semi-Markov processes; simple Markovian queues, networks of queues, general single and multiple-server queues, bounds and approximations. Prerequisite: Senior standing.

EECE 650 Client-Server Computing 3 cr.
A course that covers Internet and intranet technologies, the client-server model of interaction, design and implementation of clients and servers, interactive and concurrent servers, distributed computing, application gateways, and includes a design project. Prerequisite: EECE 350 or EECE 450.

EECE 651 Internet Engineering 3 cr.
A course that examines major protocols used in Internet engineering: IP, ICMP, TCP, UDP; new technologies introduced on the Internet, such as IP Multicast, Mobile IP, IPv6, VPNs, and quality of service; routing on the Internet; network security and firewalls design; and an overview of the application protocols such as SMTP, HTTP, RTP, and SNMP. Prerequisite: EECE 330 or EECE 450.

EECE 651L Internetworking Laboratory 1 cr.
This laboratory course covers the technologies and protocols of the Internet. The experiments cover IP, ARP, ICMP, UDP, TCP, DNS, routing protocols (RIP, OSPF, BGP), network address translation (NAT), dynamic host configuration (DHCP), SNMP, and IP multicast. Prerequisite: EECE 350 or EECE 450.

EECE 652 Web Server Design and Programming 3 cr.
This course concentrates on major technologies used in building Web servers. Alternate versions are to be given each year: the Windows-based IIS Server and the Linux-based Apache server. For IIS, ASP.NET along with C# are used for programming Web servers. For Apache, PHP is the language of choice. The course starts with a fast track on client programming, the HTTP protocol, SQL database servers, and XML programming. A weekly lab, two application projects, and a research project constitute the major requirements of the course. Prerequisite: Senior standing.

EECE 653 Multimedia and Networking 3 cr.
This course covers topics in multimedia such as system requirements, performance requirements, representation and compression. Multimedia networking is emphasized by discussing multicasting, streaming, multimedia networking protocols and quality of service-based traffic management protocols. Other topics covered include synchronization, VoIP, and Internet 2. Multimedia networking applications are designed and implemented as student projects. Prerequisite: EECE 350 or EECE 450.

EECE 654 Pervasive Computing Systems and Applications 3 cr.
This course covers design techniques used for building distributed databases, and offers topics on fragmentation, replication, and allocation. The course also discusses strategies for executing distributed queries subject to performance-related criteria. Other covered topics include parallel database implementations and design of object database systems. The course includes a hands-on project for enabling students to get hands-on experience in designing distributed database systems. Prerequisite: EECE 430.

EECE 655 Internet Security 3 cr.
The course covers topics in Internet security. The course discusses security threats, vulnerabilities of protocols and the different types of attacks. Preventive and defensive mechanisms are covered; such as: e-mail security, web security, IP security, network management security, wireless security, intrusion detection techniques, firewalls, VPNs and tracing the source of attacks. Student projects will be composed of implementation, simulation and research components. Prerequisite: EECE 350 or EECE 450.

EECE 655L Network and Computer Security Laboratory 1 cr.
A laboratory that addresses advanced network and computer security topics. Experiments include the execution of attacks, the setup of intrusion detection and prevention, securing computers and wired and wireless networks, and digital forensics. Prerequisite: EECE 350 or EECE 450.

EECE 656 Mobile Ad hoc and Sensor Networks 3 cr.
This course covers major aspects of ad hoc and sensor networking, and tackles topics related to mobility, disconnections, and battery power consumption. The course provides a detailed treatment of routing protocols in mobile wireless networks, and discusses the IEEE 802.11 Wireless LAN and Bluetooth standards. The course also includes a detailed coverage of wireless sensor networks, and a project that is meant give students hands-on experience in designing a mobile ad hoc network. Prerequisite: EECE 350 or EECE 450.
EECE 657  Wireless Security  3 cr.
A course that covers wireless network security; security challenges in wireless networks; security problems facing existing and upcoming wireless networks; security in naming, addressing, neighbor discovery, and routing; and trust and privacy. Prerequisites: EECE 350 or EECE 450 and EECE 455 or EECE 632.

EECE 660/ MECH 654  System Analysis and Design  3 cr.
A course that outlines state-space models of discrete and continuous, linear and nonlinear systems; controllability; observability; minimality; Eigenvector and transforms analysis of linear time invariant multi-input multi-output systems; pole shifting; computer control; design of controllers and observers. Prerequisite: Senior standing.

EECE 661/ MECH 641  Robotics  3 cr.
A course that examines robotic manipulators classification and work envelope; robot kinematics, dynamics and forces; joints trajectory planning for end effector desired tracking and constrained motion; control of robots using linear, non-linear, and adaptive controllers. Prerequisite: EECE 460 or MECH 435.

EECE 662/ MECH 655  Optimal Control  3 cr.
A course on optimization theory and performance measures, calculus of variations, the maximum principle, dynamic programming, numerical techniques, LQR control systems. Prerequisite: Senior standing.

EECE 663/ MECH 656  System Identification  3 cr.
This course introduces the basic mathematical tools to fit models into empirical input-output data. General time-series modeling and forecasting, such as stock prices, biological data and others. Topics include nonparametric identification methods: time and frequency response analysis; parametric identification: prediction error, least squares, linear unbiased estimation and maximum likelihood; convergence, consistency and asymptotic distribution of estimates; properties and practical modeling issues: bias distribution, experiment design and model validation. Prerequisite: Senior standing.

EECE 664  Fuzzy Sets, Logic and Applications  3 cr.
A course that outlines fuzzy sets and related concepts; logical connectives; mapping of fuzzy sets; extension principle; fuzzy relations and fuzzy set ordering; fuzzy logic inference; applications: fuzzy control, signal processing, pattern recognition, decision-making, and expert systems. Prerequisite: Senior standing.

EECE 665  Adaptive Control  3 cr.
A course that includes the control of partially known systems; analysis and design of adaptive control systems; self-tuning regulators; model reference adaptive control of uncertain dynamic systems; typical applications. Prerequisite: EECE 460.

EECE 667  Pattern Recognition  3 cr.
The course provides an overview of the algorithms used in machine learning. The course discusses modern concepts for model selection and parameter estimation, decision-making and statistical learning. Special emphasis will be given to regression and classification for supervised mode of learning. Students will be assigned typical machine learning problems to investigate as projects. Prerequisite: Senior standing.

EECE 668  Game Theory and Decision making  3 cr.
This course provides a set of tools, approaches, and perspectives on game theory to mimic the human elements of decision making that is best described by strategy and cooperation. Topics covered include: games of skills, game of chance, cooperative, mixed motive, zero sum, coalition and repeated games. Students will be assigned real-world examples of game theory to investigate as projects. Prerequisite: Senior standing.

EECE 669/ MECH 648  Nonlinear Systems: Analysis, Stability and Control  3 cr.
A course that presents a comprehensive exposition of the theory of nonlinear dynamical systems and its control with particular emphasis on techniques applicable to mechanical systems. The course will be punctuated by a rich set of mechanical system examples, ranging from violin string vibration to jet engines, from heart beats to vehicle control, and from population growth to nonlinear flight control. Prerequisite: MECH 435 or EECE 460.

EECE 670  Power System Planning  3 cr.
The course investigates electric energy and peak demand forecasts using weather sensitive, time curve, autoregressive and causal models; generation reliability evaluation, loss of energy expectation, energy limited units, probabilistic production costing, generating capacity expansion analysis, and maintenance scheduling; operational planning, unit commitment, hydrothermal coordination; power system security classification, contingency analysis, external equivalents, optimal power flow; planning in a competitive electric power environment. Prerequisite: EECE 471.

EECE 671  Environmental Aspects of Energy Systems  3 cr.
A course that examines world energy resources and classifications; sources and effects of air pollution; air quality modeling, Gaussian dispersion models for pollution estimation; motor vehicle emissions and noise pollution; environmental impacts of electricity generation, pollution control systems, electromagnetic radiation, production and impacts in high-voltage applications; environmental impact assessment; basic concepts. Prerequisite: Senior standing.

EECE 672  Energy Planning and Policy  3 cr.
This is a course that focuses on features of modern energy planning and policy. Topics covered include the interaction among the technological, economic, environmental, and sociopolitical aspects of energy supply and use; electricity, oil, and gas industries, and their market structures; elements of energy planning on the sector and national levels; energy decision-making under conditions of uncertainty, risk management in energy planning; liberalization of energy markets; case studies. Prerequisite: Senior standing.

EECE 673  Power Electronics Systems and Applications  3 cr.
A course that reviews converter topologies for AC/DC, DC/AC, and DC/DC; power supply applications; converter applications to motor drives; utility interface of distributed energy systems; static VAR systems; flexible AC transmission; high voltage DC; power quality control; active and passive harmonics compensation. Prerequisite: EECE 473 or EECE 471.
EECE 675  Renewable Energy Systems  3 cr.
A course that covers the principles of renewable energy, solar radiation, solar water heating, building and other thermal applications, photovoltaic generation, wind power, fuel cells and the hydrogen cycle, biomass, and institutional and economic factors. Prerequisite: Senior standing.

EECE 676  Computer Analysis of Power Systems  3 cr.
A course on large scale power systems, power system matrices, and programming considerations; advanced power flow studies, voltage, and reactive flow control; fault analysis, transient analysis, and power system stability. Prerequisite: EECE 471.

EECE 677  Electric Power System Stability and Control  3 cr.
A course on synchronous machine modeling and simulation, response to small disturbances, and voltage instability. Topics include Park's transformation, flux linkage, voltage, and state-space equations, subtransient and transient parameters, simplified models of the synchronous machine, treatment of saturation, system reference frame, small-signal stability, power system stabilizers, and bifurcation analysis. Prerequisite: EECE 678.

EECE 678  Advanced Power System Analysis  3 cr.
A course on optimal dispatch of generation, symmetrical components and unbalanced faults, transient stability, control of generation, state estimation in power systems and power system simulation. Prerequisite: EECE 471, or consent of instructor.

EECE 679  Energy Efficiency in the Power Sector  3 cr.
Topics covered in the course include: utility companies and energy supply, energy sustainability, cogeneration systems; combined heat and power (CHP) and combined cycle gas turbines (CCGT), reciprocating engines, distributed generation, demand side management, energy audit; types and data analysis, monitoring and targeting of energy, energy-efficient rotating machines, design and performance optimization; and case studies. Prerequisite: EECE 370 or EECE 470.

EECE 680  Antenna Theory and Design  3 cr.
This course provides the students with an understanding of the basic principles of antenna analysis and design; an overview of the fundamental characteristics and parameters of antennas; an overview of analytical and numerical methods used to analyze and design antennas with application to some basic antenna structures such as linear antennas, loop antennas, and antenna arrays. Prerequisite: EECE 380.

EECE 681  Advanced Antenna Design  3 cr.
This course provides the students with an understanding of advanced antenna structures and presents an overview of analytical and numerical methods used to analyze and design these antenna structures. The course includes broadband antennas, frequency-independent antennas, aperture antennas, horn antennas, microstrip antennas, and reflector antennas. Students will work on a research paper on a selected antenna design topic. Prerequisite: EECE 680.

EECE 682  Time-Harmonic Electromagnetic Fields  3 cr.
A course on time-varying and time-harmonic EM fields; electrical properties of matter; wave propagation and polarization; construction of solutions; reflection and transmission; electromagnetic theorems and principles in particular equivalence; rectangular waveguides and cavities; dielectric waveguide, circular waveguides, spherical waveguide; radiation from structures; scattering by wedges, cylinders and spheres; radiation from apertures, and perturbational and variational techniques. Prerequisite: EECE 380.

EECE 683  Numerical Methods in Electromagnetics  3 cr.
This course examines the principles and applications of numerical techniques for solving practical electromagnetics problems. It covers the moment methods, finite difference methods, finite element methods, and hybrid methods. The course also investigates the application of the finite-volume control method in electromagnetics. Prerequisite: EECE 682.

EECE 689  Digital Signal Processing  3 cr.
Course topics include a review of signals, systems, and transforms; design of digital filters: FIR and IIR; sampling and reconstruction of signals; multi-rate signal processing with applications; effects of finite word length; discrete random signals and spectral estimation; and an introduction to 2D signal and image processing. Prerequisite: Senior standing.

EECE 691L  Digital Signal Processing Lab  1 cr.
This graduate lab is comprised of a set of lab experiments in MATLAB, C and Assembly covering a series of real-time signal processing topics. The developed laboratory material is intended to complement the digital signal processing course (EECE 691). Upon completion of the lab, the student will have acquired the required knowledge and skills to develop real-time DSP systems. Prerequisites: EECE 691 (may be waived upon approval of course instructor), and senior standing.

EECE 692/693/694  Computer Vision  3 cr.
An introductory course on the problems and solutions of modern computer vision. Topics covered include image acquisition, sampling and quantization; image segmentation; geometric framework for vision: single view and two-views; camera calibration; stereopsis; motion and optical flow; recognition; pose estimation in perspective images. Prerequisites: MATH 202 and EECE 230.

EECE 693  Neural Networks  3 cr.
The course provides a comprehensive foundation to artificial neural networks and machine learning with applications to pattern recognition and data mining; learning processes: supervised and unsupervised, deterministic and statistical; clustering; single layer and multilayer perceptrons; least-mean-square, back propagation, and Al-Alaoui algorithms; radial-basis function networks; committee machines; principal component analysis; self-organizing maps; and current topics of interest. Prerequisite: Senior standing.

EECE 694  Digital Image Processing  3 cr.
A course on two-dimensional signals and systems; image formation and perception; representation, coding, filtering restoration, and enhancements; feature extraction and scene analysis; introduction to computer vision. Prerequisite: Senior standing.

EECE 694L  Image Processing Lab  1 cr.
The EECE 694L graduate lab comprises a set of MATLAB/C++ based lab experiments in different image processing topics covering image pre and post processing techniques, image compression, morphological transformations, image restoration and enhancement techniques, color image processing, computer vision basics, and geographical image processing. In addition, students will be exposed to software optimizations for real time image processing using SIMD instructions. Prerequisite: EECE 694, or EECE 603.
EECE 695  Adaptive Filtering  3 cr.
A course that examines the fundamentals of optimal filtering and estimation, Wiener filters, linear prediction, steepest-descent and stochastic gradient algorithms; frequency-domain adaptive filters; method of least squares, recursive least squares, fast fixed order and order-recursive (lattice) filters; misadjustment, convergence and tracking analyses, stability issues, finite precision effects; connections with Kalman filtering; and nonlinear adaptive filters. Prerequisite: Senior standing.

EECE 696  Applied Parallel Programming  3 cr.
This course is an introduction to parallel programming, and GPU computing. Topics include: GPU as a part of the PC architecture; CUDA, CUDA threads, and CUDA memory; floating point performance; Open CL; MPI; and reductions and their implementation. The course also includes application case studies, current topics, and a course project. Senior or Graduate Standing, Prerequisite: EECE 321.

EECE 697/ MECH 646  Wheeled Mobile Robotics  3 cr.
A course that provides an in-depth coverage of wheeled mobile robots. The material covers: nonholonomy and integrability of kinematic constraints. Modeling: kinematics, dynamics and state-space representation. Nonlinear control strategies (open-loop and closed –loop). Five case studies are covered all-over the course: car-like, cart-like, omni- directional wheeled, mobile wheeled pendulums and bike-like robots. Prerequisite: Senior standing.

EECE 698/ MECH 650  Autonomous Mobile Robotics  3 cr.
This course is designed to provide engineering graduate and 4th year students with the opportunity to learn about autonomous mobile robotics. Topics include sensor modeling, vehicle state estimation, map-based localization, linear and nonlinear control, and simultaneous localization and mapping. Prerequisites: EECE 230, EECE 312, and MECH 435 or EECE 230 and EECE 460.

EECE 699/ MECH 647  Hydraulic Servo Systems  3 cr.
A graduate lecture course, which teaches the fundamentals of modeling and control of hydraulic servo-systems. It provides theoretical background and practical techniques for the modeling, identification and control of hydraulic servo-systems. Classical and advanced control algorithms are discussed. The use of Matlab/Simulink and DYMOLA will be an integral part in this course. Prerequisites: MECH 314 and MECH 435 or MECH 314 and EECE 460.
The Department of Mechanical Engineering offers three undergraduate degree programs and a minor: Bachelor of Engineering, major Mechanical Engineering (BE ME); Bachelor of Engineering, major Chemical Engineering (BE ChE); Bachelor of Science, major Chemical Engineering (BS ChE); and a minor in Chemical Engineering.

Bachelor of Engineering (BE): Major Mechanical Engineering

The Mechanical Engineering Program extends over a four-year period offered exclusively on a daytime on-campus basis. The program is offered in eleven terms, eight terms are 16-week fall/spring semesters given over four years, and three terms are eight-week summer terms taken during the first three years of the program. In the summer term of the third year (Term IX), students are required to participate in a practical training program with a local, regional, or international organization. The entire program is equivalent to five academic years, but is completed in four calendar years with three summer terms.

The undergraduate program also provides the students with options to pursue minors in the following:

- Applied Energy offered by FEA
- Biomedical Engineering offered by ECE
- Chemical Engineering offered by ME
- Engineering Management offered by the EM Program

Other minors can be sought in the Faculty of Arts and Sciences and the Suliman S. Olayan School of Business.
Program Mission
The mechanical engineering faculty has agreed that the undergraduate program mission is as follows:

The undergraduate program in Mechanical Engineering seeks to empower students to pursue successful careers and to create a learning environment in which they can develop their creative and critical thinking, their ability to grow into lifelong learners in the light of ever-increasing challenges of modern technology, and their commitment to the ethical and professional responsibilities required in their calling at the global level while focusing on the needs of Lebanon and the region.

Program Educational Objectives
The program is based on the following education objectives that were approved by the mechanical engineering faculty members on May 27, 2010.

Our graduates will be able to advance successfully in their careers as reflected in continued employment, job satisfaction, leadership responsibilities, and professional recognition.

Our graduates will be able to succeed in graduate studies as reflected in admission to highly ranked programs, timely completion of degree requirements, and recognition by competitive fellowships and other awards.

Program Requirements
The undergraduate curriculum for the degree of Bachelor of Engineering (BE), Major: Mechanical Engineering is a five-year program. It consists of 173 semester credit hours of course work of which 30 credits are completed in the freshman year while the student is enrolled in the Faculty of Arts and Sciences and 143 credits are completed in four years while the student is enrolled at the Faculty of Engineering and Architecture. Students admitted at the sophomore level will be required to complete 143 credits in four years to earn the degree as outlined here:

- **General Engineering:** CIVE 210, EECE 210, EECE 230, EECE 312, EECE 312L, ENMG 400
- **Mathematics:** MATH 201, MATH 202, MATH 212, MATH 218, MATH 251, STAT 230
- **Sciences:** PHYS 211, PHYS 211L, CHEM 202, CHEM 203, and one biology elective (Biol 201 level or above, except BIOL 209)
- **General Education:** Arabic course (based on APT), ENGL 206, one English elective, two social sciences courses, three humanities courses, and a course on ethics approved for the GE program
- **ME Core Courses:** MECH 200, MECH 220, MECH 230, MECH 310, MECH 314, MECH 320, MECH 332, MECH 340, MECH 341, MECH 410, MECH 412, MECH 414, MECH 420, MECH 421, MECH 430, MECH 435, MECH 435L, MECH 510, and MECH 520
- **Technical Electives:** Five courses with at least three from the selected ME track. One elective can be from outside the major
- **Approved Experience:** MECH 500
- **Final Year Project:** MECH 501 and MECH 502

Curriculum

<table>
<thead>
<tr>
<th>Term 1 (Fall)</th>
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<tbody>
<tr>
<td>MATH 201 Calculus and Analytic Geometry III</td>
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</tr>
<tr>
<td>EECE 230 Introduction to Programming</td>
<td>3</td>
</tr>
<tr>
<td>CIVE 210 Statics</td>
<td>3</td>
</tr>
<tr>
<td>MECH 220 Engineering Graphics</td>
<td>1</td>
</tr>
<tr>
<td>ENGL 206 Technical English</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 211 Electricity and Magnetism</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 211L Electricity and Magnetism Laboratory</td>
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<tr>
<th>Term II (Spring)</th>
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<tbody>
<tr>
<td>EECE 210 Electric Circuits</td>
<td>3</td>
</tr>
<tr>
<td>MECH 200 Introduction to Mechanical Engineering</td>
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</tr>
<tr>
<td>MATH 202 Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>MECH 230 Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>English Elective</td>
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<tr>
<th>Term III (Summer)</th>
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<tr>
<td>STAT 230 Electric Circuits</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 202 Introduction to Environmental Chemistry</td>
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</tr>
<tr>
<td>CHEM 203 Introductory Chemical Techniques</td>
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<tr>
<th>Term IV (Fall)</th>
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<tr>
<td>EECE 312 Electronics</td>
<td>3</td>
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<tr>
<td>EECE 312L Circuits and Electronics Lab</td>
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<tr>
<td>MATH 212 Introductory Partial Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>MECH 310 Thermodynamics I</td>
<td>3</td>
</tr>
<tr>
<td>MECH 340 Engineering Materials</td>
<td>3</td>
</tr>
<tr>
<td>Humanities Elective</td>
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<table>
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<tr>
<th></th>
<th>Credits</th>
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</table>

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15

8

16
### Mechanical Engineering Optional Tracks

The core courses in the mechanical engineering program are offered in the following track areas:

- **Thermal and Fluid Engineering**
- **Mechatronics**
- **Design, Materials, and Manufacturing**
- **Control and Robotics**

The student may opt for any track (Thermal and Fluid – Mechatronics – Design, Materials, and Manufacturing) by taking at least three technical electives in the selected track. Normally one technical elective is allowed from outside the mechanical engineering major.

The ME Track in Control and Robotics provides a coherent academic framework between the ECE and ME departments in the area of control, instrumentation, and robotics. This track is open to all undergraduate ME and ECE students. ME students interested in taking the Control and Robotics Track must satisfy the following course requirements: MECH 432 (2 cr.), MECH 430 (3 cr.), MECH 435 (2 cr.), MECH 435L (1 cr.), one elective from list A (Control), one elective from list B (Robotics), and one elective from either list A, B, or C.
### Track I: Thermal and Fluid Engineering

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>MECH 310</td>
<td>Thermodynamics I</td>
<td>3</td>
</tr>
<tr>
<td>MECH 314/</td>
<td>Introduction to Fluids Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CHEN 311</td>
<td></td>
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<tr>
<td>MECH 414</td>
<td>Thermodynamics II</td>
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<tr>
<td>MECH 410L</td>
<td>Thermal/Fluid Systems Laboratory</td>
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<tr>
<td>MECH 412</td>
<td>Heat Transfer</td>
<td>3</td>
</tr>
<tr>
<td>MECH 501</td>
<td>Final Year Project I and</td>
<td></td>
</tr>
<tr>
<td>MECH 502</td>
<td>Final Year Project II</td>
<td>4</td>
</tr>
<tr>
<td>MECH 510</td>
<td>Design of Thermal Systems</td>
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#### Technical Electives Courses (at least three technical electives are selected)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>MECH 511</td>
<td>Intermediate Fluid Mechanics</td>
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</tr>
<tr>
<td>MECH 512</td>
<td>Internal Combustion Engines</td>
<td>3</td>
</tr>
<tr>
<td>MECH 513</td>
<td>Air Conditioning</td>
<td>3</td>
</tr>
<tr>
<td>MECH 514</td>
<td>Gas Turbines</td>
<td>3</td>
</tr>
<tr>
<td>MECH 515</td>
<td>Steam Turbines</td>
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<tr>
<td>MECH 516</td>
<td>Aerodynamics</td>
<td>3</td>
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<tr>
<td>MECH 603</td>
<td>Solar Energy</td>
<td>3</td>
</tr>
<tr>
<td>MECH 604</td>
<td>Refrigeration</td>
<td>3</td>
</tr>
<tr>
<td>MECH 606</td>
<td>Aerosol Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>MECH 607</td>
<td>Microflows Fundamentals and Applications</td>
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### Track II: Design, Materials, and Manufacturing

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<tr>
<td>CIVE 210</td>
<td>Statics</td>
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</tr>
<tr>
<td>MECH 200</td>
<td>Introduction to Mechanical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>MECH 220</td>
<td>Engineering Graphics</td>
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<tr>
<td>MECH 320</td>
<td>Mechanics of Materials</td>
<td>3</td>
</tr>
<tr>
<td>MECH 332</td>
<td>Mechanics of Machines</td>
<td>3</td>
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<tr>
<td>MECH 340</td>
<td>Engineering Materials</td>
<td>3</td>
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<tr>
<td>MECH 341L</td>
<td>Materials Lab</td>
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<tr>
<td>MECH 420</td>
<td>Mechanical Design I</td>
<td>3</td>
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<tr>
<td>MECH 421</td>
<td>Manufacturing Processes I</td>
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<td>MECH 502</td>
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<tr>
<td>MECH 520</td>
<td>Mechanical Design II</td>
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#### Technical Electives Courses (at least three technical electives are selected)

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<tr>
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<tr>
<td>MECH 521</td>
<td>Manufacturing Processes II</td>
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<tr>
<td>MECH 522</td>
<td>Mechanical CAD/CAE/CAM</td>
<td>3</td>
</tr>
<tr>
<td>MECH 540</td>
<td>Selection of Properties of Materials</td>
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<td>MECH 550</td>
<td>Computer Applications in Mechanical Engineering</td>
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<tr>
<td>MECH 622</td>
<td>Modeling of Machining Processes and Machines</td>
<td>3</td>
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<tr>
<td>MECH 624</td>
<td>Mechanics of Composite Materials</td>
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<td>MECH 625</td>
<td>Fatigue of Materials</td>
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### Track III: Mechatronics

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<tr>
<td>MECH 230</td>
<td>Dynamics</td>
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<tr>
<td>EECE 210</td>
<td>Electric Circuits</td>
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</tr>
<tr>
<td>EECE 312</td>
<td>Electronics (for mechanical engineering students)</td>
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<td>EECE 312L</td>
<td>Circuits and Electronics Lab</td>
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<tr>
<td>MECH 430</td>
<td>Instrumentation and Measurements</td>
<td>3</td>
</tr>
<tr>
<td>MECH 435</td>
<td>Control Systems</td>
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<td>MECH 435L</td>
<td>Control Systems Laboratory</td>
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<td>MECH 501</td>
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### Track IV: Control and Robotics

<table>
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<tr>
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<tr>
<td>MECH 430</td>
<td>Process Instrumentation and Measurements</td>
<td>3</td>
</tr>
<tr>
<td>MECH 432</td>
<td>Dynamic System Analysis</td>
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<tr>
<td>MECH 435</td>
<td>Control Systems</td>
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<td>MECH 435L</td>
<td>Control Systems Lab</td>
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#### Technical Elective Courses (List A Control)

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<tr>
<td>MECH648/</td>
<td>Nonlinear Systems:Analysis, Stability and Control</td>
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<td>EECE669</td>
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<tr>
<td>MECH 654/</td>
<td>System Analysis and Design</td>
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<td>EECE 660</td>
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<td>MECH 655/</td>
<td>Optimal Control</td>
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<td>EECE 662</td>
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<td>MECH 656/</td>
<td>System Identification</td>
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<td>EECE 663</td>
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#### Technical Elective Courses (List B Robotics)

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<tr>
<td>MECH 530/</td>
<td>Mechatronics</td>
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<td>EECE 530</td>
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<td>MECH 641/</td>
<td>Robotics</td>
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<td>EECE 661</td>
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<td>MECH 646/</td>
<td>Wheeled Mobile Robotics</td>
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<td>MECH 650/</td>
<td>Autonomous Mobile Robotics</td>
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</tr>
</tbody>
</table>

#### Technical Elective Courses (List C)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECH 555/</td>
<td>Artificial Intelligence for Control Systems</td>
<td>3</td>
</tr>
<tr>
<td>EECE 463</td>
<td></td>
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</tbody>
</table>
Bachelor of Engineering (BE): Major: Chemical Engineering

This is a new undergraduate program leading to the degree of Bachelor of Engineering (BE), Major: Chemical Engineering.

Program Mission

The mission of chemical engineering in FEA is to provide a stimulating and supportive environment for quality education; to prepare graduates for career opportunities in a rapidly changing world by fostering the development of professionalism, leadership qualities and ethical behavior, and to contribute to expanding the knowledge in chemical engineering and its related fields.

Program Educational Objectives

- Our graduates will be able to advance successfully in their careers as reflected in continued employment, job satisfaction, leadership responsibilities, and professional recognition; and will maintain ties with the University.
- Our graduates will be able to build upon their undergraduate-level scientific knowledge and engineering skills through graduate study in the sciences and engineering.
- Our graduates will be professionals who recognize the broader aspects of engineering practice including economic, environmental, social, political, safety, and sustainability constraints.

Bachelor of Engineering Program Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering (BE), Major: Chemical Engineering is a five-year program. It consists of 173 semester credit hours of course work of which 30 credits are completed in the freshman year while the student is enrolled in the Faculty of Arts and Sciences and 140 credits are completed in four years while the student is enrolled at the Faculty of Engineering and Architecture. Students who are admitted at the sophomore level will be required to complete 143 credits in four years to earn the degree as outlined here:

General Engineering Fundamentals (19 credits)
- CIVE 210 Statics 3 cr.
- CIVE 210 Electric Circuits 3 cr.
- EECE 230 Computers and Programming 3 cr.
- MECH 220 Engineering Graphics 1 cr.
- MECH 310 Thermodynamics I 3 cr.
- MECH 340 Engineering Materials 3 cr.
- ENMG 500 Engineering Management I 3 cr.

Mathematics (15 credits)
- MATH 201 Calculus and Analytic Geometry III 3 cr.
- MATH 202 Differential Equations 3 cr.
- STAT 230 Introduction to Probability and Random Variables 3 cr.
- MATH 218 Elementary Linear Algebra with Applications 3 cr.
- MATH 251 Numerical Computing 3 cr.

Sciences (15 credits)
- CHEM 204 Physical Chemistry for Chemical Engineers 2 cr.
- CHEM 207 Survey of Organic Chemistry and Petrochemicals 4 cr.
- CHEM 219 Analytical and Instrumental Chemistry for Chemical Engineers 3 cr.
- BIOL 210 Human Biology 3 cr.
- Science Elective 3 cr.

General Education (27 credits) beyond Freshman at 200 Level

Given the current AUB General Education Requirements, as stipulated in the undergraduate catalogue, students are required to complete twelve credits in the humanities, (one must be an ethics course) six credits in the social sciences, six credits in English, and three credits in Arabic.

Core Chemical Engineering Courses (55 credits)
- CHEN 200 Introduction to Chemical Engineering 3 cr.
- CHEN 310 Transport Phenomena Lab 2 cr.
- CHEN 311 Introduction to Fluids Engineering 3 cr.
- CHEN 312 Separation Processes 3 cr.
- CHEN 314 Chemical Engineering Thermodynamics 3 cr.
- CHEN 351 Process Instrumentation and Measurements 3 cr.
- CHEN 410 Unit Operation Lab 2 cr.
- CHEN 411 Heat and Mass Transfer Operations 3 cr.
- CHEN 417 Reaction Engineering and Reactor Design 3 cr.
- CHEN 451 Process Control 2 cr.
- CHEN 451L Process Control Lab 1 cr.
- CHEN 470 Chemical Process Design 3 cr.
- CHEN 480 Safety and Loss Prevention 3 cr.
- CHEN 500 Approved Experience 0 cr.
- CHEN 501 Final Year Project I 3 cr.
- CHEN 502 Final Year Project II 3 cr.
- CHEN 511 Transport Phenomena 3 cr.
- CHEN 515 Mechanical Unit Operations 3 cr.
- CHEN 531 Principles of Corrosion 3 cr.
- CHEN 570 Process Synthesis and Optimization 3 cr.
- CHEN 571 Chemical Product Design 3 cr.

Chemical Engineering Electives (12 credits)
- CHEN 413/CIVE 450 Water and Wastewater Treatment 3 cr.
- CHEN 490 Fundamentals of Petroleum Engineering 3 cr.
<table>
<thead>
<tr>
<th>Term III (Summer)</th>
<th>Credits</th>
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<tbody>
<tr>
<td>STAT 230</td>
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<tr>
<td>CHEM 204</td>
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<tr>
<td>CHEM 207</td>
<td>4</td>
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**Second Year (35 credits)**

<table>
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<tr>
<th>Term IV (Fall)</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Arabic Elective</td>
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<tr>
<td>Ethics Course</td>
<td>3</td>
</tr>
<tr>
<td>MATH 218</td>
<td>3</td>
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<tr>
<td>CHEN 351</td>
<td>3</td>
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<tr>
<td>CHEN 311</td>
<td>3</td>
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<tr>
<td>CHEN 314</td>
<td>3</td>
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<table>
<thead>
<tr>
<th>Term V (Spring)</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>CHEM 219</td>
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<tr>
<td>CHEN 310</td>
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<td>CHEN 312</td>
<td>3</td>
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<tr>
<td>MECH 340</td>
<td>3</td>
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<tr>
<td>MATH 251</td>
<td>3</td>
</tr>
<tr>
<td>Social Science</td>
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<td><strong>Total 17</strong></td>
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<table>
<thead>
<tr>
<th>Term VI (Summer)</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHEN 590</td>
<td>3 cr.</td>
</tr>
<tr>
<td>CHEN 541</td>
<td>3 cr.</td>
</tr>
<tr>
<td>CHEN 612</td>
<td>3 cr.</td>
</tr>
<tr>
<td>CHEN 613</td>
<td>3 cr.</td>
</tr>
<tr>
<td>CHEN 614</td>
<td>3 cr.</td>
</tr>
<tr>
<td>CHEN 617</td>
<td>3 cr.</td>
</tr>
<tr>
<td>CHEN 618</td>
<td>3 cr.</td>
</tr>
<tr>
<td>CHEN 651</td>
<td>3 cr.</td>
</tr>
<tr>
<td>CHEN 672</td>
<td>3 cr.</td>
</tr>
<tr>
<td><strong>Total 3</strong></td>
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</tbody>
</table>

**BE in Chemical Engineering: Curriculum Plan**

**Freshman year (for students admitted at freshman level)**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 101</td>
<td>Calculus I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 101</td>
<td>General Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>Social Science</td>
<td>Elective</td>
<td>3</td>
</tr>
<tr>
<td>Arabic</td>
<td>Elective</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 200</td>
<td>English elective (200 level)</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total 16</strong></td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>Credits</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 102</td>
<td>Calculus II</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 101E</td>
<td>Introductory Physics I</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 101L</td>
<td>Introductory Physics I Lab</td>
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</tr>
<tr>
<td>CHEM 102</td>
<td>General Chemistry II</td>
<td>4</td>
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<tr>
<td>Humanities</td>
<td>Elective</td>
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**First Year (40 credits)**

<table>
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<tr>
<th>Term I (Fall)</th>
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<th>Credits</th>
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<tr>
<td>MATH 201</td>
<td>Calculus and Analytic Geometry III</td>
<td>3</td>
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<tr>
<td>CIVE</td>
<td>Statics</td>
<td>3</td>
</tr>
<tr>
<td>EECE 230</td>
<td>Introduction to Programming</td>
<td>3</td>
</tr>
<tr>
<td>MECH 220</td>
<td>Engineering Graphics</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 206</td>
<td>English Technical Writing</td>
<td>3</td>
</tr>
<tr>
<td>Humanities</td>
<td>Elective</td>
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<tr>
<td><strong>Total 16</strong></td>
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</table>

<table>
<thead>
<tr>
<th>Term II (Spring)</th>
<th>Credits</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEN 200</td>
<td>Introduction to Chemical Engineering</td>
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<tr>
<td>MATH 202</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>EECE 210</td>
<td>Electric Circuits</td>
<td>3</td>
</tr>
<tr>
<td>MECH 310</td>
<td>Thermodynamics I</td>
<td>3</td>
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<tr>
<td>ENGL</td>
<td>Elective</td>
<td>3</td>
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<tr>
<td><strong>Total 15</strong></td>
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</tr>
</tbody>
</table>
Program Educational Objectives

- Our graduates will be able to advance successfully in their careers as reflected in continued employment, job satisfaction, leadership responsibilities, and professional recognition; and will maintain ties with the University.
- Our graduates will be able to build upon their undergraduate-level scientific knowledge and engineering skills through graduate study in the sciences and engineering.
- Our graduates will be professionals who recognize the broader aspects of engineering practice including economic, environmental, social, political, safety, and sustainability constraints.

Bachelor of Science Program Requirements

The undergraduate curriculum for the degree of Bachelor of Science (BS), Major: Chemical Engineering is a four-year program. It consists of 140 semester credit hours of course work of which 30 credits are completed in the freshman year while the student is enrolled in the Faculty of Arts and Sciences and 110 credits are completed in three years while the student is enrolled at the Faculty of Engineering and Architecture. Students who are admitted at the sophomore level will be required to complete 110 credits in three years to earn the degree as outlined here:

**General Engineering Fundamentals (16 credits)**
- CIVE 210 Statics 3 cr.
- EECE 210 Electric Circuits 3 cr.
- EECE 230 Introduction to Programming 3 cr.
- MECH 220 Engineering Graphics 1 cr.
- MECH 310 Thermodynamics I 3 cr.
- MECH 340 Engineering Materials 3 cr.

**Mathematics (15 credits)**
- MATH 201 Calculus and Analytic Geometry III 3 cr.
- MATH 202 Calculus and Analytic Geometry IV 3 cr.
- MATH 230 Introduction to Probability and Random Variables 3 cr.
- MATH 251 Numerical Computing 3 cr.

**Sciences (9 credits)**
- CHEM 204 Physical Chemistry for Chemical Engineers 2 cr.
- CHEM 207 Survey of Organic Chemistry and Petrochemicals 4 cr.
- CHEM 219 Analytical and Instrumental Chemistry for Chemical Engineers 3 cr.

**General Education (27 credits) beyond Freshman at 200 Level**
Given the current AUB General Education Requirements, as stipulated in the Undergraduate catalogue, students are required to complete twelve credits in the humanities (one must be an ethics course), six credits in the social sciences, and six credits in English and three credits in Arabic.

**Core Chemical Engineering Courses (37 credits)**
- CHEN 200 Introduction to Chemical Engineering 3 cr.
- CHEN 310 Transport Phenomena Lab 2 cr.
- CHEN 311 Introduction to Fluids Engineering 3 cr.
BS in Chemical Engineering: Curriculum Plan

Freshman year (for students admitted at the freshman level)

<table>
<thead>
<tr>
<th>Term</th>
<th>Credits</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td>MATH 101 Calculus I</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>CHEM 101 General Chemistry I</td>
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<tr>
<td></td>
<td>4</td>
<td>Social Science Elective</td>
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<tr>
<td></td>
<td>3</td>
<td>Arabic Elective</td>
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<tr>
<td></td>
<td>3</td>
<td>ENGL 200 English elective (200 level)</td>
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<td>16</td>
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<tr>
<td>Spring</td>
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<td>MATH 102 Calculus II</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>PHYS 101E Introductory Physics I</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>PHYS 101L Introductory Physics I Lab</td>
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<td>4</td>
<td>CHEM 102 General Chemistry II</td>
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<td>3</td>
<td>Humanities Elective</td>
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<td>First Year</td>
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<table>
<thead>
<tr>
<th>Term I (Fall)</th>
<th>Credits</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 201</td>
<td>3</td>
<td>Calculus and Analytic Geometry III</td>
</tr>
<tr>
<td>CIVE 210</td>
<td>3</td>
<td>Statics</td>
</tr>
<tr>
<td>EECE 230</td>
<td>3</td>
<td>Introduction to Programming</td>
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<td>MECH 220</td>
<td>1</td>
<td>Engineering Graphics</td>
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<td>ENGL 206</td>
<td>3</td>
<td>English Technical Writing</td>
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<tr>
<td>Term II (Spring)</td>
<td>Credits</td>
<td>Courses</td>
</tr>
<tr>
<td>CHEN 200</td>
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<td>Introduction to Chemical Engineering</td>
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<td>MATH 202</td>
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<td>Differential Equations</td>
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<tr>
<td>EECE 210</td>
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<td>Electric Circuits</td>
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<td>MECH 310</td>
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<td>Thermodynamics I</td>
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<td>ENGL</td>
<td>3</td>
<td>Elective</td>
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<tr>
<td>Term III (Summer)</td>
<td>Credits</td>
<td>Courses</td>
</tr>
<tr>
<td>STAT 230</td>
<td>3</td>
<td>Introduction to Probability and Random Variables</td>
</tr>
<tr>
<td>CHEM 204</td>
<td>2</td>
<td>Physical Chemistry for Chemical Engineers</td>
</tr>
<tr>
<td>CHEM 207</td>
<td>4</td>
<td>Survey of Organic Chemistry and Petrochemicals</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Total 9</td>
</tr>
</tbody>
</table>
Minor in Chemical Engineering

The minor in chemical engineering is open to engineering students in majors other than chemical engineering.

Minor Program Requirements (21 credits)

The student taking the minor is required to complete 21 credits from the list given below. The student has to complete 15 credits of core courses and 6 credits of elective courses.

Required Core Courses (15 credits)

- MECH 310 Thermodynamics I 3 cr.
- CHEN 311 Introduction to Fluids Engineering 3 cr.
- CHEN 312 Separation Processes 3 cr.
- CHEN 411 Heat and Mass Transfer Operations 3 cr.
- CHEN 417 Reaction Engineering and Reactor Design 3 cr.

Elective Courses (6 credits)

- CHEN 314 Chemical Engineering Thermodynamics 3 cr.
- CHEN 451 Process Control 2 cr.
- CHEN 451L Process Control Lab 1 cr.
- CHEN 470 Chemical Process Design 3 cr.
- CHEN 480 Safety and Loss Prevention 3 cr.
- CHEN 490 Fundamentals of Petroleum Engineering 3 cr.
- CHEN 515 Mechanical Unit Operations 3 cr.
- CHEN 531 Principles of Corrosion 3 cr.
- CHEN 571 Chemical Product Design 3 cr.
- CHEN 671 Process Synthesis and Optimization 3 cr.
- CHEN 672 Polymer Science 3 cr.
- CHEN 673 Engineering of Drug Delivery Systems 3 cr.

Course Descriptions

Mechanical Engineering Courses

MECH 200 Introduction to Mechanical Engineering 3 cr.
The course seeks to introduce students to the mechanical engineering discipline, build the student’s interpersonal and communication skills, and give them insight about engineering concepts and creative design principles and an overview of mechanical engineering as a profession, and ethics in engineering. Teamwork experience is stressed. Prerequisite: MECH 220.

MECH 220 Engineering Graphics 1 cr.
The course aims at preparing the future engineer to be able to understand and create technical drawings. The course seeks to develop effective utilization of computer-aided drafting (CAD) skills in order to create engineering drawings: orthogonal projection, exploded and auxiliary views, sectioning and sectional views, dimensioning and tolerance schemes, standard drawing formats, and detailing. Introduction to the use of CAD packages (AutoCAD).
MECH 230  Dynamics  3 cr.
This is a basic course in engineering mechanics covering dynamics of particles and planar rigid bodies. This course introduces Newton's law of motion, the principle of work and energy, and the principle of impulse and momentum. Diagrammatic representations of the basic laws are applied on motion of particles, systems of particles, and rigid bodies. Prerequisite: CIVE 210 and MATH 201.

MECH 310  Thermodynamics I  3 cr.
This course seeks to provide a methodology by which students view objects in the physical universe as “systems” and apply to them the basic laws of conservation of mass, energy, and the entropy balance. The course covers the thermodynamic state and properties of a pure substance, energy and mass conservation, entropy and the second law. Applications involve closed setups and flow devices. Simple vapor and gas cycles applications. Prerequisite: MECH 310.

MECH 314/ CHEN 311  Introduction to Fluids Engineering  3 cr.
An introductory course on fluid behavior emphasizing conservation of mass, momentum, energy and dimensional analysis; study of fluid motion in terms of the velocity field, fluid acceleration, the pressure field, and the viscous effects; applications of Bernoulli's equation, Navier-Stokes, and modeling; flow in ducts, potential flows, and boundary layer flows. Prerequisite: MECH 230.

MECH 320  Mechanics of Materials  3 cr.
A course that addresses the mechanical behavior of materials under different loadings such as; axial, bending, transverse shear, torsion, and combined loadings. Stress and strain transformation is discussed. Deflection of beams and buckling in columns are covered. Prerequisite: CIVE 210.

MECH 332  Mechanics of Machines  3 cr.
A course that deals with the mechanization of motion, kinematics analysis of linkage mechanisms, synthesis of cam-follower mechanisms, gear terminology and types of gears, analysis and synthesis of gear trains, force analysis, and introduction to linkage synthesis. Prerequisite: MECH 230.

MECH 340  Engineering Materials  3 cr.
The course introduces fundamental concepts in materials science as applied to engineering materials: crystalline structures; imperfections, dislocations, and strengthening mechanisms; diffusion; phase diagrams and transformations; ferrous and non-ferrous metal alloys, ceramics, and polymers; structure-property relationships; material selection case studies.

MECH 341  Materials Lab  1 cr.
The course seeks to accompany and compliment MECH 340-Engineering Materials. The laboratory sessions are designed to impart a qualitative and quantitative understanding of the mechanical properties of engineering materials. The laboratory sessions will also examine topics related to the microstructure of materials. Corequisite: MECH 340.

MECH 410L  Thermal/Fluid Systems Laboratory  1 cr.
A series of experiments on basic thermodynamic cycles, psychrometry, combustion, and elementary fluid mechanics, with special emphasis on the use of the computer as a laboratory tool for data acquisition, reduction, analysis, and report preparation. Prerequisite: MECH 310.

MECH 412  Heat Transfer  3 cr.
The course seeks to impart an understanding of the fundamental concepts and laws of conduction, convection and radiation heat transfer and their application to the solution of engineering thermal problems. The course covers steady and transient heat conduction; extended surfaces; numerical simulations of conduction in one and two-dimensional problems; external and internal forced convection of laminar and turbulent flows; natural convection; heat exchanger principles; and thermal radiation, view factors and radiation exchange between diffuse and gray surfaces. The use of Matlab is integrated into the homework assignments. Prerequisite: MECH 314.

MECH 414  Thermodynamics II  3 cr.
A course investigating the availability and work potential of systems; irreversibility; second law efficiency; availability; gas mixtures; air-conditioning; chemical reactions; high speed flow, nozzles and diffusers; environmental, economic, and social implications. Prerequisite: MECH 310.

MECH 420  Mechanical Design I  3 cr.
This is an introductory course in machine design in which one learns how to determine the structural integrity of common machine components and to apply this knowledge within the context of machine design problems. Mechanical elements such as shafts, bearings, springs, welding joints and fasteners are studied with emphasis on their behavior under both static and fatigue loading. Prerequisites: MECH 320 and MECH 340.

MECH 421  Manufacturing Processes I  2.1; 3 cr.
A course covering traditional material removal processes (machining and abrasion), CNC machining, as well as non-traditional material removal processes (EDM, ECM, thermal cutting, etc.); the science behind these technologies; assembly processes such as welding, brazing, soldering, and fastening are also covered. The course emphasizes process capabilities and limitations, relative cost, and guidelines for process selection; and design for manufacturing guidelines. This course contains hands-on exercises in a machine shop environment. Prerequisites: MECH 320 and MECH 340.

MECH 430  Process Instrumentation and Measurements  2.1; 3 cr.
A course on general concepts of measurement systems; classification of sensors and sensor types; interfacing concepts; data acquisition, manipulation, transmission, and recording; introduction to LABVIEW; applications; team project on design, and implementation of a measuring device. Prerequisites: PHYS 211 and EEEC 312.

MECH 432  Dynamic System Analysis  2 cr.
A course introducing dynamic modeling and analysis of mechanical electrical, thermal, and fluid systems. The course integrates software to test and analyze the modeled systems. Prerequisites: EEEC 210, and CIVE 210.

MECH 435  Control Systems  2 cr.
A lecture course which teaches the fundamentals about analysis of dynamic systems and design appropriate feedback control. The course includes a project and is taught in conjunction with a lab course MECH 435L. Prerequisites: EEEC 210, MECH 430 and MECH 432.

MECH 435L  Control Systems Laboratory  1 cr.
This course involves a series of hands-on experiments on modeling and design of control systems using Matlab, Simulink, and LabVIEW. The course also includes a team project. Corequisite: MECH 435.
MECH 499 Undergraduate Research 3 cr.
This course provides undergraduate students with advanced standing the opportunity to participate in faculty-supervised research. Before registering, students must submit a proposal for approval by the supervising faculty member and the department; the proposal must describe the nature of the research, specific goals, and deliverables at the end of the semester. The course may be counted once, as a technical elective. Prerequisites: Completion of 65 required credits in the major, and a cumulative average of 80 or above.

MECH 500 Approved Experience 1 b.
This is an eight-week professional training course in mechanical engineering.

MECH 501 Final Year Project I 1 cr.
The aim of this course is to provide students with practical experience in some design aspects of mechanical engineering. Students, working in groups, write a literature survey of an assigned project, critically analyze its components, and develop a bill of material necessary for the completion of the project. Prerequisites: MECH 500 and MECH 420.

MECH 502 Final Year Project II 4 cr.
A course in which the student integrates his/her acquired knowledge to deliver the product researched and planned in MECH 501. Prerequisite: MECH 501.

MECH 503 Special Topics in Mechanical Engineering 3 cr.

MECH 510 Design of Thermal Systems 2.1; 3 cr.
The course seeks to develop in students the ability to integrate rate mechanisms (i.e., heat transfer and fluid dynamics) into thermodynamic system modeling and analyses and provide design opportunities through open-ended problems with explicit considerations of engineering economics, optimization, environmental impact, ethical concerns, manufacturability and sustainability. Teamwork experience and communication skills are highly stressed. The students will gain some hands-on experience with the tools of investigation used for thermal and fluid systems and learn how to approach and solve problems typically encountered in engineering experimental work. Pre- or corequisites: MECH 410 and MECH 412.

MECH 511 Intermediate Fluid Mechanics 3 cr.
A course that deals with potential flow and boundary layer analysis; lift and drag; flow separation; the use of computational techniques to solve boundary layer problems; viscous internal channel flow and lubrication theory; one-dimensional compressible flow in nozzles and ducts; normal shock waves and channel flow with friction or heat transfer; fluid machinery including pumps and hydraulic turbines. Prerequisites: MECH 314 and MECH 412.

MECH 512 Internal Combustion Engines 2.1; 3 cr.
A course that examines the fundamentals of internal combustion engine design and operation, with emphasis on fluid/thermal processes. Topics include analysis of the respiration, combustion, and pollutant formation processes; heat transfer and friction phenomena; engine types and performance parameters; thermo-chemistry of fuel-air mixtures; the use of engine cycle models for performance predictions; and social implications of motorization. Pre- or corequisites: CHEM 202, MECH 414, and MECH 430.

MECH 513 Air Conditioning 3 cr.
A course on human thermal comfort and indoor air quality; solar radiation; heating and cooling load calculations in buildings; air conditioning systems; air and water distribution systems; computer-based calculations. Prerequisite: MECH 412.

MECH 514 Gas Turbines 3 cr.
A course that introduces the thermodynamic and aerodynamic theory forming the basis of gas turbine design: shaft power cycles; gas turbine cycles for aircraft propulsion; turbofan and turbojet engines; design and analysis of centrifugal and axial flow compressors and turbines. Prerequisites: MECH 314 and MECH 414.

MECH 515 Steam Turbines 3 cr.
A course that deals with impulse and reaction steam turbines, steam turbine cycles, flow of steam in nozzles, design aspects of turbines stage losses and efficiency, velocity diagrams; impulse and reaction blading velocities; nucleation, condensation, and two-phase phenomena in flowing steam; boiler room and its various equipment; the complete steam power plant; governors, electric generator, and power transmission lines. Pre- or corequisites: MECH 314 and MECH 414.

MECH 516 Aerodynamics 3 cr.
A course on theoretical and empirical methods for calculating the loads on airfoils and finite wings by application of classical potential theory, thin airfoil approximations, lifting line theory, and panel methods; wings and airplanes; application of linearized supersonic flow to supersonic airfoils; performance and constraint analysis; longitudinal stability and control. Pre- or corequisites: MECH 314 and MECH 414.

MECH 517 Hydraulic Turbines for Power Generation 3 cr.
This course presents the principles and development of hydraulic turbines with emphasis on the techniques for formulating and solving problems. The importance of the incoming flow direction will be stressed. The Pelton, or tangential flow, turbine will be studied in detail. The course will provide a brief introduction to cavitation. Prerequisites: MECH 310 and MECH 410.

MECH 518 Environmental Challenges in Managing Ozone Depleting Substances 3 cr.
Introduction to environmental issues related to engineering. Review of selected multilateral agreements and, in particular, review of the Montreal Protocol with emphasis on compliance strategies and discussion of the current status of ozone depleting substances (ODS); also reviews available technologies that work best now, and future and alternative technologies. Applications are related to firefighting, aerosols, solvents, foams and pesticides; management of ODS programs, good practices and safety issues. Prerequisite: MECH 310 or equivalent.

MECH 519 Compressible Flows 3 cr.
The objective of the course is to impart an understanding of the fundamental principles of steady and unsteady one-dimensional perfect-gas flow. Students learn about the behavior of homenergic and homentropic flow, develop an understanding of normal shock waves and homenergic flow in nozzles; learn how to analyze frictional homenergic flow in a constant-area duct and frictionless diabatic flow in a constant-area duct; and learn how to draw skeleton wave diagrams of wave processes. Prerequisites: MECH 310 and MECH 314.

MECH 520 Mechanical Design II 3 cr.
This is an advanced course in mechanical design. Students taking this course are expected to have a firm grasp in the fundamentals of failure theories. This course proposes the methods for designing and selecting components such as gears, belts, clutches, brakes, flywheels, and journal bearings. A design project using a finite element package is emphasized. Prerequisites: MECH 332 and MECH 420.
MECH 521 Manufacturing Processes II 2.1; 3 cr.
A course on heat treatments, deformation, phase-change, and particulate consolidation processing of metals; fabrication processing of non-metallic engineering materials such as ceramics, polymers, and composites; emphasis on process capabilities and limitations, relative cost, and guidelines for process selection; the behavior of materials under processing conditions; design for manufacturing guidelines. This course emphasizes hands-on training exercises. Prerequisite: MECH 340.

MECH 522 Mechanical CAD/CAE/CAM 3 cr.
The course gives students exposure to the realm of computer-aided design (CAD), computer-aided engineering (CAE), and computer-aided manufacturing (CAM). The course teaches the students to harness the power of these powerful tools in the solution of various problems of mechanical engineering. The course utilizes several commercially available software packages but the emphasis is placed on Pro/Engineer. Prerequisites: MECH 320, MECH 420 and MECH 432.

MECH 530/ Mechatronics System Design 2.1; 3 cr.
EECE 560
A course that discusses mechatronics; data; numbering systems, architecture of the 8-bit Motorola MC68HC11 microcontroller, assembly language programming, A/D and D/A conversion; parallel I/O programmable timer operation, interfacing sensors and actuators, applications; a team project on design and implementation of a mechatronic system. Prerequisites: EECE 312, MECH 430 or EECE 461.

MECH 531 Mechanical Vibrations 3 cr.
A course on free and forced response of non-damped and damped system; damping vibration absorption; response of discrete multi-degree of freedom systems; modal analysis; vibration measurement, case studies, vibration analysis with Matlab and Simulink. Prerequisite: MECH 230.

MECH 532 Dynamics and Applications 3 cr.
This course examines the dynamics of particles and rigid bodies moving in three dimensions. Topics include Lagrange’s equations of motion for particles, rotations of rigid bodies, Euler angles and parameters, kinematics of rigid bodies, and the Newton-Euler equations of motion for rigid bodies. The course material will be illustrated with real examples such as gyroscopes, spinning tops, vehicles, and satellites. Applications of the material range from vehicle navigation to celestial mechanics, numerical simulations, and animations. Prerequisite: MECH 230.

MECH 533 Electric Machines and Drives 3 cr.
This course covers the fundamentals of electromagnetic circuits, three-phase circuits, transformers: single-phase ideal and real transformers, construction and operation; fundamentals of AC machines, operation of synchronous generators; induction motors: construction and principle of operation, power, torque, and efficiency expressions; AC drives: starting and speed control strategies, plugging and regenerative breaking; DC motors types and control strategies, stepper motors: types, operational characteristics, drivers configurations. Prerequisites: EECE 210 and MECH 310.

MECH 535 Fluid Power Systems 3 cr.
This is a senior level undergraduate lecture course which covers the fundamentals of fluid power transmission and drive technology. Students learn about the main hydraulic and pneumatic components and their static and dynamic performance characteristics. Students learn how to read circuit diagrams and understand the principles of circuit operation. Through the use of simulation software students will learn to design and analyze complex fluid power systems. Prerequisites: MECH 314 and MECH 435.

MECH 540 Selection and Properties of Materials 3 cr.
A course that reviews the mechanical behavior of materials. Topics covered include structure-property relationships in materials; continuum mechanics and tensor notation; theorems of elastic, plastic, viscoelastic behavior of materials; elements of creep, fatigue, and fracture mechanics. Prerequisite: MECH 340.

MECH 550 Computer Applications in Mechanical Engineering 3 cr.
A course dealing with the application of numerical techniques for the solution of a variety of mechanical engineering problems involving systems of linear or non-linear algebraic equations, systems of ordinary differential equations of the initial and boundary value types, systems of ordinary differential equations, and partial differential equations of the parabolic, elliptic, and hyperbolic types. Engineering applications are introduced through a number of case study problems. Prerequisites: MATH 202 and MATH 251.

MECH 555/ Artificial Intelligence for Control Systems 3 cr.
EECE 463
This is an introductory course in the evolving field of artificial intelligence (AI) for control systems. It aims at giving students a solid foundation in AI by covering basic techniques such as A* searching, reasoning under uncertainty, probabilistic reasoning over time, multi objects tracking, path planning, scheduling, communicating, perceiving and learning as applied to control systems, robotics and manufacturing. The group project and individual lab assignments will provide students with hands on implementation experience of an intelligent control agent capable of basic learning. Prerequisite: EECE 460 or MECH 435.

MECH 600 Applied Reservoir Engineering I 3 cr.
This course introduces the concepts and principles needed to understand and analyze hydrocarbon reservoir fluid systems, and defines (with the help of geological and petrophysical principles) the size and contents of petroleum accumulations. Students will learn to organize programs for systematically collecting, recording, and analyzing data describing fundamental characteristics of individual well and reservoir performance (i.e. pressure, production, PVT data). The course covers topics on: fundamental concepts of fluid distribution, porosity distribution, trapping conditions; nature and type of primary drive mechanisms; production rates, ultimate recoveries, and reserves of reservoirs; supplementary recovery schemes to augment and improve primary recovery; economics analysis of developing and producing reservoirs and conducting supplementary recovery operations. Prerequisites: MECH 314 or CIVE 340, and CHEN 490.

MECH 602 Energy Conservation and Utilization 3 cr.
A course that deals with methods for reduction of losses and gains from a building envelope, energy conservation in cooling, heating, air-handling, and plumbing systems, energy management program. Prerequisites: MECH 310 and MECH 412.

MECH 603 Solar Energy 3 cr.
A course discussing the fundamentals of solar radiation, collectors and concentrators, energy storage, estimation and conversion formulas for solar radiation. Prerequisite: MECH 412.

MECH 604 Refrigeration 3 cr.
A course on fundamental concepts and principles, cold storage; functions and specifications of refrigeration equipment, applications. Prerequisite: MECH 412.
MECH 606  Aerosol Dynamics  3 cr.  
This course covers the physical and chemical principles that underlie the behavior of aerosols—collections of solid or liquid particles, such as clouds, smoke, and dust, suspended in gases—and the instruments used to measure them. Topics include: aerosol particle characterization; transport properties and phenomena in quiescent, laminar, and turbulent flows; gas- and particle-particle interactions; and applications to human respiratory tract deposition and atmospheric pollution. Prerequisites: MECH 314, MECH 412, and MECH 414; or approval of instructor.

MECH 607  Micro Flows Fundamentals and Applications  3 cr.  
A course on theory and applications of micro flows; the continuum hypothesis and the various flow regimes; shear and pressure driven micro flows; electrokinetically driven liquid micro flows; compressibility effects of the micro flow of gases; particulate flows in bio-applications; modeling techniques; hybrid continuum-molecular methods; reduced order modeling of micro flows in multi-physics micro flow applications; case studies in BioMEMS. Prerequisites: MECH 310, MECH 314, and MECH 412, or equivalent.

MECH 608  Applied Reservoir Engineering II  
This course introduces the advance concepts and principles needed to analyze hydrocarbon reservoir fluid systems, and defines the size and contents of petroleum accumulation. Students will learn to organize programs for collecting, recording, and analyzing data describing the advanced characteristics of individual well and reservoir performance. This course of advanced reservoir engineering topics covers a variety of topics such as: fluid flow in a porous medium; fluid distribution, fluid displacement; fractional flow equation; Bucky-Leverete equation; pressure draw-down and pressure buildup analysis; in addition to the nature and type of primary, secondary and tertiary recovery, water influx and prediction of water-flood behavior, reservoir model simulation and history matching. Prerequisite: MECH 600.

MECH 609  Experimental Methods in Fluid Dynamics  3 cr.  
This is a graduate level course to introduce students to experimental methods used to measure fluid flow quantities such as pressures, forces, and velocities. The course starts with an introduction to what and why we measure, uncertainty analysis and measurement error estimation. Some basic techniques for data reduction and data post-processing are introduced. The available fluid measurement methods are surveyed briefly, with selected applications. Emphasis is on advanced optical diagnostic techniques; namely particle image velocimetry (PIV), and laser induced fluorescence (LIF). The theoretical foundations of these techniques are established, and the discussion extended to practical considerations including software and hardware components. A few laboratory sessions are incorporated into the course to supplement the lectures and make use of the instruments available in the ME department, including the open circuit wind tunnel and the PIV system. In addition to the lectures and lab sessions, there is emphasis on the available literature. Prior knowledge of the basic principles of fluid mechanics and fluid systems is required. MATLAB is needed for course work. Prerequisite: MECH 314.

MECH 618  Enterprise Resource Planning (ERP) in Manufacturing Systems  3 cr.  
This course will cover how today's industries can cope with the challenges induced by global competition. The course will address: challenges of today's industry; consequences of these challenges on product design and on the organizations; the role of the information systems, PLM, ERP, and APS; and practice of PLM and ERP systems on the SAP Business Suite and Business by Design solution.
MECH 633  Biomechanics  3 cr.
A course on study of the biomechanical principles underlying the kinetics and kinematics of normal and abnormal human motion. Emphasis is placed on the interaction between biomechanical and physiologic factors (bone, joint, connective tissue, and muscle physiology and structure) in skeletomotor function and the application of such in testing and practice in rehabilitation. The course is designed for senior level undergraduate/graduate engineering students with no previous anatomy/physiology. Prerequisite: MECH 320 or CIVE 310, or consent of instructor.

MECH 634  Biomaterial and Medical Devices  3 cr.
A course that examines the structure-property relationships for biomaterials and the medical applications of biomaterials and devices. The first part of the course focuses on the main classes of biomaterials, metal, ceramic, polymeric, and composite implant materials, as well as their interactions with the human body (biocompatibility). The second part examines the various applications of biomaterials and devices in different tissue and organ systems such as orthopedic, cardiovascular, dermatology, and dental applications. Experts from the medical community will be invited to discuss the various applications. Prerequisite: MECH 340, or approval of instructor.

MECH 637  Micromechanics and Crystal Plasticity  3 cr.
This course covers the theoretical knowledge of the deformation process in single and polycrystalline solids with an emphasis on the role of dislocations and other types of defects on the overall mechanical properties of materials. Topics will include an introduction to crystallography, defects in crystals, fundamentals of dislocations, strengthening mechanisms, microstructures, and yielding. Prerequisites: MECH 340 and MECH 320.

MECH 641/ EECE 661  Robotics  3 cr.
A course discussing concepts and subsystems; robot architecture; mechanics of robots: kinematics and kinetics; sensors and intelligence; actuators; trajectory planning of end effector motion; motion and force control of manipulators; robot languages. Prerequisite: MECH 435 or EECE 460.

MECH 642/ EECE 692  Computer Vision  3 cr.
An introductory course on the problems and solutions of modern computer vision. Topics covered include image acquisition, sampling and quantization; image segmentation; geometric framework for vision: single view and two-views; camera calibration; stereopsis; motion and optical flow; recognition; pose estimation in perspective images. Prerequisites: MATH 202 and EECE 230.

MECH 643  Mechatronics and Intelligent Machine Engineering II  3 cr.
A course on sensors, sensor noise and sensor fusion; actuators; system models and automated computer simulation; information, perception, and cognition; planning and control; architectures, design, and development; a team project is included. Prerequisites: MECH 340 and MECH 530.

MECH 644  Modal Analysis  3 cr.
A course reviewing MDOF system vibrations, frequency response functions, damping, mobility measurement, curve fitting and modal parameter extraction, derivation of mathematical models, laboratory experiments, and projects are included. Prerequisite: MECH 531.

MECH 645  Noise and Vibration Control  3 cr.
A course on fundamental concepts in noise and vibration, passive and active damping strategies, damping materials, control methods; and applications. Prerequisites: MECH 230, MATH 212, and MECH 531.

MECH 646/ EECE 697  Wheeled Mobile Robotics  3 cr.
A course that provides an in-depth coverage of wheeled mobile robots. The material covers: nonholonomy and integrability of kinematic constraints; modeling; kinematics, dynamics and state-space representation; and nonlinear control strategies (open-loop and closed-loop). Five case studies are covered all-over the course: car-like, cart-like, omni-directional wheeled, mobile wheeled pendulums and bike-like robots. Prerequisite: Senior or graduate standing.

MECH 647/ EECE 699  Hydraulic Servo Systems  3 cr.
A graduate lecture course which covers the fundamentals of modeling and control of hydraulic servo-systems. It provides theoretical background and practical techniques for the modeling, identification and control of hydraulic servo-systems. Classical and advanced control algorithms are discussed. The use of Matlab/Simulink and DYMOLA will be an integral part in this course. Prerequisites: MECH 314 and MECH 435 or MECH 314 and EECE 460.

MECH 648/ EECE 669  Nonlinear Systems: Analysis, Stability, and Control  3 cr.
This course presents a comprehensive exposition of the theory of nonlinear dynamical systems and its control with particular emphasis on techniques applicable to mechanical systems. The course will be punctuated by a rich set of mechanical system examples, ranging from violin string vibration to jet engines, from heart beats to vehicle control, and from population growth to nonlinear flight control. Prerequisite: MECH 435 or EECE 460.

MECH 650/ EECE 698  Autonomous Mobile Robotics  3 cr.
This course is designed to provide engineering graduate and 4th year students with the opportunity to learn about autonomous mobile robotics. Topics include sensor modeling, vehicle state estimation, map-based localization, linear and nonlinear control, and simultaneous localization and mapping. Prerequisites: EECE 230, EECE 312, and MECH 435 or EECE 230 and EECE 460.

MECH 654/ EECE 660  System Analysis and Design  3 cr.
A course that outlines state-space models of discrete and continuous, linear and nonlinear systems; controllability;observability; minimality; Eigenvector and transforms analysis of linear time invariant multi-input multi-output systems; pole shifting; computer control; design of controllers and observers. Prerequisite: Senior or graduate standing, or consent of instructor.

MECH 655/ EECE 662  Optimal Control  3 cr.
A course on optimization theory and performance measures, calculus of variations, the maximum principle, dynamic programming, numerical techniques, LQR control systems. Prerequisite: Senior or graduate standing, or consent of instructor.
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tr>
<td>MECH 656</td>
<td>System Identification</td>
<td>3 cr.</td>
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<tr>
<td>EECE 663</td>
<td>A course that introduces the fundamentals of system identification as the basic mathematical tools to fit models into empirical input-output data. While rooted in control theory, applications extend to general time-series modeling and forecasting, such as stock prices, biological data and others. Topics covered include nonparametric identification methods: time and frequency response analysis; parametric identification methods: prediction error methods, least squares, linear unbiased estimation and maximum likelihood; Convergence, consistency and asymptotic distribution of estimates; properties and practical modeling issues: bias distribution, experiment design and model validation. Prerequisite: Senior or graduate standing, or consent of instructor.</td>
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<td>MECH 663</td>
<td>Computational Fluid Dynamics</td>
<td>3 cr.</td>
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<td>A course that deals with discretization process in fluid dynamics, numerical approaches and applications, iterative and direct matrix methods and numerical implementation of turbulence models. Prerequisites: MECH 314 and MECH 412.</td>
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<td>MECH 665</td>
<td>Unsteady Gas Flow</td>
<td>3 cr.</td>
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<td>A course examining equations of unsteady continuous adiabatic multidimensional flows, unsteady continuous one-dimensional flow of a perfect gas with and without discontinuities, applications and pressure exchangers. Prerequisite: MECH 414.</td>
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<td>MECH 670</td>
<td>Laboratory for Renewable Energy in Buildings</td>
<td>2 cr.</td>
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<td>A laboratory course that will investigate means of reducing building energy consumption first through green building design, giving consideration to building orientation, thermal massing, wind- and buoyancy-driven flows, &quot;urban heat island&quot; effects, and second, by retrofitting existing buildings with energy saving materials and devices such as window films, solar water heaters, and green roofs. This course is offered because in Lebanon and the region, electricity consumption for building services accounts for a major portion of national energy use and greenhouse gas emissions. Students will measure and compare effects of various designs and retrofit interventions on the thermal performance, lighting and glare, and natural ventilation of model-scale buildings, and characterize performance of devices used in green building design. Lab assignments may vary by semester but will normally include mathematical modeling and experimental measurement components organized around aspects of building physics. Prerequisite: MECH 430.</td>
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<td>A course that covers the principles and utilization of solar (thermal and photovoltaic), wind, and geothermal energy, as well as energy from biomass. Issues relevant to energy efficiency and energy storage are discussed (heat and power store and bio-tanks). The course distinguishes between energy sources for large-scale, industrial/commercial settings and those intended for smaller structures. The potential of using renewable energy technologies as a complement to and, to the extent possible, replacement for conventional technologies, and the possibility of combining renewable and non-renewable energy technologies in hybrid systems are analyzed. Design aspects of active, passive, wind, bio-energy, and photovoltaic energy conversion systems for buildings; and strategies for enhancing the future use of renewable energy resources are presented. The course will include several demonstrations of concept experiments. Prerequisite: MECH 310. Students cannot receive credit for both MECH 671 and EECE 675.</td>
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<td>MECH 672</td>
<td>Modeling Energy Systems</td>
<td>3 cr.</td>
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<td>A course that covers indoor space thermal models. The course also deals with the analysis and modeling of building energy systems involving applications of thermodynamics, economics, heat transfer, fluid flow and optimization. The use of modern computational tools to model thermal performance characteristics of components of HVAC systems including chillers, recovery systems, flow control devices, heat exchanges, solar panels, dehumidification systems, boilers, condensers, cooling towers, fans, duct systems, piping systems and pumps. The course will use modern simulation tools extensively. Prerequisite: MECH 310.</td>
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<td>MECH 673</td>
<td>Energy Efficient Buildings with Good Indoor Air Quality</td>
<td>3 cr.</td>
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<td>The course covers energy consumption standards and codes in buildings; energy conservation measures in built in environment to enhance the building's energy efficiency while maintaining space thermal comfort and indoor air quality requirement; fundamental ventilation, indoor-air-quality, infiltration natural and mechanical ventilation, importance and impact of indoor air quality on human health and energy performance of the building air conditioning system; and ASHRAE requirement for ventilation. Particular focus will be given to green energy alternative measures. An overview of the different heating, ventilation and air conditioning system designs is covered. Performance and energy consumption of the conventional air conditioning system (constant and variable air volume) as well as the hybrid integrated air conditioning systems will be discussed and compared. The course will include several demonstrations of concept experiments. Prerequisite: MECH 310.</td>
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<td>MECH 674</td>
<td>Energy Economics and Policy</td>
<td>3 cr.</td>
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<td>A course that aims at developing an understanding of practical analytical skills of energy economics and planning approaches taking into account the cost of impact on the environment. This course will cover fundamental concepts of economic issues and theories related to energy, such as economics of natural and energy resources, aggregate supply and demand analysis, and the interrelationship between energy, economics and the environment as well as some important issues in energy policy. The course will also demonstrate the use of economic tools for decision making in energy and environment planning and policy. It will explore the terminology, conventions, procedures and planning policy applications. It will also cover a number of contemporary energy and environmental policy issues, including energy security, global warming, regulations of energy industries, energy research and development, and energy technology commercialization. Prerequisite: ENGM 400. Students cannot receive credit for both MECH 674 and ECON 333.</td>
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<td>MECH 675</td>
<td>Building Energy Management Systems</td>
<td>3 cr.</td>
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<td>A course that provides an opportunity for students to explore topics in energy management systems and management strategies for new and existing buildings; energy use in buildings; energy systems analysis and methods for evaluating the energy system efficiency; energy audit programs and practices for buildings and facilities; initiating energy management programs; guidelines for methods of reducing energy usage in each area in buildings; conservation of the energy in the planning, design, installation, utilization, maintenance; control and automation of the mechanical systems in existing and new buildings; air conditioning and ventilation systems in buildings; assessment and optimization of energy control strategies; prediction methods of economic and environmental impact of implemented control strategies and indoor settings. Prerequisites: MECH 310 and MECH 412.</td>
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MECH 676  Passive Building Design  3 cr.
A course that centers on issues surrounding the integration of sustainable and passive design principles into conceptual and practical building design. Topics will include: solar geometry, climate/regional limitations, natural lighting, passive design and sustainability initiatives, insulating and energy storing material, and bioclimatic design and concepts. Case studies will be used extensively as a vehicle to discuss the success/failure of ideas and their physical applications. The course will focus on the use of energy auditing/modeling methods as means to both design and evaluate the relative “greenness” of buildings, as well as to understand the global implications of sustainable buildings. The course will include several demonstrations of concept experiments. Prerequisite: MECH 671.

MECH 677  Heat Pumps  3 cr.
A course that focuses on heat pumps in low energy and passive buildings as well as ground source heat pump fundamentals, loop systems, open systems, soil-rock classification and conductivity, grouting procedures, and performance of ground source heat pumps in housing units; water loop heat pumps, inside the building, bore holes, design and optimization of heat pump plants, including heat sources for such plants, and cost effective design options will also be considered. The course includes study visits and seminars given by industry experts. Prerequisite: MECH 671.

MECH 678  Solar Electricity  3 cr.
A course that focuses on the solar cell: photo generation of current, characteristic current-voltage (I-V) curve, equivalent circuit, effect of illumination intensity and temperature: the Photovoltaic (PV) generator: characteristic I-V curve of a PV generator; the PV module, connections of modules, support, safeguards, shadowing; the PV system: batteries, power conditioning, PV Systems: grid- connected and stand-alone systems, economics and sizing, reliability, applications; and manufacturing: preparation of crystalline silicon wafers, formation of contacts, coatings, construction of modules. The course will include several demonstrations of concept experiments. Prerequisite: EECE 210.

MECH 679  Energy Audit Lab  2 cr.
A course designed to give the students “hands-on” experience with carrying out energy audit measurements and studies on buildings to identify possible savings through selected energy conservation measures. Students will carry out measurements to investigate ventilation, air conditioning equipment, lighting and other office and lab equipment. Students will then be introduced to Visual DOE or E-Quest to perform energy simulation of buildings. Such tools will then be used to carry out a full building simulation taking into consideration occupancy data, equipment, lights, and building envelope. A base case of energy usage will thus be established and energy conservation is then applied to deduce possible savings and their economic value. Pre- or corequisite: MECH 672.

Chemical Engineering Courses

CHEN 200  Introduction to Chemical Engineering  3 cr.
This course is an introduction to the most important processes employed by the chemical industries, such as plastics, pharmaceutical, chemical, petrochemical and biochemical. Major emphasis is on formulating and solving material and energy balances for simple and complex systems. Equilibrium concepts for chemical process systems are developed and applied. Computer software is utilized extensively. The course activities include guest speakers and plant trips.

CHEN 310  Transport Phenomena Lab  2 cr.
This lab includes experimentation in thermodynamics and heat, mass, and momentum transport on a bench scale; and measurement error estimation and analysis. Prerequisites: MECH 310 and CHEN 311.

CHEN 311  Introduction to Fluids Engineering  3 cr.
An introductory course on fluid behavior emphasizing conservation of mass, momentum, energy and dimensional analysis; study of fluid motion in terms of the velocity field, fluid acceleration, the pressure field, and the viscous effects; applications of Bernoulli’s equation, Navier-Stokes, and modeling; flow in ducts, potential flows, and boundary layer flows. Prerequisite: MECH 310.

CHEN 312  Separation Processes  3 cr.
This course includes the design of industrial separation equipment using both analytical and graphical methods; equilibrium based design techniques for single and multiple stages in distillation, absorption/stripping, and liquid-liquid extraction are employed; and an introduction to gas-solid and solid-liquid systems is presented as well. Mass transfer considerations are included in efficiency calculations and design procedures for packed absorption towers, membrane separations, and adsorption. Ion exchange and chromatography are discussed. Degrees of freedom analyses are threaded throughout the course as well as the appropriate use of software. Prerequisites: MECH 310, MATH 202, and CHEN 200.

CHEN 314  Chemical Engineering Thermodynamics  3 cr.
This course covers the applications of thermodynamics to pure and mixed fluids; and to phase equilibria and chemical reaction equilibria. Prerequisites: MECH 310, MATH 202, and CHEN 200.

CHEN 351  Process Instrumentation and Measurements  3 cr.
This course covers the general concepts of measurement systems; classification of sensors and sensor types; interfacing concepts; data acquisition, manipulation, transmission, and recording; introduction to LABVIEW and applications. A team design project related to instrumentation will be included. Prerequisites: EECE 210 and MATH 202.

CHEN 400  Approved Experience  0 cr.
This is an eight-week professional training course in chemical engineering for students enrolled in the BS program.

CHEN 401  Final Year Project (for students in the BS program)  3 cr.
The Final Year Project provides collaborative design experiences with a problem of industrial or societal significance. Projects can originate with an industrial sponsor, from an engineering project on campus, or from other industrial or academic sources. In all cases, a project is a capstone experience that draws extensively from the students’ engineering and scientific background and requires independent judgments and actions. The projects generally involve a number of unit operations, a detailed economic analysis, simulation, use of industrial economic and process software packages, and experimentation and/or prototype construction.

CHEN 410  Unit Operations Lab  2 cr.
This laboratory introduces students to basic concepts, experimental techniques and calculation procedures in unit operations. Experiments include fluid dynamics, heat exchange (pilot-scale units designed to study air-solid, steam-water, water-water heat transfer), cooling towers, gas absorption, solvent extraction, ultrafiltration of hemoglobin solutions in water, chemical reactions (to study stoichiometry and kinetics of batch reactions in the liquid phase), drying of solid materials, and distillation. Some reaction kinetics experiments and flow patterns in industrial process equipment are also included. Prerequisites: CHEN 310, CHEN 312, and CHEN 411.
CHEN 411  Heat and Mass Transfer Operations  3 cr.
The course covers heat conduction, convection, and radiation; general differential equations for energy transfer; conductive and convective heat transfer; radiation heat transfer; process heat exchangers molecular, convective and interface mass transfer; the differential equation for mass transfer; steady state molecular diffusion and film theory; convective mass transfer correlations; and mass transfer equipment. Prerequisites: MECH 310 and CHEN 311.

CHEN 417  Reactor Engineering and Reactor Design  3 cr.
This course introduces the subject of chemical reaction engineering and reactor design. Classical reaction kinetics concerning rates, mechanisms, temperature effects, and multiple reactions are studied. The concepts of batch, continuous stirred-tank, and plug flow reactors are introduced for the ideal case. Non-isothermal reactors and non-isothermal flow are considered in the design of chemical reactor systems. Heterogeneous reactors and catalysis are also discussed. Prerequisites: CHEN 314, MATH 251, and CHEM 204.

CHEN 451  Process Control  2 cr.
This course covers the development of deterministic and non-deterministic models for physical systems, engineering applications, and simulation tools for case studies and projects. Prerequisites: CHEN 312, CHEN 351, and CHEN 470.

CHEN 451L  Process Control Lab  1 cr.
Laboratory experiments demonstrating the principles covered in the process dynamic and control course CHEN 451. These include temperature, temperature flow, and concentration measuring devices, and process control simulation for typical chemical plants. Corequisite CHEN 451.

CHEN 470  Chemical Process Design  3 cr.
This course is an integration of material from other chemical engineering courses with applications to the design of plants and processes representative of the chemical and related process industries: basic concepts and methodology for making rational decisions; and the implementation of real engineering projects and comparing alternatives. Prerequisites: MATH 251, CHEN 312, and CHEN 470.

CHEN 480  Safety and Loss Prevention  3 cr.
Topics covered in this class include: history of health and safety; causes and effects of loss; policy development; loss control and health basics; emergency preparedness and standards; hazard identification; safe process design; inspection and investigation processes; measurement, evaluation and audits of OH&S program elements; legislation, HAZOP and HAZAN. Prerequisite: CHEN 200.

CHEN 500  Approved Experience  0 cr.
This is an eight-week professional training course in chemical engineering for students enrolled in the BE program.

CHEN 501  Final Year Project I  3 cr.
The Final Year Project provides collaborative design experiences with a problem of industrial or societal significance. Projects can originate with an industrial sponsor or from other industrial or academic sources.

CHEN 502  Final Year Project II  3 cr.
This course will be a continuation of CHEN 501 where the student will employ his/her acquired knowledge to investigate the design of overall processes, detailed design of individual unit operations, economic analysis and to use industrial economic and process software packages, experimentation and/or prototype construction integrating safety and environmental issues to produce the final optimized design and/or product. Prerequisite: CHEN 501.

CHEN 511  Transport Phenomena  3 cr.
This course covers the applications of the principles of momentum, heat and mass transfer to steady state and transient problems; molecular concepts; transport in turbulent flow; boundary layer theory; and numerical applications. Prerequisite: CHEN 411.

CHEN 515  Mechanical Unit Operations  3 cr.
This course introduces students to the principles and practices involved in conveying, separating, and storing single and multiphase systems. It includes the flow of incompressible fluids in conduits and past immersed bodies; as well as the transportation, metering, and mixing of fluids. Unit operations involved in the contacting and physical separation of phases, such as fluidization, sedimentation and centrifugation, evaporation and membrane separation, are also studied. Prerequisites: MECH 310, CHEN 311, and CHEN 312.

CHEN 531  Principles of Corrosion  3 cr.
This course includes the application of electrochemical principles, corrosion reactions, passivation, cathodic and anodic protection, stress corrosion, and high-temperature oxidation. Prerequisites: MECH 340 and CHEN 314.

CHEN 570  Process Synthesis and Optimization  3 cr.
An introduction to the design and synthesis for the large scale production and processing of materials such as water, chemicals, petroleum products, foods, drugs and wastes. The course introduces principles of optimization: continuous, linear and non-linear, and mixed-integer linear and nonlinear problems. Applications to heat exchanger network synthesis, energy systems design, distillation and separation systems selection and optimization and design under uncertainty. Prerequisites: CHEN 411 and CHEN 470.

CHEN 571  Chemical Product Design  3 cr.
This course covers the application of the design process to products based on chemical technology. It covers the entire design process from initial identification of product needs, to the generation and selection of product ideas, and culminates in the manufacture of a new product. Prerequisites: CHEN 411 and CHEN 470.

Chemical Engineering Technical Electives

CHEN 490  Fundamentals of Petroleum Engineering  3 cr.
This course introduces the integrated view of Petroleum Engineering, and presents the nature of petroleum: chemical composition, properties of liquid petroleum and natural gas; defines the concept of exploration methods (geological and geophysical); drilling and well completion operations; reservoir fluids, rock properties, coring and core analysis; well logging, and formation damage.

CHEN 541  Biochemical and Bioprocess Engineering  3 cr.
This course will be taught in two stages. In the first stage, elementary biochemistry of living organisms, with emphasis on the biochemical pathways that bring about growth and cellular energy production, is presented, along with enzyme kinetics and microbial growth models. In the second stage, bioreactors used to bring about the biomass growth either for metabolite production or for degradation are studied. Mass balances and design equations incorporating cellular kinetics and concepts are presented for batch and continuous stirred tank reactors. Vapor phase, fixed-bed reactor designs such as biofilters are presented as applications in air pollution control. Pre- or corequisites: CHEN 312, CHEN 417 and CHEM 204.
CHEN 517 Reaction Engineering and Reactor Design II 3 cr.
This course covers reaction kinetics; heterogeneous catalytic reactions; transport processes with fluid-solid heterogeneous reactions; noncatalytic gas-solid reactions; catalyst deactivation; gas-liquid reactions. Prerequisite: CHEN 417.

CHEN 590 Petroleum Refining 3 cr.
General review of refining processes of crude oil; Shortcut methods for practical design calculations; Design of atmospheric, vacuum, and pressure columns for petroleum fractionation, including auxiliary furnaces and condensers; Recent developments in heavy oil processing. Prerequisites: CHEN 312 and CHEN 490.

CHEN 612 Desalination 3 cr.
A course that will provide an in depth coverage of the commonly used thermal and membrane based desalination technologies. Fundamental thermodynamic and transport processes which govern desalination will be developed. Environmental, sustainability and economic factors which may influence the performance, affordability and more wide-spread use of desalination systems for fresh water production and reuse will be highlighted. Renewable energy technologies coupled with desalination processes will be reviewed. A team based student project will be assigned to design a reverse osmosis membrane desalination plant (brackish water, seawater, or treated sewage effluent) using conventional or alternative energy sources. Prerequisites: MECH 310 and CHEN 411, or MECH 412.

CHEN 613 Membrane Separation Processes 3 cr.
The course will provide a general introduction to membrane science and technology: transport mechanisms, membrane preparation and boundary layer effects. The course will also cover the various types of membranes used in industry: microfiltration, ultrafiltration, reverse osmosis, electro-dialysis and pervaporation. Prerequisites: CHEN 312 and CHEN 411.

CHEN 614 Environmental Engineering Separation Processes 3 cr.
This course includes a discussion of the unit operations associated with environmental engineering separation processes of solid-liquid, liquid-liquid and gas-liquid systems; general use, principles of operation and design procedures for specific type of equipment. Prerequisite: approval of instructor.

CHEN 615 Advanced Mass Transfer 3 cr.
This course will cover a review of molecular and turbulent diffusion and mass transfer coefficients, mass transfer equipment design including absorption and cooling towers, adsorption and ion exchange. Prerequisite: CHEN 411.

CHEN 617 Chemical Reactor Analysis and Design 3 cr.
This course covers design for optimum selectivity; stability and transient behavior of the mixed flow reactor; non-ideal flow and balance models; fixed and fluidized bed reactors; and multiphase flow reactors. Prerequisite: CHEN 417.

CHEN 618 Colloid and Interface Science 3 cr.
This is a first course in colloid and interface science. The repulsive and attractive forces at interfaces are described along with the dynamics of the interfaces. Topics include the stability of macroemulsions, the formulation and properties of microemulsions, and surface metal-support interactions of catalysts. Prerequisite: CHEN 314.

CHEN 651 Advanced Process Control 3 cr.
This course covers the mathematical modeling and computer simulation of process dynamics and control. Prerequisites: CHEN 451 and CHEN 451L.
Engineering Management Program

Coordinator: Yassine, Ali
Professors: Abdul Malak, M. Asem; Salameh, Moueen; Yassine, Ali
Associate Professors: Maddah, Bacel; Nasrallah, Walid
Assistant Professors: Naoum-Sawaya, Joe; Srour, Issam
Senior Lecturers: Charif, Hassan; Ghazal, Nader; Noueiheid, Nazim; Trabulsi, Samir
Instructors: Itani, Mona; Saad, Youssef

Minor in Engineering Management

The Engineering Management Program offers a minor in engineering management that can be pursued by undergraduate engineering and architecture students, as well as by students from related majors, starting as early as the fall semester of their third year of enrollment. Only students who have a cumulative average of 70 or more are eligible to apply for the minor. To satisfy the requirements of this minor, a student must earn 18 credits of course work from the engineering management course offerings as follows:

- At least nine of the total requirement of 18 credits must be fulfilled from the six undergraduate courses offered by the program, which must include ENMG 400: Engineering Economy. These nine credits must also include either ENMG 500: Engineering Management I, or ENMG 501: Engineering Management II.

- The other nine credits can be satisfied by taking courses either from the list of undergraduate courses (offered by the program), or from the elective graduate courses offered by the program (See AUB Graduate Catalogue).

A minimum grade of 70 is required for a course to be counted toward the fulfillment of a minor in engineering management. Additionally, a cumulative average of 75 or above in all the minor courses is required.

Undergraduate Courses

ENMG 400  Engineering Economy  3 cr.
A course that covers principles, basic concepts, and methodology for making rational decisions in the design and implementation of real engineering projects; time value of money, depreciation, comparing alternatives, effect of taxes, inflation, capital financing and allocation, and decision under uncertainty. Prerequisite: STAT 230 or equivalent. Every semester.

ENMG 500  Engineering Management I  3 cr.
A course on operations research modeling concepts with emphasis on linear programming; topics include: linear programming, network programming, and project management. Annually.

ENMG 501  Engineering Management II  3 cr.
A course outlining basic management models used to optimize systems; discrete- and continuous-time Markov chains and their application in modeling queues, inventories, and production process behavior. Prerequisite: STAT 230 or equivalent. Annually.

ENMG 502  Construction Management  3 cr.
A course on organizing for construction projects; pre-construction activities; bidding and contracts; fundamentals of construction planning, monitoring, and control; application of construction control tools: CPM, materials management, operations analysis, and quality control. Annually.

ENMG 503  Specifications and Cost Estimation  3 cr.
A course on the structure of construction documents and their interrelationships; bidding requirements; general and particular contract conditions; administrative and procedural requirements for construction; technical specifications; construction cost estimation process; and unit rates determination. Prerequisite: ENMG 502 or CIVE 580. Annually.

ENMG 504  Engineering Ethics  3 cr.
A course on engineering ethics covering responsibility in engineering; framing the moral problem; organizing principles of ethical theories; computers, individual morality, and social policy; honesty, integrity, and reliability; safety, risk, and liability in engineering; engineers as employees; engineers and the environment; international engineering professionalism; and future challenges. Every regular semester.

ENMG 505  Entrepreneurship for Engineers  3 cr.
This course provides students with the tools necessary to create and grow a successful, innovative technology enterprise. Topics include evaluating market opportunities, designing profitable business models, producing a solid business plan, raising capital, addressing legal considerations and developing a winning team. Prerequisite: ENMG 400 or equivalent course.