Maroun Semaan Faculty of Engineering and Architecture (MSFEA)

Undergraduate

Officers of the Faculty

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Zaher Dawy	Provost
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Mahmoud Al-Hindi	Associate Dean
Daniel Asmar	Associate Dean
Riad Chedid	Associate Dean
Imad El Hajj	Associate Dean
Howayda Al-Harithy	Director of the School of Architecture and Design
Bradley Jon Tucker	Vice-Provost and Registrar
Antoine Sabbagh	Director of Admissions
Lokman Meho	University Librarian

Faculty Administrative Support

Alia Kazma Serhal	Student Services Manager
Olga Safa	Financial and Administrative Manager
Sara Jibbaoui	Financial Officer
Nagham Kanj	Student Services Officer
Aya Wehbe	Contracts 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 towards the new curricula, which were 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, conform to sound developments in engineering and architecture education, and 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 leading to a bachelor of graphic design. In 2006, the name of the degree was changed to bachelor of fine arts in graphic design, and the name of the bachelor of engineering in electrical engineering degree was changed to bachelor of engineering in electrical and computer engineering. In 2009, two bachelor of science programs were introduced, the first in construction engineering, housed in the Department of Civil and Environmental Engineering, and the second in chemical engineering, housed in the Department of Mechanical Engineering. A bachelor of engineering program in chemical engineering was simultaneously launched in 2009 with the bachelor of science program. In 2014, a bachelor of engineering program in industrial engineering was introduced. The chemical engineering programs are now housed in the Department of Chemical and Petroleum Engineering, while the industrial engineering program is housed in the Department of Industrial Engineering and Management. The faculty was renamed Maroun Semaan Faculty of Engineering and Architecture in 2017.

In 2019, a bachelor of engineering program in computer science and engineering was started in the Department of Electrical and Computer Engineering.

The program of landscape architecture previously at FAFS, was transferred to MSFEA starting July 2024.

Accreditation

The bachelor of engineering programs in chemical engineering, civil engineering, computer and communications engineering, electrical and computer engineering, industrial engineering, and mechanical engineering, and the bachelor of science program in chemical engineering are accredited by the Engineering Accreditation Commission of ABET.
The bachelor of landscape architecture (BLA) is accredited by the Landscape Architectural Accreditation Board (LAAB), the academic arm of the American Society of Landscape Architects (ASLA).

Mission

We offer world-class educational programs that prepare students for the engineering, architecture, and design professions. Rooted in the liberal education model, our programs also prepare students to be engaged citizens and leaders, entrepreneurs and researchers who deploy their skills with ingenuity, integrity, and a sense of responsibility towards future generations. Our faculty produces transformative knowledge and technology through internationally-recognized research and design, and seeks to leverage the special contexts of Lebanon and the region to define highly novel and relevant research programs. We impact policy and practice through our alumni and by directly engaging industry, government, and the public at large.

Vision

A viable, livable, and equitable world.

Undergraduate Programs

The Maroun Semaan Faculty of Engineering and Architecture offers programs of study leading to the degrees of bachelor of architecture (BArch), bachelor of fine arts (BFA) in graphic design, bachelor of landscape architecture (BLA), bachelor of engineering (BE), with majors in chemical engineering, civil engineering, computer and communications engineering, computer science and engineering, electrical and computer engineering, industrial engineering, and mechanical engineering; and bachelor of science (BS) with majors in chemical engineering and construction engineering. The curriculum of the BArch degree extends over 14 terms (ten 16-week terms 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 BLA degree and of the BE degree and that of the BFA degree are divided into 11 terms (eight 16-week terms and three eight-week summer terms), totaling 152 weeks. This duration is equivalent to five academic years without summers, but the programs are completed in four calendar years. The curriculum of the BS degree extends over eight or nine terms (six 16-week terms and two or three eight-week summer terms).

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

Admissions

Admission to First Year

Admission is by selection of a limited number of the most promising, eligible applicants. All candidates for admission to the Maroun Semaan 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 Maroun Semaan Faculty of Engineering and Architecture, are listed in the the Office of Admissions section of this catalogue. Holders of the technical baccalaureate (BT) are only eligible for admission to the same major as that of their BT.

Transfers

Students attending recognized institutions of higher learning, including AUB, may apply for transfer to any of the undergraduate majors in the MSFEA, depending on availability of places and subject to the following conditions. Students admitted to the architecture or graphic design programs can start in the fall term only. Applicants must have:

- completed the equivalent of the sophomore class at the college or university from which they are transferring.
- attained a minimum cumulative GPA of 3.0 (2.3 for the landscape architecture program).
- 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. This requirement does not apply to applicants to the architecture and graphic design programs. Applicants to the landscape architecture program should have taken any combination of science courses totaling 9 credits (an elective in each of geology, chemistry, and biology), completion of MATH 101 or MATH 203 with a minimum grade of 70 (C+ or GPA 2.3).
- Transfer students must have obtained a minimum grade of B to transfer a technical, math or science course or a minimum grade of C+ to transfer other types of courses.
- have satisfied the university English requirements for admission.

Applications of transfer students are evaluated and approved by the departments and the Undergraduate Admissions Committee of the faculty. The term in which the students are placed and the complete program of study in the major in which they are admitted, are determined by the department concerned.

Class Status

The class status of students is as follows:

Students' status is changed to that of a higher year if their cumulative number of failed, withdrawn, or unregistered credits from the regular credit hour requirements does not exceed seven.

First Year	Terms I and II
Second Year	Terms III, IV and V
Third Year	Terms VI, VII and VIII
Fourth Year	Terms IX, X and XI
Fifth Year (Architecture)	Terms XII, XIII and XIV

Residency Requirements

Students of the Maroun Semaan Faculty of Engineering and Architecture must meet the following minimum residency requirements:

Engineering, Graphic Design, or Landscape Architecture Majors: Students must register in residence at the Maroun Semaan Faculty of Engineering and Architecture for the last four regular terms and should complete at least 50 credits during this period.

Architecture Major: Students must register in residence at the Maroun Semaan Faculty of Engineering and Architecture for the last five regular terms and should complete at least 65 credits during this period.

Courses

Required course

FEAA 200 Introduction to Engineering and Architecture 3 cr.
The course is designed to familiarize first year students with the different disciplines in engineering and architecture, including: architecture, civil, mechanical, electrical, chemical, industrial and technologies used in the fields. The course takes a unique interdisciplinary approach to the field and introduces the related disciplines in the world of engineering and architecture. One key objective is to promote interdisciplinary interaction and innovative thinking. The course is organized into modules covering the different disciplines within the Maroun Semaan Faculty of Engineering and Architecture (MSFEA). The last module of the class showcases interdisciplinary projects demonstrating interactions among the different fields. The lectures explain as applicable to each discipline, through examples, notions of problem solving, design thinking, process of invention and innovation, environmental and civic responsibility, and measures of success in aesthetics and performance. The course project is a key component of the course. It is interdisciplinary in nature bringing ideas and solutions from all disciplines in engineering and architecture. Annually.

Elective courses

FEAA 500 (0 cr./3 b.) / 500A (3 cr. /0 b.) Cooperative Education and Experiential Learning
This course places students in a recognized firm in Lebanon or abroad for a supervised immersive learning experience in which they work as junior-level professionals in their fields of study. For a minimum of six months, students work full-time in a paid position where they apply their knowledge to challenging problems related to their field of study. This course extends over two terms and is registered twice as FEAA 500 and FEAA 500A in order to cover the six-months period. FEAA 500: 0 credit- 3 billing - grade (PR) – prerequisites: approval of the course coordinator and completion of a minimum of 90 credits for engineering students (120 credits for architecture students). FEAA 500A: 3 credits – 0 billing – prerequisite: FEAA 500.

FEAA 501 Final-Year Project Accelerator I 0 cr.
This sequence of two courses provides selected Final-Year Project (FYP) students with the knowledge, tools, and mentorship needed to transform their technical FYP into a viable business by the time they graduate. Topics include design thinking, business planning, business modeling, team formation, marketing, finance, legal aspects, and pitching. Annually in fall term. Corequisite: final-year project in student home department.

FEAA 502 Final-Year Project Accelerator II 0 cr.
This sequence of two courses provides selected Final-Year Project (FYP) students with the knowledge, tools, and mentorship needed to transform their technical FYP into a viable business by the time they graduate. Topics include design thinking, business planning, business modeling, team formation, marketing, finance, legal aspects, and pitching. Annually in spring term. Prerequisite: FEAA 501.

FEAA 510 Design for Circularity 3 cr.
Circular design is a design approach that contributes to Circular Economy (CE) through regenerative systems that maintain the quality of life while creating social, economic, and ecological value. This project-based studio course builds a systemic understanding of the needed shift in design perspective to transform the current linear model to a circular one. It provides students with the mindset, tools, and knowledge to assess the circularity of products and processes, design circular processes, and design products to be easily reused, repaired, remanufactured, or recycled. It also introduces the importance of the use of digital technologies to enable and accelerate the transition to CE. 3 credits, Prerequisite: instructor's approval.

FEAA 520 Data Centric Design 3 cr.
This course introduces students to the various types of data, the basics of sensing, data acquisition, database design, and data analytics. FEAA 520 combines theoretical topics in machine learning with practical methods for solving problems, using Python or other programming languages. The students are exposed to supervised and unsupervised machine learning algorithms (e.g., clustering, linear regression, and classification), as well as basic deep learning architectures. The topics are demonstrated with examples from all engineering disciplines and several hands-on laboratory sessions. Prerequisites: EECE 230/231, MATH 201, and STAT 230 (MATH 218/219 is preferred but not mandatory).

VIPP 201 Vertical Integrated Project 1 cr.
for first-year students.

VIPP 202 Vertical Integrated Project 2 cr.
for second-year students.

VIPP 301 Vertical Integrated Project 1 or 2 or 3 cr.
for third-year students.

VIPP 401 Undergraduate Research for VIPP students 3 cr.
In this course, undergraduate senior or junior students engage in applied research with faculty and graduate students on multi-disciplinary, team-based research projects. Students work with faculty and industry mentors on real-world large-scale projects with students from different majors. Participants develop research experience and team skills while integrating knowledge from previous courses and refining their professional skills (teamwork, project planning, and communications).

Minors

Description of all minors at MSFEA is situated in its specific department. However, there are two minors offered that do not fall under a specific department listed below.

Minor in Humanitarian Engineering and Public Health Innovations

The minor in humanitarian engineering and public health Innovations is offered jointly by the Faculty of Health Sciences and the Maroun Semaan Faculty of Engineering and Architecture.

The minor is open to undergraduate students from all majors. It is a multidisciplinary offering that provides undergraduate students with the knowledge of the humanitarian engineering field, and equips them with the skills required to find innovative design solutions for challenges faced by disadvantaged populations taking into consideration two complementary perspectives; public health perspective and engineering perspective.

Students who complete the minor will be able to:

1. apply participatory needs assessment tools and analyze the different dimensions of a public health problem.
2. apply formal design methods to develop practical, feasible, scalable, and sustainable humanitarian engineering and public health innovations and interventions.
3. apply skills required to manage complex projects while working in multidisciplinary teams.
4. demonstrate entrepreneurial skills to take a solution/intervention from prototype to product.
5. articulate and adhere to ethical standards in the process followed and in the intervention designed.
6. present and document a problem and its solution to a diverse target audience.

The minor in humanitarian engineering and public health innovations consists of 15 credits, according to the following requirements:

- HEHI 201, “Foundations of Humanitarian Engineering and Public Health Innovations”
- HEHI 202 A/B, “Humanitarian Engineering and Public Health Innovations Capstone”
- One design course from the following list: AGSC 330, ARCH 061, ARCH 064, ARCH 072, ARCH 344, BMEN 501, CHEN 351, CHEN 471/571, CHEN 619, CHEN 798A, CIVE 552, CIVE 601, CIVE 628, CIVE 691, EECE 461, EECE 560, EECE 675, ENMG 663, ENMG 698E, ENSC 633, ENST 300, FSEC 310, FSEC 315, HPCH 204, HPCH 212, INFO 205, LDEM 254, LDEM 298, LDEM 633, MECH 430, MECH 530, MKTG 234, NFSC 306, NURS, 408 PBHL 303, URDS 664, URPL 641.
- One ethics course from the following list: BUSS 215, INDE 410, MCOM 215, MHRM 304, PHIL 205, PHIL 209, PSYC 305.
- One social entrepreneurship course from the following list: AGBU 229, ARCH 068, ENMG 654, ENTM 220, INDE 412.

Students interested to enroll in the minor are encouraged to inform the coordinators of the program at healthengineering@aub.edu.lb to benefit from adequate advising on study plans and ensure completion of all requirements.

HEHI 201 Foundations of Humanitarian Engineering and Public Health Innovations 3 cr.
This is a multidisciplinary course that covers fundamentals of designing solutions for health challenges faced by disadvantaged populations. It introduces tools for identifying humanitarian and/or development needs and designing practical, scalable, and sustainable solutions and interventions. The course is offered to students from all majors. Students will be exposed to health and health system challenges in addition to design fundamentals including participatory needs assessment, formal multidisciplinary design processes, and relevant technologies and tools with real world applications and case studies. Open to students in advanced standing (second and third year for three years program and third and fourth year for four years program).

HEHI 202A/B Humanitarian Engineering and Public Health Innovations Capstone 3 cr.

The capstone project course is an interdisciplinary service-learning design course focused on development and humanitarian engineering solutions for health challenges. In the capstone, students apply all tools learned in HEHI 201. Students work in multidisciplinary teams with disadvantaged communities, under joint supervision of at least two mentors from MSFEA, FHS, and other faculties. The capstone is divided into two sub-courses, HEHI 202A (1cr.) and HEHI 202B (2cr.), and must be registered in two consecutive terms. HEHI 202A has as a prerequisite: HEHI 201. HEHI 202B has as a prerequisite: HEHI 202A.

Upon prior approval of the students' adviser and the coordinators of the humanitarian engineering initiative, students who are required, as part of their degree requirement, to complete a capstone or final year project, can count that experience towards fulfilling the capstone requirement for the minor.
To graduate with the minor, students must attain a minor GPA of 2.3 or more to satisfy its requirements.

Certificate Option

Students can opt for a certificate in humanitarian engineering and public health innovations.
The "Humanitarian Engineering and Public Health Innovations" certificate requirements are:

- HEHI 201, "Foundations of Humanitarian Engineering and Public Health Innovations"
- HEHI 202 A/B, "Humanitarian Engineering and Public Health Innovations Capstone"
- An internship approved by the humanitarian engineering initiative of at least 8 weeks full-time

Students should declare the certificate before completing the requirements.

Upon prior approval of the students' adviser and the coordinators of the humanitarian engineering Initiative, students who are required, as part of their degree requirement, to complete an internship or practicum, can also count that experience towards fulfilling the internship requirement for the certificate.

Minor in Biomedical Engineering Design (18 Credits)

Coordinator	Mhanna, Rami (Biomedical Engineering, MSFEA)
Co-coordinator	Rahal, Elias (Experimental Pathology, Immunology, and Microbiology, FM)
Coordinating Committee Members	Amatoury, Jason (Biomedical Engineering, MSFEA) Daou, Arij (Biomedical Engineering, MSFEA) Darwiche, Nadine (Biochemistry & Molecular Genetics, FM) El Hajj, Albert (Surgery, FM) Khraiche, Massoud (Biomedical Engineering, MSFEA) Refaat, Marwan (Internal Medicine, FM) Saad, Walid (Chemical Engineering, MSFEA) Zouein, Fouad (Pharmacology and Toxicology, FM)

The Biomedical Engineering (BMEN) program at the American University of Beirut is offering an interdisciplinary minor in the Maroun Semaan Faculty of Engineering and Architecture (MSFEA) aimed at preparing students for design and innovation in the field of bioengineering. The minor will educate students on the process of designing engineering solutions with focus on biomedical and healthcare applications. This is achieved through a set of courses that include two new courses, BMEN 501 and BMEN 502. In BMEN 501 “Bioengineering Design Fundamentals,” students will be exposed to the key steps of engineering design from needs assessment and problem identification to prototyping and validation including concepts, methodologies, and tools with focus on biomedical and healthcare use cases. BMEN 501 is a regular course and includes weekly lectures by the instructor and invited guests, assignments, a course project, and several quizzes. In BMEN 502 “Bioengineering Design Capstone”, students will apply the engineering process to an interdisciplinary biomedical project with joint mentoring from MSFEA and FM faculty members. The minor also includes additional courses aimed at covering basic background in biology/ physiology, a broad overview of the various subfields of biomedical engineering, and advanced topics.

The minor in biomedical engineering design is open to AUB students from all majors who have completed their first academic year (non-engineering students) or their first two academic years (engineering students) and who have a cumulative GPA of 2.3 or more. The minor will be indicated on the transcript of the students who complete all the requirements described below. To graduate with a minor, students must attain a minor GPA of 2.3 or more to satisfy its requirement.

The minor requirements are divided into a set of core courses and a set of elective courses with a total of 18 credits, as follows:

- BIOL 210 [3 cr.] (can be replaced by BIOL 202 or PHYL 246)
- BMEN 501 [3 cr.]
- BMEN 502 [3 cr.]
- BMEN 600 [3 cr.]
- One biomedical engineering advanced topics course from List A below [3 cr.]
- One elective course from either List A or List B below [3 cr.]

Elective Courses

- List A: BMEN 603/CHEN 675/MECH 798J, BMEN 606, BMEN 609, BMEN 610, BMEN 611/MECH 611.
- List B: INDE 412, BMEN 601/MECH 635, , BMEN 604/CHEN 673, BMEN 605, BMEN 606, BMEN 607/ MECH 633, BMEN 608/MECH 634, BMEN 610, EECE 488/688, EECE 490/690, EECE 601, EECE 602, , MECH 340, MECH 607, MECH 631, MECH 705, BIOC 321 and BIOC 322 and 1 credit biomedical course (e.g., HUMR 310A lab), BIOC 326A and BIOC 326B and 1 credit biomedical course (e.g., HUMR 310A lab), BIOL 251, BIOL 310, EPHD 310.

Minor Topics

- Biosensors and Bioelectronics:
  - Classes: BMEN 606, EECE 688/488.
- Biomaterials:
  - Classes: BMEN 603/CHEN 675/ MECH 798J MECH 340 or BMEN 608/MECH 634.
- Neural Engineering/Neuroscience:
  - Classes: BMEN 609, BMEN 610.
- Data Science and Biosensor Technologies:
  - Classes: BMEN 606 or EECE 688/488, EECE 490/690.
- Biomechanics:
  - BMEN 607/MECH 633, BMEN 611/ MECH 611
- No Topic:
  - Must take 2 classes one from list A and one from list B.

BMEN 501 Bioengineering Design Fundamentals 3 cr.
The course aims to educate and train students in the process of utilizing engineering design concepts, methodologies, and tools for developing medical technologies. The course will teach the design process focused on development of engineering solutions in healthcare. This will include problem definition, identifying needs, setting specifications, and translating them to prototypes, testing and design refinements. The material will be taught partly through active discussions, in class, of design topics, case studies, and design exercises. Also, in the final part of the course the students will be challenged to identify a problem and use the design process to develop the needs and specifications. In addition, students will learn about intellectual property, research ethics, and various regulations for biomedical technology and human safety considerations.

BMEN 502 Bioengineering Design Capstone 3 cr.
The course provides practical training in engineering design as students are placed within design groups to work through a real-life iteration of the engineering design process they learned in BMEN501 for an idea either of their own or provided by faculty members. Interdisciplinary teams will typically be paired up with two faculty mentors, one from MSFEA and one from FM. Students will be challenged to innovate and improve clinical, diagnostic, or patient care technologies via need-based problem statements under the guidance of their faculty mentors. Each team will complete the course by delivering a prototype or a proof of concept of their engineering solution capable of demonstrating the required functions of the intended solution. Each team will present the outcome of their work in technical reports and oral presentations. Prerequisite: BMEN 501.

BMEN 600 Biomedical Engineering Applications 3 cr.
Biomedical engineering is an interdisciplinary domain which applies principles of engineering to find solutions for biological and health problems. Biomedical engineering aims to improve our fundamental understanding of biological processes and develop approaches for optimized therapeutic/diagnostic healthcare procedures. The field of biomedical engineering involves the development of materials to replace or enhance the operation of damaged or malfunctioning biological entities, development of diagnostic and therapeutic tools, modeling of biological systems, signal processing and bioinformatics. This course will introduce students to biomedical engineering and provide insight into the various applications in the biomedical engineering field. The course will be divided into modules, and each will be given by a specialist in a certain biomedical engineering area.

BMEN 601/MECH 635 Computational Modeling of Physiological Systems 3 cr.
This course focuses on the quantitative modeling of different physiological systems. It provides students with current concepts of the mathematical modeling, and different quantitative descriptions of cellular and organ physiology. At the subcellular/cellular level, we will examine mechanisms of regulation and homeostasis. At the system level, the course will cover basic aspects of anatomical and pathophysiological features of the nervous, neural, cardiovascular, and respiratory systems. Several physiological processes are treated as case studies for increasing complexity in modeling dynamical systems. Prerequisites: MATH 202 and PHYL 346, or consent of instructor.

BMEN 603/CHEN 675/MECH798J Tissue Engineering 3 cr.
In a world of aging population, an ever-increasing demand for improvement of healthcare services and need for replacement organs and tissues are arising. The limited pool of donors together with the problem of donor organ rejection is a strong driver for engineering tissues and other body parts. Tissue engineering is an interdisciplinary field that uses cells, biomaterials, biochemical (e.g., growth factors) and physical (e.g., mechanical stimulation) signals, as well as their combination to generate tissue-like structures. The goal of tissue engineering is to provide biological substitutes that can maintain, restore, or improve the function of damaged organs in the body. This course will introduce interested students to the new field of tissue engineering and provide insight on cutting edge applications in this area.

BMEN 604/CHEN 673 Engineering of Drug Delivery Systems 3 cr.
This course focuses on recent advances in the development of novel drug delivery systems. The fundamentals of drug delivery are discussed. Various strategies to tune and control the release of active agents for optimized therapeutic outcomes are explored. The course covers polymers and techniques used to produce drug nanoparticles, with specific examples of nanoparticle-based drug delivery systems. Prerequisites: CHEN 314 and CHEN 411, or consent of instructor.

BMEN 605 Biomedical Imaging 3 cr.
Biomedical imaging offers an unprecedented view into the structure and function of a living body, and as such plays an essential role in medical practice and research. This course will provide students with an overview of the key concepts underlying the primary diagnostic biomedical imaging modalities, including: ultrasound, x-ray, computed tomography and magnetic resonance imaging. Students will gain an understanding of the physical principles and theoretical foundations governing the operation of each imaging modality, the technology that translates theory into practice, and the basics of image formation. Students will also learn about clinical and research applications in imaging. The course includes class sessions, demonstrations, tours, and research seminars.

BMEN 606 Nanobiosensors 3 cr.
This course will provide a comprehensive analysis of the field of nanoengineering with a focus on biosensors including common modalities, basic theoretical considerations for sensor operation, physics of detection and applications in research and medical diagnostics. The course will cover the major types of electronic nanobiosensors for biological signal detection (potentiometric, amperometric, and mass-based sensors) and their applications in the fields of neural engineering, DNA sequencing and cardiovascular early disease detection. The course will enable students to have a strong grasp of fundamentals of biosensor design, select sensors for various applications and evaluate new and emerging technologies. Prerequisites: EECE 210 (or equivalent) and BIOL 210 (or equivalent); or consent of instructor.

BMEN 607/MECH 633 Biomechanics 3 cr.
A course on the 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 skeleto-motor function and the application of such in testing and practice in rehabilitation. The course is designed for engineering students with no previous anatomy/physiology. Prerequisites: CIVE 210, MECH 320 or CIVE 310; or consent of instructor.

BMEN 608/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 on their interactions with the human body (biocompatibility). The second part of the course examines the various applications of biomaterials and devices in different tissue and organ systems such as orthopedic, cardiovascular, dermatologic, and dental applications. Experts from the medical community will be invited to discuss the various applications. Prerequisite: MECH 340 or consent of instructor.

BMEN 609 Computational Neuroscience 3 cr.
The human brain, perhaps the most complex, sophisticated, and complicated learning system, controls virtually every aspect of our behavior. The central assumption of computational neuroscience is that the brain computes. What does that mean? Generally speaking, a computer is a dynamical system whose state variables encode information about the external world. In short, computation equals coding plus dynamics. Some neuroscientists study the way that information is encoded in neural activity and other dynamical variables of the brain. Others try to characterize how these dynamical variables evolve with time. The study of neural dynamics can be subdivided into two separate strands. One tradition, exemplified by the work of Hodgkin and Huxley, focuses on the biophysics of single neurons. The other focuses on the dynamics of networks, concerning itself with phenomena that emerge from the interactions between neurons. Therefore, computational neuroscience can be divided into three sub-specialties: neural coding, biophysics of neurons, and neural networks. This course will introduce engineers, physicists, computational scientists, mathematicians, and other audiences to the neurosciences from the cellular level and the network level as seen from computational lenses. Prerequisites: BIOL 201 (or equivalent) and Math 202, or consent of instructor.

BMEN 610 Micro and Nano Neural Interfaces 3 cr.
Neural interfaces are micro and nano devices that form the connection between the biological neural tissue and the external electronic devices. These devices are designed for mapping, assisting, augmenting, or repairing neural pathways. The course will focus on physical, chemical, and neurophysiological principles of neural interfaces, theoretical and functional basis for their design, micro and nano fabrication techniques, and applications in neural prosthesis for Brain Machine Interface. Topics covered in class will include: neural engineering, brain machine interface, microfabrication, nanofabrication, soft-lithography, electrokinetics, electrochemistry, neural probes, biocompatibility, microelectrodes, NeuroMEMS (neuro microelectromechanical systems), BioMEMS (biomedical microelectromechanical systems).

BMEN 611/MECH 611 Computational Modeling in Biomechanics 3 cr.
This course is open to engineering, math, science, and medical students wanting a glimpse into the world of computational finite element modeling and simulation to investigate and solve biomedical problems. Students will take a journey through the processes involved in producing a computational finite element model in the biomedical field; starting at construction of model geometry from medical imaging data (CT/MRI), through to model creation, simulation and visualization using finite element analysis software (ANSYS Workbench). Students will also be exposed to select experimental lab techniques in biomechanics and physiology that are used in model development and validation. In pursuit of developing an appreciation for the areas covered, the course will incorporate a mix of theory, demonstrations, practice, real-world modeling applications, and research seminars.

School of Architecture and Design

Founding Director of the School of Architecture and Design	Al-Harithy, Howayda
Graduate Programs Coordinator	Fawaz, Mona
Architecture Track Convener	Patt, Trevor Ryan
Graphic Design Track Convener	El-Gharbie', Ahmad
Landscape Architecture Track Convener	Abunnasr, Yaser
Professors	Al-Harithy, Howayda; Harb, Mona; Musfy, Leila; Fawaz, Mona; Talhouk, Salma; Zurayk, Rami
Associate Professors	Abunnasr, Yaser; Ghaibeh, Lina; El-Gharbie', Ahmad; Najjar, Karim, Aramouny, Carla; Dreksler, Beata
Assistant Professors	Acikgoz, Umit Firat; Al-Akl, Nayla; Khoury, Yara; Patt, Trevor Ryan; Traboulsi, Jana; Yeretzian, Aram
Associate Professor of Practice	Garcia, Vida Mia
Assistant Professors of Practice	Fayad, Nicolas; Frem, Sandra
Adjunct Professors	Makhzoumi, Jala; Tabet, Jad
Adjunct Associate Professor	Trovato, Maria Gabriella
Senior Lecturers	Abboud, Rania; Abdalhay Alkhayat, Nadine; Al-Kadi, Makram; Alamuddine, Hana; Balaa, Lara; Berro, Maher; Braidy, Michele; Boyadjian, Raffi; Charafeddine, Leen; Fayad, Farah; Gemayel, Imad; Genz, Bettina; El-Imam, Hatem; Hassan, Sinan; Jamal, Sany; Kosermelli, Simone; Mallat, Bernard; Shaiban, Houssam; Yamout, Nadine
Lecturers	Abi Hanna, Ghita; Al-Hage, Carla; Apelian, Khajag; Bacha, Karim; Bacho, Omar; Badran, Noura; Basbous, Monica; Baz, Joan; Bou Nasr, Roland; Denris, Alicia; Hanna, George; Hassoun, Nour; Issa, Maha; Khouja, Ahmad; Khoury, Greta; Melhem, Wissam; Moussawer, Karim; Muhsen, Dana; Nader, Halim; Youssef, Shawki; Zahzah, Abdul-Rahman

Senior Instructors	Badran, Zeina; Fidawi, Maya; Saksouk Sasso, Abir
Instructors	Al Baalbaky, Ahmad; Fabian, Monika; Faour, Batoul; Farah, Karim; Mezher, Fouad; Kanaan, Mohamad; Kattan, Sarah-Rita; Ohannessian, Shoghag; Saber, Romy; Traboulsi, Tanya
Lab Instructors	Azzi, Ghinwa; Khalil, Mirella

The School of Architecture and Design (SoAD) offers the degrees of bachelor of architecture (BArch), bachelor of fine arts in graphic design (BFA), and a bachelor of landscape architecture (BLA).

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 practice and who have a sense of responsibility for the built environment and 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 take a leading role in 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 that 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 two-term design thesis and project and advanced electives. In order to pass a year, students must obtain a minimum GPA of 2.3 in both design courses offered in any given year. If the GPA is below 2.3, students must repeat the design studio(s) in which they received a grade below C+.

The degree requirements in architecture consist of the following:

- 117 credit hours of mandatory core courses
- 24 credit hours of approved SoAD/MSFEA field electives distributed as follows:
  - 3 credit hours in Category A: Representation
  - 3 credit hours in Category B: History and Theory
  - 3 credit hours in Category C: Technology and Professional Practice
  - 15 credit hours in any of categories A, B or C
- 6 credit hours of free electives in consultation with the academic adviser
- 27 credits hours of general education courses
- **Note:** Total GE requirement of 39 credit hours includes 12 to 15 credits satisfied within the architecture core program

To meet the general education requirements of AUB, students must take:

- 6 credit hours in Understanding Communication (English), including ENGL 203 and ENGL 206
- 3 credit hours in Understanding Communication (Arabic)
- 9 credit hours of approved electives in Cultures and Histories, including 6 credit hours satisfied by ARCH 121 and ARCH 122
- 3 credit hours of approved elective in Human Values
- 6 credit hours of approved electives in Societies and Individuals, including 3 credit hours by ARCH 432
- 9 credit hours of approved electives in Understanding the World and Quantitative Reasoning with at least 3 credits from each, including ARCH 151 (from the Understanding the World category)
- 3 credit hours of an approved elective in Community Engaged Learning (can be satisfied from a GE course, or from an approved field elective such as ARCH 061 DI-Lab). If the Community Engaged Learning requirement is satisfied by a field elective within the program, then an additional 3 credit hours free elective will be required.
- Additional thematic requirements: One of the GE courses above has to cover the theme of History of Ideas (CHLA designation), and one course has to cover the theme of Social Inequalities (satisfied by ARCH 432).

Curriculum for the Degree of Bachelor of Architecture

First Year

Fall Term		**Credits**
ARCH 100	Basic Design	6
ARCH 111	Drawing I	3
ARCH 121	History of Art and Architecture I	3
FEAA 200	Introduction to Engineering and Architecture	3
ENGL 203	Academic English	3
		Total 18

Spring Term		**Credits**
ARCH 101	Architecture Design I	6
ARCH 112	Drawing II	3
ARCH 122	History of Art and Architecture II	3
ARCH 151	Statics and Mechanics of Solids	3
		Total 15

Second Year

Summer Term		Credits
ARCH 241	Surveying Regional Architecture 2D-3D	9

Fall Term		Credits
ARCH 202	Architecture Design II	6
ARCH 223	History of Art and Architecture III	3
ARCH 252	Structural Systems	3
ARCH 242	Building Construction I	3
1 General Education Requirement		3
		Total 18

Spring Term		Credits
ARCH 203	Architecture Design III	6
ARCH 231	Contemporary Architecture	3
ARCH 243	Building Construction II	3
1 General Education Requirement		3
		Total 15

Third Year

Summer Term	Credits
3 General Education Requirements	9

Fall Term		Credits
ARCH 304	Architecture Design IV	6
ARCH 360	Environment I - Climate Responsive	3
ARCH 313	Digital Tools	3
1 Field or Free Elective or 1 General Education Requirement		3
		Total 15

Spring Term		Credits
ARCH 305	Vertical Studio I	6
ARCH 353	Environment II - Building Systems	3
ARCH 432	Urbanism	3
1 General Education Requirement		3
		Total 15

Fourth Year

Summer Term	Credits
No courses are required. Students can make up for credits missed prior to this term in general education or free electives.	

Fall Term		Credits
ARCH 406	Architecture Design V	6
1 Field or Free Electives		3
2 General Education Requirement		6
		Total 15

Spring Term		Credits
ARCH 407	Vertical Studio II	6
ARCH 461	Professional Practice	3
2 Field or Free Electives		6
		Total 15

Fifth Year

Summer Term		Credits
ARCH 572	Professional Training	1 b

Fall Term		Credits
ARCH 508	Design Thesis I	6
3 Field or Free Electives		9
		Total 15

Spring Term		Credits
ARCH 509	Design Thesis II	6
3 Field or Free Electives		9
		Total 15

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 100/101, 202/203, 304/305, 406/407 and 508/509. In order to pass a year, students must obtain a minimum GPA of 2.3 in both design courses offered in any given year. If the GPA is below 2.3, students must repeat the design studio(s) in which they received a grade below C+. Non-majors must secure the approval of the school and the instructor concerned to enroll in any of the courses listed below.

FEAA 200 Introduction to Engineering and Architecture 3 cr.
The course is designed to familiarize first year students with the different disciplines in engineering and architecture, including: architecture, civil, mechanical, electrical, chemical, industrial and technologies used in the fields. The course takes a unique interdisciplinary approach to the field and introduces the related disciplines in the world of engineering and architecture. One key objective is to promote interdisciplinary interaction and innovative thinking. The course is organized into modules covering the different disciplines within the Maroun Semaan Faculty of Engineering and Architecture (MSFEA). The last module of the class showcases interdisciplinary projects demonstrating interactions among the different fields. The lectures explain as applicable to each discipline, through examples, notions of problem solving, design thinking, process of invention and innovation, environmental and civic responsibility, and measures of success in aesthetics and performance. The course project is a key component of the course. It is interdisciplinary in nature bringing ideas and solutions from all disciplines in engineering and architecture. Annually.

ARCH 100 Basic Design 6 cr.
The studio introduces students to the field of design and its fundamental principles. It is required for all first year students in architecture and graphic design. The aim of the course is to expose students to basic design principles and train them in design studio skills, including 2D drawing and model-making.

ARCH 101 Architecture Design I Introduction to Tectonics, Space, and Representation 6 cr.
The course introduces the generic issues that influence and shape architectural design, and aims at developing the skills to address them. The studio focuses on such elements as tectonics, design method and representation, human scale, space, form and light, function, place, and time. Design is understood as a method of inquiry, through hands- on exercises. With an introduction to basic structural principles, the students acquire fabrication skills that inform architectural expression and encourage inventiveness. They learn how model-making and drawing are tools that inform the design process and form-making in architecture. Prerequisite: ARCH 100.

ARCH 111 Drawing I 3 cr.
This course is the first in a sequence of representation courses that introduce students to the visual representations of objects and the built environment. Students learn to use basic media, free-hand, and manual drafting tools. The course covers geometry, basic drawing, and representation conventions in 2D and 3D, namely orthogonal projections (plans, sections, and elevations) and paraline projections (axonometrics and isometrics). Lectures about conventions, methods, and historical references to architects and artists' drawings and work supplement the course.

ARCH 112 Drawing II 3 cr.
This course is the second in a sequence of representation courses. It covers more advanced visual representation techniques in architecture and teaches students to work across analog and digital representation tools. The course moves between free hand sketching, perspective methods to more complex 3D and composite architecture drawings. It also introduces students to basic concepts of diagramming and collages as methods for imagining architectural space. Students learn to use 2D digital tools (CAD) in parallel to hand drawing. Lectures about conventions, methods and historical references to architects and artists' drawings and work supplement the course. Prerequisite: ARCH 111.

ARCH 121 History of Art and Architecture I 3 cr.
The first course in the history of art and architecture sequence looks at the origins and development of architecture, artifacts, and urbanism from prehistoric times through the later medieval period. We move beyond the chronological model to include themes that link art and the cultures that produced it through comparison of objects associated both with the activities of daily life and with the different practices of kingship and religion, especially beliefs and rituals surrounding death, burial, and the afterlife. The course focuses on cultures around the Mediterranean rim and beyond. Local field trips are an important component of the class. The course is required for students in the architecture and graphic design programs but is open to all students.

ARCH 122 History of Art and Architecture II 3 cr.
This course, the second in the history of art and architecture sequence, focuses on global cultural encounters and exchanges in the post-Medieval period. A thematic and analytic study of major developments in different cultures, it challenges the hegemony of the geographic center. Adaptation, initiative, and innovation flow along many different pathways, and in addition to the formal differences amongst visual languages, the course emphasizes processes of cultural production in imperial contexts, their ideological frameworks, and their socio-political significance in writing the history of art, architecture and artifacts. The course is required for students in the Architecture and Graphic Design programs but is open to all students.

ARCH 151 Statics and Mechanics of Solids 3 cr.
The course covers basic physics principles and structural analysis, the strength of materials and their structural properties. It combines lectures and lab work, and imparts a basic understanding of how structural elements of a building work and how they can be manipulated.

ARCH 202 Architecture Design II Materials and Structures in the Natural Environment 6 cr.
The studio focuses on materials and structures in the natural environment. It is taught concurrently with technical courses: Structural Systems and Building Construction I. Through lectures, analyses of precedents, material case studies and different exercises, students investigate structural systems, materials, and construction methods, exploring their formal, spatial, and aesthetic possibilities and environmental characteristics. Students apply their explorations to integrate structures in a natural environment. Through site visits and studio exercises, students are introduced to site analysis and landscape basics, and begin to address environmental conditions as they relate to climate, topography, and vegetation. The course aims at clarifying the dialectic relationship of material, structure, architectural form, and site. Prerequisites: ARCH 101, ARCH 241 and a combined grade average of C+ (GPA: 2.3) in ARCH 100 and ARCH 101.

ARCH 203 Architecture Design III Public Architecture in an Urban Context 6 cr.
Building on the previous design courses, Architecture Design III addresses public building structures in urban environments. Through exercises, site visits, lectures and discussions, students are introduced to different themes and methods in understanding architecture in the urban realm. They look at urban areas with reference to historical, cultural, and socioeconomic factors. Mapping and abstraction are key tools for design inquiries. Students are asked to develop and integrate program and architectural design in the urban context, with reference to quantitative data on the ground, such as density, traffic, etc. as well as qualitative data such as culture, habits, behavior, etc. Through various exercises they learn about the urban context at different scales ranging from small urban installations to medium-scale buildings with hybrid programs; they also address accessibility, and pedestrian and vehicular circulation. The course balances analytical skills with design interventions. Prerequisite: ARCH 202.

ARCH 223 History of Art and Architecture III 3 cr.
The last course of the History of Art and Architecture sequence surveys the development of Western art and architecture from 1830 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 or consent of instructor.

ARCH 231 Contemporary Architecture 3 cr.
The Contemporary Architecture course investigates theory and practice in architecture and urbanism from late modernism to contemporary times. As a logical continuation of history of modern art and architecture: 1760-1945, the course begins with an overview of major post-World War II architects and architectural movements representing late modernism or challenges to the modern movement. Rather being a historical and descriptive survey of movements, trends or isms, the course then adopts a thematic and analytical approach to developments from late modernism to contemporary practice. It focuses on philosophies, theories and themes underlying contemporary architectural writings and built works and addressing issues of globalization; place and cultural identity; relationship to history and heritage; relationship to nature and landscape; environmental, social, and economic sustainability; use of technology; materials and light; and spatial and formal explorations. Prerequisite: ARCH 223.

ARCH 241 Surveying Regional Architecture 2D-3D 9 cr.
In this fieldwork course, students study and document the traditional and transitional architecture of a given region. On the macro level, the region of interest expands to the Eastern Mediterranean Sea Basin and the Middle East. On a micro level, it covers the sub regional variations within Lebanon in terms of traditional, transitional, and contemporary architecture. The scope of study encompasses different scales of rural and urban settlements. Case studies are generally structured around the investigation of building types, regional variations in architecture, and the study of historical buildings and neighborhoods. Prerequisites: ARCH 112 and ARCH 101.

ARCH 242 Building Construction I 3 cr.
This is the first in a sequence of two courses on building construction materials and methods. Having studied the structural systems and properties of various building materials in the Structures courses, in this course, students focus on materials' properties, methods of construction, assembly systems, and environmental performance and impact of masonry, concrete (cast-in-place and precast systems), steel and wood (different types). Availability and use of regional materials, material extraction, fabrication, erection, craftsmanship and jointing of different materials are addressed. The course also introduces construction sequence, site works, excavations and foundation systems. In addition to including an introduction to detailing the main constituents of the buildings' envelope, the course allows students to get hands-on experience by building scale models of masonry walls, wood frames and steel joints.

ARCH 243 Building Construction II 3 cr.
The second building construction course focuses on building enclosure and finish construction as well as on construction drawings. In the first section, basic principles and components of the building envelope are studied with their environmental performance. Topics include damp-proofing and waterproofing, thermal insulation, exterior wall systems and materials, exterior windows and doors, glazing systems, solar control and shading devices, and roofing systems. Students learn to design and detail building envelopes that provide protection from water, wind and temperature extremes and to optimize solar control. A wide range of exterior wall systems is explored. The second section of the course covers finish construction; including interior partitions, floor, stairs, wall finishes and suspended ceilings. Materials embodied energy, environmental impact and reuse are also investigated, and selection of "green" materials is discussed. In the third section, students develop the working drawing plans, elevations, sections, and details of a small house. Prerequisite: ARCH 242.

ARCH 252 Structural Systems 3 cr.
In this second structures course, students acquire a deeper knowledge of structural systems as they relate to architectural design. The course explores synergies of form, structures, and materials with an emphasis on aesthetics and efficiency. Lectures are combined with lab work to develop an understanding of structures as integral to the creative design process. The course enables students to develop structural design strategies, assume a leading role in the design and construction process and effectively communicate with structural engineers. Numerical calculation methods used are intended for rough estimations of loads and sizes. Prerequisite: ARCH 151.

ARCH 304 Architecture Design IV Environmentally Responsive Architecture 6 cr.
This studio focuses on environmental issues and the integration of green strategies into the design of mixed-use projects with a housing component in natural, rural, or urban settings. The studio is taught concurrently with a lecture course on climate-responsive design. Through lectures, analyses of historical and contemporary precedents and vernacular examples, discussions and hands-on exercises, students explore environmentally responsible site development and landscape approaches as well as passive design strategies. They also investigate housing typologies as manifestations of the needs, aspirations, and sociocultural characteristics of various groups/ communities. Prerequisites: ARCH 203 and a combined grade average of C+ (GPA: 2.3) in ARCH 202 and ARCH 203.

ARCH 305 Vertical Design Studio I 6 cr.
In Vertical Studios I and II, 3rd and 4th year students join common optional studios in the spring term. Studios are designed to address specific themes relevant to architecture. Inspired by other disciplines, such as art, history, social sciences and technology, students explore new design approaches that encourage lateral thinking and experimentation. Studios provide opportunities to explore different themes ranging from media, structures, installations, and heritage to urban, social, and environmental issues. Prerequisite: ARCH 304.

ARCH 313 Digital Tools 3 cr.
This course is the third in a sequence of representation courses. With the beginning of the millennium, traces of traditional drawing in architecture have been replaced by digitized models and layouts. From initial design and visual construction to final renderings, digital tools have shifted the way an architecture project is conceived. Software, such as Rhinoceros and 3DMax, have become essential for architecture representation, especially when combined with post-production tools such as Adobe Illustrator, Photoshop, or InDesign. This course is aimed towards developing students' 3D modeling and visualization skills, as well as providing them with the tools needed to complete the construction, rendering and presentation of architectural ideas. Prerequisite: ARCH 112.

ARCH 432/URPL 632 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 placemaking (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 231.

ARCH 360 Environment I – Climate Responsive Design 3 cr.
The course addresses sustainability and climate-responsive architecture and site planning. After a brief overview of energy issues as they relate to architecture and urbanism, the course examines the interaction between climate, people, and buildings, and presents basic principles of passive design and sustainable site planning. An introduction to climatic parameters and thermal comfort is followed by a study of the elements of sun, wind, and daylight as they pertain to passive design, focusing on building form and solar radiation, natural ventilation strategies and daylighting design principles and applications. The course also briefly addresses other sustainable design strategies and includes an overview of active systems (solar, photovoltaic panels, geothermal), water reduction and reuse, green materials, and acoustics.

ARCH 353 Environment II – Building Systems 3 cr.
This course is the second environmental systems course. It provides a design-oriented study of environmental control, life safety and building service systems; consisting of electrical, lighting, heating, ventilation, air-conditioning, water and waste, acoustics, fire safety and fire protection, and vertical transportation. The course covers basic principles, applications, and performance of environmental control systems, and addresses these systems as they impact building planning and design, and occupant health and comfort. Sustainable design strategies, energy efficiency, optimization of indoor environmental quality and economic soundness are key issues. Prerequisite: ARCH 360.

ARCH 461 Professional Practice 3 cr.
The professional practice course exposes students to the scope and key aspects of design professional practice. In the first part of the course, students investigate the establishment and management of a design-focused practice with emphasis on financial planning, navigating legal and regulatory requirements, marketing strategies and team building, and ethics and professional conduct. Types of practice and professional options after graduation in the national, regional, and international realms, as well as prospects for postgraduate education and specialization are also discussed.

ARCH 406 Architecture Design V Comprehensive Design Studio 6 cr.
In this comprehensive design studio, students apply the knowledge and skills acquired in all previous design studios, theory, and technical courses. Projects assigned are medium to large-scale buildings, and themes can relate to culture, education, tourism, work, retail, and transportation. Projects envisioned are complex building structures with preferably hybrid functions addressing the public domain, circulation, accessibility, life safety, parking, building codes and zoning regulations. Prerequisites: ARCH 305 and a combined grade average of C+ (GPA: 2.3) in ARCH 304 and ARCH 305.

ARCH 407 Vertical Design Studio II 6 cr.
See description of ARCH 305. Prerequisite: ARCH 406.

ARCH 508 Design Thesis I 6 cr.
In this course, students start a year-long design investigation of an architecture issue of their choice and develop a related design thesis. The design investigation must be of a professional caliber that entitles students to graduate and join professional practice as licensed architects. It is also an opportunity to pursue a comprehensive architectural design process that integrates design research, theoretical paradigms, representational methods, regulatory systems, and technical knowledge. Prerequisite: ARCH 407.

ARCH 509 Design Thesis II 6 cr.
Design Thesis is the culmination of undergraduate education in architecture. This course is the second part of a year-long thesis project. It consists of an architectural design intervention derived and developed from the issues raised and researched in Design Thesis I. Students work independently in a studio setting. Prerequisite: ARCH 508.

ARCH 572 Professional Training 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 they apply their knowledge and acquire professional experience in the field of architecture. Prerequisite: ARCH406.

For Architecture and Graphic Design elective courses see list at end of Graphic Design section.

Minor in Integrated Product Design

Integrated product design is an interdisciplinary minor, located at the intersection of design, engineering, business, art, humanities, and social sciences. The minor in integrated product design is open to all AUB students who are interested in expanding their knowledge of design and obtaining a deeper understanding of the design process of goods, systems, and services from research and conceptualization, to design development and prototyping, and to marketing and branding. It is a minor for students who are inspired to become social entrepreneurs to design and develop products that can be implemented and scaled to trigger positive systemic change. Through the minor, students are exposed to a range of design skills and methods, from visualization of ideas to creative problem solving, and transformative design thinking. They also learn to work with multidisciplinary teams on hands-on projects and in a studio environment.

Students must earn 18 credits to satisfy the requirements for the minor in integrated product design. These are distributed as follows:

1. 6 credits of foundational design skills. Students must select 3 credits in basic design methods courses and 3 credits in visualization courses (see list 1).
2. 6 credits of core product design and development. Students must select 6 credits in product design courses (see list 2).
3. 6 credits of thematic field electives. Students must select 6 credits in two of the thematic areas A, B, C, and D (see list 3).

List 1: Foundational courses with a focus on basic design, visualization, and prototyping. Students should take 6 credits from this list.

ENMG 664	Introduction to Human-Centered Design	3 cr.
ARCH 100	Basic Design	6 cr.
MECH 201	Computer-Aided Drawing and Design (CADD)	3 cr.
MECH 421	Manufacturing Processes I Prerequisites: MECH 320, MECH 340	3 cr.
MECH 522	Mechanical CAD/CAE/CAM Prerequisites: MECH 320, MECH 420, and MECH 432	3 cr.
ARCH 111	Drawing I	3 cr.
ARCH 112	Drawing II Prerequisite: ARCH 111	3 cr.
ARCH 313	Digital Tools Prerequisite: ARCH 112	3 cr.
GRDS 111	Drawing	3 cr.
GRDS 141	Computer Graphics	3 cr.

List 2: Core courses with a focus on product design and development. Students should take 6 credits from this list.

MECH 525	Product Design and Development Prerequisites: MECH 332, MECH 420	3 cr.
MECH 510	Design of Thermal Systems Prerequisites: MECH 410L, MECH 412, and MATH 251	3 cr.
ARDS 400	Systems Thinking Prerequisite: ENMG 698E	3 cr.
ENMG 663	Product Design and Development	3 cr.
BMEN 501	Bioengineering Design Fundamentals	3 cr.
CHEN 571	Chemical Product Design Prerequisite: CHEM 470	3 cr.
GRDS 305	Graphic Design V Prerequisite: GRDS 304	6 cr.
MECH 502, EECE 502, INDE 502, CHEN 502, CIVE 402	Approval of adviser	3 cr.

List 3: Field electives. Students must take 6 cr. from at least two categories (A-D).

Category A

INDE 412	Engineering Entrepreneurship	3 cr.
ARCH 068	Design Innovation and Entrepreneurship	3 cr.
ENMG 654	Technology-Based Entrepreneurship	3 cr.
ENMG 655	Management of Technology	3 cr.
ENMG 656	Management of Technological Innovations	3 cr.
MKTG 312	Consumer Behavior Prerequisite: MKTG 306	3 cr.
MKTG 311	Applied Market Research	3 cr.

DCSN 310	Operations and Process Management	3 cr.
DCSN 340	Supply Chain Management Prerequisite: DCSN 310	3 cr.
EMBA 521	Digital Marketing	3 cr.
ENTM 320	Social Entrepreneurship	3 cr.
ENTM 220	Entrepreneurship and Business Planning	3 cr.
INFO 220/ MKTG 220	Electronic Marketing Prerequisites: MKTG 210, INFO 200	3 cr.
FINA 211	Introduction to Finance for Engineers Prerequisite: ACCT 210	3 cr.
INFO 227/ MKTG 227	Social Media in Digital Management Prerequisite: MKTG 210, Permission of the instructor for non-OSB students	3 cr.
ENTM 230	Decision-Making Skills for Entrepreneurs Prerequisite: MNGT 215	3 cr.
MKTG 234	Marketing for Social Change Prerequisite: MKTG 210 (or equivalent). Permission of instructor for non-OSB students	3 cr.
ENTM 270	Launching a New Venture Prerequisite: MNGT 215, FINA 210	3 cr.

Category B

MECH 617	Smart Materials and Structures	3 cr.
MECH 631	Micro Electro Mechanical Systems (MEMS) Prerequisite: MECH 430	3 cr.
MECH 632	Structural Health Monitoring Prerequisites: MECH 320, MECH 430	3 cr.
MECH 798C	Sustainable Materials	3 cr.
MECH 634/ BMEN 608	Biomaterial and Medical Devices Prerequisite: MECH 340 or consent of instructor	3 cr.

ARCH 040	“Making It”: Models and Prototypes of Complex Structures	3 cr.
ARCH 060	Algorithm an Iteration	3 cr.
ARCH 063	Do It, Then Fix It As You Go	3 cr.
ARCH 069	New Territories	3 cr.
GRDS 040	3D Animation	3 cr.
GRDS 043	Advanced Digital Animation	3 cr.
EECE 625/425	Embedded and IOT Systems Prerequisite: EECE 321	3 cr.
EECE 652	Web Server Design and Programming	3 cr.
EECE 680	Antennas for Wireless Communications Prerequisite: EECE 380	3 cr.
EECE 684	Microwave Engineering	3 cr.
EECE 487/687	Radio-Frequency Integrated Circuit (RFIC) Design Prerequisites: EECE 380, EECE 311	3 cr.
EECE 685	Radio Frequency (RF) Circuits Design Prerequisites: ECE 311, EECE 340, EECE 380	3 cr.
EECE 686	Radio-Frequency (RF) Transceiver Design Prerequisites: EECE 311, EECE 380	3 cr.
EECE 687/487	Radio-Frequency Integrated Circuit (RFIC) Design | Prerequisites: ECE 380, EECE 311	3 cr.
EECE 697/ MECH 646	Wheeled Mobile Robotics	3 cr.
EECE 698/ MECH 650	Autonomous Mobile Robotics Prerequisites: EECE 230, EECE 312, and MECH 436; or EECE 230 and EECE 460	3 cr.
CHEN 619	Sustainability Science: Human and Environment Interaction	3 cr.

Category C

GRDS 062	Brand Inc.	3 cr.
MKTG 225	Strategic Brand Management Prerequisite: MKTG 210. Students cannot receive credit for both SOAN 231 and MKTG 225 or both SOAN 235 and MKTG 225	3 cr.
MKTG 210	Principles of Marketing Corequisite: ENGL 204	3 cr.

Category D

GRDS 033	Pre-Brand: A History of Identity Design	3 cr.
GRDS 331	Introduction to Visual Theory	3 cr.

Minor in Urban Studies

The minor in urban studies is open to all AUB students who are interested in expanding their knowledge of the contemporary opportunities and challenges posed by the ongoing transformations of the natural and built environments as the world shifts to a “planetary” urbanization. Through the minor, students familiarize themselves with a range of contemporary debates discussing the implications of urbanization across disciplinary fields. They also strengthen their command over some of the methods and tools used in social and environmental sciences, humanities, and urban planning and design to analyze urbanization processes.

In order to satisfy the requirements of a minor in urban studies, students must earn 15 credits of coursework, as described below.

Students enrolled in architecture, engineering or landscape architecture who hold a minor in urban studies qualify for an advanced standing if they apply for the master of urban planning and policy (open to all students with a first degree in engineering, architecture, landscape, and/or the social sciences) and the master of urban design (open to all students with a first professional degree in architecture and/or landscape architecture).

The minor in urban studies is administered by the coordinator of the master in urban planning and policy and master in urban design programs in the School of Architecture and Design at MSFEA.

Course Requirements

In order to obtain a minor in urban studies, students must complete fifteen credits distributed as follows:

- Two courses in the general theory/methods framework are required:

ARCH 332/ URPL 632	Urbanism (3cr.)
URPL 630/SOAN 210/PPIA 308/ PSPA 300	Research Methods (3cr.)

- Register for the 0-credit seminar City Debates once (URPL 660).
- At least one course about the interaction of urban studies with a professional field is required such as the below (or equivalent, approved by the program coordinator):

Design & Landscape

URDS 632	From Urban Design to Landscape Urbanism
LDEM 301	Urban Greening
LDEM 302	Green Infrastructure for Resilient Landscapes and Cities

Urban Planning

URPL 631	Introduction to Planning Theory and Policy
PPIA 301	Public Policy and Practice

Environmental Studies and Management

LDEM 630	Natural Resource Management
CIVE 656	Environmental Impact Assessment
CIVE 601	GIS and Geospatial Data Modeling

Urban Transportation and Infrastructure

CIVE 686/ ARCH 073	Environmentally Responsive Buildings and Environments
CIVE 661	Urban Transportation Planning I
CIVE 666	Public Transportation
SOAN 323AG	Infrastructures and Materiality in the Middle East

> At least one of the special-topics theory courses (3 credits) that intersect directly with the study of the city in the School of Architecture and Design such as the below (or equivalent, approved by the program coordinator):

URPL 621	Urban Form and its Formation
URPL 637/ ARCH 036	Illegal Cities
URPL 638/ ARDS 030	Politics of/in Design
URPL 665/ ARCH 065	Development and Planning Policies
URPL 669	Building and Planning Codes
URDS 624	Hybrid Beirut: Morphogenesis of the Contemporary City
URDS 632	From Urban Design to Landscape Urbanism
URDS 634	The Contested Urban Heritage of Cities in the Arab World
ARCH 015	Micro Infrastructures
ARCH 020	Interwar Urban History
ARCH 021	Istanbul: Imperial to Metropolis
ARCH 022N	The Politics of Arab Modernism
ARCH 305B	Territorial Imaginaries

- One of the following courses (3 credits) may also be taken towards the minor in urban studies. Other courses relevant to urban studies may also be eligible, as approved by the MUPP-MUD program coordinator:

HIST 263	Islamic Cities, 600-1500
CVSP 205	Ancient, Medieval, Islamic, and Renaissance Civilizations
SOAN 220	City and Society
SOAN 216	Hands-On Anthropology
SOAN 221	Political Anthropology
SOAN 223	Social Inequality: Conflict and Consensus
FINA 232	Real Estate Management
FINA 234	Real Estate Finance and Investment
PPIA 310K	Making of Global Developmental Policies

Graphic Design

Mission Statement

The undergraduate program in graphic design offers a professional degree with a well-rounded scope covering the multiple practice areas of the discipline. The curriculum focuses on solid training in the theoretical, practical and technical aspects of graphic design, while promoting a socially responsible practice and awareness of both local and international developments in the field. The goal of the program is to produce graduates with expert design proficiencies, grounded in historical knowledge, who are capable of adapting graphic and visual tools to the changing demands of the design industry. Students develop intellectual and critical thinking skills and contribute to aesthetic and technological innovations by generating ideas in response to a wide range of design challenges. The program is committed to the role design plays in the multicultural and multilingual contemporary regional context and provides a creative teaching and learning environment to address these issues.

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, and history 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, and theory courses, reinforced by the field electives and General Education requirements. 3) Final year, fourth year, with a one-year design project and advanced electives. In order to pass a year, students must obtain a minimum GPA of 2.3 in both design courses offered in any given year. If the average is below C+, students must repeat the design studio(s) in which they received a grade below C+.

The degree requirements in graphic design consist of the following:

- 94 credit hours of mandatory core courses
- 15 credit hours of approved ArD/MSFEA field electives:
  - 3 credit hours in Category A: Representation
  - 3 credit hours in Category B: History, Theory, and Methodology
  - 3 credit hours in Category C: Digital Media, Typography, and Professional Practice
  - 6 credit hours: choice between A, B & C
- 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: English 203 and English 204
- 3 credit hours in Understanding Communication (Arabic)
- 9 credit hours of approved electives in Cultures and Histories, including 6 credit hours satisfied by ARCH 121 and ARCH 122
- 3 credit hours of approved elective in Human Values
- 6 credit hours of approved electives in Societies and Individuals, including 3 credit hours satisfied by GRDS 331
- 9 credit hours of approved electives in Understanding the World and Quantitative Reasoning with at least 3 credits from each. One of the Quantitative Reasoning courses has to be CMPS 207

- 3 credit hours of an approved elective in Community Engaged Learning, satisfied by GRDS 203
- Additional thematic requirements: One of the GE courses above has to cover the theme of History of Ideas (CHLA designation), and one course has to cover the theme of Social Inequalities

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

First Year

Fall Term		Credits
ARCH 100	Basic Design	6
GRDS 111	Drawing	3
ARCH 121	History of Art and Architecture	3
ENGL 203	Academic English	3
1 General Education Requirement		3
		Total 18

Spring Term		Credits
GRDS 101	Graphic Design	6
ARCH 122	History of Art and Architecture II	3
GRDS 151	Typography I	3
GRDS 141	Computer Graphics	3
	Advanced Academic English	3
		Total 18

Second Year

Summer Term		Credits
GRDS 212	Photography	3
2 General Education Requirements		6
		Total 9

Fall Term		Credits
GRDS 202	Graphic Design II	6
ARCH 223	History of Art and Architecture III	3
GRDS 252	Typography II	3
GRDS 213	Illustration	3
		Total 15

Spring Term		Credits
GRDS 203	Graphic Design III	6
GRDS 224	History of Graphic Design	3
GRDS 242	Motion Graphics	3
GRDS 214	Printmaking	3
		Total 15

Third Year

Summer Term	Credits
2 General Education Requirements	6
1 General Education Course: CMPS 207	3
	Total 9

Fall Term		Credits
GRDS 304	Graphic Design IV	6
GRDS 331	Introduction to Visual Theory	3
GRDS 361	Professional Practice	3
GRDS 343	Interaction Design I	3
		Total 15

Spring Term		Credits
GRDS 305	Graphic Design V	6
GRDS 344	Interaction Design II	3
1 General Education Requirement		3
1 Field Elective		3
		Total 15

Fourth Year

Summer Term		Credits
GRDS 462	Approved Experience	1 b

Fall Term		Credits
GRDS 406	Final Project Research	4
2 Field Electives		6
1 Free Elective		3
		Total 13

Spring Term		Credits
GRDS 407	Final Project Design Research	6
2 Field Electives		6
		Total 12

Course Descriptions

Mandatory Core Courses

ARCH 100 Basic Design 6 cr.
See Architecture section.

ARCH 121 History of Art and Architecture I 3 cr.
See Architecture section.

ARCH 122 History of Art and Architecture II 3 cr.
See Architecture section.

GRDS 101 Graphic Design I 6 cr.
This is an introductory studio on graphic design methods and processes where fundamentals of visual communication are addressed. The studio starts with basic investigations in form making, and gradually moves on to cover more complex components of graphic design dealing with the construction of meaningful visual messages and the organization of information as well as the dynamic interaction of color and its applications. Prerequisite: ARCH 100.

GRDS 111 Drawing 3 cr.
This studio course is an introduction to visual representation. Students learn drawing skills and pictorial conventions, and consider the historical specificity and contemporary relevance of such skills and conventions.

GRDS 141 Computer Graphics 3 cr.
This course introduces students to digital imaging techniques through computer software learning. Students are introduced to the mac operating system platform and move on to cover basics of industry standard software from vector-based programs (such as Adobe Illustrator) to pixel-based image creation and manipulation (such as Adobe Photoshop), while addressing desktop publishing design programs (such as In-Design).

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 C+ (GPA: 2.3) 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 212 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 213 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.

GRDS 214 Printmaking 3 cr.
Basic printmaking covers traditional printmaking techniques such as lithography, etching, silkscreen and woodcut. Students acquire a foundation and understanding of print/printmaking techniques and processes through project-based exercises creating unique impressions on various surfaces.

ARCH 223 History of Art and Architecture III 3 cr.
See Architecture section.

GRDS 224 History of Graphic Design 3 cr.
The course will go through key moments in graphic design history surveying some of the most significant periods, dominant styles and influential designers until the present day. 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 students to take part in the current debate around graphic design theory and practice. Prerequisite: ARCH 223.

GRDS 151 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 that 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 (Typography 1 is now GRDS 151). 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 151.

GRDS 304 Graphic Design IV 6 cr.
The course covers the design of printed publications in their various formats and for various 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 C+ (GPA: 2.3) in GRDS 202 and GRDS 203.

GRDS 305 Graphic Design V 6 cr.
The course covers package design, installations and signage 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 the final stage (real situation scenario); and experiment with acquired (design) language and vocabulary. Prerequisite: GRDS 304.

GRDS 331 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 242 Motion Graphics 3 cr.
This course provides students with the basics of designing for time-based media and the moving image. The course covers animation in its various forms, studying the process in depth from animation principles to concepts and story boarding, to the final output edited with the soundtrack. Students will be exposed to and use various techniques of animation, from the classical hand drawn frame by frame animation, to experimental stop motion animation, and computer-based motion graphics title sequences, infographics, and TV branding. Prerequisite: GRDS 141.

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, etc.), in addition to building knowledge about pre- press production and production techniques essential to the design practice. Prerequisite: GRDS 203.

GRDS 343 Interaction Design I 3 cr.
In this course, students learn to design for interactive media while building on the skills acquired in previous design studios. The course covers the principles, methods, and tools to plan, organize and implement interactive content ranging from interface design to digital publishing and best practices in typography, navigation, and information design. Students acquire an understanding of structuring and representing information, properly integrating elements of text, image (still and moving), audio, and video to create and deliver different interactive experiences. The course also covers the foundation of font-end programming language and software used by the industry. Prerequisites: GRDS 141 and GRDS 242.

GRDS 344 Interaction Design II 3 cr.
This course provides students with practical knowledge and implementation of user experience design. It focuses on the principles of human-centered design and interaction, the interface between humans and technology, understanding and defining user behaviors, designing for multiple platforms and multi-sensory experiences. Students explore the process of user research, prototyping concepts, usability testing, evaluation of multimedia, accessible and inclusive design. They acquire knowledge and hands-on-experience by designing for different user experiences, including interfaces (screens), systems, products and spaces. Prerequisites: GRDS 242 and GRDS 343.

GRDS 406 Final Project Research I 4 cr.
In this course, students start a year-long design investigation of a research topic and a project of their choice. The process begins by submitting a proposal in which they identify the project's design statement(s)/question(s), 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 experimentations that would enable them to refine their initial proposals, respond to its questions, argue their position and, accordingly, arrive at a well-defined design concept statement and a concrete design project proposal. The work will be synthesized in a dossier of research and design experimentations to be submitted at the end of the fall term, allowing students to move to the design implementation phase in the following spring. Prerequisites: GRDS 304 and GRDS 305, and a combined average of C+ (GPA: 2.3) in GRDS 304 and GRDS 305.

GRDS 407 Final Project Design Research 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 experimentation and implementation, 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 term. 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 students apply their knowledge and acquire professional experience in the field of graphic design.

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

ARD Elective Course Offerings

The elective courses in the Department of Architecture and Design are distributed into three main categories and are subject to change as new electives are introduced every year. Some electives are open to students in all faculties.

Category A: Representation (ARCH 01 and GRDS 01).
Category B: History (ARCH 02 and GRDS 02) and Theory (ARCH 03 and GRDS 03)
Category C: Technology (ARCH 04), Engineering (05), Professional Practice (ARCH 06, GRDS 06), Digital Media (GRDS 04) and Typography (GRDS 05).

Electives are chosen in consultation with the assigned adviser and in accordance with the load distribution.

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 011 Imaginary Landscapes: Utopia and Architecture 3 cr.
Although utopia does not belong to a particular field of research, it often relates to architecture, representing a delicate discrepancy between 'ideals' and 'space.' It has always been the concern of architects and designers to imagine utopias, so much so that the history of architecture may no longer ignore this literature and abundant work that relates the sociopolitical and economic field to spatial manifestations of desires and dreams.

ARCH 015 Micro Infrastructure 3 cr.
Micro Devices is a course that teaches visualization and diagramming as analytical methods to pursue research on a specific local infrastructural problematic (water, transportation, energy, etc.). The aim is to rigorously tackle that infrastructural issue through mapping and diagramming to produce a visual pamphlet while proposing hybrid and speculative design interventions.

ARCH 017 Remaking our World: Cities and Cinema 3 cr.
This course examines how shifts in urban form and plans for development or reconstruction give rise to cinematic representations. We will also look at how discourses of cinema and their production and design process affect architecture, urbanism, and our experiences in the city. In addition, through a workshop, we will get our hands dirty with cameras and experiment with a few short clips ourselves.

ARCH 018 Counter-FIction as Narrative 3 cr.
The course introduces counter-fiction as a productive method of exercising design imagination and an alternative tool for design realization and presentation. Students will use museum collections and archives as a context to develop counter-fictional plots based on relevant historic events. These reimagined plots will be explored visually across different media. The course is divided into three parts: method development, visual interpretation and research, and project development and presentation. The course is a workshop and seminar, and open to architecture, graphic design, and other students.

GRDS 010 Digital Illustration 3 cr.
This course focuses on developing technical proficiency with digital tools to build an advanced understanding of illustration principles. The class covers essential skills required for working with illustration, ranging from character and environment design to translating complex ideas with maximum clarity and audience engagement. Additionally, this course will emphasize a methodical sketching process that integrates traditional drawing techniques with digital solutions to better prepare students for working with illustration in the professional practice.

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, ARCH 112 or FAAH 202, and FAAH 234.

GRDS 014 Engraving and Etching 3 cr.
This course is an exploration 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, ARCH 112 or FAAH 202.

GRDS 015 The Artist Book 3 cr.
This course examines 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 texts and images. This course also introduces students to different techniques of bookbinding in order to produce an artist book. Prerequisite: GRDS 214 or FAAH 202.

GRDS 016 Advanced Photography 3 cr.
This course engages students with artistic photographic practice by encouraging them to make photographs that respond to and challenge issues raised through class discussions and assigned readings. While focusing on contemporary aspects of photography, students are expected to intensively produce their own works with the objective of developing their individual visual language. Weekly practical assignments are designed to push students to explore questions in current photographic practice as they relate to the history and development of the medium. A conversation on photography as a thought process is emphasized through readings, class presentations and slide lectures, in parallel to a visual and conceptual exploration through practical assignments. Prerequisite: GRDS 212.

GRDS 017 Elastic: An Intro to Generative Art 3 cr.
The class introduces students to coding through the language of processing, an opensource “programming sketchbook”: They will learn to draw static images and transform them into moving and interactive compositions; they will input sounds or other stimulus and create the recipes for them to become visuals. All the while, they will be placing these experiments within a theoretical framework of abstraction, autonomy, and algorithmic creation. What are the similarities between programming and the formative centuries of Islamic art? early 20th Century art movements? Mid-century art movements? This two- fold approach of practice and history hopes to form a well-rounded context of the skills acquired and hence a critical stance on the programming tool.

Category B: History and theory

ARCH 020/URPL 626 Interwar Urban History 3 cr.
This course explores the momentous urban transformations across the world during the interwar, a period when cities became more populous, complex, sophisticated, and contested than ever. From Berlin and Rio de Janeiro to Beirut and Calcutta, cities went through major physical and social transformations during the interwar. In addition to the advent of international modernism in architecture, the emergence of urban planning as a discipline shaped urban forms and infrastructures in radical ways. This course embraces a global urban history approach, examining the parallel and divergent ways in which cities responded to the political, economic, and social challenges of the interwar. There are three modules in this course. The first involves contestations over cities, focusing on the issues of how political struggles crystallized in urban spaces; how the nascent notions of urban rights mobilized masses into action; and the role of heritage in a modern city. The second module is about physical interventions in cities and the disciplinary apparatuses that shaped them. This module explores the institutionalization and dissemination of urban planning; infrastructural modernization; housing; and real estate. The third module moves on to the realm of representation. It focuses on how cities figured in some of the notable literary, artistic, and cinematic works of the interwar.

ARCH 020A Spatial Politics of Revolution: from Tehran to Beirut 3 cr.
Tehran and Beirut have their differences in size, population, geography, politics, economy, and urban form. They have both had their fair share of conflict and upheaval. Both cities suffer from a lack of basic services, extreme pollution, congestion, and a socio-economic divide that manifests itself in all aspects of daily life and result in perpetual social upheaval and unrest. This seminar builds on the premise that urban form is a vessel for social norms and cultural practices. Once this urban form is removed, new norms and practices must be created, which can lead to social unrest and upheaval. Examples of this abound in modern history, some of which have resulted in successful revolutions.

ARCH 021/URPL 622 Istanbul: From Imperial Capital to Global Metropolis 3 cr.
This is a thematic course on the architectural and urban history of Istanbul from the mid fifteenth century up to the present. The course explores the built environment of Istanbul at different historical moments focusing on such themes as imperial ideology, patronage, cross cultural encounters, gender, multiculturalism, nationalism, globalization, informal settlements, and gentrification.

ARCH 024/URDS 624 Hybrid Beirut: Morphogenesis of the Contemporary City 3 cr.
Looking East and West, Beirut has developed its own response to early modernization through the assimilation of Western urban models and architectural trends. The resulting cultural hybridity and townscape diversity can only be understood by exploring the transitional years of the city formation and transformation from a medieval Arab-Islamic town in the 1840s to a showcase of the French Mandate in the Levant in the 1920s and 30s. This course is an attempt to read contemporary Beirut through its recent colonial past, and to trace the continuity and change in its social, economic, and cultural conditions as mirrored in the urban structure and building typologies.

ARCH 027 Regional Architecture: Lebanon 3 cr.
This course presents various aspects (mainly physical and social) of regional architecture in Lebanon, covering a period of over a century and a half (1970-1820). It introduces students to various typologies of local architecture, based on case studies of the city of Beirut as well as other rural areas in Lebanon. It also examines the importance of heritage architecture in shaping urban neighborhoods and socio-spatial practices and introduces urban renewal strategies in areas facing various forms of dilapidation.

ARCH 028 Generative Tropes of Contemporary Architecture 3 cr.
At the cusp of a new digital era, that of the parametric, laden with scripted form and built with a combination of digital and manual fabrication tools, this seminar will consider the production of architecture in the past two decades in search of formal tendencies– tropes or systems— that have been repeatedly utilized in the production of contemporary architecture. By categorically identifying these 'tropes,' the overarching pedagogical agenda of this seminar is to enable students to develop tectonic and formal literacy. The first part of this seminar will involve a survey of contemporary architecture in order to identify and categorize recurring formal tropes while introducing students to a thematic lexicon in contemporary architecture. The second part of the seminar will include projective and analytical diagramming of select buildings in order to identify part-to-whole relationships as generative tools in production of contemporary architecture while investigating the possibilities of genealogical relationships within the categories.

ARCH 031 On Housing 3 cr.
The course will expose students to housing typology, the study of housing types, through the intensive use of drawing as a critical tool of analysis and representation. Housing types will be analyzed using key local and global case studies drawn from the histories of architecture. Types are understood as distinct architectural inventions that are open to change and mutation. Questions related to the shifting boundaries between private and public, changing demographics, work/life patterns, climatic response and affordable housing will be addressed through the transformations of type.

ARCH 032/URDS 634 Contested Urban Heritage: Reconstructed Cityscapes 3 cr.
The seminar focuses on urban heritage and the politics of its identification, conservation, and reproduction in relation to processes of nation building and postwar reconstruction in the Arab world. The principal theoretical position recognizes heritage as an intrinsically contested notion. The seminar is interdisciplinary in its approach and aims at understanding urban heritage, not only as a historical product, but also as a negotiated entity reproduced every day through the dynamics of city life; social, economic, and political. Class discussions are set against theoretical works that include Bourdieu's Field of Cultural Production, Boyer's City of Collective Memory, Barthes' Semiology and the Urban, Lefebvre's Production of Space, Hewison's Heritage Industry and Hobsbawm's Invention of Tradition.

ARCH 033 Building Texts 3 cr.
The course investigates how the design of identities evolved in response to distinctive industrial, corporate, cultural and political sectors of operation, how it behaved independently across separate historical contexts, and how divergent trends ultimately converged into a homogeneous model built around the concept of the brand, deployed today to uniquely distinguish everything from business services to ideological views. Students will be exposed to and get to research the work of seminal identity designers/studios and landmark identity design programs, and examine cases of a less iconic nature that challenge common generalizations about the practice. Alongside this historical investigation, students will be introduced to critical viewpoints around the practice of identity design by examining a body of literature comprising key texts on the subject.

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 Cities After War 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 until the present. The focus will be on Lebanon as a primary laboratory of postwar reconstruction in the 1990s and 2000s, from which to explore, evaluate and generalize. 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.

GRDS 030 Turning Towards Conflict 3 cr.
This course inquires how we, as artists, designers, writers, and makers, can critically, meaningfully, and admittedly leisurely turn towards conflict. It is a seminar class in the history/theory category. It will therefore develop from student-led presentations and in-depth discussions of a complex set of overlapping topics: aesthetics and politics, poetics, representations of violence and other relevant themes that will organically emerge throughout the term based on the students' research interests.

GRDS 033 Pre-Brand: A History of Identity Design 3 cr.
The course investigates how the design of identities evolved in response to distinctive industrial, corporate, cultural and political sectors of operation, how it behaved independently across separate historical contexts, and how divergent trends ultimately converged into a homogeneous model built around the concept of the brand, deployed today to uniquely distinguish everything from business services to ideological views. Students will be exposed to and get to research the work of seminal identity designers/studios and landmark identity design programs, and examine cases of a less iconic nature that challenge common generalizations about the practice. Alongside this historical investigation, students will be introduced to critical viewpoints around the practice of identity design by examining a body of literature comprising key texts on the subject.

Elective Courses Category C: Technology, Professional Practice, Digital Media, Typography and Urban Studies

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 their 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 042 Collaborative Research Workshop 3 cr.
This course operates as an intensive multidisciplinary digital design workshop, aiming at engaging undergraduate students in a lab-based research environment. It aims at forging collaborative research projects among faculty and among students at AUB, linking art, craft, engineering, science, and technology with design. The course will engage in experimentation with materials and technology to develop collaborative projects that can impact the built and human environment, intersecting research methods with digital fabrication techniques the outcome of the course will be to produce a common physical outcome either as a built 1:1 scale intervention or as a physical prototype. Prerequisite: senior standing or consent of instructor(s).

ARCH 043 Assembling It All 3 cr.
This course teaches students how to develop innovative assemblies that allow the creation of advanced architectural facades, envelopes, roofs. The course bases itself on the knowledge acquired by the students in the two preceding building construction courses, about a building's materials, construction typologies and their detailing. It aims at advancing the students design and detail creation skills and know-how by teaching them how to use, adapt, modify and re-assemble building parts to create custom tailored assemblies of building envelopes to respond to specific conditions and design desiderata. To do so, the course analyzes detailed assemblies of envelopes made of various materials: precast concrete, GRC, metal skins, meshes, glass and polymer assemblies in addition to detailed assemblies for roofs clad with metal, glass, polymers.

Architecture Professional Practice

ARCH 060 Algorithm and Iteration 3 cr.
Using Grasshopper/Rhino 3D 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 061 DI-LAB Design-Impact Laboratory 3 cr.
DI-LAB course is designed to engage a group of young architects and engineers in designing and implementing community-based projects in Lebanon. It is a one-of-a kind platform that provides design and engineering services intended to improve the living conditions of marginalized and neglected communities. It aims for a participatory process that engages the beneficiaries and users in order to incubate sustainable development. DI-LAB is organized by the American University of Beirut, Department of Architecture and Design and the Center of Civic Engagement and Community Services (CCECS).

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, as well as the social and environmental impacts, on the built and un-built environments. 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 Do It, Then Fix It As You Go 3 cr.
The course introduces students to alternative ways in starting a design project, whether an object, an installation or a building. It is mainly a hands-on set of small exercises, through modeling, observing and description in a lab-like manner. Through these exercises, students will slowly discover how a ready-made can influence, guide and affect the course of evolution of a project and help in generating new ideas. The ready-made is a mindset preparation that will allow students to deconstruct preconceived ideas about design putting aside all a priori. The aim of such a methodology, that seems unrelated to the subject, will unknowingly allow them to lose their familiarity with the “project-to-be” and see it under a new light. This confrontational process has proven to be a dialectical tool that can be applied to any scale from a small object to an urban scale project. It is a method of work, a line of thought, a new line of investigation.

ARCH 064 Inclusive Design 3 cr.
The material in this course is designed to provide a detailed introduction to the inclusive/ universal design philosophy and a theoretical understanding of design tools and techniques.

ARCH 065 Architecture and Culture: Geometry and Design 3 cr.
The course will analyze cultural disciplines, meaning and practice in Islamic architecture from classic to contemporary works. Recognizing the paradigms of Islamic architecture, the course will concentrate on the essential role of geometry in design and urban planning. There will be an in-depth review and discussion of the direction and influence in design, with attention drawn towards a better understanding and discussion of the creative processes relevant to Islamic architecture and the crafts. Living and historic examples will be drawn from Andalusia, North Africa, the Middle East, Turkey, Iran, Arabia and the Indian subcontinent. A workshop will be conducted in Tunis, Fes, or Cairo at the beginning of the term.

ARCH 066/URPL 669 Building and Planning Codes 3 cr.
The class focuses on the spatial and design aspects of property development codes, offering both normative outlook and practical application. The course covers such topics as controls and regulations on development intensity, bulk, accessibility, egress, and health and safety. In a comparative approach, a theoretical overview of planning and building codes from the American context (with reference to best practice planning zoning acts and the international building code) will be used to study the Lebanese code.

ARCH 068 Design Innovation and Entrepreneurship 3 cr.
This course introduces the relationship between architecture and design, entrepreneurship, and business innovation, where students are invited to engage their skills beyond the architecture and design fields. The course underlines the role of design thinking as a core trigger to recognizing opportunities and processing them into innovative and successful ventures. With a focus on case studies of start-up companies, the course includes subjects such as establishing a clear project vision, assessing its business prospects, designing a solid business model, and developing a creative implementation strategy.

ARCH 069 New Territories 3 cr.
The course introduces students to digital design and fabrication through lectures and an applied project in which they will test and experiment with new digital and fabrication techniques. Digital fabrication, between advancements in software, simulation, and machinery, is pushing practice today towards more complexity. These techniques have set forth a revolution in the way we make buildings, where the process of making has radically changed from the traditional sequence of design-analyze-build to a more interactive and integrative process that intercrosses analytical tools with design, simulation and fabrication.

CIVE 601/URPL 641 Introduction to GIS and Spatial Analysis 3 cr.
This course offers an introduction to geographic information systems (GIS) as applied to urban and regional planning, community development and local government. Emphasis is placed on learning GIS technology and spatial analysis techniques through extensive hands-on exercises using real-world data sets such as the census of population and housing. The course includes a small project on an urban planning problem involving the selection of appropriate methods, the use of primary and secondary data, computer- based modeling and spatial analysis.

URPL 664 Urban Land Use Planning 3 cr.
This course examines the theory and practice of land use planning as it has developed within the wider practice and theorization of planning. The course explores the ways in which land use controls have been developed and managed in different institutional and regional contexts, unraveling the different conceptualizations of planning that support each of them. Special emphasis is placed on the case of Lebanon where the practice of land use planning is explored through a detailed introduction to planning institutions, agencies, and regulations.

CIVE 661/URPL 666 Urban Transportation Planning 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.

ARCH 070 Parametric Mapping and Analysis Algorithms 3 cr.
Students learn to extract geometric, climatic, and topographic data from local climatic statistical and satellite info using parametric tools such as grasshopper and building physics platforms such as energy plus and open studio. The charted data is applied through digital simulations to test the environmental and topological performance of massing and the built environment in a specific context. Students will also use optimization algorithms to test the best-fit iterations to the required parameters. The course outcome will help generate possible topological solutions and environmental strategies to adopt in a specific climate and context. Prerequisite: period ARCH 060.

ARCH 071 Research and Practices of Public Interest Design 3 cr.
The course explores Public Interest Design (PID), an approach where architectural projects result from a participatory approach involving the community in the design process. After mapping the different stakeholders involved in PID, students have the opportunity to survey needs of targeted communities and research methodologies and case studies that helped achieve humanitarian designs. Based on partnerships and a collaborative approach, students develop conceptual project proposals which contribute to solving issues affecting our society today.

ARCH 072 Earth: Design and Building 3 cr.
The course will investigate the developed techniques and creative design in earth architecture, from brick to city making. We will examine natural materials: stone, mud brick (baked and sundried), pisé or rammed earth, salt, coral rock, and shale. This architecture was integral to the environment and settlement patterns (urban and rural) of different cities, towns, and villages, hence its considerable ecological and sustainable impact. The course is based on first-hand materials, projects and living examples from contemporary sites across the region (Spain, Morocco to the Indian subcontinent) and modern earth projects globally. (previously ARCH 039)

ARCH 073 Sustainable Built Environments 3 cr.
A course that enhances knowledge pertaining to design aspects and application possibilities of climate responsive and environmentally friendly buildings. The impact of using construction building materials throughout the lifecycle of projects will also be discussed. At the end of the course, students will be equipped with the necessary knowledge that will enable them to make informed decisions regarding green projects in their careers.

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 consent of instructor.

GRDS 043 Advanced Digital Animation 3 cr.
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: 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 a sequential narrative, identifying characteristics of the lead elements (humanoid or design-based) and rendering these “personalities” in the way they move.

GRDS 046 Arabic Type in Motion 3 cr.
This course focuses on the integration of Arabic typography into motion design, recognizing its increasing importance in the graphic design field. While kinetic type is prevalent in digital media and branding, Arabic script often lags behind Roman type in this context. The course aims to bridge this gap by exploring the unique features of Arabic script, such as its anatomy, right-to-left direction, and connectedness (cursivity) to create innovative, kinetic Arabic typography. Students will engage in practical projects, discussions, and research to bring static Arabic text to life, addressing technical challenges along the way. Additionally, the course will cover the history of Arabic typography in screen-based media, offering insights from industry professionals.

Typography

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, calligraphy, as an art by itself and the other that ponders its reformist and media function or its applications in modern life. Prerequisite: GRDS 252.

Graphic Design Professional Practice

GRDS 060 Critical Mapping 3 cr.
The course aims to introduce students to the possibilities of mapping as a research method and 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 consent of instructor. For architecture students only.

GRDS 062 Brand Inc. 3 cr.
This course offers 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 lifecycle.

GRDS 063 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, students will produce a complete edited stop motion animation short film that will be publicly screened in the original setting. Prerequisite: GRDS 305 or consent of instructor. For architecture students only.

GRDS 066 Alternative Comics: The Study and Making of Graphic Narratives 3 cr.
Through this course students 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.

GRDS 064 Storytelling in Comics 3 cr.
This class focuses on crafting engaging stories through comics, emphasizing scriptwriting for a visual medium, page layout construction, and character development. Students are encouraged to tackle a variety of subjects, ranging from the fantastical to the intimate, always aiming to make contemporary concerns relatable, and taking full advantage of the narrative tools provided by the medium.

GRDS 050 Arabic Type Design 3 cr.
This course is an introduction to Arabic type design. It focuses on the skills and critical thinking required to design and produce digital typefaces. Lectures will take students through the history, technology and contemporary practices of the industry that has started to take shape during the past 20 years. Basic lettering skills will be explored to aid in the primary focus of creating a functional, flexible, and useful Arabic typeface. This course will enhance an understanding of the link between writing by hand, lettering, and type design; that is, the transition from script to digital.

GRDS 067 Fanzine 3 cr.
Printed matter has provided a way for artists and individuals to express themselves to just a few, or to many. This class will explore the use of alternative media and will build upon the lessons learned in the publication design class. Projects will apply a variety of specialized publications—some traditional and some completely free-form— allowing students to focus more specifically on the content of their printed pieces, while expanding on the techniques available to them when developing the form thereof. Using printing methods both high- and low-end as well as high- and low-tech, students will explore the ways in which serial media and other types of publications provide an outlet for personal expression. Students will be expected to view this class not as a 'how-to' but as a 'have to,' and they should be prepared to engage politically, socially, culturally, poetically, narratively, but most of all personally.

GRDS 068 Contemporary Jewelry Design 3 cr.
This course is an introduction to contemporary jewelry design spanning from the conceptual to the technical. It will cover a brief contemporary history, concept creation, technical drawing, prototyping and fabrication, as well as documentation and art-direction. The course proposes an experimental approach to sketching, making, and material exploration while maintaining a critical awareness of the social, political, cultural, and aesthetical issues in contemporary jewelry design.

Landscape Architecture

Mission Statement

The mission of the program is to graduate lifelong learners and critical thinkers who adopt a holistic view of the landscape, and who are equipped with interdisciplinary, scientific, and creative skills to start as entry-level landscape architects and to become, with experience, successful professionals serving their communities.

Program Description

This is a four-year professional program which leads to a bachelor of landscape architecture (BLA) and a diploma of ingénieur agricole. The program integrates sciences and the arts as a foundation to design, plan and manage landscapes in natural and urban settings.

The BLA program received accreditation from the Landscape Architectural Accreditation Board (LAAB) in September 2021 for a period of six years, making it the first BLA program worldwide to be accredited by LAAB outside the USA. LAAB is the academic arm of the American Society of Landscape Architects (ASLA).

The degree requirements in landscape architecture (BLA) consist of the following:

- complete a minimum of 144 term credit hours (out of which 108 credit hours of mandatory core courses).
- 27 credits hours of general education courses (Total GE requirement of 36 credit hours includes 9 credits satisfied within the landscape architecture core program).
- 9 credit hours of elective courses in FAFS.
- 3 credit hours of a core course in Community Engaged Learning (LDEM 263).
- achieve an overall minimum grade average of C+ GPA 2.3.
- be approved for graduation by the faculty.

To meet the general education requirements of AUB, BLA students must complete 27 credits of elective courses as following:

- 6 credit hours in Understanding Communication (English), including ENGL 203 and ENGL 204
- 3 credit hours in Understanding Communication (Arabic)
- 3 credit hours of an approved elective in Cultures and Histories
- 3 credit hours of an approved elective in Human Values
- 6 credit hours of approved electives in Societies and Individuals, including LDEM 262
- 3 credit hours of an approved elective in Quantitative Reasoning
- 3 credit hours of an approved elective in Understanding the World.
- Additional Thematic requirements:

One of the GE courses above has to cover the theme of History of Ideas (CHLA designation), and one course has to cover the theme of Social Inequalities.

Curriculum for the Degree of Bachelor of Landscape Architecture (BLA) and Diploma of Ingénieur Agricole

First Year

Fall Term		Credits
LDEM 202	Studio I: Landscape Design Fundamentals	4
LDEM 200	Landscape Technical Drawing	4
LDEM 214	Landscape and Geomorphology	3
LDEM 207	Landscape Architecture History I (Cultures and Histories)	3
ENGL 203	Understanding Communication - English	3
		Total 17

Spring Term		Credits
LDEM 216	Studio II: Landscape Garden Design	4
LDEM 201	Landscape Descriptive Drawing	4
LDEM 217	Soils in the Landscape (Understanding the World)	3
LDEM 291	Surveying and Base Plan Development	3
LDEM 211	Landscape Horticulture	3
		Total 17

Summer Term		Credits
LDEM 252	Computer Aided Design	3
1 General Education Requirement - Cultures and Histories Elective		3
		Total 6

Second Year

Fall Term		Credits
LDEM 222	Studio III: Landscape Planting Design	4
LDEM 210	Botany and Plant Ecology for Landscape Architects	3
LDEM 248	Site Engineering: Construction Material	3
LDEM 219	Plant Material I	2
1 General Education Requirement - Understanding the World Elective		3
		Total 15

Spring Term		Credits
LDEM 204	Studio IV: Cultural Landscape Design	6
LDEM 208	Landscape Architecture History II (Cultures and Histories)	3
LDEM 247	Site Engineering: Earthworks, Roads, and Drainage	4
LDEM 263	Landscape Appreciation and Site Analysis (Community-Engaged Learning course)	3
LDEM 221	Plant Material II	1
		Total 17

Summer Term		Credits
LDEM 249	Site Engineering: Design Implementation	3
LDEM 231	Sustainable Water Management Techniques	3
FAFS Elective		3
		Total 9

Third Year

Fall Term		Credits
LDEM 246	Studio V: Natural Landscape Design	6
LDEM 251	Geographic Information System (GIS)	3
LDEM 218	Landscape Ecology	3
1 General Education Requirement - Societies and Individuals Elective		3
		Total 15

Spring Term		Credits
LDEM 228	Studio VI: Urban Landscape Design	6
LDEM 265	Landscape Management	3
1 General Education Requirement - Quantitative Reasoning Elective	Any course from the GE list, except; MATH 203 (only students coming from Humanities school background can take it); EDUC 271, EPHD 203, and NURS 203	3
LDEM 290	Professional Practice	3
		Total 15

Summer Term		Credits
LDEM 292	Internship (Practicum)	2
		Total 2

Fourth Year

Fall Term		Credits
LDEM 241	Studio VII: Landscape Capstone Project I	4
LDEM 260	Contemporary Issues in Landscape Architecture	3
ENGL 204	Understanding Communication - English	3
FAFS Elective		3
1 General Education Requirement - Societies and Individuals Elective		3
		Total 16

Spring Term		Credits
LDEM 242	Studio VIII: Landscape Capstone Project II	6
ARAB	Understanding Communication - Arabic	3
FAFS Elective		3
1 General Education Requirement - Human Values Elective (Ethics course)		3
		Total 15

Course Descriptions

Mandatory Core Courses

The following design courses are part of the program requirements. There is a grade average requirement for LDEM 202, LDEM 216, LDEM 222, LDEM 204, LDEM 246, LDEM 228, LDEM 241 and LDEM 242. Students should maintain a combined average GPA of 2.3 in any two consecutive design studios within any given year during their BLA course of study. Failure to achieve this will result in the students having to repeat the design studio in which they received the lowest grade.

In addition to the above GPA 2.3 rule, students will be allowed to register LDEM 241 and LDEM 242 (Final Year Capstone Project I and II) only if they have successfully met studio passing requirements and passed all core courses prior to the final year.

LDEM 200 Landscape Technical Drawing 4 cr.
This is a course in descriptive geometry and graphic communication in landscape 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 that cover construction of shades and shadows, as well as representation of open space, trees, and elements of the natural and built landscapes. Students are introduced to the basics of manual and digital drawing techniques. The technical drawing techniques are regulated by a set of worldwide conventions used to clarify and visualize ideas and design process.

LDEM 201 Landscape Descriptive Drawing 4 cr.
The focus of the studio is to emphasize visual thinking techniques and graphical information representation. Through the use of multiple media to sketch and draw the landscape, students learn to understand their environment through developing skills in mapping information, understanding their relationships and graphically representing it.

LDEM 202 Studio I: Landscape Design Fundamentals 4 cr.
This course is the first of two fundamental design courses (the second is LDEM 216). It is a foundation for subsequent design courses. It introduces students to theories of design through readings, analysis and hands-on projects. The course is structured as a series of short exercises and is divided into two parts:

Part 1: Fundamental Elements of Landscape Design
This course is an exploration into the modes of space which are two-dimensional surfaces, three-dimensional objects, spatial enclosure and the open continuous landscape. The emphasis is on the media of landform, water, plants, and structures as defining agents of human space in the garden and the landscape at large. The form and character of the space is further determined by the context of the site and the nature of spatial geometry with studies of form, pattern, texture, tone, and color.

Part 2: Basics of Design
This studio introduces students to reading and responding to the site. Goals include learning to experience and record the landscape, design in response to the site, think creatively, generate design ideas and understand design as a process, gain knowledge of design precedents and principles, and learn tools and techniques of visual expression. Students will learn through in-class exercises, reading assignments and design projects. Studio time is divided among lectures, field trips, studio design work, desk critiques, pinups, and presentations.

LDEM 204 Studio IV: Cultural Landscape Design 6 cr.

Part 1: Cultural Landscapes
The cultural landscape studio introduces students to the process of research, planning, design, and management of historically and culturally significant landscapes through selected real-world site projects. Part one introduces methods of assessment, approaches and policies (local and international), case studies of similar projects as well as historical analysis of the study area.

Part 2: Historic Preservation and Design
The course explores landscape design proposals for sites within historically significant areas. Emphasis is on methods of analysis and design development. Graphic and photographic documentation of existing built forms serve as the basis for design proposals. Students engage in the following five steps in the process of their study: 1) Students investigate a landscape's site history using primary and secondary resources. 2) They analyze, document, and evaluate existing conditions. 3) They interpret the significance of the natural, historic, and cultural importance of the landscape site. 4) They recommend appropriate treatment strategies. 5) Finally, they present the findings of this research process. Prerequisite: LDEM 222.

LDEM 207 Landscape Architecture History I 3 cr.
This course aims to explore significant transformation in landscape architecture history and present a range of information to enable the development of alternative, diverse and nuanced communication tools for issues of the landscape. A series of lectures combined with literature study and a visual and textual project analysis aims to guide students to be able to analyze, evaluate and understand historic landscapes in contemporary society. (Students who receive credits for LDEM 207 cannot receive credits for LDEM 107. Fall only).

LDEM 208 Landscape Architecture History II 3 cr.
The course aims to explore the development of designed landscapes and manifestations of landscape architecture from the 18th century to the present. By investigating the complex relationships between people and their environments, it will shed light on the shaping of outdoor space and the evolution of human settlements within built and natural settings. The course will provide a critical and historical understanding of landscape architecture as ideology, experience, spatial form and profession. It will focus on pioneers within the field and on historical examples of gardens, parks, community spaces and environmental planning strategies, which explain landscape designs as products of cultural, political, social, and environmental influences. Prerequisite for LDEM students only: LDEM 207. (Students who receive credits for LDEM 208 cannot receive credit for LDEM 108. Spring only).

LDEM 210 Botany and Plant Ecology for Landscape Architects 3 cr.
This course tackles key concepts, principles and current issues in botany, plant ecology and plant conservation and discusses their application to the Middle East region and to landscape architecture. The course is structured to include peer teaching, debates, and discussion of articles and case studies. Upon completion of the course, students will have solid knowledge and a reference base to readily integrate natural and human made vegetation into their designs.

LDEM 211 Landscape Horticulture 2.3; 3 cr.
This course covers basic principles of selection and management of landscape plants. Students will learn how to select plants appropriate to site and purpose, and will be introduced to concepts and applications of environmental horticulture and its contribution to the well-being of humans and nature. The course relies on hands-on field projects, site visits, essays, and photo-documentation.

LDEM 214 Landscape and Geomorphology 3 cr.
This course provides crucial insights on how landforms and hence landscapes develop in space and time. It introduces students to the geomorphological underpinnings of landscape formation and trains them to read the natural and anthropogeomorphic aspects of landscapes.

LDEM 216 Studio II: Landscape Garden Design 4 cr.
This course is the second of two design introductory courses. It is a foundation for subsequent courses that explore project design in varied contexts and scales. It introduces students to theory and practice of landscape design and site planning by doing, observing, reading, and reflecting. Students apply knowledge acquired from LDEM 202 on real site contexts with an emphasis on site design. The focus is on two dominant landscape design types: the park (public) and the garden (private). Students will analyze case studies and relevant readings pertaining to both landscape typologies. Prerequisite: LDEM 202.

Part 1: The Park
The focus is on the application of spatial theory and design process to a specific site context. Work will develop map-reading skills at various scales and strengthen drawing, lettering, and cross-section representation skills. The emphasis is on landform design in a public park setting (urban and non-urban).

Part 2: The Garden
The garden is a personal, direct, and intimate expression of landscape architecture. It is explored here as a contemporary art primarily through the design of individual sites and, secondarily, through guided research and discussion sessions which explore important works and design theory in the genre. The emphasis is on developing an informed and creative personal approach that inspires while solving practical problems on real sites. The focus here is on residential gardens or gardens pertaining to institutions.

LDEM 217 Soils in the Landscape 2.3; 3 cr.
This course will examine soils as integral components of the landscape and as a medium for landscaping activities. It is designed to help students 1) acquire a good understanding of the relationship between geology, landform, soil, vegetation, and landscape, and 2) implement management actions essential in landscaping, such as soil preparation, soil amendment and fertilization. Emphasis will be placed on soils as a component of Mediterranean ecosystems and land mosaics with special focus on soil resources in Lebanon. Labs and field trips will be organized in order to observe and analyze soils in the environment, and to manipulate soil substrates for optimizing plant growth. Prerequisite for LDEM students only: LDEM 214.

LDEM 218 Landscape Ecology 3 cr.
Students will be introduced to the discipline of landscape ecology. The course will focus on the interplay between landscape patterns and ecological processes at large (landscape scale). It also focuses on detecting and characterizing social and natural patterns of influence on landscapes and landscape dynamics. Implications of landscape pattern and landscape management will also be covered. Case studies will be selected from different Mediterranean environments where the co-evolution of human communities with the natural settings have permanently shaped and modified landscape structures and ecosystem functions. The course will also explore applications in relevance to landscape architecture and planning. Prerequisites: LDEM 210 and LDEM 217.

LDEM 219 Plant Material I 1.3; 2 cr.
This course will introduce students to the botanical and horticultural dimension of designed landscapes by focusing on the species and cultivars that have a landscape interest. In the process of learning about landscape plants, students will be introduced to the taxonomic, horticultural, ornamental and landscape aspects of approximately 300 plants during the sessions. Emphasis is placed on major categories of herbaceous plants and woody plants used in landscape including trees, shrubs, vines, flowering plants, ornamentals, and hedge plants commonly utilized in this region by a combination of experiential activities, discussions, online resources and homework assignments. Students will also learn the proper selection and usage of these plants in landscape situations, plant assets and liabilities, alternative plants for various situations and cultural aspects.

LDEM 221 Plant Material II 0.3; 1 cr.
This course will introduce students to the botanical and horticultural dimension of designed landscapes by focusing on the species and cultivars that are used in edible and medicinal native and urban gardens. In the process of learning about landscape plants, students will be introduced to the taxonomic, horticultural, ornamental and landscape aspects of approximately 150 plants during the sessions. Emphasis is placed on major categories of herbaceous plants, as well as on woody ornamentals, fruit trees and native plants used in the landscape including trees, shrubs, and vines. Students will also learn the proper selection and usage of these plants in landscape situations, plant assets and liabilities, alternative plants for various situations and cultural aspects.

LDEM 222 Studio III: Landscape Planting Design 4 cr.
The course introduces students to the basic principles of designing with plants. Landscape architecture combines elements of art and science to create a functional, aesthetic, and spatial experience of the outdoor space. One initial purpose of designing with plants is to understand how to blend technology (the built environment) into the natural surroundings and to bring natural elements into the built environment. In order to work towards a desirable landscape design and hence successful planting plan, students will develop working knowledge of artistic elements, design principles and basic horticultural knowledge of plants. Successful plant composition and layout is obtained with acknowledgement of the importance of plants as a design material that enhances the definition and spatial experience of outdoor spaces. Prerequisites: LDEM 216, LDEM 211, and LDEM 219.

LDEM 228 Studio VI: Urban Landscape Design 6 cr.
The focus of this studio is site design in the urban context. As such, it will enable students to explore the particular challenges of designing in complex urban environments. By their nature, urban environments have multiple layers and meanings and are influenced by an array of forces. Urban landscapes are an amalgam of myriad social, cultural, political, economic, and ecological processes on physical space. Designing in the urban context therefore requires sensitivity to these many layers and influences. Creative response to the challenges of urban environments requires careful attention to the landscape narratives students choose to tell, and how users of a space learn and discover new things from a site. Prerequisite: LDEM 246.

Part 1: Understanding and Analyzing Urban Landscape Systems
The purpose here is to briefly overview basic concepts of urbanism (transportation, infrastructure, zoning laws, real estate markets, economic development, social issues and so on) with strong emphasis on understanding urban open spaces and networks through readings. Students will analyze case studies of similar contexts and analyze urban landscape systems pertaining to the study area.

Part 2: Study Area
An application of urban design theories to various scales of urban design, with special focus on civic scale design elements and spatial and functional requirements. The end goal is to design a landscape system or site with an urban context.

LDEM 231 Sustainable Water Management Techniques 3 cr.
The course will focus on water as a scarce resource in Lebanon and the region. Students will be exposed to theoretical and practical aspects of sustainable water resources management as related to landscape design, namely in the areas of demand efficient water use and management. Students will learn about efficient indigenous and exotic landscape irrigation, surface and subsurface drainage design, rainwater harvesting and water conservation. Offered in the summer term only.

LDEM 241 Studio VII: Landscape Capstone Project I 4 cr.
This course is intended to assist students in selecting an individual capstone project, finding, and organizing appropriate information needed for the project, and establishing parameters and questions for the design and development of the project. The studio focuses on an approved design problem requiring individual work, which will serve as a comprehensive examination. Preparation and presentation include a written and graphic problem statement, analysis and detailed plans or other approaches approved by the instructor. Prerequisites: LDEM 228 and LDEM 246.

LDEM 242 Studio VIII: Landscape Capstone Project II 6 cr.
This course includes the Final Year Project (FYP), conducted with a faculty adviser, and includes collection, analysis, and interpretation of project information. The final studio covers a variety of projects that may include landscape design projects involving fine arts, urban design, and town planning. Students are expected to achieve a comprehensive understanding of ideas, processes, and concepts. This is the capstone project where students demonstrate their acquired design skills and knowledge. They are expected to develop their design, produce presentation drawings, and defend their ideas orally at a professional level. Students are assessed by department faculty. Note: This course fulfills the capstone writing intensive requirement for the Landscape Architecture major. Prerequisite: LDEM 241.

LDEM 246 Studio V: Natural Landscape Design 6 cr.
This course examines the relationship between ecological landscape design and natural elements/ resources. The emphasis is on understanding natural and human/cultural systems and the interactions across. Of primary importance is understanding of ecological processes that occur within. Students will learn the significance of these systems and their potential contribution to sustainable environments while highlighting the threats and opportunities from anthropogenic impacts. As a design studio, students will explore landscape planning and design from the regional to the site-development scale and they will learn how to integrate ecological design and planning frameworks within their design proposals to balance human use and ecological integrity. This will require the ability to synthesize information about natural features, cultural resources, and development patterns to create spatial landscape strategies that address the unique problems and opportunities of a chosen study area. Prerequisite: LDEM 204.

LDEM 247 Site Engineering – Earthworks, Roads and Drainage 4 cr.
This is the second of the three courses in the LDEM site engineering sequence. This course focuses on the study of techniques essential to the horizontal and vertical development of site designs; emphasis on grading, cut and fill calculation, storm-water drainage and management, erosion control, road alignments and earthwork. This is a lecture course with intensive exercises for engineering calculation and drawing techniques. Prerequisite: LDEM 248.

LDEM 248 Site Engineering - Construction Material 3 cr.
This is the first of the three courses in the LDEM site engineering sequence. This course will serve as a capstone to landscape architectural construction with emphasis on understanding and preparing complete sets of construction documents for landscape architecture projects. It includes methods and procedures necessary for transforming a design idea into a set of construction drawings that is accurate, precise and clearly understood; and the principles, processes and techniques of site engineering for the “hard” and “soft” elements of landscape architecture and surfaces, including wood construction, free-standing and retaining walls, pavement, steps, decks, lighting and planting irrigation. Students will also implement their designs through hands-on experience.

LDEM 249 Site Engineering - Design Implementation 2.5; 3 cr.
This is the third and last of the three courses in the LDEM site engineering sequence. This course includes presentation and classification of landscape construction and materials: in particular, material types and measurement standards of construction elements. Floor elements, such as paving materials, pedestrian ways, stairs and ramps, are emphasized. Border and enclosure elements, such as walls and fences, are studied. Shelter elements, such as pergolas and gazebos, are explored. Water elements, such as ponds, waterfalls, pools, and fountains, are studied. Outdoor space, furniture, and ornaments, such as benches, litterbins, lighting elements, pedestrian bridges, and decks, are focused upon. Interactions between materials, buildings, spaces, and humans will be explored. Research studies and case studies will be conducted for designing original landscape construction and material. This studio course will focus on lectures, exercises and projects dealing with landscape equipment, and design methods. In addition, students have exposure to measuring quantities and defining specifications. Prerequisites: LDEM 247 and LDEM 248. Offered in the summer term only.

LDEM 251/LDEM 632 Geographic Information System (GIS) 2.3; 3 cr.
This course acquaints students with classical and modern methods of landscape analyses as well as assessment and changes in landscape structure using ArcGIS and its extensions. Students will be gradually introduced to the subject both to acquire and integrate geographic data, and to learn how to analyze and interpret the results. All topics are demonstrated on selected tasks. The goal of this course is to explore various approaches to modeling landscape pattern and change. The focus is on the design and use of computerized geographic information systems for land planning and design decisions and on understanding, describing, and predicting land-use and land-cover. The course will move between social and ecological processes and applications of the models. Students will learn to evaluate the trade-offs associated with use of a particular modeling approach within a given situation, and to implement (at least minimally) several of the approaches discussed.

LDEM 252 Computer Aided Design 4.5; 3 cr.
This is an introductory course that covers computer aided design digital drawings to develop skills for landscape architects to communicate, create and implement. The course includes lectures and computer labs focused on learning the basic commands for drawing in two dimensions including: absolute and relative coordinates; working in layers, paper, and model space; manipulation of text and plotting. The focus is on understanding the software environment and basic applications of AutoCAD and on using relevant tools of this graphic design software to develop high quality landscape design graphic outputs, such as diagrams, perspectives, sections, plans, and 3D models. These skills will enable students to employ computer graphic design tools in landscape architecture studios throughout the rest of their degree courses. Prerequisite: LDEM 200. Offered in the summer term only.

LDEM 260/ URDS 630 Contemporary Issues in Landscape Architecture 3 cr.
This course addresses recent trends in landscape architecture that cover the multitude of approaches, in order to broaden the students' theoretical knowledge, encourage their critical and analytical abilities, and sharpen their understanding of systems and the landscape as a cultural expression. The course discusses recent interventions by landscape architects in different parts of the world and assesses them in relation to their natural, cultural and socioeconomic contexts. At the same time, students are asked to critically evaluate the current open space situation in Beirut and discuss ideas and approaches related to it. Prerequisites (for LDEM students only): LDEM 207 and LDEM 208.

LDEM 263 Landscape Appreciation and Site Analysis 3 cr.
This course introduces students to specific landscapes of Lebanon and teaches them how to read spaces by analyzing the interrelationship between natural conditions, human settlement, and land use over time. The course is based on an integrated view of the landscape, taking into consideration both natural and cultural components. Students will be exposed to different approaches to perceiving, reading, and interpreting the landscape. Prerequisite: LDEM 291.

LDEM 265 Landscape Management 3 cr.
This course is designed to help students acquire the necessary knowledge to produce landscape management manuals. Students will also have the opportunity to learn about the various aspects and issues related to landscape management by reading and discussing peer-reviewed articles related to the field or observing the management of actual projects. Prerequisites: LDEM 211, LDEM 217, and LDEM 231.

LDEM 290 Professional Practice 3 cr.
The course discusses the professional practice of landscape architecture. It is structured to give students an overview of the professional opportunities, roles, and responsibilities within which graduates of the program will most likely practice their trade. The course will be structured as a series of lectures, workshops, discussions and presentations from practicing landscape architects, engineers and other professionals who will expose students to different aspects of the trade. It introduces basic issues in the practice and profession of landscape architecture, challenging the students to critically examine professional, ethical, economic, political, social, and other issues in the current practice. It covers the different typologies of landscape projects, firms and clients, and introduces the full cycle of a landscape project from award and conception to construction and site supervision.

LDEM 291 Surveying and Base Plan Development 2.3; 3 cr.
The course focuses on the fundamentals of plane surveying: basic measurement of distance, angles, and elevations. It also focuses on the use of basic surveying equipment, such as total stations, levels and tapes, theodolites field notes; and basic computations, such as traverse closure and determination of areas. It is comprised of lectures and studio projects dealing with earthwork estimating, storm water management, site surveys, site layout, and horizontal and vertical road alignment. Students will survey a site, collect, and analyze data and transform measurements into a base plan essential for any design process. This will include features such as topographic contours, spot levels, structures, vegetation, water ways, and utilities.

LDEM 292 Internship (Practicum) 2 cr.
The objective of the landscape architecture internship is to offer students the opportunity to broaden their educational experiences by actively participating in a professional landscape architecture, planning, and/or engineering office environment. The intention is to provide an opportunity for exploring the world of landscape architectural practice through professional and reflective activities that address educational goals and objectives. Prerequisites: LDEM III standing and LDEM 290. Offered in the summer term only.

Elective Courses

LDEM 107 Landscape Architecture History I 3 cr.
The purpose of this course is to investigate the history of landscape architecture and understand the process of creating it. The course outlines the principles of landscape history in relation to the history of art, nature, technology, and culture in general and tries to interpret their scientific and artistic meaning within the current debate on the goals of landscape architecture among the other design disciplines. (Students who receive credits for LDEM 107 cannot receive credits for LDEM 207. Freshman-level. Fall only).

LDEM 108 Landscape Architecture History II 3 cr.
The course explores the development of designed landscapes and manifestations of landscape architecture from the 18th century to the present. It will focus on pioneers within the field and on historical examples of gardens, parks, community spaces and environmental planning strategies, which explain landscape designs as products of cultural, political, social, and environmental influences. (Students who receive credits for LDEM 108 cannot receive credits for LDEM 208. Freshman-level. Spring only).

LDEM 203/FEAA 400 The Environment and Sustainable Development 3 cr.
This interdisciplinary course introduces students to the principles and practices of sustainability through the lens of socioecological systems. It examines human-environment interactions in the Anthropocene, using frameworks such as Planetary Boundaries and Doughnut Economics. The course integrates systems thinking with technical and design perspectives and invites students to critically explore how sustainability and resilience can be integrated into their disciplines. A strong emphasis is placed on community engagement, encouraging students to interact directly with local stakeholders and develop context-aware solutions for real-world environmental challenges.

LDEM 230 Water and the Environment 3 cr.
This is an introductory course addressing the interactions between water and the natural environment, and the role of human activities in these interactions. This course covers a broad range of topics, including climate change, the hydrologic cycle, watershed hydrology, runoff generation, groundwater, point and nonpoint sources of pollution, best management practices and a multitude of water quality issues. Local, regional, and international case studies will be covered to foster a better understanding of water quality and quantity concepts, applications, and principles. (Open to all students except LDEM students).

LDEM 254/ARCH 061L Regional and Community Studies 1.3; 3 cr.
The department will identify a community-driven project in which local and possible international students will participate. The target community will be selected at least 6 months prior to the start of the summer term. The selection process will depend on input from outreach activities performed by the department and by other academic units with which the department coordinates closely, such as NCC and CCECS. This course focuses on applied knowledge and is thus taught by doing, as in by creating a design that is ready to be applied as well as a full proposal. Landscape designed elements are thus site/context dependent; therefore, applied ecology and cultural landscape history are important to concept development. Students enrolled in the course will work fourteen days on site with community partners and stay with local families during that period, and spend 1 week on campus working on the design and proposal. Working together in groups, students will create a practical design. Using a combination of lectures, discussions, interactions with nature, hands-on projects and community immersion, students will analyze the local environment and design holistic systems that meet the needs of people while respecting the needs of nature.

LDEM 261 Spatial Structure and Movement 3 cr.
The course is concerned with the experience of outdoor and indoor spaces, and the direct influence the placement of any object has on the perception of the latter and on the movement within. The course is based on the assumption that the notion of movement and body proportion for mankind has been a primary design tool throughout history and will try to reevaluate this tool for contemporary design.

LDEM 262 Healing Nature: Theoretical Perspectives and Applications 3 cr.
This course investigates the relationship between people and nature and seeks to deepen students' sense of connection with the natural world. There is a large body of literature that sheds light on the beneficial effects of nature. Students will learn about theories that explain how nature, outdoor green spaces and gardening have a positive impact on our lives and well-being. They will be introduced to current research findings and be trained in reading and comprehending peer-reviewed articles related to this field. Students will learn basic research methods and use these to implement class projects to gain first-hand experience of people's response to nature.

LDEM 264 Interior Landscaping 2.3; 3 cr.
This course is an introduction to the principles and practices of interior landscaping with an emphasis on plant selection and handling, environmental conditions, specifying and maintaining healthy plant materials, developing portfolios of interior planting designs and details for proper installation of drainage and irrigation, and fixed or movable containers. The course also includes design compositions of planned interior landscapes in a creative and aesthetic environment and the availability of plant material on the market.

LDEM 266 Introduction to Edible Landscapes 3 cr.
This course introduces students to the principles of edible landscaping and offers an overview of the history and significance of the topic in our region. Edible landscapes incorporate fruit trees, vegetable plants, as well as wild edible plants in a way that is both productive and aesthetically interesting. The course will shed light on the history and the evolution of human settlements in relation to edible and food growing landscapes within built and natural settings.

LDEM 267 Introduction to Restoration Ecology 3 cr.
This course introduces various practical tools required for the recovery of various degraded, damaged, or destroyed ecosystems with an emphasis on urban ecosystems.

LDEM 268 Introduction to Permaculture Design 3 cr.
Permaculture is an ethically-based design approach which aims to create sustainable human communities through ecological and regenerative design. This course covers the theory and basic principles of permaculture. Students will develop a good knowledge about the permaculture ethics and principles, their applications and how these can be integrated both at urban and at rural surroundings.

LDEM 270 Ornamental Plants for Dry Landscapes 3 cr.
This course is a survey of native, wild, and domesticated plants adapted to dry areas with potential use in dry landscapes, with an overview of the different environmental and physiological factors that determine plant growth and development under such dry conditions.

LDEM 271/ARCH 073/CIVE 686/MECH 681 Sustainable Built Environments 3 cr.
This course enhances knowledge pertaining to design aspects and application possibilities of climate responsive and environmentally friendly buildings. The impact of using construction building materials throughout the lifecycle of projects will also be discussed. At the end of the course, students will be equipped with the necessary knowledge that will enable them to make informed decisions regarding green projects in their careers. Prerequisite: LDEM III or LDEM IV or graduate standing and consent of instructor.

LDEM 272 Landscape Architecture: Gender, Women, and Inclusion 3 cr.
The course places the concept of inclusion and gender at the center of explorations of landscape architecture. It investigates the complex relationships between people and their environments, and the ways in which people read, experience, define and create landscapes. It places an emphasis on the role of women in particular, and the way in which women have shaped, and have been shaped by, their physical environments. It looks at women as users, as thinkers and community leaders, as well as designers, and highlights their overall influence on landscape theory and practice from these different perspectives.

LDEM 298 Special Topics in Landscape Architecture: Project/Workshop 1; 2 or 3 cr.
The project/workshop course provides opportunities for students to participate in hands-on experiences, gain new skills and be exposed to real projects. Students will work on issues and applications that are not included in regular courses. General prerequisites will be identified whenever the project/workshop course is offered. The topic, format, and prerequisites will vary; therefore, it might be repeated for credits.

LDEM 299 Special Topics in Landscape Architecture: Tutorial 1; 2 or 3 cr.
The tutorial provides opportunities for students to pursue directed study readings and preliminary research relevant to their concentration when existing courses do not offer the required subject matter. It covers special topics developed under the direction of a faculty member on a tutorial basis. The topic, format, and prerequisites will vary; therefore, it might be repeated for credits.

Baha and Walid Bassatne Department of Chemical Engineering and Advanced Energy

Chairperson	Ahmad, Mohammad
Professor	Ahmad, Mohammad
Associate Professors	Al-Hindi, Mahmoud; Azizi, Fouad; Saad, Walid; Zeaiter, Joseph
Assistant Professors	Ghorayeb, Kassem; Maalouf, Elsa
Instructor	Itani, Adnan
Assistant Instructor	El Berjawi, Mohammad

The Baha and Walid Bassatne Department of Chemical Engineering and Advanced Energy offers two undergraduate degree programs, bachelor of engineering in chemical engineering (BE ChE), and bachelor of science in chemical engineering (BS ChE), a minor in chemical engineering, and a minor in petroleum engineering.

Bachelor of Engineering (BE) Major: Chemical Engineering

Mission

The mission of chemical engineering in MSFEA 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 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 while always maintaining ties with the university.
- apply their scientific knowledge and engineering skills in graduate studies and/or industry.
- 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) in chemical engineering is a five-year program. It consists of 180 term credit hours of coursework, of which 30 credits are completed in the freshman year while students are enrolled in the Faculty of Arts and Sciences, and of which 150 credits are completed in four years while the students are enrolled in the Maroun Semaan Faculty of Engineering and Architecture. Students who are admitted at the sophomore level will be required to complete 150 credits in four years to earn the degree as outlined here:

General Engineering Fundamentals (16 credits)		
FEAA 200	Introduction to Engineering and Architecture	3 cr.
CIVE 210	Statics	3 cr.
EECE 210	Electric Circuits	3 cr.
EECE 231	Introduction to Programming Using C++ and MATLAB	3 cr.
MECH 220	Engineering Graphics	1 cr.
INDE 302	Operations Research 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.
Science Elective	(From approved list)	3 cr.
Science Elective	(From approved list)	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 expected to complete:

- 6 credits in Cultures and Histories
- 3 credits in History of Ideas (From CHLA)
- 6 credits in Societies and Individuals (including 3 credits from ECON 212) and (3 credits from Cultures and Histories or Societies and Individuals should cover the theme of Social Inequalities refer to the GE list)
- 6 credits in understanding communications (ENGL 203 and ENGL 206)
- 3 credits in understanding communications (Arabic)
- 3 credits Community Engaged Learning satisfied by the FYP course
- 3 credits Human Values (INDE 410 or PHIL 210)

Core Chemical Engineering Courses (58 credits)		
CHEN 201	Chemical Process Principles	3 cr.
CHEN 214	Thermodynamics I	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 Operations Lab	3 cr.
CHEN 411	Heat and Mass Transfer Operations	3 cr.
CHEN 417	Reaction Engineering and Reactor Design	3 cr.
CHEN 415	Mechanical Unit Operations	3 cr.
CHEN 431	Materials Engineering and Corrosion	3 cr.
CHEN 451	Process Control	3 cr.
CHEN 470	Chemical Process Design	3 cr.
CHEN 480	Safety and Loss Prevention	3 cr.
CHEN 500	Approved Experience	6 cr.

CHEN 501	Final Year Project I	3 cr.
CHEN 502	Final Year Project II	3 cr.
CHEN 541	Biochemical and Bioprocess Engineering	3 cr.
CHEN 570	Process Synthesis and Optimization	3 cr.
CHEN 571	Chemical Product Design	3 cr.

Chemical Engineering Electives (12 credits) Students can choose courses from the following list and any new (CHEN -600 level course or above)		
CHEN 413	Water and Wastewater Treatment	3 cr.
CHEN 490	Fundamentals of Petroleum Engineering	3 cr.
CHEN 499	Undergraduate Research	3 cr.
CHEN 590	Petroleum Refining	3 cr.
CHEN 591	Natural Gas	3 cr.
CHEN 593	Reservoir Petrophysics	3 cr.
CHEN 592	Production Engineering	3 cr.
CHEN 595	Drilling Engineering	3 cr.
CHEN 594	Reservoir Engineering	3 cr.
CHEN 6XX	(CHEN 600-Level and above)	3 cr.
CHEN 610	Materials Design and Characterization	3 cr.
CHEN 611	Transport Phenomena	3 cr.
CHEN 612	Desalination	3 cr.
CHEN 613	Membrane Separation Processes	3 cr.
CHEN 614	Environmental Engineering Separation Processes	3 cr.
CHEN 615	Advanced Mass Transfer	3 cr.
CHEN 617	Chemical Reactor Analysis and Design	3 cr.
CHEN 618	Colloid and Interface Science	3 cr.

CHEN 619	Sustainability Science: Human and Environment Interaction	3 cr.
CHEN 620	Reaction Engineering and Reactor Design II	3 cr.
CHEN 630	Sustainable Biorefinery Processes	3 cr.
CHEN 632	Carbon Capture, Usage, and Storage	3 cr.
CHEN 651	Advanced Process Control	3 cr.
CHEN 670	Advanced Process Flow-Sheeting	3 cr.
CHEN 672	Polymer Science	3 cr.
CHEN 673	Engineering of Drug Delivery Systems	3 cr.
CHEN 674	Process Operations and Diagnosis	3 cr.
CHEN 675	Tissue Engineering	3 cr.
CHEN 690	Reservoir Engineering	3 cr.
CHEN 691	Reservoir Characterization: Carbonate Rocks	3 cr.
CHEN 696	Reservoir Modeling	3 cr.
CHEN 697	Reservoir Economics and Risk Management	3 cr.
CHEN 798A	Waste Minimization in the Process Industry	3 cr.

Curriculum for BE in Chemical Engineering

First Year (31 credits)

Term I (Fall)		Credits
FEAA 200	Introduction to Engineering and Architecture	3
CIVE 210	Statics	3
EECE 210	Electric Circuits	3
MECH 220	Engineering Graphics	1
MATH 201	Calculus and Analytic Geometry III	3
ENGL 203	Academic English (Understanding Communication)	3
		Total 16

Term II (Spring)		Credits
CHEN 201	Chemical Process Principles	3
CHEN 214	Thermodynamics I	3
STAT 230	Introduction to Probability and Random Variables	3
ENGL 206	English Technical Writing (Understanding Communication)	3
MATH 202	Differential Equations	3
		Total 15

Second Year (42 credits)

Term III (Summer)		Credits
Arabic Elective	Understanding Communication - Arabic	3
CHEM 204	Physical Chemistry for Chemical Engineers	2
CHEM 207	Survey of Organic Chemistry and Petrochemicals	4
		Total 9

Term IV (Fall)		Credits
CHEN 311	Introduction to Fluids Engineering	3
CHEN 314	Chemical Engineering Thermodynamics	3
CHEN 351	Process Instrumentation and Measurements	3
ECON 212	Elementary Macroeconomics Theory	3
MATH 218	Elementary Linear Algebra with Applications	3
EECE 231	Introduction to Programming Using C++ and MATLAB	3
		Total 18

Term V (Spring)		Credits
CHEM 219	Analytical and Instrumental Chemistry for Chemical Engineers	3
CHEN 312	Separation Processes	3
CHEN 415	Mechanical Unit Operations	3
MATH 251	Numerical Computing	3
Societies and Individuals Elective		3
		Total 15

Third Year (40 credits)

Term VI (Summer)		Credits
Cultures and Histories (History of Ideas)		3
Understanding the World (approved list)		3
		Total 6

Term VII (Fall)		Credits
CHEN 310	Transport Phenomena Lab	2
CHEN 411	Heat and Mass Transfer Operations	3
CHEN 417	Reaction Engineering and Reactor Design	3
CHEN 470	Chemical Process Design	3
CHEN 480	Safety and Loss Prevention	3
Human Values Elective		3
		Total 17

Term VIII (Spring)		Credits
CHEN 410	Unit Operations Lab	3
CHEN 431	Materials Engineering & Corrosion	3
CHEN 451	Process Control	3
CHEN 541	Biochemical and Bioprocess Engineering	3
Community Engaged Learning Technical Elective I		3
Cultures and Histories		3
		Total 18

Fourth Year (30 credits)

Term IX (Summer)		Credits
CHEN 500	Approved Experience	6
		Total 6

Term X (Fall)		Credits
CHEN 501	Final Year Project I	3
CHEN 570	Process Synthesis and Optimization	3
Cultures and Histories Elective		3
CHEN 571	Chemical Product Design	3
INDE 302	Operations Research I	3
		Total 15

Term XI (Spring)		Credits
CHEN xxx	Technical Elective II	3
CHEN xxx	Technical Elective III	3
CHEN xxx	Technical Elective IV	3
CHEN 502	Final Year Project II	3
Understanding the World Elective (approved list)		3
		Total 15

Bachelor of Science (BS) Major: Chemical Engineering

Mission

The mission of chemical engineering in MSFEA 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 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 while always maintaining ties with the University.
- apply their scientific knowledge and engineering skills in graduate studies and/or industry.
- 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) in chemical engineering is a four-year program. It consists of 140 term credit hours of coursework, of which 30 credits are completed in the freshman year while the students are enrolled in the Faculty of Arts and Sciences, and of which 110 credits are completed in three years while the students are enrolled in the Maroun Semaan 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 (13 credits)		
FEAA 200	Introduction to Engineering and Architecture	3 cr.
CIVE 210	Statics	3 cr.
EECE 210	Electric Circuits	3 cr.
EECE 231	Introduction to Programming Using C++ and MATLAB	3 cr.
MECH 220	Engineering Graphics	1 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 (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 expected to complete:

- 6 credits in Cultures and Histories
- 3 credits in History of Ideas (From CHLA)
- 6 credits in Societies and Individuals (including 3 credits from ECON 212) and (3 credits from Cultures and Histories or Societies and Individuals should cover the theme of Social Inequalities refer to the GE list)
- 6 credits in understanding communications (ENGL 203 and ENGL 206)
- 3 credits in understanding communications (Arabic)
- 3 credits Community Engaged Learning satisfied by the FYP course
- 3 credits Human Values (INDE 410 or PHIL 210)

Core Chemical Engineering Courses (46 credits)		
CHEN 201	Chemical Process Principles	3 cr.
CHEN 214	Thermodynamics I	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 400	Approved Experience	0 cr.
CHEN 401	Final Year Project	3 cr.
CHEN 410	Unit Operation Lab	2 cr.
CHEN 411	Heat and Mass Transfer Operations	3 cr.
CHEN 415	Mechanical Unit Operations	3 cr.
CHEN 417	Reaction Engineering and Reactor Design	3 cr.
CHEN 451	Process Control	3 cr.
CHEN 470	Chemical Process Design	3 cr.
CHEN 480	Safety and Loss Prevention	3 cr.
CHEN 541	Biochemical and Bioprocess Engineering	3 cr.

Curriculum for BS in Chemical Engineering

First Year (31 credits)

Term I (Fall)		Credits
MATH 201	Calculus and Analytic Geometry III	3
CIVE 210	Statics	3
EECE 210	Electric Circuits	3
MECH 220	Engineering Graphics	1
ENGL 203	Academic Writing (Understanding Communication)	3
FEAA 200	Introduction to Engineering and Architecture	3
		Total 16

Term II (Spring)		Credits
CHEN 201	Chemical Process Principles	3
MATH 202	Differential Equations	3
STAT 230	Introduction to Probability and Random Variables	3
CHEN 214	Thermodynamics I	3
ENGL 206	English Technical Writing (Understanding Communication)	3
		Total 15

Second Year (45 credits)

Term III (Summer)		Credits
Arabic Elective	(Understanding Communication-Arabic)	3
CHEM 204	Physical Chemistry for Chemical Engineers	2
CHEM 207	Survey of Organic Chemistry and Petrochemicals	4
		Total 9

Term IV (Fall)		Credits
ECON 212	Elementary Macroeconomics Theory	3
CHEN 311	Introduction to Fluids Engineering	3
CHEN 314	Chemical Engineering Thermodynamics	3
CHEN 351	Process Instrumentation and Measurements	3
EECE 231	Introduction to Programming Using C++ MATLAB	3
MATH 218	Elementary Linear Algebra with Applications	3
		Total 18

Term V (Spring)		Credits
CHEM 219	Analytical and Instrumental Chemistry for Chemical Engineers	3
CHEN 312	Separation Processes	3
CHEN 415	Mechanical Unit Operations	3
MATH 251	Numerical Computing	3
Societies and Individuals Elective		3
Cultures and Histories (History of Ideas)		3
		Total 18

Third Year (34 credits)

Term VI (Summer)		Credits
CHEN 400	Approved Experience	0
		Total 0

Term VII (Fall)		Credits
CHEN 310	Transport Phenomena Lab	2
CHEN 411	Heat and Mass Transfer Operations	3
CHEN 417	Reaction Engineering and Reactor Design	3
CHEN 470	Chemical Process Design	3
CHEN 480	Safety and Loss Prevention	3
Human Values Elective		3
		Total 17

Term VIII (Spring)		Credits
CHEN 401	Final Year Project	3
CHEN 410	Unit Operations Lab	2
CHEN 451	Process Control	3
CHEN 541	Biochemical and Bioprocess Engineering	3
Cultures and Histories Elective		3
Cultures and Histories Elective		3
		Total 17

Minor in Chemical Engineering

The minor in chemical engineering is open to engineering students in majors other than chemical engineering who have finished their first two academic years in engineering. Only students who have a GPA of 2.3 or more are eligible to apply for the minor.

Minor Program Requirements (21 credits)

Students taking the minor are required to complete 21 credits from the list given below. students have to complete 15 credits of core courses and 6 credits of elective courses.

Please refer to the General University Academic Information section of the catalogue for more information regarding minors.

Required Core Courses (15 credits)		
CHEN 214	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 415	Mechanical Unit Operations	3 cr.
CHEN 451	Process Control	3 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 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.

Minor in Petroleum Engineering

Minor Program Requirements (18 Credits)

The minor in petroleum engineering is open to AUB students from all majors who have finished their first academic year (non-engineering students) or their first two academic years (engineering students) and who have attained a GPA of 2.3.

Please refer to the General University Academic Information section of the catalogue for more information regarding minors.

Required Core Courses (9 Credits)		
PETR 200/CHEN 490	Introduction to Petroleum Engineering	3 cr.

Two courses from the following list:		
PETR 322/CHEN 595	Drilling Engineering I	3 cr.
PETR 421/CHEN 690	Reservoir Engineering	3 cr.
PETR 432/CHEN 592	Production Engineering	3 cr.
PETR 312/CHEN 593	Reservoir Petrophysics	3 cr.

Elective Courses (9 Credits)		
Selected from the following courses:		
PETR 300	Petroleum Exploration	3 cr.
PETR 321/CHEN 594	Reservoir Fluids	3 cr.
PETR 520/CHEN 696	Reservoir Modeling	3 cr.
PETR 514/CHEN 697	Reservoir Economics and Risk Management	3 cr.
CHEN 480	Safety and Loss Prevention	3 cr.
CHEN 590	Petroleum Refining	3 cr.
CHEN 591	Natural Gas Processing	3 cr.
MECH 768	Transport Through Porous Media	3 cr.
GEOL 225	Petroleum Geology	3 cr.
GEOL 226	Introduction to Geophysics	3 cr.

Note: Other courses may be approved as minor equivalents at consent of the B. & W. Bassatne Department of Chemical Engineering and Advanced Energy. Students cannot receive more than 6 credits for both PETR/CHEN cross-listed courses as technical electives in the chemical engineering major. When students take 2 out of the 4 core courses from the core courses list, the other 2 courses can be taken as electives for the minor.

Course Descriptions

FEAA 200 Introduction to Engineering and Architecture 3 cr.
The course is designed to familiarize first year students with the different disciplines in engineering and architecture, including: architecture, civil, mechanical, electrical, chemical, industrial and technologies used in the fields. The course takes a unique interdisciplinary approach to the field and introduces the related disciplines in the world of engineering and architecture. One key objective is to promote interdisciplinary interaction and innovative thinking. The course is organized into modules covering the different disciplines within the Maroun Semaan Faculty of Engineering and Architecture (MSFEA). The last module of the class showcases interdisciplinary projects demonstrating interactions among the different fields. The lectures explain as applicable to each discipline, through examples, notions of problem solving, design thinking, process of invention and innovation, environmental and civic responsibility, and measures of success in aesthetics and performance. The course project is a key component of the course. It has an interdisciplinary nature, bringing ideas and solutions from all disciplines in engineering and architecture. Annually.

CHEN 201 Chemical Process Principles 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 214/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 and simple vapor and liquid cycles.

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: CHEN 214 or MECH 310, and CHEN 311.

CHEN 311/MECH 314 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, pressure field and viscous effects; applications of Bernoulli’s equation, Navier-Stokes and modeling; flow in ducts, potential flows and boundary layer flows. Prerequisites: CHEN 214 or MECH 310, and CIVE 210.

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. The role of solution thermodynamics and the methods of estimating or calculating thermodynamic properties are also studied. Degrees of freedom analyses are threaded throughout the course as well as the appropriate use of software. Prerequisite: CHEN 314; Pre/corequisite: MECH 220.

CHEN 314 Chemical Engineering Thermodynamics 3 cr.
This course addresses the principles of classical thermodynamics and focuses on applying them to various unit operations and chemical processes. The course will begin with a review of the first and second laws and their application to closed and open systems. Power and refrigeration cycles are covered. Equations of state (virial, PR, SRK) are detailed. Starting with ideal gas mixtures and ideal solutions, the concepts of bubble and dew points are introduced to enable flash calculations and design of process components. Prerequisites: CHEN 201, CHEN 214 or MECH 310, and MATH 202.

CHEN 351 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: EECE 210, STAT 230, and MATH 202.

CHEN 400 Approved Experience 0 cr.; 1 b
This is an eight-week professional training course in chemical engineering for students enrolled in the BS program.

CHEN 401 Final Year Project 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. Prerequisites: CHEN 470, CHEN 411, and CHEN 480.

CHEN 410 Unit Operations Lab 3 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 pattern in industrial process equipment are also included. Prerequisites: CHEN 310, CHEN 312, CHEN 411 and CHEN 417.

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: CHEN 214 or MECH 310, and CHEN 311.

CHEN 415 Mechanical Unit Operations 3 cr.
This course introduces students to the principles and practices involved in contacting, 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. Prerequisite: CHEN 311; pre/corequisite: CHEN 312.

CHEN 417 Reaction 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-ideal 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 431 Materials Engineering and Corrosion 3 cr.
This course covers: Materials engineering; Properties and performance; Crystalline phases; Imperfection in crystalline solids; Solid solution; Elastic and Plastic deformation; Hardness testing; Fatigue and creep testing; Phase diagrams, engineering alloys and Corrosion. Prerequisite: CHEN 214 or MECH 310.

CHEN 451 Process Control 3 cr.
A course covering the concepts of feedback control systems in the chemical and process industry. The course involves dynamic modeling, design, and analysis of dynamic control systems. The course is synchronized with a laboratory component, CHEN 451L, which provides hands-on experience with various control applications. Prerequisites: CHEN 312 and CHEN 351.

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. Prerequisite: CHEN 312; pre/corequisites: CHEN 411 and CHEN 417.

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 312.

CHEN 500 Approved Experience 6 cr.; 1 b
This is an eight-week professional training course in chemical engineering for students enrolled in the BE program. Prerequisite: CHEN 470

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. Prerequisites: CHEN 470, CHEN 411, CHEN 480, and CHEN 500.

CHEN 502 Final Year Project II 3 cr.
This course will be a continuation of CHEN 501 where students will employ their acquired knowledge to investigate the design of overall processes and the detailed design of individual unit operations, perform economic analysis and 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 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. Prerequisites: CHEN 312 and CHEN 417.

CHEN 570 Process Synthesis and Optimization 3 cr.
An introduction to the design and synthesis of large-scale production and processing of materials such as water, chemicals, petroleum products, food, drugs and wastes. The course introduces principles of optimization: continuous, linear, and nonlinear, and mixed integer linear and nonlinear problems. Applications to heat exchanger network synthesis, energy systems design, distillation, and separation systems selection, optimization, and design under uncertainty. Prerequisites: CHEN 411, CHEN 451, 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. Prerequisite: CHEN 470.

Chemical Engineering Technical Electives

CHEN 413 Water and Waste Treatment 3 cr.
A course that examines the quality and treatment methods of water and wastewater; testing for physical, chemical and biological parameters. Prerequisite: consent of instructor.

CHEN 499 Undergraduate Research 3 cr.
This course requires participation, under supervision of a faculty member, in a research project. Before registering, the students 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 term IX required in the major and a cumulative GPA of 3.3 or above.

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. Prerequisite: CHEN 312.

CHEN 591 Natural Gas Processing 3 cr.
Natural gas properties including real gas mixtures behavior and the equations of state. Natural gas water systems, natural gas condensate systems, hydrate formation and inhibition. Separation processes. Field treatment of natural gas, absorption, and adsorption processes. Natural gas dehydration, sweetening and sulfur recovery. Design and sizing of the main equipment. Pre/corequisites: CHEM 204, CHEN 311, CHEN 312, and CHEN 314.

CHEN 610 Materials Design and Characterization 3 cr.
This course is designed for chemical engineering students who want to gain knowledge and technical exposure with modern analytical instrumentation used in research and industry. The course will cover the theoretical and scientific aspects involved in analytical applications including: spectroscopy, chromatography, X-ray diffraction etc. It also encompasses laboratory sessions for sample preparation and instrumental operation, analytical method optimization and data interpretation. At the end of the course, students will become familiar with various analytical instruments and methods, and they will be able to decide on the appropriate instrument to carry out specific laboratory analysis for the development and characterization of novel material. Prerequisites: CHEM 219 and CHEN 410.

CHEN 611 Transport Phenomena 3 cr.
This course covers 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 or MECH 412.

CHEN 612 Desalination 3 cr.
This course will survey 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 widespread 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 to design a reverse osmosis membrane desalination plant (brackish water, seawater or treated sewage effluent) using conventional or alternative energy sources. Prerequisite: 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 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 types of equipment. Prerequisite: consent of instructor.

CHEN 615 Advanced Mass Transfer 3 cr.
This course is 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 or MECH 412.

CHEN 617 Chemical Reactor Analysis and Design 3 cr.
An advanced treatment of chemical reactors. 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 course aims at introducing the basic concept of colloid and interface science, properties, behavior, and interactions. It explores the application of surface and colloid chemistry principles to technologies involving particulate dispersions, emulsions, foams, aerosols, water-soluble polymers, wetting, flocculation, flotation, separation, and stabilization. The goal is to provide background in surface and colloidal science and give students a solid framework for applying knowledge in colloid and surface science to the solution of practical problems and the development of new technologies. Prerequisite: CHEN 314 or MECH 414.

CHEN 619 Sustainability Science: Human and Environment Interaction 3 cr.
Sustainability is the grand challenge of our time especially with the UN SDG (Sustainable Development Goals) 2030 Agenda. This course addresses the basics of sustainability science and its challenges to promote economic growth and address social needs, while tackling climate change and environmental protection. The goal of the course is to introduce students to the four pillars of sustainability (human, economic, social, environmental) and help them incorporate its principles and models into engineering design practices. Students will be also introduced to current challenges, active debates, and unresolved research questions in sustainability.

CHEN 620 Reaction Engineering and Reactor Design II 3 cr.
The course presents advanced concepts of reaction engineering and reactor design. The course covers fundamentals of heterogeneously catalyzed chemical reactions including kinetics and transport processes. The Reactor design part of the course focuses on the modeling of catalytic reactors. Prerequisite: CHEN 417.

CHEN 630 Sustainable Biorefinery Process 3 cr.
This course provides students with an understanding of the principles, technologies, and design of sustainable bioprocesses and biorefineries. In this course we will focus on techniques and processes needed to efficiently disentangle, separate and convert different biomass-based feedstock into biofuels and high value chemicals. We will also explore the design of a biorefinery taking into account feedstock and the desired product. The design will be evaluated with respect to sustainability and economic criteria. The students will have the opportunity to work in a team on a feasibility/ simulation/ experimental project. Prerequisite: CHEN 417.

CHEN 632 Carbon Capture, Usage and Storage 3 cr.
This course refers to a suite of technologies and processes that enable the mitigation of carbon dioxide (CO2) emissions from large point sources such as power plants, refineries and other industrial facilities, or the removal of existing CO2 from the atmosphere. CCUS plays a crucial role in meeting global climate targets and supporting the transition to a low-carbon energy system. The latest IPCC assessment report warns that the deployment of carbon dioxide removal technologies is 'unavoidable' if net zero emissions are to be achieved and many ambitious net zero scenarios show carbon capture expanding to 6-8 Gt of CO2/year by 2050. This course identifies the need and key steps for CCUS and explains the associated environmental, technical, economical, and regulatory considerations, opportunities, risks, and challenges. Case studies from CCUS projects with varying geographical locations, levels of maturity, and scales will be discussed.

CHEN 651 Advanced Process Control 3 cr.
This course covers the mathematical modeling and computer simulation of process dynamics and control. Prerequisite: CHEN 451.

CHEN 670 Advanced Process Flow-Sheeting 3 cr.
This course highlights the engineering tools used during the lifecycle of chemical plants from the Front-End and Engineering Design (FEED) stage to operation. Flow- sheeting tools will be used for analysis, dynamic modeling for startup-shutdown and control dynamics, and plant-wide optimization for plant performance improvement. Prerequisite: CHEN 570.

CHEN 672 Polymer Science 3 cr.
This course is a broad technical overview of the nature of synthetic macromolecules, including the formation of polymers and their structure, structure-property relationships, polymer characterization and processing, and applications of polymers. The course tends to focus on thermoplastic polymers and elastomers. Prerequisite: CHEN 431 or MECH 340.

CHEN 673/BMEN 604 Engineering of Drug Delivery Systems 3 cr.
This course focuses on recent advances in the development of novel drug delivery systems. The fundamentals of drug delivery are discussed. Various strategies to tune and control the release of active agents for optimized therapeutic outcomes are explored. The course covers polymers and techniques used to produce drug nanoparticles, with specific examples of nanoparticle-based drug delivery systems. Prerequisites: CHEN 314 or MECH 414, and CHEN 411 or MECH 412.

CHEN 674 Process Operations and Diagnosis 3 cr.
This course covers troubleshooting, fault detection and diagnostics in key chemical processes. Statistical tools such as Principle Component Analysis, Fisher Discriminant Analysis, Partial Least Squares and Canonical Variate Analysis methods are studied. Analytical and knowledge-based approaches are also covered. Processes and case studies include: gas-oil separation (GOSP), natural gas processing (AGR, NGL, SRU, fractionation, amine scrubbing), crude oil refining (CDU, VDU, delayed cocking, fluid catalytic cracking) and power plants. Prerequisites: CHEN 451 and CHEN 570.

CHEN 675/BMEN 603 Tissue Engineering 3 cr.
Tissue engineering is an interdisciplinary field that uses cells, biomaterials, biochemical (e.g., growth factors) and physical (e.g., mechanical stimulation) signals, as well as their combination to generate tissue-like structures. The goal of tissue engineering is to provide biological substitutes that can maintain, restore, or improve the function of damaged tissues in the body.

CHEN 691 Reservoir Characterization: Carbonate Rocks 3 cr.
This course is an introduction to the common, modern approaches to the characterization of carbonate reservoirs. State-of-the-art petrographic tools will be introduced. The major depositional environments of carbonate rocks and carbonate platform types as well as the principal controls on carbonate sedimentation will be highlighted. Diagenesis (modification of reservoir properties through time) will be discussed through related processes and products, including the process of dolomitization. In-depth coverage of secondary porosity evolution in carbonate reservoirs will be provided (including elements of appropriate rocktyping). A team-based project to solve a case study in reservoir characterization as well as a field trip to provide a practical view of carbonate reservoir rocks will be included. Prerequisite: CHEN 490.

CHEN 798A Waste Minimization in the Process Industry 3 cr.
The objective of this course is to become familiar with waste minimization principles, quality management systems and pollution control and legislation. The course contents include: introduction and background to waste minimization, benefits of waste minimization, implementation of a waste minimization program, practical techniques to minimize waste, methodology of waste minimization, typical causes and sources of waste and examples of practical waste minimization techniques.

PETR 200/CHEN 490 Introduction to Petroleum Engineering 3 cr.
This course gives an overview on the hydrocarbon reservoirs lifecycle starting from the exploration stage till the production and reservoir management stage. It will introduce students to the fundamental concepts of petroleum engineering including petroleum geosciences, drilling engineering, formation evaluation, reservoir engineering, production engineering and hydrocarbon reservoirs economic evaluation. As an outcome of this course, students will gain a foundational understanding of the upstream petroleum industry and get accustomed to its integrated nature, involved terminology and multiple disciplines. Students cannot receive credits for both CHEN 490 and PETR 200.

PETR 300 Petroleum Exploration 3 cr.
This course focuses on the major foundational concepts about how the Earth works as an integrated system and, particularly, how petroleum systems operate within an important part of the crust, sedimentary basins. Throughout the course, relevant aspects of geoscience are discussed, and impacts of these concepts on various exploration and reservoir development activities are emphasized. Importance of real rock samples, the processes of deposition, subsurface imaging, and evaluation of petrophysical properties are discussed. Effect of heterogeneities on fluid distribution and flow, and relations between engineering concepts and geological structures will be introduced. Prerequisite: PETR 200 or CHEN 490.

PETR 312/CHEN 593 Reservoir Petrophysics 3 cr.
This course provides students with a systematic understanding of physical properties of petroleum reservoir rocks: lithology, porosity, relative and effective permeability, fluid saturations, capillary characteristics, compressibility, rock stress and fluid-rock interaction. The different sources of formation evaluation data acquired to characterize oil and gas reservoirs will be introduced together with the process through which data is interpreted to estimate the reservoir properties.

PETR 321/CHEN 594 Reservoire Fluids 3 cr.
This course discusses the different types of reservoir fluids and their related fundamental thermodynamics properties. It will equip students with practical understanding of oil and gas reservoir fluids properties and related behavior as applied to reservoir and production engineering studies. The different types of experimental data acquired and used to build PVT models for reservoir and production system simulation. Prerequisite: CHEN 214 or MECH 310.

PETR 322/CHEN 595 Drilling Engineering I 3 cr.
This course acquaints students with the terminology, concepts, equipment, techniques, and processes used in the oil and natural gas well drilling operations.

PETR 421/CHEN 690 Oil and Gas Reservoir Engineering 3 cr.
This course covers both fundamental and applied reservoir engineering concepts. It aims at understanding the rock and fluid properties and how these properties interact to affect production from a hydrocarbon reservoir. From a practical perspective, the course focuses on classical reservoir engineering, reservoir drive mechanisms, well testing and well test analysis as well as the use of reservoir simulation to assist the reservoir engineer at different stages of a hydrocarbon reservoir lifecycle.

PETR 432/CHEN 592 Production Engineering 3 cr.
The course covers the principles and methods used to produce oil and natural gas from the reservoir to surface facilities. It provides techniques for predicting the flow within the system including reservoir and wellbore hydraulics. Performance analysis methods and equipment used are discussed along with methods to enhance well performance.

PETR 514/CHEN 697 Reservoir Economics and Risk Management 3 cr.
Review of financial concepts and economic evaluation techniques and related financial concepts used in the oil and gas upstream business to assist decision-making on either the investment of capital or the divestment of assets. The course will focus on the conversion of hydrocarbon volumes to 'monetary value' and the requirement for consistent means of determining both the absolute and relative attractiveness of investment opportunities, from new field developments to portfolio management decisions. Prerequisite: PETR 421 or CHEN 690.

PETR 520/CHEN 696 Reservoir Modeling 3 cr.
This course introduces students to the theory and practice of hydrocarbon reservoir simulation. It details the mathematics of the governing equations and numerical techniques that form reservoir simulation models. The course will cover data preparation, simulation grid preparation, reservoir model calibration, forecasting of future performance, and interpretation of simulation results. Students will learn about the elements of a reservoir simulation model, the types of reservoir simulators and the role of simulation in field development planning, reservoir management and production optimization. Prerequisites: PETR 421 or CHEN 690.

Department of Civil and Environmental Engineering

Chairperson	Najjar, Shadi
Professors	Abou Zeid, Maya; Basha, Habib; Hamad, Bilal; Harajli, Muhamad; Mabsout, Mounir; Najjar, Shadi; Sadek, Salah; Srour, Issam
Associate Professors	Dabaghi, Mayssa; Hantouche, Elie; Khoury, Hiam; Salam, Darine
Assistant Professors	Yehya, Alissar; Yeretzian, Aram (jointly with ArD)
Professor Emeritus	Ayoub, George
Adjunct Professors	Alameddine, Ibrahim; El Fadel, Mutasem; Kaysi, Isam
Visiting Professor	Abdul Malak, Mohamed-Asem
Senior Lecturer	Basha, Hisham
Part-time Senior Lecturer	Fawwaz, Youssef
Part-time Lecturers	Awad, Elie; Demachkieh, Farah; El Chiti, Imad; El Meski, Fatima; Elsouri, Amer; Malaeb, Lilian; Nader, Halim; Yousef Abdul Massih, Dalia
Part-time Instructors	El Chartouni, Joseph; El Khatib, Helmi; Hage Ali, Nadine
Laboratories	Al Hassanieh, Dima; El Zein, Leticia; Zayyat, Ramez

The Department of Civil and Environmental Engineering (CEE) offers the degrees of bachelor of engineering (BE) with the major of civil engineering (CE) and bachelor of science (BS) with the major of construction engineering (ConsE).

Mission

The mission of the CE undergraduate programs is to provide a stimulating and supportive environment for high-standard education and research; to prepare graduates for life-long learning and productive careers, 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, through teaching and research, to expanding the knowledge and technology base in civil and environmental engineering.

Bachelor of Engineering (BE) Major: Civil Engineering

Program Educational Objectives

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

- **Engineers** who hold central positions, create sustainable and ethical solutions, and advance the knowledge in various sub-disciplines of civil engineering in local, regional, and international practice.
- **Graduates** who are admitted to, and successfully complete, advanced degrees in leading universities around the world.
- **Leaders** and innovators in their profession and in the service of their community.

Curriculum for the BE in Civil Engineering

Term I (Fall)		**Credits**
FEAA 200	Introduction to Engineering and Architecture	3
CIVE 201	Engineering Drawings and Tools	3
MATH 201	Calculus and Analytical Geometry III	3
CHEM 202	Introduction to Environmental Chemistry	3
CHEM 203	Introductory Chemical Techniques	2
ENGL 203	Academic English (Understanding Communication)	3
		Total 17

Term II (Spring)		**Credits**
CIVE 210	Statics	3
MATH 202	Differential Equations	3
PHYS 210	Introductory Physics II	3
PHYS 210L	Introductory Physics Laboratory II	1
ARAB 2xx	Arabic Elective (Understanding Communication)	3
	Cultures and Histories - History of Ideas Elective	3
		Total 16

Term III (Summer)		Credits
CIVE 301	Surveying	3
CIVE 330	Engineering Geology (or Geology Elective)	3
	Societies and Individuals Elective	3
		Total 9

Term IV (Fall)		Credits
CIVE 310	Mechanics of Materials	3
CIVE 370	Construction Materials and Technologies	3
EECE 231	Introduction to Programming with C++ and MATLAB	3
ENGL 206	Technical English (Understanding Communication)	3
MATH 218	Elementary Linear Algebra with Applications	3
		Total 15

Term V (Spring)		Credits
CIVE 311	Theory of Structures	3
CIVE 340	Fluid Mechanics and Laboratory	3
MATH 251	Numerical Computing	3
BIOL 2xx	Biology Elective	3
INDE 410	Engineering Ethics (Human Values)	3
		Total 15

Term VI (Summer)		Credits
STAT 230	Introduction to Probability and Random Variables	3
INDE 301	Engineering Economy	3
	Societies and Individuals Elective	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 or 551	Water Treatment and Laboratory or Wastewater Treatment and Laboratory	3
CIVE 460	Transportation Engineering and Laboratory	3
		Total 15

Term VIII (Spring)		Credits
CIVE 421	Construction Management	3
CIVE 411	Indeterminate Structural Analysis	3
CIVE 54x	Hydrology Elective	3
CIVE x5x	Environmental Elective	3
CIVE 461	Highway Engineering	3
		Total 15

Term IX (Summer)		Credits
CIVE 400	Approved Experience	6
		Total 6

Term X (Fall)		**Credits**
CIVE 401	Final Year Project I	3
CIVE 41x	Structures Elective	3
CIVE 431	Foundation Engineering	3
CIVE 5xx/6xx	CEE Technical Elective	3
CIVE 5xx/6xx	CEE Technical Elective	3
	Culture and Histories	3
		Total 18

Term XI (Spring)		**Credits**
CIVE 402	Final Year Project II	3
CIVE 42x	Construction Elective	3
CIVE 5xx/6xx	CEE Technical Elective	3
CEE/MSFEA/ AUB	CEE or Approved MSFEA/AUB Technical Elective	3
	Culture and Histories	3
		Total 15

Total Credit Hours:	**150**
One of the electives for “cultural and histories” or “societies and individuals” should cover the theme of social inequalities. Community Engaged Learning should be satisfied by the FYP course.	

Bachelor of Science (BS) Major: Construction Engineering (ConsE)

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 for the BS in Construction Engineering

Term I (Fall)		**Credits**
FEAA 200	Introduction to Engineering and Architecture	3
CIVE 201	Engineering Drawings and Tools	3
MATH 201	Calculus and Analytical Geometry III	3
CHEM 202	Introduction to Environmental Chemistry	3
CHEM 203	Introductory Chemical Techniques	2
ARAB 2xx	Arabic Elective (Understanding Communication)	3
		Total 17

Term II (Spring)		**Credits**
CIVE 210	Statics	3
MATH 202	Differential Equations	3
PHYS 210	Introductory Physics II	3
PHYS 210L	Introductory Physics Laboratory II	1
ENGL 203	Academic English (Understanding Communication)	3
	Cultures and Histories - History of Ideas Elective	3
		Total 16

Term III (Summer)		**Credits**
CIVE 301	Surveying	2
STAT 230	Introduction to Probability and Random Variables	3
	Societies and Individuals Elective	3
		Total 8

Term IV (Fall)		**Credits**
CIVE 310	Mechanics of Materials	3
CIVE 370	Construction Materials and Technologies	3
EECE 231	Introduction to Programming with C++ and MATLAB	3
ENGL 206	Technical English (Understanding Communication)	3
MATH 2xx	Mathematics Elective	3
		Total 15

Term V (Spring)		**Credits**
CIVE 311	Theory of Structures	3
CIVE 340	Fluid Mechanics and Laboratory	3
MATH 251	Numerical Computing	3
INDE 410	Engineering Ethics (Human Values)	3
BIOL 2xx	Biology Elective	3
		Total 15

Term VI (Summer)		**Credits**
CIVE 330	Engineering Geology (or Geology Elective)	3
INDE 301	Engineering Economy	3
ECON 212	Elementary Macroeconomic Theory	3
		Total 9

Term VII (Fall)		**Credits**
CIVE 413	Concrete Design	3
CIVE 421	Construction Management	3
CIVE 430	Soil Mechanics and Laboratory	3
CIVE 440	Hydraulics and Laboratory	3
	Cultures and Histories Elective	3
		Total 15

Term VIII (Spring)		**Credits**
CIVE 422	Construction Methods and Safety	3
CIVE 423	Construction Planning and Scheduling	3
CIVE 522	Building Construction and Estimating	3
CIVE 461	Highway Engineering	3
	Cultures and Histories Elective	3
		Total 15

Term IX (Summer)		**Credits**
CIVE 400	Approved Experience	0
		Total 0

Total Credit Hours:	**110**
One of the electives for “cultural and histories” or “societies and individuals” should cover the theme of social inequalities.	

Elective Courses

- List of Biology Elective Courses: BIOL 201, BIOL 202, BIOL 209, BIOL 210, BIOL 250, BIOL 252, BIOL 255, BIOL 258, BIOL 259, CIVE 252
- List of Construction Elective Courses: CIVE 422, CIVE 423
- List of Environmental Elective Courses: CIVE 451
- List of General Education Elective Courses (Cultures and Histories, History of Ideas, Societies, and Individuals): refer to the AUB General Education program.
- List of Geology Elective Courses: GEOL 201, GEOL 211, CIVE 330
- List of Hydrology Elective Courses: CIVE 541, CIVE 542
- List of Mathematics Elective Courses: MATH 211, MATH 212, MATH 218, MATH 281
- List of Structural Design Elective Courses: CIVE 412, CIVE 414

General Education Requirements

Civil Engineering Major: 6 credits in Cultures and Histories, 3 credits in History of Ideas (from CHLA), 6 credits in Societies and Individuals (3 credits from Cultures and Histories OR Societies and Individuals should cover the theme of Social Inequalities), 6 credits in Understanding Communication
- English: ENGL 203 and ENGL 206, and 3 credits in Understanding Communication – Arabic, 3 credits in Human Values (INDE 410). 3 credits in Community Engaged Learning satisfied by the FYP course.

Construction Engineering Major: Students are required to complete 9 credits in Cultures and Histories (including one History of Ideas), 3 credits in Human Values (INDE 410), 6 credits in Societies and Individuals, including ECON 212, 6 credits in Understanding Communication - English: ENGL 203 and ENGL 206, and 3 credits in Understanding Communication - Arabic. Students must also take a course in Community-Engaged Learning. One elective should cover the theme of Social Inequalities.

Course Descriptions

Common Courses

FEAA 200 Introduction to Engineering and Architecture 3 cr.
The course is designed to familiarize first year students with the different disciplines in engineering and architecture, including: architecture, civil, mechanical, electrical, chemical, industrial and technologies used in the fields. The course takes a unique interdisciplinary approach to the field and introduces the related disciplines in the world of engineering and architecture. One key objective is to promote interdisciplinary interaction and innovative thinking. The course is organized into modules covering the different disciplines within the Maroun Semaan Faculty of Engineering and Architecture (MSFEA). The last module of the class showcases interdisciplinary projects demonstrating interactions among the different fields. The lectures explain as applicable to each discipline, through examples, notions of problem solving, design thinking, process of invention and innovation, environmental and civic responsibility, and measures of success in aesthetics and performance. The course project is a key component of the course. It is interdisciplinary in nature bringing ideas and solutions from all disciplines in engineering and architecture. Annually.

CIVE 201 Engineering Drawings and Tools 3 cr.
An introductory course that aims 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 and CIVE 210.

CIVE 400 Approved Experience 6 cr. ; 1 b.
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: fourth year.

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, Fourth year.

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.
Special Topics in Civil and Environmental Engineering.

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 and three dimensions; concentrated and distributed loading; supports and external reactions; internal axial forces, shear forces, and bending moments in beams; internal axial forces in plane trusses; centroid and center of gravity. Moment of Inertia. Pre/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 spreadsheet. Prerequisite: CIVE 210.

CIVE 311 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, and PHYS 210L.

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 311.

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 311.

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 311.

CIVE 414 Concrete Design II 3 cr.
A course that covers continuous beams, short columns, lender columns and biaxially bent columns; wall footings, concentrically and eccentrically 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 and 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 311.

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 pre-stressed 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, conoidal, and ellipsoidal domes. 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 311 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. Prerequisite: CIVE 411.

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; iso-parametric 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 Hooke'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. Prerequisite: CIVE 411.

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. Prerequisite: CIVE 411.

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.

CIVE 714 Seismic Design of Reinforced Concrete Structures 3 cr.
A course on the seismic behavior and design of reinforced concrete structures; introduction to concepts of seismic design and performance-based earthquake engineering; mechanical behavior of steel reinforcement, concrete and confined concrete under monotonic and cyclic loading; seismic behavior, analysis and design of reinforced concrete elements and systems; design of special structural/shear wall systems; design of special moment resisting frames. Prerequisite: CIVE 411 and CIVE 414.

Construction Engineering and Management 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. Prerequisite: CIVE 311.

CIVE 422 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 and operating costs, and safety management. Prerequisites: CIVE 370 and CIVE 421.

CIVE 423 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. Prerequisite: CIVE 421.

CIVE 520 Construction Contract Administration 3 cr.
The course deals with contract documents, with focus on specifications structure, procedural requirements, specifying methods and the basis for unit rate estimation. It covers the engineer's roles along with contract administration issues. Prerequisite: CIVE 421.

CIVE 522 Building Construction and Estimating 3 cr.
A course that exposes students to different building systems (concrete, masonry, steel, waterproofing, mechanical, electrical, etc.) and how to price them by choosing the best materials and methods. The use of drawings and specifications will also be covered. Prerequisites: CIVE 400 (site work) and CIVE 421.

CIVE 524 Logistics, Technologies, and Productivity Concepts 3 cr.
The course covers construction site layout, team organization, information flow and complexities. The focus is on productivity improvement approaches, data gathering for analysis of construction operations, and issues related to process innovation and automation.

CIVE 525 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 620 Pre-Project Planning and Feasibility Analysis 3 cr.
A course covering the studies needed to make a go-ahead decision, including assimilation of client needs, surveys of project area and infrastructure conditions, scope validation, team development, project planning and cost estimation, and financial feasibility. Prerequisite: CIVE 421 or equivalent.

CIVE 621 Design Management for Large Projects 3 cr.
The course covers the characteristics of the design phase, design team selection, and design services agreement formation and negotiation. It focuses on value engineering and management, constructability considerations and project cost management during design.

CIVE 622 Advanced Topics in Construction Management (Blended) 3 cr.
A course focusing on the construction phase of a project's lifecycle. Topics include: site organization structure, construction safety, labor management, materials procurement systems, site information management, scheduling, project controls and sustainability. Prerequisite: CIVE 421 or equivalent.

CIVE 623 Construction Project Management 3 cr.
The course offers an extended overview of project management. It covers integrated planning-estimating-scheduling concept; project time, budget, and quality baselines; materials management and subcontracting issues; and integrated project cost-time control. Prerequisite: CIVE 421 or equivalent.

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 IT Applications in Construction 3 cr.
A course that covers computing tools impacting the construction industry such as mobile sensing, instrumentation, and information systems to support field engineering tasks and computerized systems applications to perform specific functions, such as estimating, scheduling, and cost control.

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 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 628 Sustainable Building Design and Construction 3 cr.
A course that covers principles of sustainable design and construction, including lifecycle assessment, economic and environmental impacts, carbon footprint, and green building rating systems such as LEED and BREEAM.

CIVE 629 Construction Business Management 3 cr.
A course that covers the principles of business management of construction companies and projects including financial management, accounting, costs and profits management, cash flows management, evaluation of sources of construction funding and financial decisions analysis. Prerequisite: CIVE 370.

CIVE 720 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. Prerequisite: CIVE 422.

CIVE 721 Advanced Scheduling Analysis 3 cr.
A course that provides advanced techniques in construction scheduling. It examines monitoring, updating, and controlling the project schedule. It introduces the methods used in performing forensic scheduling analysis. Prerequisite: CIVE 423.

CIVE 722 Project Deliverance and Contracts 3 cr.
The course offers an overview of project delivery organizations, risk considerations and contracts. It covers the elements of construction contracts, with emphasis on contract formation, substantial completion, and close-out processes. Prerequisite: CIVE 421 or equivalent.

CIVE 723 Dispute Resolution on Projects 3 cr.
The course covers construction contract conditions governing claims and disputes. Focus is on claim evolvement and administration (including issues dealing with time barring, notification, and substantiation), ADR methods and amicable settlement. Prerequisite: CIVE 421.

CIVE 724 Mediation of Engineering Disputes 3 cr.
This course focuses on the use of mediation for resolving construction related disputes. Topics include: dispute avoidance in construction, alternative dispute resolution techniques, and the mechanics of mediation and negotiation. Prerequisite: CIVE 520.

CIVE 725 Construction Decisions Under Uncertainty 3 cr.
A course that covers construction project and organization decisions for the uncertain future. The course addresses decision theory, competitive bid analysis, probabilistic modeling and simulation, and multiple regression analysis in managing construction. Prerequisite: STAT 230.

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 and 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. Prerequisite: CIVE 430.

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, drained and undrained conditions, constitutive models, and failure criteria applications. Prerequisite: CIVE 430.

CIVE 635 Earth Dams 3 cr.
A course that examines hydraulic dams, rolled earth dams, homogenous dams, thin core dams, filters, causes of dam failures, see page control, and seismic stability of dams. Prerequisite: CIVE 430.

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, and laboratory experiments. Prerequisites: CIVE 210, MATH 201, and 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, MATH 251, and 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 and 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, and 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 541 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 541.

CIVE 644 Coastal Engineering 3 cr.
A course on small-amplitude wave theory (linear theory); finite-amplitude wave theory (nonlinear theory); conoidal 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 and 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 as well as 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 socioeconomics analysis, conflict management and concepts in strategic assessment.

CIVE 648 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 252 Environmental Microbiology 3 cr.
A course that introduces 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 microorganisms involved in environmental systems; their ecology, interactions with various pollutants, and beneficial or harmful effects on humans.

CIVE 451 Contemporary Environmental Issues 3 cr.
Introduction to environmental quality and the technical background necessary for understanding environmental issues, controlling environmental degradation, and preserving air and water quality. Material balance concepts for tracking substances in the environmental systems.

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 and CIVE 251L or CHEM 202 and CHEM 203 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 BIOL 209, or BIOL 210 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 that examines current and emerging environmental biotechnologies used for environmental quality evaluation, monitoring, and remediation of contaminated environments; and provides students with working knowledge of the science that underpins them. Prerequisite: CIVE 252 or BIOL 209, or BIOL 210 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. Prerequisite: CIVE 550 or 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 and 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: CIVE 552 or 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 and 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 and 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: fourth-year 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. Prerequisites: CIVE 251 and 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: fourth-year 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 opponent's perspective and the 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 academic concepts and principles. Prerequisites: STAT 230 and 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 and 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. Prerequisite: 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. Prerequisite: CIVE 460.

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; and reliability in transit services. Prerequisites: CIVE 460 and 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; and privatization issues. Prerequisite: CIVE 460 or 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 762 Traffic Flow Theory 3 cr.
A course on characteristics of traffic flow, density, and speed; models describing traffic flow; hydrodynamic analogue; and computer simulation models. Prerequisite: CIVE 460.

Materials Sequence

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 students with materials, testing methods, equipment and standards. Corequisite: CIVE 310.

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 nonlinear viscoelastic models. Prerequisite: graduate standing.

CIVE 771 Pavement Management Systems 3 cr.
A course that covers the principles of pavement management including types of pavement systems, common distresses and their assessment, pavement evaluation and rating systems, in addition to performance prediction and lifecycle analysis. Various field assessment methods in addition to non-destructive and accelerated tests will be discussed and demonstrated. Maintenance and rehabilitation techniques will be compared with emphasis on selection of the most efficient, environment-friendly and cost-effective approaches. Students will utilize computer applications using GIS, regional and international inventory data, and relevant software packages. Pre/corequisite: CIVE 671 or CIVE 672.

Multidisciplinary Graduate and Senior Elective Courses

CIVE 601 GIS and Geospatial Data Modeling 3 cr.
A course that examines the concepts and principles of Geographic Information System (GIS). It provides coverage of state-of-the-art GIS methods and tools: spatial and terrain analysis, geostatistical analysis, time series analysis and development of GIS integrated models.

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 experimental 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 3cr.
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.

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.

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.

CIVE 685 Environmentally Sustainable Renewable Energy Sources 3 cr.
A course that covers basic principles, potentials and limitations of various renewable energy sources and technologies, including solar energy, hydroelectricity, wind energy, bioenergy, fuel cells, batteries, and supercapacitors. Sustainability and impact of renewable energy sources on the environment will be discussed. Prerequisite: CIVE 251 or CHEM 202.

CIVE 686 Sustainable Built Environments 3 cr.
A course that enhances knowledge about the past, present and future conditions of the built environment. The course starts with a general overview of global / regional environmental, social, and economic issues. Then, focusing on the built environment, students are introduced to climate responsive and environmentally friendly concepts in planning and design. The impact of using construction materials and their environmental impact throughout the building's lifecycle will also be discussed. Students will gain critical knowledge through interactive lectures, case study analysis and the proposal of concepts relating to a particular theme. Upon completing the course, students will be equipped with the necessary knowledge that will enable them to make informed project-related design decisions in their careers.

CIVE 688 Engineering Sustainability 3 cr.
Sustainability is the grand challenge of our time especially with the UN SDG (Sustainable Development Goals) 2030 Agenda. This course addresses the basics of sustainability and its practical application in engineering to confront the main challenges of our planet, including climate change, resource depletion, social justice, environmental and health protection. The goal of the course is to introduce students to systems thinking and sustainable design principles with a focus on the effect of human activities and engineering projects on natural systems and societies. The course teaches students to use the four pillars of sustainability (human, economic, social, environmental) as a holistic approach for engineering practices. It also provides the necessary scientific tools for sustainability assessment of products and systems. Students will be also introduced to the current challenges, active debates, and unresolved research questions in sustainability.

Special Courses

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

CIVE 690 Special Projects 3 cr.
Special Projects

CIVE 691 Special Topics in Civil and Environmental Engineering 3 cr.
Special Topics in Civil and Environmental Engineering.

CIVE 692 Advanced Topics in Civil and Environmental Engineering 3 cr.
Advanced Topics in Civil and Environmental Engineering.

CIVE 799 ME Thesis 6 cr.
ME/MS Thesis.

CIVE 980 Qualifying Exam I: Comprehensive Exam 0 cr.
Qualifying Exam I: Comprehensive Exam.

CIVE 981 Qualifying Exam II: Thesis Proposal Defense 0 cr.
Qualifying Exam II: Thesis Proposal Defense.

CIVE 982 PhD Thesis 3 cr.
PhD Thesis.

CIVE 983 PhD Thesis 6 cr.
PhD Thesis.

CIVE 984 PhD Thesis 9 cr.
PhD Thesis.

CIVE 985 PhD Thesis 12 cr.
PhD Thesis.

CIVE 986 PhD Thesis 0 cr.
PhD Thesis.

CIVE 987 PhD Thesis Defense 0 cr.
PhD Thesis Defense.

Department of Electrical and Computer Engineering

Chairperson	Chehab, Ali
Professors	Abou-Faycal, Ibrahim; Bazzi, Louay; Chaaban, Farid; Chedid, Riad; Chehab, Ali; Costantine, Joseph; Dawy, Zaher; Elhajj, Imad; El-Hajj, Ali; Jabr, Rabih; Kabalan, Karim; Karaki, Sami; Kayssi, Ayman; Sharafeddine, Sanaa
Associate Professors	Awad, Mariette; Daher, Naseem; Saghir, Mazen; Tawk, Youssef; Zaraket, Fadi
Assistant Professors	Atallah, Jad ; Chehimi, Mahdi ; Fahs, Jihad ; Issa, Ibrahim ; Sarieddine, Hadi ; Tajeddine Razane
Adjunct Professors	Hajj, Hazem; Mansour, Mohammad; Kanj, Rouwaida
Full-time Lecturers	Bakri, Hussein; El Dassouki, Khaled; Mohanna, Ammar; Moukadem, Imad; Shwaykani, Hassan
Part-time Lecturers	Hussein, Ali; Jlailaty, Hussein
Instructors	Ashkar, Nicolas; Chebaro, Malek

Undergraduate Programs

The Department of Electrical and Computer Engineering offers three undergraduate programs leading to the degree of bachelor of engineering in addition to two minors and two tracks.

The three undergraduate programs are:

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

Mission

We promote excellence in undergraduate and graduate education, research, and service to the profession at the regional and global levels. We offer world-class academic programs built upon a solid foundation of engineering, science, and liberal education. We prepare students to be professionals, capable of being leaders, entrepreneurs, and researchers, who deploy their skills with ingenuity, integrity, and responsibility.

The Computer and Communications Engineering program allows students to focus on the areas of communication systems, networks, or software systems. The computer science and engineering program allows students to focus on the areas of software engineering, systems and networks, cybersecurity, theory and algorithms, data science, or bioinformatics. The CSE program is offered in cooperation with the Computer Science Department of the Faculty of Arts and Sciences. The Electrical and Computer Engineering program allows students to focus on the areas of power and energy systems, electromagnetics and radio frequency systems, or control and intelligent systems. The ECE and CCE programs also allow students to focus on electronics or computer systems.

All three programs require the completion of 150 credits including an internship and a final year project; and prepare students for professional careers as well as graduate studies.

The ECE department also offers a minor in biomedical engineering and a track in control and robotics, in addition to a minor and a track in artificial intelligence.

Undergraduate Programs Educational Objectives

The objectives of the ECE department undergraduate programs are to enable the graduates of the program to:

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

Computer and Communications Engineering Program

Program Requirements

- **Mathematics:** MATH 201; MATH 202; MATH 211 or CMPS 211; MATH 218 or 219; STAT 230/233; and one of MATH 210, 224, 227, MATH/CMPS 251 or 261
- **Sciences:** PHYS 210, PHYS 210L, CHEM 201 or 202, CHEM 203 or 205, and one additional science elective
- **General Education Requirements:**
  - 6 credits in Cultures and Histories
  - 3 credits in History of Ideas (CHLA)
  - 6 credits in Societies and Individuals
  - 3 credits from Cultures and Societies and Individuals should cover the theme of Social Inequalities - refer to the GE list
  - 6 credits in Understanding Communications (ENGL 203 and ENGL 206)
  - 3 credits in Understanding Communications (Arabic)

  - 3 credits Community Engaged Learning
  - 3 credits Human Values (INDE 410)
- **INDE 301:** Engineering Economy
- **ECE Core Courses:** FEAA 200, EECE 210, EECE 230, EECE 290, EECE 310, EECE 311, EECE 320, EECE 321, EECE 330, EECE 340, EECE 350, EECE 380, EECE 442
- **ECE Laboratories:** EECE 310L, EECE 321L, EECE 410L, two additional laboratories: one restricted laboratory and one elective laboratory
- **ECE Restricted Electives:** Four restricted elective courses from the list of CCE Focus Area courses with a minimum of two courses from one area and no more than three courses from any given area.
- **Undergraduate Elective Courses:** 3 credits of EECE 300 or 400 level courses
- **EECE Electives:** 6 credits of EECE with a number equal to, or greater than, 300 (except EECE 312)
- **Pre-Approved Electives:** 9 credits of coursework. No more than 6 credits may be taken from the same department, program or track (except EECE & CMPS)
- **Approved Experience:** EECE 500
- **Final Year Project:** EECE 501 and EECE 502

Curriculum for BE in Computer and Communications Engineering

Term I (Fall)		**Credits**
FEAA 200	Introduction to Engineering and Architecture	3
EECE 210	Electric Circuits	3
ENGL 203	Academic English	3
MATH 201	Calculus and Analytic Geometry III	3
MATH/CMPS 211	Discrete Structures	3
		Total 15

Term II (Spring)		**Credits**
EECE 230	Introduction to Computation and Programming	3
EECE 290	Analog Signal Processing	3
MATH 202	Differential Equations	3
MATH 218/219	Linear Algebra	3
PHYS 210	Introductory Physics II	3
PHYS 210L	Introductory Physics Laboratory II	1
		Total 16

Term III (Summer)		Credits
CHEM 201/202	Chemistry Course	3
CHEM 203/205	Chemistry Laboratory	2
Humanities or Social Sciences Elective 3		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 380	Engineering Electromagnetics	3
STAT 230/233	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 350	Computer Networks	3
Science Elective		3
		Total 16

Term VI (Summer)		Credits
ENGL 206	Technical English	3
ARAB		3
Cultures and Histories or Societies and Individuals Elective		3
		Total 9

Term VII (Fall)		Credits
EECE 442	Communication Systems	3
EECE 3xx/4xx	Restricted Elective	3
EECE 3xx/4xx	Restricted Elective	3
MATH	Elective	3
INDE 301	Engineering Economy	3
		Total 15

Term VIII (Spring)		Credits
EECE 3xx/4xx	Restricted Elective	3
EECE 3xx/4xx	Restricted Elective	3
Community Engaged Learning		3
EECE 410L	System Integration Laboratory	1
INDE 410	Human values	3
Cultures and Histories or Societies and Individuals Elective		3
		Total 16

Term IX (Summer)		Credits
EECE 500	Approved Experience	6
		Total 6

Term X (Fall)		Credits
EECE 501	Final Year Project	3
EECE	Restricted Laboratory	1
EECE 3xx/4xx	Elective	3
EECE	EECE Elective	3
Pre-Approved Electives	EECE or Other	3
Cultures and Histories or Societies and Individuals Elective		3
		Total 16

Term XI (Spring)		Credits
EECE 502	Final Year Project	4
EECE	Elective Laboratory	1
EECE	EECE Elective	3
Two Pre-Approved Electives	EECE or Other	6
Cultures and Histories or Societies and Individuals Elective		3
		Total 17

Total Credit Hours	**150**

List of CCE Focus Area Courses

- Area 1: Applied Electromagnetics and RF Systems: EECE 480, 481, 482, 484, 485, 486, 487, 488
- Area 2: Computer Hardware Systems: EECE 412, 420, 421, 422, 423, 425
- Area 3: Communications and Networking: EECE 440, 444, 446, 451, 454, 455, 491
- Area 4: Software Systems: EECE 331, 332, 334, 338, 430, 432, 433, 437, 438, 439, 490

List of CCE Restricted Labs

- EECE 412L, 430L, 431L, 434L, 435L, 442L, 451L, 480L, 655L

List of Pre-Approved Electives

Refer to the section of pre-approved electives.

List of Science Electives

- BIOL 201, BIOL 202, BIOL 209, BIOL 210, CHEM 201, CHEM 207/211, GEOL 201, GEOL 204, GEOL 205, GEOL 211, MAUD 204, PHYL 246, PHYS 212, PHYS 217, PHYS 223, PHYS 235, PHYS 236, PSYC 222, PSYC 224

Computer Science and Engineering Program

Program Requirements

- **Mathematics:** MATH 201, MATH 211 or CMPS 211, MATH 218 or 219, STAT 230 or 233, and two courses from the list of CSE MATH electives.
- **Sciences:** PHYS 211; PHYS 211L; and at least 8 credits from the list of science electives, to include at least one natural science elective.
- **General Education Requirements:**
  - 6 credits in Cultures and Histories
  - 3 credits in History of Idea (CHLA)
  - 6 credits in Societies and Individuals
  - 3 credits from Cultures and Societies and Individuals should cover the theme of Social Inequalities - refer to the GE list
  - 6 credits in understanding communications (ENGL 203 and ENGL 206)
  - 3 credits in understanding communications (Arabic)
  - 3 credits Community Engaged Learning
  - 3 credits Human Values (INDE 410)
- **INDE 301:** Engineering Economy
- **INDE 412:** Engineering Entrepreneurship
- **CSE Core Courses:** FEAA 200, EECE 230, 320, 321, 330, 331, 332, 334, 338, 351, 430, 432, 455, 490.
- **CSE Laboratories:** EECE 321L, 430L, 435L, and one restricted CSE laboratory.
- **CSE Focus Areas:** 9 credits to satisfy the requirements of one of the CSE focus areas.
- **Pre-Approved Electives:** Five 3-credit courses selected from the list of pre-approved Electives.
- **Approved Experience:** EECE 500
- **Final Year Project:** EECE 501 and EECE 502.

Curriculum for BE in Computer Science and Engineering

Term I (Fall)		Credits
FEAA 200	Introduction to Engineering and Architecture	3
EECE 230	Introduction to Computation and Programing	3
MATH/CMPS 211	Discrete Math	3
MATH 201	Calculus and Analytic Geometry III	3
ENGL 203	Academic English	3
		Total 15

Term II (Spring)		Credits
EECE 330	Data Structures and Algorithms	3
MATH 218/219	Linear Algebra	3
STAT 230/233	Probability and Random Variables	3
PHYS 211	Electricity and Magnetism	3
PHYS 211L	Electricity and Magnetism Lab	1
Cultures and Histories or Societies and Individuals Elective		3
		Total 16

Term III (Summer)	Credits
At least 4 credits from the List of CSE Science Electives	4
Cultures and Histories or Societies and Individuals Elective	3
	Total 7

Term IV (Fall)		Credits
EECE 331	Design and Analysis of Algorithms	3
EECE 332	Object-Oriented and Effective Java Programing	3
EECE 320	Digital Design	3
EECE 351	Computing Networks and Services	3
At least 4 credits from the List of CSE Science Electives		4
		Total 16

Term V (Spring)		Credits
EECE 338	Theory of Computation	3
EECE 334	Programming Language Design and Implementation	3
EECE 321	Computer Organization	3
EECE 321L	Computer Organization Lab	1
INDE 301	Engineering Economy	3
Cultures and Histories or Societies and Individuals Elective		3
		Total 16

Term VI (Summer)		Credits
Math Elective		3
ENGL 206	Technical English	3
Arabic Elective		3
		Total 9

Term VII (Fall)		Credits
EECE 455	Cryptography and Network Security	3
EECE 490	Machine Learning	3
EECE 432	Operating Systems	3
EECE	CSE Restricted Laboratory	1
EECE or Other	CSE Concentration Area Elective	3
INDE 410	Human Values	3
		Total 16

Term VIIII (Spring)		Credits
Math Elective		3
EECE 430	Software Engineering	3
EECE 430L	Web, Mobile, and Application Development Lab	2
EECE or Other	Pre-Approved Elective	3
EECE or Other	CSE Concentration Area Elective CSE Focus Area	3
INDE 412	Engineering Entrepreneurship	3
		Total 17

Term IX (Summer)		Credits
EECE 500	Approved Experience	6
		Total 6

Term X (Fall)		Credits
EECE 501	Final Year Project	3
EECE 435L	Software Tools Lab	1
Community Engaged Learning		3
EECE or Other	Two Pre-Approved Electives	6
Cultures and Histories or Societies and Individuals Elective		3
		Total 16

Term XI (Spring)		Credits
EECE 502	Final Year Project	4
EECE or Other	CSE Focus Area	3
EECE or Other	Two Pre-Approved Electives	6
Cultures and Histories or Societies and Individuals Elective		3
		Total 16

Total Credit Hours	**150**

List of CSE Focus Areas

- **Software Engineering (3 courses, 9 credits):** CMPS 224, EECE 433/CMPS 244, EECE 437, EECE 438, EECE 636, EECE 499 in Software Design and Validation
- **Systems and Networks (3 courses, 9 credits):** CMPS 224, EECE 420, EECE 421, EECE 422, EECE 425, EECE 439, EECE 451, EECE 454, EECE 503E, EECE 503F, EECE 651, EECE 499 in Systems and Networks
- **Cybersecurity (3 courses, 9 credits):** EECE 503G, EECE 503J, EECE 635, EECE 641, EECE 655, EECE 657, EECE 798I, EECE 798J, EECE 499 in Cybersecurity
- **Theory and Algorithms (3 courses, 9 credits):** MATH 210, MATH 241 or MATH 261 and one from CMPS 316, EECE 635, EECE 636, EECE 641, EECE 642, EECE 499 in Theory and Algorithms. (Students interested in theory and algorithms are advised to choose MATH 219 from MATH 218/219 and STAT 233 from STAT 230/233.)
- **Artificial Intelligence and Data Science (3 courses, 9 credits):** CMPS 262, EECE 433/ CMPS 244, EECE 634, EECE 636, EECE 668, EECE 693, EECE 699, STAT 234, STAT/MATH 238, STAT 239, EECE 499 in Artificial Intelligence and Data Science.
- **Bioinformatics:** BIOL 210 or BIOL 223 and BIOL 370 or CMPS 297/396 and one from: EECE 433/CMPS 244, EECE 634, EECE 636, EECE 668, EECE 693, EECE 699, CMPS 262, STAT 234, STAT/MATH 238, STAT 239, EECE 499 in Bioinformatics.

List of CSE Restricted Laboratories:

- EECE 451L and EECE 655L

List of CSE MATH Electives:

- MATH 202, MATH 210, MATH 220, MATH 224, MATH 227, MATH 241, MATH 242, MATH 251 or CMPS 251, and MATH 261.

List of Pre-Approved Electives

Refer to the section of pre-approved electives.

List of CSE Science Electives

- BIOL 201(1), BIOL 202, BIOL 209, BIOL 210, CHEM 201(1), CHEM 202(1), CHEM 203, CHEM 205(1), CHEM 207(1)/211, GEOL 201(1), GEOL 203, GEOL 204, GEOL 205(1), GEOL 211, MAUD 204, PHYL 246, PHYS 210(1), PHYS 210L, PHYS 212(1), PHYS 217, PHYS 223, PHYS 228, PHYS 228L, PHYS 235, PHYS 236, PSYC 222, PSYC 224.

Electrical and Computer Engineering Program

Program Requirements

- **Mathematics:** MATH 201; MATH 202; MATH 211 or CMPS 211; MATH 218 or 219; STAT 230/233; and one of MATH 210, 224, 227, MATH/CMPS 251, 261
- **Sciences:** PHYS 210, PHYS 210L, CHEM 201 or 202, CHEM 203 or 205, and one additional science elective
- **General Education Requirements:**
  - 6 credits in Cultures and Histories
  - 3 credits in History of Ideas (CHLA)
  - 6 credits in Societies and Individuals
  - 3 credits from Cultures and Societies and Individuals should cover the theme of Social Inequalities - refer to the GE list
  - 6 credits in understanding communications (ENGL 203 and ENGL 206)
  - 3 credits in understanding communications (Arabic)
  - 3 credits Community Engaged Learning
  - 3 credits Human Values (INDE 410)

- **INDE 301:** Engineering Economy
- **ECE Core Courses:** FEAA 200, EECE 210, 230, 290, 310, 311, 320, 321, 330, 340, 370, 380
- **ECE Laboratories:** EECE 310L, EECE 321L, EECE 410L, two additional laboratories: one restricted laboratory and one elective laboratory
- **ECE Restricted Electives:** Four restricted elective courses from the list of ECE Focus Area courses with a minimum of two courses from one area and no more than three courses from any given area.
- **Undergraduate Elective Courses:** 6 credits of EECE 300 or 400 level courses
- **EECE Electives:** 6 credits of EECE with a number equal to, or greater than, 300 (except EECE 312)
- **Pre-Approved Electives:** 9 credits of coursework. No more than 6 credits may be taken from the same department, program or track (except EECE & CMPS)
- **Approved Experience:** EECE 500
- **Final Year Project:** EECE 501 and EECE 502

Curriculum for BE in Electrical and computer Engineering

Term I (Fall)		**Credits**
FEAA 200	Introduction to Engineering and Architecture	3
EECE 210	Electric Circuits	3
ENGL 203	Academic English	3
MATH 201	Calculus and Analytic Geometry III	3
PHYS 210	Introductory Physics II	3
PHYS 210L	Introductory Physics Laboratory II	1
		Total 16

Term II (Spring)		**Credits**
EECE 230	Introduction to Computation and Programming	3
EECE 290	Analog Signal Processing	3
MATH 202	Differential Equations	3
MATH 218/219	Linear Algebra	3
MATH/CMPS 211	Discrete Structures	3
		Total 15

Term III (Summer)		Credits
CHEM 201/202	Chemistry Course	3
CHEM 203/205	Chemistry Laboratory	2
Cultures and Histories or Societies and Individuals 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 230/233	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 206	Technical English	3
ARAB	Arabic Course	3
Cultures and Histories or Societies and Individuals Elective		3
		Total 9

Term VII (Fall)		Credits
EECE 4xx	Restricted Elective	3
EECE 4xx	Restricted Elective	3
Community Engaged Learning		3
MATH	Math Elective	3
INDE 301	Engineering Economy	3
		Total 15

Term VIII (Spring)		Credits
EECE 4xx	Restricted Elective	3
EECE 4xx	Restricted Elective	3
EECE 3xx/4xx	Elective	3
EECE 410L	System Integration Laboratory	1
INDE 410	Human Values	3
Cultures and Histories or Societies and Individuals Elective		3
		Total 16

Term IX (Summer)		Credits
EECE 500	Approved Experience	6
		Total 6

Term X (Fall)		**Credits**
EECE 501	Final Year Project	3
EECE 3xx/4xx	EECE Elective	3
EECE	Restricted Laboratory	1
EECE	EECE Elective	3
Pre-Approved Electives	EECE or Other	3
Cultures and Histories or Societies and Individuals Elective		3
		Total 16

Term XI (Spring)		**Credits**
EECE 502	Final Year Project	4
EECE	EECE Elective	3
EECE	Elective Laboratory	1
Two Pre-Approved Electives	EECE or Other	6
Cultures and Histories or Societies and Individuals Elective		3
		Total 17

Total Credit Hours	**150**

List of ECE Focus Area Courses

- Area 1: Electromagnetics and RF Systems: EECE 480, 481, 482, 484, 485, 486, 487, 488
- Area 2: Computer Hardware Systems: EECE 412, 420, 421, 422, 423, 425
- Area 3: Power and Energy Systems: EECE 471, 473, 474, 476
- Area 4: Control and Intelligence Systems: EECE 460, 461, 463

List of ECE Restricted Labs

EECE 412L, 460L, 462L, 470L, 471L, 473L, 480L

List of Science Electives

- BIOL 201, BIOL 202, BIOL 209, BIOL 210, CHEM 201, CHEM 207/211, GEOL 201, GEOL 204, GEOL 205, GEOL 211, MAUD 204, PHYL 246, PHYS 212, PHYS 217, PHYS 223, PHYS 235, PHYS 236, PSYC 222, PSYC 224

List of Pre-Approved Electives (CCE, CSE, and ECE)

Electives Within Major

- Any EECE course with a number equal to, or greater than, 300 (except EECE 312)
- Any of the following courses in CMPS: 232/332, 262, 279, 280, 285/385, 288, 297, 314, 315, 316, 323, 345, 351, 365, 371.
- VIPP 201A, 202A, 301A, 401A

Electives Outside Major

- Any ENMG course with a number equal to, or greater than, 600
- ACCT 211, 215
- ARDS 400
- BIOL 201, 202, 210, 223, 224, 225, 243, 244, 247, 260, 268, 290, 370
- BMEN 501, 502, 600, 601, 603, 605, 606, 607, 608, 609, 610, 611, 798CC
- CHEM 200, 201, 202, 206, 208, 211, 212, 215, 217, 218, 227, 228, 229
- CHEN 490, 675
- CIVE 460, 461, 553, 601, 602, 655, 661, 662, 663, 664, 665
- DCSN 200, 210, 216
- ECON 214, 215, 217, 218, 222, 223/224, 226, 227, 228, 230, 232, 235, 236, 237, 239, 240, 241, 242, 243, 333, 341
- ENST 300
- ENTM 225, 235
- FEAA 520
- FINA 211, 220
- GEOL 201, 204, 205, 211, 212, 213, 219, 221
- INDE 302, 303, 412
- MATH 210, 212, 213, 214, 220, 223, 224, 227, 234, 238, 241, 242, 251, 261, 271, 281, 303, 304, 306, 314, 315, 341, 344, 351

- MECH 310, 314, 320, 340, 550, 631, 633, 634, 641, 642, 674
- MKTG 210, 225
- MNGT 218, 220, 229, 230
- PHYL 246
- PHYS 212, 217, 223, 225, 226, 235, 236, 249
- PSYC 226, 229
- Any STAT course with a number equal to, or greater than, 234
- VIPP 201B, 202B, 301B, 401B

Track and Minor in Artificial Intelligence

The track in artificial intelligence can be pursued by all ECMP/EECE students in the ECE department, and the minor in artificial intelligence can be pursued by all AUB undergraduate students. Only students who have a cumulative GPA of 2.3 or more are eligible to apply for the minor.

Track Requirements (for ECMP/ EECE)

In order to satisfy the requirements of the track, students must earn 18 credits of course work from the courses listed below.

- EECE 490 (required)
- EECE 693 (required)
- One of the following PSYC courses: 220, 222, 224, 226 or 229
- One elective from List A
- One elective from List A or List B
- One elective from either List A, B, or C

Elective courses

- **List A:** EECE 463, 633, 639, 664, 668, 699, CMPS 276/262, STAT 239.
- **List B:** CMPS 351, EECE 634, EECE 641, EECE 669, EECE 692, ENMG 604, ENMG 616, MATH 234, MATH 351, MECH 691/EECE 648/ENMG 628, STAT 234, STAT 235.
- **List C:** EECE 331, 334, 422, 423/623, 433, 491, 603, 636, 644, 660, 661, 665, 694, 696.

At least THREE courses must be EECE courses taken in the ECE Department. At least one course from List A or List B must be an EECE course. Required EECE courses cannot be replaced by equivalent courses taken outside the department. Track open only for ECMP and EECE majors. Track cannot be claimed together with minor in AI in the ECE Department or minor in data science in the CMPS Department.

Minor Requirements (for all AUB students)

In order to satisfy the requirements of the minor, students must earn 18 credits of course work from the courses listed below.

- EECE 230, EECE 231 or CMPS 200/201
- EECE 490 (required)
- One of the following STAT courses: 201, 210, 230, or 233
- One of the following PSYC courses: 220, 222, 224, 226 or 229
- One elective from List A
- One elective from List A or List B

Elective courses

- **List A:** EECE 633, 639, 664, 668, 692, 693, 699, CMPS 276/262, MECH 642
- **List B:** CMPS 200/201, CMPS 212/202, EECE 330, 433, 634, 636, 641, 663, 694, 696, MATH 234, STAT 234.

At least TWO courses must be EECE courses taken in the ECE Department. At least one course from List A or List B must be an EECE course. Required EECE courses cannot be replaced by equivalent courses taken outside the department. Minor cannot be claimed together with the track in AI in the ECE Department or minor in data science in the CMPS Department. No more than 9 credit hours taken in the major field of study may be used to satisfy a requirement for another minor.

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 areas 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, upon its completion, on the transcript of participating students.

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 A- Control:** EECE 660/MECH 653, EECE 662/MECH 655, EECE 663/MECH 656, EECE 665/MECH 654, and EECE 669/MECH648
- **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 648/MECH 691/ENMG 628, EECE 692/MECH642, and MECH 647

Course Descriptions

FEAA 200 Introduction to Engineering and Architecture 3 cr.
The course is designed to familiarize first year students with the different disciplines in engineering and architecture including: architecture, civil, mechanical, electrical, chemical, industrial and technologies used in the fields. The course takes a unique interdisciplinary approach to the field and introduces the related disciplines in the world of engineering and architecture. One key objective is to promote interdisciplinary interaction and innovative thinking. The course is organized into modules covering the different disciplines within the Maroun Semaan Faculty of Engineering and Architecture (MSFEA). The last module of the class showcases interdisciplinary projects demonstrating interactions among the different fields. The lectures explain as applicable to each discipline, through examples, notions of problem solving, design thinking, process of invention and innovation, environmental and civic responsibility, and measures of success in aesthetics and performance. The course project is a key component of the course. It is interdisciplinary in nature bringing ideas and solutions from all disciplines in engineering and architecture. Annually.

FEAA 500 (0 cr./3 b.) / 500A (3 cr./3 b.) Cooperative Education and Experiential Learning
This course places students in a recognized firm in Lebanon or abroad for a supervised immersive learning experience in which they work as junior-level professionals in their fields of study. For a minimum of six months, students work full-time in a paid position where they apply their knowledge to challenging problems related to their field of study. This course extends over two terms and is registered twice as FEAA 500 and FEAA 500A in order to cover the six-months period. FEAA 500: 0 credit- 3 billing - grade (PR) – prerequisites: approval of the course coordinator and completion of a minimum of 90 credits for engineering students (120 credits for architecture students). FEAA 500A: 3 credits – 0 billing – prerequisites: FEAA 500.

FEAA 520 Data Centric Design 3 cr.
This course introduces students to the various types of data, the basics of sensing, data acquisition, database design, and data analytics. FEAA 520 combines theoretical topics in machine learning with practical methods for solving problems, using Python or other programming languages. The students are exposed to supervised and unsupervised machine learning algorithms (e.g., clustering, linear regression, and classification), as well as basic deep learning architectures. The topics are demonstrated with examples from all engineering disciplines and several hands-on laboratory sessions. Prerequisites: EECE 230/231, MATH 201, and STAT 230 (MATH 218/219 is preferred but not mandatory).

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, superposition, Thevenin's and Norton's theorems, and source transformation; operational amplifiers; inductors, capacitors, and duality; mutual inductance and transformers; steady-state AC circuits; power calculation in ac circuits; analysis of balanced three phase circuits with power calculations; circuit simulation using PSPICE.

EECE 230 Introduction to Computation and Programming 3 cr.
This is an introductory programming course with an emphasis on abstractions and elementary algorithmic ideas. It uses the Python programming language. Topics include data types, selection, repetition, lists, tuples, strings, functions, files, plotting, exception handling, program efficiency, recursion, divide and conquer algorithms, recurrence relations, sorting and searching algorithms, binary search, merge sort, randomized quicksort, dictionaries, memorization, classes and object-oriented programming, stacks and queues, applications, and selected topics. The course has a weekly lab. Students cannot receive credits for both EECE 230 and CMPS 201.

EECE 231 Introduction to Computation and Programming with Applications 3 cr.
This is an introductory course designed to provide students with a comprehensive foundation in Python programming with a strong emphasis on data-centric applications. Students will embark on a journey through the fundamental principles of programming, mastering Python syntax, data types, control structures, functions, lists, dictionaries, sets, tuples, object-oriented programming, etc. while simultaneously delving into the realm of data science by gaining hands-on experience applying these skills to analyze, manipulate, and visualize data from various disciplines of engineering and sciences. Through a hands-on and assignments/project-based approach, students will develop the skills necessary to analyze, visualize, and draw insights from real-world datasets. This course is not considered equivalent to EECE 230; hence, students who have taken this course and wish to transfer to ECE will need to take EECE 230.

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. Prerequisite: EECE 290.

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/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 fundamentals of electronics and electronic circuits to non- majors. Its objectives are to provide concise treatment of the basic concepts of electronic components and to introduce students to 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. Prerequisite: EECE 210.

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 circuits and applications, transistor applications, op-amp circuits, passive filters, digital circuits, and instrumentation. Pre/corequisite: EECE 312.

EECE 320 Digital Systems Design 3 cr.
This course introduces basic principles and practices of combinational and sequential design of digital systems: binary codes, Boolean algebra, combinational circuits design, combinational and sequential building blocks, and design of finite state machines. The course introduces the Verilog hardware description language. Students work on two design and implementation projects using Verilog, one for a combinational circuit and another for a sequential circuit. Prerequisite: EECE 230 or EECE 231 or CMPS 200 or CMPS 201.

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 Verilog design project of a single-cycle RISC-V microprocessor core. Students cannot receive credits for both EECE 321 and CMPS 221. Prerequisites: EECE 320 and Pre/corequisite EECE 330.

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/corequisite: EECE 321.

EECE 330 Data Structures and Algorithms 3 cr.
This is an introductory course in data structures and algorithms with an emphasis on programming. The course uses the C++ programming language. Topics include: elements of C++, memory management, C++ classes and templates, linked-lists, sacks, queues, standard template library, binary trees, binary search trees, balanced trees, heaps, priority queues, hashing, graph traversals, introduction to graph algorithms. The course has a weekly lab. Students cannot receive credits for both EECE 330 and CMPS 202. Prerequisites: EECE 230 and Pre or corequisite: MATH 211 or CMPS 211.

EECE 331 Design and Analysis of Algorithms 3 cr.
This course covers techniques for the design and analysis of efficient algorithms. Topics include: divide and conquer, dynamic programing, and greedy design strategies; sorting algorithms including merge sort, randomized quicksort, counting sort, and radix sort; median and order statistics algorithms; sorting lower bound; matrix multiplication and elementary arithmetic algorithms; balanced search trees; augmenting data structures; hash tables; data structures for disjoint sets; amortized analysis; graph traversal algorithms and applications, minimum spanning tree algorithms, shortest path algorithms; maximum flow; introduction to NP completeness. Students cannot receive credits for both EECE 331 and CMPS 214. Prerequisite: EECE 330.

EECE 332 Object-Oriented and Effective Java Programming 3 cr.
This course covers object-oriented and effective Java programming concepts for the production of reliable and maintainable code. Topics include data abstraction and encapsulation; polymorphism; generics; specifications and exceptions; reflection; multi-threading; database connectivity with JDBC; in addition to traditional testing techniques and test-driven development. The course will highlight good programming practices and expose bad practices. Prerequisite: EECE 330.

EECE 334 Programming Language Design and Implementation 3 cr.
This course examines the design and implementation of widely adopted programming languages. Topics include data types; bindings; run-time management; object- orientation; syntax analysis; semantic analysis; and the implementation of compilers and interpreters. Functional and logic programming principles are also covered. This course is considered equivalent to CMPS 231; hence, students cannot receive credits for both EECE 334 and CMPS 231. Prerequisite: EECE 332.

EECE 338 Theory of Computation 2 cr.
This course covers the basics of automata and language theory, computation theory, and complexity theory. The first part of the course is about automata and regular languages, context free grammar, Church's thesis, decidability, and reducibility. Topics in the second part of the course include: time complexity and NP-completeness, space complexity, polynomial-space and log-space computations, circuit complexity, probabilistic computations and complexity classes, approximation algorithms, and selected topics as time permits. Students cannot receive credits for both EECE 338 and CMPS 215. Prerequisites: EECE 330 and STAT 230 or STAT 233.

EECE 340 Signals and Systems 3 cr.
This 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. Prerequisites: EECE 290 and MATH 202.

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. Students cannot get credit for both EECE 350 and EECE 351. This course is considered equivalent to CMPS 242; hence, students cannot receive credits for both EECE 350 and CMPS 242. Prerequisite: EECE 330.

EECE 351 Computing Networks and Services 3 cr.
A course that outlines data networks and cloud services, application layer protocols, web services and related protocols, cloud computing and service models, socket programming, TCP service protocols, internetworking, and software-defined networking. Students cannot get credit for both EECE 350 and EECE 351. Prerequisite: EECE 330.

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 three-phase transformers; fundamentals of AC machine: 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 290.

EECE 380 Engineering Electromagnetics 3 cr.
The course covers three-phase circuits and power calculation, magnetic circuits, transformers: single-phase ideal and real transformers, 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, torque, and efficiency expressions. Prerequisites: EECE 210 and MATH 202.

EECE 401 Biomedical Engineering Seminar 1 cr.
Biweekly seminars given by members of the Maroun Semaan 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 a graded assignment based on each seminar. The seminar is required of all students taking the biomedical engineering minor. Students cannot receive credit for both EECE 401 and BMEN 600. Prerequisite: EECE 601 or EECE 603 or MECH 633.

EECE 407/607 Quantum Communication Networks 3 cr.
This course provides a deep dive into quantum communications, quantum networks, and the emerging quantum Internet. Starting with the basics of quantum information, the course explores the building blocks of quantum communication networks, including single-photon and entanglement generation sources, quantum channels (free-space optical and optical fiber), quantum noise, and decoherence. Advanced topics include quantum memory, quantum switches, quantum repeaters, and quantum detectors. We will also cover distributed quantum sensing and machine learning applications over the quantum Internet, along with secure quantum communication protocols like quantum key distribution and the necessary process of entanglement distribution over the quantum Internet. Finally, the course will cover advanced techniques to enable scalable quantum communications including entanglement swapping, entanglement distillation, and quantum error correction. In achieving these goals, the course will include an introduction to state-of-the-art quantum network simulators, like NetSquid, where students will get a chance to design and simulate hybrid quantum-classical communication networks and evaluate their performance. A solid understanding of linear algebra is necessary, in addition to a good understanding of communication theory. Prerequisites: MATH 218/219 and STAT 230/233.

EECE 410L System Integration Laboratory 1 cr.
A laboratory course that introduces students to a variety of tools and reinforces their design skills to successfully 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 and Pre/corequisites: EECE 321L and EECE 311.

EECE 411/611 Analog Integrated Circuits 3 cr.
Technology and limitations. IC design flow. Differential structures. Voltage regulators and converters, reference, and bias circuits. Output stages. Mixed-signal circuits overview. Noise and linearity analysis and modeling. Comparators. Sample-and-hold and trans-linear circuits. Discrete-time signals. Switched-capacitor circuits. Data converter fundamentals. Nyquist-rate D/A converters. Nyquist-rate A/D converters. Oversampling converters. Phase-locked loops. This course makes extensive use of EDA tools for custom IC design. Prerequisite: EECE 311.

EECE 412/612 Digital Integrated Circuits 3 cr.
This course is an introduction to digital integrated circuits. Material will cover CMOS devices and manufacturing technology, CMOS inverters and gates, propagation delay, noise margins, power dissipation, and regenerative logic circuits. Various design styles as well as issues designers face, such as technology scaling and the impact of interconnect, are investigated. The course starts with the core digital design block, the CMOS inverter, and then various CMOS implementations are discussed. The design of more complex combinational gates such as NAND, NOR, XORs will be considered, looking at optimizations for speed, area, or power the influence of interconnect parasitics on circuit performance and approaches to cope with them are treated in detail. The course concludes with an examination of design methodologies. Spice simulation will be embedded in lectures as practical application for lectures to emphasize DC and transient analysis. 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. Pre/corequisite: EECE 412 or EECE 612.

EECE 420 Digital Systems Design II 3 cr.
This course builds on background from a first course on logic design and 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, data path subsystems, data path controllers, programmable storage devices (ROM, SRAM, FLASH, DRAM), programmable logic devices (CPLDs, FPGAs), and memory buffers. Synchronous and asynchronous logic design principles are covered, including pipelining, asynchronous handshake methodologies, and synchronization across multiple clock domains. Behavioral modeling and synthesis of combinational and sequential logic are discussed. The Verilog language is introduced in an integrated manner throughout the course to support design examples. The course includes a design project to be integrated on a modern FPGA platform. Prerequisite: EECE 320.

EECE 421/621 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; domain-specific architectures. Prerequisite: EECE 321.

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 simultaneous multithreading processors, multicore processors, SIMD processors, UMA, NUMA and COMA shared-memory multiprocessors, distributed multiprocessors, snoopy and directory-based cache coherence protocols, memory consistency models, high performance synchronization methods, speculative lock elision, shared memory programming model, message passing programming model and transactional memory programming model. To consolidate the material presented in class, students work on designing parallel programs using the OpenMP threading environment and MPI message passing programming standard. Prerequisite: EECE 321.

EECE 423/623 Reconfigurable Computing 3 cr.
A course on reconfigurable computing systems and applications. Contemporary FPGA architecture. FPGA design flows and tools. Hardware/software partitioning. Host, memory, and peripheral interfaces. Hardware accelerators. Classical and emerging applications. Students work on a set of design assignments and design/research projects using appropriate FPGA development boards and tools. Prerequisite: EECE 321.

EECE 425/625 Embedded and IoT Systems 3 cr.
An introduction to the basic building blocks and technologies used to design contemporary embedded and IoT systems. Topics include microcontroller architecture and programming; peripheral device controllers (GPIO; timers/counters; interrupts); serial interfaces (UART; SPI; I2C); device networking; pulse-width modulation; analog/digital conversion; real-time operating systems; and edge intelligence. Students work on a sequence of lab assignments and a major design or research project using appropriate microcontroller development boards and tools. Prerequisite: EECE 321.

EECE 430 Software Engineering 3 cr.
A course that teaches students modern processes and tools for working on software projects, including the design, development, testing, and deployment of software systems. They will understand and use agile development methodologies and tools, including lo-fi UI sketching, user stories, behavior-driven development, and version control for team-based development, management tools, and design patterns. The course requires the completion of a group-based real-life software project. This course is considered equivalent to CMPS 271; hence, students cannot receive credits for both EECE 430 and CMPS 271. Prerequisite: EECE 330.

EECE 430L Web, Mobile, and Application Development Lab 2 cr.
A two-credit lab course that takes the students in a journey on building and deploying software systems on several platforms including standalone desktop applications, mobile devices, application servers and web applications. The course consists of one lecture per week (1 credit) that cover tutorials followed by one lab session per week where students apply the tutorials. This is a BYOD course. The lab exercises end up with the students building a software game or a computer-aided design tool that works seamlessly across different platforms while sharing the same core business logic. Prerequisite: EECE 330.

EECE 432 Operating Systems 3 cr.
This course provides a comprehensive exploration of the fundamental principles and concepts underlying modern operating systems and systems programming. Students will delve into key topics such as processes, threads, concurrency, synchronization, CPU scheduling, deadlock prevention and detection, memory management, file systems, I/O device management, and the basics of parallel and distributed systems. Additionally, the course will address critical aspects of system security and protection mechanisms. To bridge theory with practice, the course includes hands-on programming assignments that involve working with contemporary linux kernels. These practical exercises are designed to reinforce theoretical concepts and provide students with real-world experience in systems programming and operating system internals. By the end of the course, students will have a solid understanding of how operating systems function and the skills to develop and optimize system-level software. This course is considered equivalent to CMPS 240; hence, students cannot receive credits for both EECE 432 and CMPS 240. Prerequisite: EECE 321.

EECE 433 Database Systems 3 cr.
This course offers a comprehensive and hands-on introduction to the fundamental concepts and practices of database systems. Students will explore key topics such as database design, implementation, and administration, with a strong focus on practical skills. The curriculum covers essential areas including SQL programming, data modeling, database storage and indexing, and database design theory. Additionally, the course delves into database application development, normalization techniques, and the basics of database administration. To provide a well-rounded perspective, students will also be introduced to NoSQL databases and the foundational concepts of data warehouses. By the end of the course, students will gain the knowledge and skills necessary to design, manage, and optimize databases effectively in real-world scenarios. This course is considered equivalent to CMPS 244; hence, students cannot receive credits for both EECE 433 and CMPS 244. Prerequisite: EECE 330.

EECE 435/606 Introduction to Quantum Computing 3 cr.
This course introduces the basics of quantum information science and quantum computing. We will cover classical vs quantum bits, quantum states, quantum gates and circuits, and foundational quantum algorithms. The course will also introduce quantum communication and quantum machine learning. No prior knowledge of quantum theory or physics is required, but a solid understanding of linear algebra is necessary. Pre or corequisite: MATH 218 or MATH 219.

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. The students will be grouped into teams of two (or three) that each will undertake a software project guided by a set of several designed lab experiments. 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 are asked to use Python to conduct their work. Prerequisite: EECE 330.

EECE 437 Software Architecture and Design Fundamentals 3 cr.
This course offers a comprehensive and hands-on introduction to the fundamental concepts and practices of database systems. Students will explore key topics such as database design, implementation, and administration, with a strong focus on practical skills. The curriculum covers essential areas including SQL programming, data modeling, database storage and indexing, and database design theory. Additionally, the course delves into database application development, normalization techniques, and the basics of database administration. To provide a well-rounded perspective, students will also be introduced to NoSQL databases and the foundational concepts of data warehouses. By the end of the course, students will gain the knowledge and skills necessary to design, manage, and optimize databases effectively in real-world scenarios. Prerequisite: EECE 330.

EECE 438 Software Engineering II 3 cr.
This course aims to develop a broad understanding of advanced concepts in software engineering including: system dependability, component-based software engineering, distributed software engineering, service-oriented software engineering, real-time software engineering, user interface design, and software management. The students will apply the learned techniques in assignments. They will work on a specific advanced topic in software engineering, prepare a report and give a short presentation on the selected topic. Prerequisite: EECE 430.

EECE 439 Cloud computing 3 cr.
This course aims to develop a broad understanding of cloud computing including: data center design, infrastructure, cloud storage technologies, types of clouds and service models, virtualization and containerization, automation and orchestration, programming models, administration, security and privacy, and applications. The students will apply the learned techniques in assignments and a team project. Prerequisite: EECE 330.

EECE 440/640 Wireless Communications 3 cr.
A course that covers the fundamentals of wireless communications with emphasis on wireless channel modeling; detection and diversity techniques; resource management and power control; OFDM and ultra-wideband systems; opportunistic communication; multiple-antenna systems; multiple-access techniques and multi-user communication; diversity-multiplexing tradeoff; precoding; emerging topics in wireless communications systems. Prerequisite: EECE 442.

EECE 442 Communication Systems 3 cr.
A laboratory course with experiments covering the following topics: AM and FM modulation and demodulation, sampling and quantization, baseband transmission, digital modulation (PSK, FSK, MSK, GMSK), digital demodulation, and inter-symbol interference. Prerequisites: EECE 340 and STAT 230 or STAT 233.

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

EECE 444/644 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 or STAT 233 and EECE 340.

EECE 446/646 Data Communications 3 cr.
This course provides an integral view of data communication systems and their digital signal-processing solutions at the link level. The course studies contemporary techniques for signal representation (sampling, quantization, compression), signal transmission and reception (modulation, data detection, channel estimation), and error correction coding (soft and hard, code-specific and noise-centric channel decoding). Conventional signal processing techniques are compared to machine-learning-based solutions under practical multi-antenna and high-frequency wireless constraints. The techniques are studied from information-theoretic and algorithmic/architectural (complexity) perspectives, laying the foundations for analysis and design. Pre/corequisite: EECE 442.

EECE 451 Mobile Networks and Applications 3 cr.
This course covers mobile networking topics with a focus on wireless networking technologies and mobile computing applications. It addresses the following standards: Bluetooth, ZigBee, Wi-Fi, GSM (2G), UMTS (3G), and LTE (4G). It also introduces the technologies that are part of the emerging 5G networks, covers Mobile IP, and an overview of Web Services and cloud computing. The course includes a project on mobile app development that involves communication among mobile devices. Prerequisite: EECE 350 or EECE 351.

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 351.

EECE 454/654 Communication Networks-Modeling and Optimization 3 cr.
The course covers the modeling and optimization of communication networks with applications that span fundamental and emerging design problems. Topics include modeling network resources, performance metrics, and requirements; optimization problem formulations and solution methods for multi-hop communications, resource allocation, network planning and topology design; and emerging research problems such as drone-based cell planning, edge computing, and ultra-low latency communications. Prerequisite: EECE 350 or EECE 351.

EECE 455/632 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, finite fields, advanced encryption standard, confidentiality using symmetric encryption, public-key cryptography, key management, hash and MAC algorithms, digital signatures, authentication applications, Web security, email security and IP security. Prerequisite: senior standing.

EECE 460 Control Systems 3 cr.
This course seeks to impart in students a sound understanding of fundamental principles in control engineering based on analog technologies. The course includes: mathematical modeling of linear continuous time invariant single input-single output dynamical systems; transfer functions and state space models, performance specifications, analysis and design of closed loop analog control systems. Prerequisite: EECE 340.

EECE 460L Control Systems Laboratory 1 cr.
This course involves students in the practical implementation of concepts acquired in EECE 460 by analyzing different types of dynamical systems, designing and understanding controllers suitable to specific models, simulating system responses, and experimentally verifying the effectiveness of various control schemes. Pre/corequisite: EECE 460.

EECE 461 Instrumentation 3 cr.
A design course for complete instrumentation systems, including measurements, sensors, data acquisition and component integration. Application areas and course projects include industrial control, laboratory measurements, automation systems and the like. This course is completed with a set of laboratory experiments. Prerequisite: senior standing.

EECE 462L Industrial Control Laboratory 1 cr.
A laboratory that addresses topics related to industrial automation and process control. Experiments include Programmable Logic Controllers (PLC), Supervisory Control and Data Acquisition (SCADA), Human Machine Interface (HMI), industrial networks, machine vision, and motion control applications. Prerequisite: EECE 460 or MECH 431.

EECE 463/MECH 555 Artificial Intelligence for Control Systems 3 cr.
EECE463 is an introductory course in the evolving field of artificial intelligence (AI) in control systems. It aims at giving students a foundation in AI by covering basic techniques for searching, reasoning under uncertainty and over time, scheduling, communicating, perceiving, and learning as applied to control systems. 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 436.

EECE 470/670 Power System Planning 3 cr.
Electric energy and peak demand forecasts using weather sensitive, time curve, and autoregressive models; generation reliability evaluation, loss of energy expectation, probabilistic production costing, generating capacity expansion analysis, maintenance scheduling, and planning with renewable energy sources, power flow and security analysis, optimal power flow; planning in a competitive electric power environment. Prerequisite: EECE 471

EECE 470L Electric Machines Laboratory 1 cr.
This course covers open circuit, short circuit and load test; unbalanced loading and parallel operation of transformers; speed control and load characteristics of shunt, series and compound DC machines; induction machines: blocked rotor, no-load and loading tests; operation of single-phase induction motors; operation of a synchronous machine connected to a large external source. Prerequisite: EECE 370.

EECE 471 Fundamentals of Power Systems Analysis 3 cr.
This course covers three-phase systems, generation modeling review and generation capability curve; transformers, autotransformers, three-winding transformers and regulating transformers. Calculation of transmission line parameters, evaluation of steady state operation of transmission lines, reactive power compensation, line capability, power flow analysis using Gauss-Seidel and Newton-Raphson methods, economic load dispatch, symmetrical fault analysis. Prerequisite: EECE 370.

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 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.
Overview of power electronics devices used and their desired characteristics; introduction to gate and base drive circuits, snubber circuits; diode circuits and rectifiers, effect of source inductance, three-phase rectifiers, three-phase converters; dc-dc switched mode converters, buck, boost, and buck-boost circuits, bridge converter; pulse-width modulated inverters, voltage control, harmonics, three-phase inverters. Prerequisite: EECE 310.

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-quandrant 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. Pre/corequisite: EECE 473.

EECE 474 Electric Drives 3 cr.
A course that covers steady- state analysis of dc and 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 drives: rectifier and chopper drives, dynamic and regenerative braking, plugging. Stepper motors: types, operational characteristics, control algorithms, power drive configurations. Special-purpose motors. Prerequisite: EECE 370.

EECE 475 Building Management 3 cr.
The Building Management Systems course focuses on the design and execution of electrical and control systems pertaining to Buildings for industrial, commercial, utility, or residential use. The course will detail the design criteria, specifications, equipment, devices, and tools needed to size, select, wire, power, and control low voltage electrical equipment for building applications. The course covers topics about low voltage power distribution and low voltage power protection devices, cables and wires, motor and drives, solar electricity, back-up power, lighting design and calculations, small power equipment, EV charging stations and building wiring/cabling design. The course will include sections about and basic controls using elementary devices as well as computer-based systems with sensors and instruments for building applications. The material will highlight the importance of energy audit and energy efficiency to realize better power reliability, higher energy efficiency, and lower operational costs.

EECE 476 Power System Design, Control, and Protection 3 cr.
This course covers the main equipment and subsystems of a power distribution system, namely step-up and step-down transformers, HV and MV Switchgears and associated circuit breakers, network protection devices, electronic (and electromechanical) protection relays, substation and substation automation. The course includes a section about power monitoring and control along with the associated SCADA and related sensors and field devices. Prerequisite: EECE 370.

EECE 478/678 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.

EECE 479/679 Energy Efficiency in the Power Sector 3 cr.
Introduction to the concept of sustainable development and its roots as an interdisciplinary vision, the framework of the 17 SDGs, with 169 targets, and the history of development, achievements and challenges facing the SDGs deployment, role of engineers in achieving sustainability, outcomes of COP28. Selected topics covered in the course include: energy conversion, generation and cogeneration, load duration curves, losses and efficiency optimization, theory and application of energy analysis techniques, energy audit: definition and types, data analysis, reporting, and recommendation. Prerequisites: EECE210, senior standing.

EECE 480/680 Antennas for Wireless Communications 3 cr.
This course provides students with an understanding of basic principles of antenna analysis and design for wireless communications. The course covers an overview of the fundamental characteristics and parameters of antennas, an overview of analytical methods used to analyze and design antennas with application to some basic antenna structures such as linear antennas, loop antennas, antenna arrays, and microstrip antennas. Prerequisite: EECE 380.

EECE 480L Electromagnetics and Radio Frequency Laboratory 1 cr.
A laboratory course with experiments on concepts of applied electromagnetics and radio frequency systems. This lab includes the demonstration of Coulomb's, Ampere's and Faraday's laws; the design and implementation of capacitors and inductors; the realization of a wireless power transfer system; the design of transmission lines and impedance matching networks; the simulation and fabrication of passive and active RF circuits, wire and planar antennas as well as a full transceiver architecture. Prerequisites: EECE 340 and EECE 380.

EECE 481 Applications of Electromagnetic Fields 3 cr.
This course covers basic concepts and methods related to time varying electromagnetic wave propagation. The course includes full analysis of Maxwell's equations, plane wave propagation, reflection and transmission in lossless and lossy media, normal and oblique incidence, waveguides, impedance matching and introduction to microwave engineering. Prerequisite: EECE 380.

EECE 482 Applied Radio Frequency Engineering 3 cr.
The course introduces fundamental design concepts of radio frequency (RF) circuits and systems along with their physical realization. The course theoretical aspect is supplemented by laboratory implementation of the designed circuits and systems. The course covers topics such as microstrip lines, network analysis, distributed impedance matching as well as electromagnetic interference and compatibility. Furthermore, the course introduces the design and development of passive and active RF circuits and systems such as filters, power dividers, directional couplers, low-noise amplifiers, power amplifiers, down conversion mixers, oscillators, multi-technology transceivers and radars. The course provides students with a design capability accompanied by hands-on experience on applied RF engineering. Prerequisite: EECE 380.

EECE 484/684 Microwave Engineering 3 cr.
This course focuses on the analysis and design of passive microwave circuits. It covers the fundamentals for radio frequency and microwave engineering. It discusses the theories of transmission lines, waveguides, impedance matching, microwave networks, scattering parameters, power dividers, directional couplers, microwave resonators and microwave filters. The course enables students to study and analyze their own microwave network using computer-aided design tools and measurement equipment. Prerequisite: EECE 380.

EECE 485/685 Radio Frequency (RF) Circuits Design 3 cr.
This course covers advanced RF circuit design principles and techniques, beginning with the behavior of passive components like high-frequency resistors, capacitors, and inductors. Students learn to design RF circuits using transmission line theory and the Smith Chart, then delve into the study of two-port networks and their representations in terms of S-parameters. The course emphasizes impedance matching, biasing, and RF transistor modeling. Various RF amplifier configurations such as low noise, high power, and broadband amplifiers are explored along with their applications. Nonlinear systems in RF oscillator and mixer circuits are discussed, as are RF switches and phase shifters. Throughout the course, students use computer-aided design tools for simulation and analysis, gaining practical skills in RF circuit design. Prerequisites: EECE 310 and EECE 380.

EECE 486/686 Radio Frequency (RF) Transceiver Design 3 cr.
This course targets the physical layer of a communication system by focusing on the interactions between the various transceiver blocks. The course addresses the design and operation of the components that reside between the signal processing unit and the antenna within the RF chain. The course also details the functional level modeling of different transceiver architectures by accounting for the gain, noise, nonlinearity, sensitivity, and dynamic range. In addition, students are exposed to recent computer-aided simulation tools and measurement techniques through a set of laboratory experiments that are tailored based on the course content. As a result, the course equips the students with theoretical and practical experience in RF transceiver design. Prerequisites: EECE 380.

EECE 487/687 Radio-Frequency Integrated Circuit (RFIC) Design 3 cr.
The course addresses the analysis and design of various Radio Frequency Integrated Circuits (RFICs) with an emphasis on specific RF blocks such as low noise amplifiers, oscillators, mixers, phase locked loops and frequency synthesizers. It also introduces the design of on-chip lumped elements and passive RF components. The course provides students with hands-on experience in the simulation of RFICs as well as the different techniques for RFIC measurements. As a result, the students will be equipped with essential theoretical and practical experience in RFIC design. Prerequisites: EECE 380 and EECE 311.

EECE 488/688 Engineering Bio-Electromagnetics 3 cr.
This course discusses the interaction between biological material and electromagnetic fields. The course introduces bio-electromagnetics along with its sub-divisions and reviews the fundamental properties of electromagnetic fields and their propagation characteristics in lossy biological tissues. The course then elaborates on the electromagnetic properties of biological tissues from a bioelectric perspective. Bio-Electromagnetism is then analyzed at DC, extremely low frequencies, radio frequencies, up to Terahertz frequencies and beyond. The concept of dosimetry and the principles of energy absorption in biological tissues are then studied along the design of electromagnetic sensors and electrodes for monitoring, reception and stimulation in the human body. The human body is then analyzed as a communication channel and as a generator of electromagnetic fields. The course is concluded with an introduction to the various electromagnetic simulation tools and the corresponding measurement techniques. Prerequisites: EECE 380 and EECE 340.

EECE 490/690 / MECH 534/658 Introduction to Machine Learning 3 cr.
The course provides an introduction to machine learning theory and algorithms which learn from experience to predict or control yet to be seen instances. The course discusses the intuition and the theory of some selected modern machine learning concepts as well as the practical know how to successfully apply them to new problems. It covers topics in supervised learning such as parametric /non-parametric, generative/discriminative algorithms for classification and regression and in unsupervised learning for clustering, dimensionality reduction and reinforcement learning. The course also includes case studies and applications so that students can gain practice on regularization, model selection, parameter estimation, support vector machines, neural networks, and deep learning. For the graduate version of the course, the students are required to conduct a research project which constitutes a significant component of the course This course is considered equivalent to CMPS 261; hence, students cannot receive credits for both EECE 490/690, CMPS 261 and EECE 667. Prerequisites: EECE 330, MATH 218 or MATH 219, and STAT 230 or STAT 233.

EECE 491/691 Digital Signal Processing 3 cr.
Digital Signal Processing (DSP) is at the heart of almost all modern technology. This course introduces the fundamentals of DSP systems, including properties of discrete-time linear systems, digital filter design, sampling and reconstruction, A/D and D/A conversion, quantization, discrete-time fourier analysis, spectral analysis, sample-rate conversion, FFT and fast convolution, filter structures and realizations, and multirate DSP and filter banks. The course also discusses applications of DSP in areas such as speech/audio processing and includes a project to implement one such application. Prerequisite: EECE 340.

EECE 499 Undergraduate Research 3 cr.
This course requires participation, under the supervision of a faculty member, in a research project. Before registering, students 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 GPA of 3.3 or above.

EECE 500 Approved Experience 6 cr.; 1 b.
This is an eight-week professional training course in electrical and computer engineering. (Students who register FEAA 500 cannot register EECE 500.)

EECE 501 Final Year Project 3 cr.
A supervised project in groups of normally three 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 acquire the necessary material needed for the completion of the project in the spring term. A professional report and oral presentation are also required. Prerequisite: EECE 410L or EECE 430L.

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 poster are also project deliverables. Prerequisite: EECE 501.

EECE 503 Special Topics in ECE 3 cr.
Special Topics in ECE

EECE 505/FEAA 502 Final Year Project Accelerator 3 cr.
This course is part 2 of a two-course sequence that provides selected Final-Year Project (FYP) students with the knowledge, tools, and mentorship needed to transform their technical FYP into a viable business by the time they graduate. Topics covered include value proposition design, business modeling, pricing, go-to-market strategies, startup finance and unit economics, IP and legal aspects, market sizing and competitive analysis, branding, and launch planning. Students will pitch their startup to investors at the end of the program. The course is offered annually in the spring term. Prerequisite: FEAA 501.

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 603 Biomedical Signal and Image Processing 3 cr.
This course introduces the fundamentals of digital signal and image processing as implemented in biomedical applications. It provides a concise treatment of the tools utilized to describe deterministic and random signals as the basis in analyzing biological signals. Such tools include data acquisition and imaging, denoising and filtering, feature extraction, and modeling. The course is very tightly coupled with a practical component as it looks at and assigns laboratory projects on the auditory system, speech generation, electrocardiogram, neuronal activity, and medical imaging. Pre or corequisite: EECE 340 and STAT 230 or STAT 233.

EECE 606/435 Introduction to Quantum Computing 3 cr.
This course introduces the basics of quantum information science and quantum computing. We will cover classical vs quantum bits, quantum states, quantum gates and circuits, and foundational quantum algorithms. The course will also introduce quantum communication and quantum machine learning. No prior knowledge of quantum theory or physics is required, but a solid understanding of linear algebra is necessary. Pre or corequisite: MATH 218 or MATH 219.

EECE 607/407 Quantum Communication Networks 3 cr.
This course provides a deep dive into quantum communications, quantum networks, and the emerging quantum Internet. Starting with the basics of quantum information, the course explores the building blocks of quantum communication networks, including single-photon and entanglement generation sources, quantum channels (free-space optical and optical fiber), quantum noise, and decoherence. Advanced topics include quantum memory, quantum switches, quantum repeaters, and quantum detectors. We will also cover distributed quantum sensing and machine learning applications over the quantum Internet, along with secure quantum communication protocols like quantum key distribution and the necessary process of entanglement distribution over the quantum Internet. Finally, the course will cover advanced techniques to enable scalable quantum communications including entanglement swapping, entanglement distillation, and quantum error correction. In achieving these goals, the course will include an introduction to state-of-the-art quantum network simulators, like Net Squid, where students will get a chance to design and simulate hybrid quantum-classical communication networks and evaluate their performance. A solid understanding of linear algebra is necessary, in addition to a good understanding of communication theory. Prerequisites: MATH 218/219 and STAT 230/233.

EECE 608 Trustworthy machine learning 3 cr.
This course provides an introduction to trustworthy machine learning and AI. With the increasing use of predictive machine learning, trustworthiness of the models is becoming more of a concern. This course will cover the main aspects of trustworthy machine learning. Those are: the privacy of the user data used in the model, which could include confidential and sensitive information, the fairness of the model towards all groups/individuals, the robustness of the model to attacks, the transparency of the model, and the explainability of the model. Students will learn how to reliably build trustworthy machine learning models by understanding machine learning system vulnerabilities and possible ways to defend against them. Prerequisites: EECE 230, EECE 490, and STAT 230/233.

EECE 611/411 Analog Integrated Circuits 3 cr.
Technology and limitations. IC design flow. Differential structures. Voltage regulators and converters, reference, and bias circuits. Output stages. Mixed-signal circuits overview. Noise and linearity analysis and modeling. Comparators. Sample-and-hold and trans-linear circuits. Discrete-time signals. Switched-capacitor circuits. Data converter fundamentals. Nyquist-rate D/A converters. Nyquist-rate A/D converters. Oversampling converters. Phase-locked loops. This course makes extensive use of EDA tools for custom IC design. Prerequisite: EECE 311.

EECE 612/412 Digital Integrated Circuits 3 cr.
This course is an introduction to digital integrated circuits. Material will cover CMOS devices and manufacturing technology, CMOS inverters and gates, propagation delay, noise margins, power dissipation, and regenerative logic circuits. Various design styles as well as issues designers face, such as technology scaling and the impact of interconnect, are investigated. The course starts with the core digital design block, the CMOS inverter, and then various CMOS implementations are discussed. The design of more complex combinational gates such as NAND, NOR, XORs will be considered, looking at optimizations for speed, area, or power the influence of interconnect parasitics on circuit performance and approaches to cope with them are treated in detail. The course concludes with an examination of design methodologies. Spice simulation will be embedded in lectures as practical application for lectures to emphasize DC and transient analysis. Prerequisites: EECE 310 and EECE 320.

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 manufacturability challenges of advanced circuits and implications on low power design. Prerequisite: senior standing.

EECE 621 Advanced 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; domain-specific architectures. 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 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 623/423 Reconfigurable Computing 3 cr.
A course on reconfigurable computing systems and applications; Contemporary FPGA architecture. FPGA design flows and tools. Hardware/software partitioning. Host, memory, and peripheral interfaces. Hardware accelerators. Classical and emerging applications. Students work on a set of design assignments and design/research projects using appropriate FPGA development boards and tools. Prerequisite: EECE 321.

EECE 625/425 Embedded and IoT Systems 3 cr.
An introduction to the basic building blocks and technologies used to design contemporary embedded and IoT systems. Topics include microcontroller architecture and programming; peripheral device controllers (GPIO; timers/counters; interrupts); serial interfaces (UART; SPI; I2C); device networking; pulse-width modulation; analog/digital conversion; real-time operating systems; and edge intelligence. Students work on a sequence of lab assignments and a major design or research project using appropriate microcontroller development boards and tools. Prerequisite: EECE 321.

EECE 626 Hardware Accelerators for Machine Learning 3 cr.
This course provides an in-depth coverage of architectural techniques used to design accelerators for training and inference in machine learning systems, with focus on recent advances towards enabling efficient processing of DNNs. It provides an overview of DNNs, discusses various hardware platforms and architectures that support DNNs, and highlights key trends in reducing the computational cost of DNNs via hardware design changes only or through joint hardware design and DNN algorithm optimizations. It also covers various development tools that enable students to quickly get started in this field and highlights important benchmarking metrics and design considerations to be used for evaluating a plethora of DNN hardware design options. Case studies include Google's TPU, Apple's Neural Engine, Intel's Nervana processor, and ARM's Project Trillium. The course involves a term project that focuses on developing architectures for hardware ML accelerators. Prerequisites: EECE 490 and EECE 420 or EECE 421.

EECE 632/455 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, finite fields, advanced encryption standard, confidentiality using symmetric encryption, public-key cryptography, key management, hash and MAC algorithms, digital signatures, authentication applications, web security, email security and IP security. Prerequisite: senior standing.

EECE 634 Introduction to Computational Arabic 3 cr.
The course concerns basic computational methods and techniques leveraged for automating the understanding and generation of text in natural languages. The methods include representation in strings, text algorithms, distance algorithms, language models, inversed indices, vector semantics. The course will also cover applying naïve Bayes, logistic regression, hidden markov models, and neural networks for text processing. Applications and case studies include stemming, lemmatization, part of speech tagging, information retrieval, question answering, text classification, social network models, chatbots, machine translation, genomic sequence extraction, and word meaning extraction. Prerequisite: EECE 330.

EECE 635 Theoretical Foundations of Security and Privacy 3 cr.
This course provides a rigorous framework to study security and privacy using suitable mathematical models. Such models enable the assessment of the security/privacy guarantees of a given system, including communication and computing systems and databases. In particular, this course covers both computational and information-theoretic notions of security and privacy. Students learn various adversarial models and their corresponding information theoretic measures, in addition to basic cryptographic principles and protocols. Topics include: the Shannon cipher system, one-time pads and perfect secrecy, semantic security and the RSA algorithm, equivocation, and guessing entropy (and other measures). A particular focus is given to the notion of differential privacy and its applications. Prerequisites: EECE 330 and STAT 230 or STAT 233.

EECE 636 Automated reasoning 3 cr.
This course introduces automated reasoning basics, techniques, and applications. It covers both logical and probabilistic approaches and offers a perspective on how automated reasoning algorithms are at heart of the sophisticated artificial intelligence and machine learning engines. Topics include foundations on logic and probability, backtracking strategies and satisfiability solving, construction and querying of probabilistic reasoning structures such as Bayesian networks, temporal reasoning, and classes of reasoning tasks, reductions, and applications. Prerequisite: EECE 330.

EECE 637 Advanced Programming Practice 3 cr.
This course is an advanced course on programming practices with a focus on verification. The course introduces programming tools and techniques that make individual engineers more effective and productive and help them develop quality code. Teams will work in Agile and extreme programming environments with a focus on design by contract. They will use formal specifications, design patterns and aspect oriented programming. Projects will use tools for code control, building, configuration, language recognition, dynamic documentation, fast prototyping, refinement, coverage, automated and manual debugging, and dynamic and static verification. Prerequisite: EECE 330.

EECE 640/440 Wireless Communications 3 cr.
A course that covers the fundamentals of wireless communications with emphasis on wireless channel modeling; detection and diversity techniques; resource management and power control; OFDM and ultra-wideband systems; opportunistic communication; multiple-antenna systems; multiple-access techniques and multi-user communication; diversity-multiplexing tradeoff; precoding; emerging topics in wireless communications systems. Prerequisite: EECE 442.

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 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 STAT 233 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, algebraic, and algorithmic aspects. Topics include: Background material from combinatorics, probability, 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. A course on abstract algebra is not a prerequisite. The needed algebra background will be covered. Prerequisite: senior standing.

EECE 648/MECH 691/ENMG 628 Convex Optimization 3 cr.
Advanced course that covers topics such as convex sets, convex functions, convex optimization problems, scalarization for vector optimization, duality theory, optimality conditions. Example problems include least-squares, maximum likelihood estimation, minimax, and extremal volume problems. Prerequisite: Math 218.

EECE 644/444 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 or STAT 233 and EECE 340.

EECE 646/446 Data Communications 3 cr.
This course provides an integral view of data communication systems and their digital signal-processing solutions at the link level. The course studies contemporary techniques for signal representation (sampling, quantization, compression), signal transmission and reception (modulation, data detection, channel estimation), and error correction coding (soft and hard, code-specific and noise-centric channel decoding). Conventional signal processing techniques are compared to machine-learning-based solutions under practical multi-antenna and high-frequency wireless constraints. The techniques are studied from information-theoretic and algorithmic/architectural (complexity) perspectives, laying the foundations for analysis and design. Pre/corequisite: EECE 442.

EECE 649 The Art and Science of Thick Tails 3 cr.
This course examines the theory and application of thick-tailed statistical models, focusing on their role in various learning and estimation problems from both mathematical and practical perspectives. In contrast to standard Gaussian techniques, this course introduces the fundamentals of thick tails through examples taken from the real world. We further explore the statistical implications of thick tails in real-life applications in engineering and in the financial sector. Concepts such as stability, Central Limit Theorems, domain of attractions, and law of large and medium numbers are explained. The course also discusses the inadequacy of standard statistical tools and techniques under thick tails in typical learning problems such as linear regression, classification, and dimensionality reduction. The course includes a project in which students have to deal with data sampled from a thick-tailed distribution and compare Gaussian to robust methods within a specific context related to their discipline. Prerequisites: MATH 201 and STAT 230.

EECE 651 Internet Engineering 3 cr.
A course that provides in-depth coverage of Internet architecture, Internet protocols and routing; discusses recent developments on the Internet such as IPv6, switching and mobility; and gives a detailed study of TCP. This course is considered equivalent to CMPS 342; hence, students cannot receive credits for both EECE 651 and CMPS 342. Prerequisite: EECE 350 or EECE 351.

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 351.

EECE 654/454 Communication Networks-Modeling and Optimization 3 cr.
The course covers the modeling and optimization of communication networks with applications that span fundamental and emerging design problems. Topics include modeling network resources, performance metrics, and requirements; optimization problem formulations and solution methods for multihop communications, resource allocation, network planning and topology design; and emerging research problems such as drone-based cell planning, edge computing, and ultra-low latency communications. Prerequisite: EECE 350 or EECE 351.

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. Students cannot receive credits for both EECE 655 and CMPS 243.Prerequisite: EECE 350 or EECE 351.

EECE 655L Network and Computer Security Laboratory 1 cr.
A laboratory course that addresses advanced network and computer security topics. Experiments include execution of attacks, setup of intrusion detection and prevention, securing computers and wired and wireless networks, and digital forensics. Prerequisite: EECE 350 or EECE 351.

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 351, and EECE 455 or EECE 632.

EECE 660/MECH 653 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: EECE 460 or MECH 436.

EECE 661/MECH 641 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. Pre or corequisite: EECE 460 or MECH 436.

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 665/MECH 654 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 or MECH 436.

ECCE 666/MECH 659 Aerial Robotics 3 cr.
This course provides a comprehensive understanding of aerial robotics, focusing on the design, control, and application of unmanned aerial vehicles (UAVs). Students will gain hands-on experience with UAV systems, delve into advanced control algorithms, and explore real-world applications of aerial robotics. The technology is set to have a profound impact on society from delivering packages to watering crops and inspecting and repairing building structures etc. This course will introduce the topic of aerial robotics and provide the foundations to be skilled in their design and control, as well as operational aspects such as ethical & legal considerations. Prerequisites: EECE460 or MECH 436, PHYS 210 and PHYS 210L or MECH 420, EECE 320 or MECH 201, EECE 230, MATH 202.

EECE 667 Pattern Recognition 3 cr.
The course provides an overview of algorithms used in machine learning. The course discusses modern concepts for model selection and parameter estimation, decision- making and statistical learning. Special attention 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.
Game theory provides a set of tools, approaches, and perspectives on decision making to mimic the human elements of decision making that is best described by strategy, coercion and cooperation. This course offers an introduction to fundamentals of game theory and decision making with a special emphasis on the foundations of the mathematical background. 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.
Introduction to the theory of systems of coupled, nonlinear, time-varying ordinary differential equations. Topics include existence and uniqueness of solutions, stability of equilibria, nonlinear stability theory, Lyapunov analysis, Barbalat's lemma, input-to-state stability, input-output stability, nonlinear control design techniques, feedback linearization, backstepping, and sliding mode control. Prerequisite: EECE 460 or MECH 436.

EECE 670/470 Power System Planning 3 cr.
Electric energy and peak demand forecasts using weather sensitive, time curve, and autoregressive models; generation reliability evaluation, loss of energy expectation, probabilistic production costing, generating capacity expansion analysis, maintenance scheduling, and planning with renewable energy sources, power flow and security analysis, 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 674 Energy Storage and Sustainable Systems 3 cr.
The course covers the principles of sustainable energy systems, solar radiation, solar thermal applications, the Stirling engine, fuel cells and the hydrogen cycle. Various energy storage technologies are also investigated, e.g., thermal storage, compressed air, flywheels, batteries, and ultra-capacitors. The operation principles of each application will be discussed, its current developments and future trends, and students will design an energy storage solution for a selected application. prerequisites: EECE 230, EECE 310, and PHYS 210.

EECE 675 PV and Wind Electric Energy Systems 3 cr.
This course seeks to impart in students a sound understanding of photovoltaic (PV) and wind electric energy systems in terms of their physics, design, technology, and operation. Models and characteristics of autonomous and grid connected systems. Economics, optimization techniques and feasibility studies of PV and wind electric energy systems. Prerequisite: senior standing.

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 statespace equations, sub-transient 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 678/478 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.

EECE 679/479 Energy Efficiency in the Power Sector 3 cr.
Introduction to the concept of sustainable development and its roots as an interdisciplinary vision, the framework of the 17 SDGs, with 169 targets, and the history of development, achievements and challenges facing the SDGs deployment, role of engineers in achieving sustainability, outcomes of COP28. Selected topics covered in the course include: energy conversion, generation and cogeneration, load duration curves, losses and efficiency optimization, theory and application of energy analysis techniques, power capability curves, energy audit: definition and types, data analysis, reporting and recommendation. Prerequisite: EECE 210, senior standing.

EECE 680/480 Antennas for Wireless Communications 3 cr.
This course provides students with an understanding of basic principles of antenna analysis and design for wireless communications. The course covers an overview of the fundamental characteristics and parameters of antennas, an overview of analytical methods used to analyze and design antennas with application to some basic antenna structures such as linear antennas, loop antennas, antenna arrays and microstrip antennas. Prerequisite: EECE 380.

EECE 684/484 Microwave Engineering 3 cr.
This course focuses on the analysis and design of passive microwave circuits. It covers the fundamentals for radio frequency and microwave engineering. It discusses the theories of transmission lines, waveguides, impedance matching, microwave networks, scattering parameters, power dividers, directional couplers, microwave resonators and microwave filters. The course enables students to study and analyze their own microwave network using computer-aided design tools and measurement equipment. Prerequisite: EECE 380.

EECE 685/485 Radio Frequency (RF) Circuits Design 3 cr.
This course covers advanced RF circuit design principles and techniques, beginning with the behavior of passive components like high-frequency resistors, capacitors, and inductors. Students learn to design RF circuits using transmission line theory and the Smith Chart, then delve into the study of two-port networks and their representations in terms of S-parameters. The course emphasizes impedance matching, biasing, and RF transistor modeling. Various RF amplifier configurations such as low noise, high power, and broadband amplifiers are explored along with their applications. Nonlinear systems in RF oscillator and mixer circuits are discussed, as are RF switches and phase shifters. Throughout the course, students use computer-aided design tools for simulation and analysis, gaining practical skills in RF circuit design. Prerequisites: EECE 310 and EECE 380.

EECE 686/486 Radio-Frequency (RF) Transceiver Design 3 cr.
This course targets the physical layer of a communication system by focusing on the interactions between the various transceiver blocks. The course addresses the design and operation of the components that reside between the signal processing unit and the antenna within the RF chain. The course also details the functional level modeling of different transceiver architectures by accounting for the gain, noise, nonlinearity, sensitivity, and dynamic range. In addition, students are exposed to recent computer-aided simulation tools and measurement techniques through a set of laboratory experiments that are tailored based on the course content. As a result, the course equips the students with theoretical and practical experience in RF transceiver design. Prerequisite: EECE 380.

EECE 687/487 Radio-Frequency Integrated Circuit (RFIC) Design 3 cr.
The course addresses the analysis and design of various Radio Frequency Integrated Circuits (RFICs) with an emphasis on specific RF blocks such as low noise amplifiers, oscillators, mixers, phase locked loops and frequency synthesizers. It also introduces the design of on-chip lumped elements and passive RF components. The course provides students with hands-on experience in the simulation of RFICs as well as the different techniques for RFIC measurements. As a result, the students will be equipped with essential theoretical and practical experience in RFIC design. Prerequisites: EECE 380 and EECE 311.

EECE 688/488 Engineering Bio-Electromagnetics 3 cr.
This course discusses the interaction between biological material and electromagnetic fields. The course introduces bio-electromagnetics along with its sub-divisions and reviews the fundamental properties of electromagnetic fields and their propagation characteristics in lossy biological tissues. The course then elaborates on the electromagnetic properties of biological tissues from a bioelectric perspective. Bio-electromagnetism is then analyzed at DC, extremely low frequencies, radio frequencies, up to Terahertz frequencies and beyond. The concept of dosimetry and the principles of energy absorption in biological tissues are then studied along the design of electromagnetic sensors and electrodes for monitoring, reception, and stimulation in the human body. The human body is then analyzed as a communication channel and as a generator of electromagnetic fields. The course is concluded with an introduction to the various electromagnetic simulation tools and the corresponding measurement techniques. Prerequisites: EECE 380 and EECE 340.

EECE 690/490/ MECH 658/534 Introduction to Machine Learning 3 cr.
The course provides an introduction to machine learning theory and algorithms which learn from experience to predict or control yet to be seen instances. The course discusses the intuition and the theory of some selected modern machine learning concepts as well as the practical know how to successfully apply them to new problems. It covers topics in supervised learning such as parametric /non-parametric, generative/discriminative algorithms for classification and regression and in unsupervised learning for clustering, dimensionality reduction and reinforcement learning. The course also includes case studies and applications so that students can gain practice on regularization, model selection, parameter estimation, support vector machines, neural networks and deep learning. For the graduate version of the course, the students are required to conduct a research project which constitutes a significant component of the course. This course is considered equivalent to CMPS 261; hence, students cannot receive credits for both EECE 490/690, CMPS 261 and EECE 667. Prerequisites: EECE 330, MATH 218 or MATH 219, and STAT 230 or STAT 233.

EECE 691/491 Digital Signal Processing 3 cr.
Digital Signal Processing (DSP) is at the heart of almost all modern technology. This course introduces the fundamentals of DSP systems, including properties of discrete-time linear systems, digital filter design, sampling and reconstruction, A/D and D/A conversion, quantization, discrete-time Fourier analysis, spectral analysis, sample-rate conversion, FFT and fast convolution, filter structures and realizations, and multirate DSP and filter banks. The course also discusses applications of DSP in areas such as speech/audio processing and includes a project to implement one such application. Prerequisite: senior standing.

EECE 691L Digital Signal Processing Lab 1 cr.
The EECE 691L graduate lab comprises of a set of lab experiments in C and MATLAB covering a series of real-time signal processing topics which include introductions to MATLAB and code composer studio, programming in C, assembly and linear assembly, code optimization techniques, using the BIOS and BSL, IIR and FIR filter design, aliasing and echo effects. Prerequisites: EECE 491 or EECE 691.

EECE 692/MECH 642 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. Prerequisite: senior standing.

EECE 693 Neural Networks 3 cr.
The course provides a foundation to deep learning neural networks, including an overview of deep learning methods and related applications. We will discuss deep learning methods for supervised and unsupervised tasks covering different topologies in deep neural networks such as deep feedforward networks, autoencoders, convolutional networks, generative networks, recurrent and recursive networks. We will also discuss optimized learning techniques such as stochastic gradient descent. The course will include a project that explores advances or applications in deep learning. This course is considered equivalent to CMPS 364; hence, students cannot receive credits for both EECE 693 and CMPS 364. Prerequisite: senior standing. Prerequisite: EECE 490/690.

EECE 697/MECH 646 Wheeled Mobile Robotics 3 cr.
A course that provides in-depth coverage of wheeled mobile robots. The material covers: non holonomy 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 throughout 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 2 cr.
This course is designed to provide engineering graduates 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 Pre/corequisite: MECH 436; or Prerequisites: EECE 230 and Pre/corequisite EECE 460.

EECE 699 Topics in Artificial Intelligence 3 cr.

Many Artificial Intelligence (AI) technologies from self-driving cars to robot surgeons and video games, to name a few, are having an increasing societal impact. AI techniques involve self-learning systems that extract information from heterogeneous data sources to produce knowledge or goal-directed behavior. This course focuses on some selected topics in AI related to agent and multi-agent systems, life-long learning, and artificial life. Specifically, this course covers in the form of seminar both theoretical and technical issues in reinforcement learning, transfer learning, evolutionary approaches, quantum genetic algorithms and explainable AI. The course also has a practical project for students to explore learned concepts from a contemporary lens. Prerequisite: senior standing.

Department of Industrial Engineering and Management (IEM)

Chairperson	Maddah, Bacel
Professors	Maddah, Bacel; Salameh, Moueen
Associate Professors	Tarhini, Hussein
Assistant Professors	Nouiehed, Maher; Abou Ibrahim, Hisham; Zahed, Karim; Olleik, Majd
Senior Lecturers	Abou Jamra, Fadi; Nehme, Nabil, Noueihed, Nazim; Saad, Youssef; Trabulsi, Samir
Lecturers	Abboud, Jacques; Bdeir, Fadl; Dandache, Moustapha, Hamade, Tarek; Kalach, Mayssa; Khraibani, Rayan; Youness, Hasan
Instructors	Abdallah, Raja; Basmadjian, Garo; Gharios, Nadim; Hosn, Majd; Jaafar, Maysaa; Kadi, Samir; Karam, Mario; Mattar, Maurice; Sfeir, Rana

The Department of Industrial Engineering and Management offers an undergraduate degree program leading to a bachelor of engineering in industrial engineering and a minor in engineering management.

Bachelor of Engineering (BE) Major: Industrial Engineering (IE)

The Industrial Engineering program extends over a four-year period and is offered exclusively on a daytime, on-campus basis. The program is offered in eleven terms whereby eight terms are 16- week fall/spring terms 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.

Program Mission

The mission of the Industrial Engineering program is to graduate students who assume leadership positions in the industrial engineering profession and excel in graduate education. Our graduates are sought to be lifelong learners that contribute to the wellbeing of Lebanon and the region.

Program Educational Objectives

Graduates of the IE program will be able to:

- assume key roles in a range of industries that use industrial engineering, including manufacturing and service.
- effectively participate in, coordinate, and manage diverse teams of engineers and analysts, especially in large-scale systems.
- pursue advanced degrees in industrial engineering and other related fields at reputable regional and international universities.
- appreciate the importance of professional ethics and actively use their knowledge and experience to the benefit of the community.

IE Program Learning Outcomes

Upon graduation, IE students will be able to demonstrate:

- an ability to apply knowledge of mathematics, science, and engineering to model, optimize and evaluate integrated systems of people, technology, and information.
- an ability to design and conduct experiments, as well as to analyze and interpret data.
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- an ability to function on multidisciplinary engineering teams.
- an ability to identify, formulate and solve engineering problems and to develop integrated solutions to large-scale, sociotechnical problems through quantitative models.
- an understanding of professional and ethical responsibility.
- an ability to communicate effectively in oral and written form.
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- recognition of the need for, and ability to engage in, lifelong learning.
- knowledge of contemporary issues.
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Program Requirements

The BE curriculum in industrial engineering is a four-year program (with three summers) consisting of 150 credit hours of coursework.

The IE curriculum is supported by four pillars:

a. Basic science courses.
b. General education courses.
c. Basic business courses.
d. General engineering fundamental courses.

The specific course requirements are as follows:

- Basic Science Courses: MATH 201, MATH 202, MATH 218/219, MATH 251, STAT 230, PHYS 210, PHYS 210L, CHEM 201/202, CHEM 203, BIOL 210
- 6 credits in Cultures and Histories
- 3 credits in History of Ideas (From CHLA)
- 6 credits in Societies and Individuals (including 3 credits from ECON 211)
- (3 credits from Cultures and Histories OR Societies and Individuals should cover the theme of Social Inequalities - refer to the GE list)
- 6 credits in understanding communications (ENGL 203 and ENGL 206)
- 3 credits in understanding communications (Arabic)
- 3 credits Community Engaged Learning
- 3 credits Human Values (INDE 410)
- Basic Business Courses: MNGT 215, ACCT 210, MKTG 210
- Engineering Fundamentals: CIVE 210, MECH 220, MECH 230, EECE 210, EECE 230, MECH 421

The IE courses are distributed in three core areas:

a. Operations Research.
b. Engineering Management.
c. Production Systems.

Curriculum for BE in Industrial Engineering

Term I (Fall)		Credits
FEAA 200	Introduction to Engineering and Architecture	3
INDE 301	Engineering Economy	3
MATH 218/219	Linear Algebra	3
MATH 201	Calculus and Analytic Geometry III	3
CIVE 210	Statics	3
		Total 15

Term II (Spring)		Credits
EECE 210	Electric Circuits	3
EECE 231	Introduction to programming using C++ and Matlab	3
MATH 202	Differential Equations	3
BIOL 210	Human Biology	3
ENGL 203	Academic English (Understanding Communication)	3
MECH 220	Engineering Graphics	1
		Total 16

Term III (Summer)		Credits
CHEM 201/202	Chemistry Course	3
ENGL 206	Technical English (Understanding Communication)	3
ECON 211	Microeconomic Theory (Societies and Individuals)	3
		Total 9

Term IV (Fall)		**Credits**
INDE 302	Operations Research I	3
INDE 411	Introduction to Project Management	3
STAT 230	Introduction to Probability and Random Variables	3
PHYS 210	Introductory Physics II	3
PHYS 210L	Introductory Physics LAB II	1
ARAB xxx	Arabic Elective (Understanding Communication)	3
		Total 16

Term V (Spring)		**Credits**
INDE 303	Operations Research II	3
INDE 320	Work Measurement and Methods Engineering	3
INDE 430	Statistical Quality Control	3
MECH 230	Dynamics	3
	Cultures and Histories Elective I	3
		Total 15

Term VI (Summer)		**Credits**
MKTG 210	Principles of Marketing	3
MATH 251	Numerical Computing	3
	Societies and Individuals Elective	3
		Total 9

Term VII (Fall)		Credits
INDE 410	Engineering Ethics (Human Values)	3
INDE 412	Engineering Entrepreneurship	3
INDE 421	Human Factors Engineering	3
INDE 504	Discrete Event Simulation	4
MNGT 215	Fundamentals of Management and Organizational Behavior	3
		Total 16

Term VIII (Spring)		Credits
INDE 402	Facilities Planning and Material Handling	3
INDE 431	Production Planning and Inventory Control	3
INDE 535	Data Analytics for Operations Research and Financial Engineering	4
MECH 421	Manufacturing Processes I	3
ACCT 210	Financial Accounting	3
		Total 16

Term IX (Summer)		Credits
INDE 500	Approved Experience	6

Term X (Fall)		Credits
INDE 501	Final Year Project I	3
INDE 513	Information Systems	3
CHEM 203	Chemistry Lab	2
	Technical Elective I	3
	Cultures and Histories Elective II	3
	Community Engaged Learning	3
		Total 17

Term XI (Spring)		Credits
INDE 502	Final Year Project II	3
	Technical Elective II	3
	Technical Elective III	3
	Technical Elective IV	3
	Cultures and Histories Elective III	3
		Total 15

Total Credit Hours	**150**

The 12-credit technical electives requirement should consist of (i) 6-9 credits from the graduate courses offered by the IEM Department, (ii) 0-3 credits from outside the IEM Department and (iii) 3 credits from sciences.

Minor in Engineering Management

The Department of Industrial Engineering and Management 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 term of their third year of enrollment. Only students who have a cumulative GPA of 2.3 or more are eligible to apply for the minor. To satisfy the requirements of this minor, students (GPA: 2.3 or more) must earn 18 credits of coursework from the IEM Department course offerings as follows:

- 9 credits from the undergraduate (industrial engineering) courses offered by the IEM Department, which must include INDE 301 Engineering Economy.
- 9 credits from either the undergraduate or the graduate (engineering management) courses offered by the IEM Department.
- A minimum grade of C+ is required for a course to be counted towards the fulfillment of a minor in Engineering Management. Additionally, a cumulative average of B (GPA 3.0) or above in all minor courses is required.

Course Descriptions

FEAA 200 Introduction to Engineering and Architecture 3 cr.
The course is designed to familiarize first year students with the different disciplines in engineering and architecture including: architecture, civil, mechanical, electrical, chemical, industrial and technologies used in the fields. The course takes a unique interdisciplinary approach to the field and introduces the related disciplines in the world of engineering and architecture. One key objective is to promote interdisciplinary interaction and innovative thinking. The course is organized into modules covering the different disciplines within the Maroun Semaan Faculty of Engineering and Architecture (MSFEA). The last module of the class showcases interdisciplinary projects demonstrating interactions among the different fields. The lectures explain as applicable to each discipline, through examples, notions of problem solving, design thinking, process of invention and innovation, environmental and civic responsibility, and measures of success in aesthetics and performance. The course project is a key component of the course. It is interdisciplinary in nature bringing ideas and solutions from all disciplines in engineering and architecture. Annually.

INDE 301 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. Every term. Formerly ENMG 400.

INDE 302 Operations Research I 3 cr.
A course on operation research modeling concepts, with an emphasis on linear programming; topics include: linear programming, network programming and project management. Prerequisite: MATH 218 or Math 219, or equivalent. Annually. Formerly ENMG 500.

INDE 303 Operations Research II 3 cr.
Another course on operation research modeling concepts with an emphasis on probability models and stochastic processes; topics include conditional probability, discrete and continuous time Markov chains and their application in modeling queues, inventories, and production process behavior. Prerequisite: STAT 230 or equivalent. Formerly ENMG 501. Annually.

INDE 320 Work Measurement and Methods Engineering 3 cr.
A course on system and work design concepts; time studies; performance rating and allowances; standard and pre-determined times; work methods improvement; design of manual work, equipment, tools, and work environments; line balancing; manpower determinations, job analysis and incentives; systems analysis, lean and value analysis. Prerequisite: STAT 230 or equivalent. Annually.

INDE 402 Facility Planning and Material Handling 3 cr.
Inter-relationships between facilities, process design, systematic layout procedures, computer aided layout, location analysis models, material handling analysis and concepts, warehousing storage, and retrieval systems. Prerequisites: INDE 302 and INDE 303. Annually.

INDE 410 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. Formerly ENMG 504. Every term.

INDE 411 Introduction to Project Management 3 cr.
Introduction to project management for engineers. Conception, planning, scheduling, budgeting, leadership, management, tracking and completion of projects. Project management software is introduced and used. Annually.

INDE 412 Engineering Entrepreneurship 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: INDE 301 or equivalent. Every term. Formerly ENMG 505.

INDE 421 Human Factors Engineering 3 cr.
Designing for human performance effectiveness and productivity. Introducing human factors and ergonomics; Design and evaluation methods; Perception: vision and hearing; Cognition; Displays and controls; Work-space design; Biomechanics of work; Stress and workload; Safety and human error; Human-computer interaction. Prerequisite: INDE 320. Formerly ENMG 614. Annually.

INDE 430 Statistical Quality Control 3 cr.
Design of quality control systems; quality methods for establishing product specifications; process control; variables and attributes charts; acceptance sampling; operating characteristics curves; process capabilities; QC software. Prerequisite: STAT 230. Annually.

INDE 431 Production Planning and Inventory Control 3 cr.
Methods of production and inventory planning. Single-product replenishment systems. Inventory management for special classes of items and products. Multiple item and multiple location inventories. Production planning and scheduling: aggregate production planning, MRP, JIT, OPT and short-range production scheduling. Prerequisites: INDE 302 and 303. Annually.

INDE 500 Approved Experience 6 cr.
Practical training program with a local, regional, or international organization.

INDE 501 Final Year Project I 3 cr.
This is a capstone course where IE students utilize knowledge they acquired from different courses to design and develop an IE-related product or service. This is the first part of the course that spans through the final year of the student's study. Prerequisite: Completion of third year in IE requirements. Fall. Annually.

INDE 502 Final Year Project II 3 cr.
This is the second part of the IE capstone course. Prerequisite: INDE 501. Spring.

INDE 504 Discrete Event Simulation 4 cr.
System definition; model formulation, Monte-Carlo method; random number generation; discrete events; system entities and its attributes. Emphasis on analysis of systems and models of real-life problems. Lab experience with a modern discrete-event simulation package (e.g., ARENA). Prerequisite: INDE 303. Annually.

INDE 513 Information System 3 cr.
This is a course that answers the questions: What is information? How can it best be stored? What to call it? The course also covers the following topics: abstraction, interfaces, barriers, specification, documentation, relational calculus and architectural abstractions, data structures for fast data storage and retrieval, encryption, putting things on the web, data warehousing and data mining. Annually. Formerly ENMG 652.

INDE 533 Industrial Automation 3 cr.
A course that introduces students to the field of industrial automation and control. The course covers a wide range of topic covering areas of instrumentation, basic control, electrical actuators and motors, pneumatics, hydraulics, basic mechanical systems and industrial controllers. The course also introduces concepts on numeric control NC and industrial robots, in addition to brief introduction on factory business and lean manufacturing as related to automation. The course consists of a lecture component (2 cr.) and a laboratory component (1 cr.).

INDE 534 Manufacturing Systems Analysis 3 cr.
Introduction which brings together useful models and modeling approaches that address a wide variety of manufacturing system design and operation issues: assembly line, transfer lines, job shops, flexible manufacturing systems and group technology. Prerequisites: INDE 431 and INDE 402. Formerly ENMG 613. Annually.

INDE 535 Data Analytics for Operations Research and Financial Engineering 4 cr.
Students will learn to identify, evaluate, and capture analytic opportunities that create value for an organization. Basic descriptive analytics methods are reviewed utilizing specialized software (e.g. R) in analyzing large data sets. Predictive analytics techniques including clustering, classification and regression are covered in detail. Prescriptive analytics applications on utilization simulation and optimization over large data to improve business decisions are presented. Annually.

Department of Mechanical Engineering

Chairperson	Lakkis, Issam
Professors	Asmar, Daniel; Ghaddar, Nesreen; Lakkis, Issam, Moukalled, Fadl; Shihadeh, Alan
Professor Emeritus	Sakkal, Fateh
Associate Professors	Mustapha, Samir; Harb, Mohammad; Oweis, Ghanem
Assistant Professors	Abou Jaoude, Dany; Bakarji, Joseph; Honein, Theresa; Hussein, Hussein; Kaddouh, Bilal
Assistant Research Professor	Talih, Soha
Instructors	Al Saidi, Abed Alkader; Balhas, Zainab; Fayad, Rami; Kassis, Lina; Kfoury, Elie

The Department of Mechanical Engineering offers one undergraduate degree program that leads to a bachelor of engineering with a major in mechanical engineering (BE in ME) and a minor in applied energy.

Bachelor of Engineering (BE) Major: Mechanical Engineering

The Mechanical Engineering program extends over a four-year period and is offered exclusively on a daytime, on-campus basis. The program is offered in 11 terms whereby eight terms are 16-week fall/spring terms 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 students with options to pursue minors in the following:

- Applied Energy Minor
- Other minors offered by the Maroun Semaan Faculty of Engineering and Architecture, Faculty of Arts and Sciences, and the Suliman S. Olayan School of Business

Program Mission

The mechanical engineering faculty members have 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 skills, grow into lifelong learners in light of ever-increasing challenges of modern technology, and commit 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 educational 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 180 term credit hours of coursework of which 30 credits are completed in the freshman year while the students are enrolled in the Faculty of Arts and Sciences and 150 credits are completed in four years while the students are enrolled in the Maroun Semaan Faculty of Engineering and Architecture. Students admitted at the sophomore level will be required to complete 150 credits in four years to earn the degree as outlined here:

- **General Engineering:** FEAA 200, CIVE 210, EECE 210, EECE 230, EECE 312, EECE 312L, INDE 301
- **Mathematics:** MATH 201, MATH 202, MATH 212, MATH 218, MATH 251, STAT 230
- **Sciences:** PHYS 211, PHYS 211L, CHEM 202, and one biology elective (BIOL 201 level or above, except BIOL 209)
- **General Education:** Arabic course, ENGL 203 and ENGL 206, two courses in Cultures and histories, one course in History of Ideas (from CHLA), and two courses in Societies and Individuals, one course in human values, and one course in community engaged learning. To cover the student engaged learning requirement, students may opt to take their free elective as HEHI 201 (Foundations of Humanitarian Engineering and Public Health Innovations); or complete an UG research (MECH 499) related to the topic (by approved petition); or do an FYP project related to humanitarian engineering (by approved petition). Please note that 3 cr. from Cultures and Histories Or societies and individuals should cover the theme of social inequalities (refer to GE list)
- **ME Core Courses:** MECH 201, MECH 230, MECH 310, MECH 314, MECH 320, MECH 332, MECH 340, MECH 341, MECH 410L, MECH 412, MECH 414, MECH 420, MECH 421, MECH 430, MECH 432, MECH 436, MECH 510, and MECH 525

- **Technical Electives:** Five courses with at least three from the selected ME track. One elective can be from outside the major and one free elective (such as engineering, math, economics, business, or science).
- **Approved Experience:** MECH 500
- **Final Year Project:** MECH 501 and MECH 502

Curriculum for BE in Mechanical Engineering

Term I (Fall)		Credits
MATH 201	Calculus and Analytic Geometry III	3
FEAA 200	Introduction to Engineering and Architecture	3
EECE 230	Intro to Computation and Programming	3
CIVE 210	Statics	3
PHYS 211	Electricity and Magnetism	3
PHYS 211L	Electricity and Magnetism Laboratory	1
		Total 16

Term II (Spring)		Credits
EECE 210	Electric Circuits	3
MECH 201	Computer Aided Drawing and Design (CADD)	3
MATH 202	Differential Equations	3
MECH 230	Dynamics	3
ENGL 203	Academic English	3
		Total 15

Term III (Summer)		Credits
MATH 218 or 219	Elementary Linear Algebra with Applications or Linear Algebra I	3
CHEM 202	Introduction to Environmental Chemistry	3
ENGL 206	Technical English	3
		Total 9

Term IV (Fall)		**Credits**
EECE 312	Electronics	3
EECE 312L	Circuits and Electronics Lab	1
MATH 212	Introductory Partial Differential Equations	3
MECH 310	Thermodynamics I	3
MECH 340	Engineering Materials	3
Cultures and Histories		3
		Total 16

Term V (Spring)		**Credits**
STAT 230	Introduction to Probability and Random Variables	3
MECH 314	Introduction to Fluid Mechanics	3
MECH 320	Mechanics of Materials	3
MECH 332	Mechanics of Machines	3
MECH 341	Materials Lab	1
MECH 430	Process Instrumentation and Measurements	3
		Total 16

Term VI (Summer)		**Credits**
MECH 432	Dynamics System Analysis	3
Biology Elective		3
Arabic Elective		3
		Total 9

Term VII (Fall)		Credits
MATH 251	Numerical Computing	3
MECH 410L	Thermal Fluid Laboratory	1
MECH 414	Thermodynamics II	3
MECH 420	Mechanical Design I	3
MECH 421	Manufacturing Processes I	3
Societies and Individuals Elective (students can take one of these courses as social inequalities)		3
		Total 16

Term VIII (Spring)		Credits
INDE 301	Engineering Economy	3
MECH 412	Heat Transfer	3
MECH 436	Control Systems	3
MECH 525	Product Design and Development	3
Societies and Individuals Elective (students can take one of these courses as social inequalities)		3
		Total 15

Term IX (Summer)		Credits
MECH 500	Approved Experience	6cr / 1 billing
		Total 6

Term X (Fall)		Credits
MECH 501	Final Year Project	1
MECH 510	Design of Thermal Systems	3
Approved Human Values Course		3
Technical Elective I		3
Technical Elective II		3
Cultures and Histories Elective (students can take one of these courses as History of Ideas)		3
		Total 16

Term XI (Spring)		Credits
MECH 502	Final Year Project II	4
Technical Elective III		3
Technical Elective IV		3
Technical Elective V		3
Cultures and Histories Elective (students can take one of these courses as History of Ideas)		3
		Total 16

List of Pre-Approved Technical Electives

- **Engineering Electives: BMEN:** 600, 602, 604, 605, 606, 609, 610, 611. **CHEN:** 531, 611, 614, 615, 619, 672, 673, 675, 798A. **CIVE:** 421, 451, 460, 552, 555, 602, 603, 610, 648, 655, 658, 659, 670. **FEAA:** 500A, 502, 520. **INDE:** 412, 513, 533. VIPP 301B, VIPP 401B.
- **Science Electives: BIOL:** 201, 202, 210, 223, 244, 246, 250, 260, 268. **CHEM:** 206, 208, 211, 212, 217, 218, 228, 233, 234. **MATH:** 210, 219, 223, 224, 225, 227, 233, 241, 261, 271, 303, 304, 305, 306, 314, 341, 350, 351, 358. **PHYS:** 216, 217, 220, 222, 223, 225, 226, 228, 235, 236, 237, 249, 301, 302, 303, 305, 306, 307.
- **Other Electives: CMPS:** 257, 272, 274, 277, 281, 285, 286, 287, 288, 350, 368, 372, 373. **DCSN:** 200, 210. **ECON:** 214, 215, 217, 218, 222, 223, 226, 227, 228, 230, 232, 235, 236, 237, 239, 240, 241, 242, 243. **GEOL:** 202, 205, 211, 226, 227. **ENST:** 320, 396. **MNGT:** 215, 218, 220, 226, 229, 230. **STAT:** Any course with a number equal to or greater than 234.

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**

The students may opt for any track (thermal and fluid engineering; mechatronics; or 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 focus area in control and robotics provides a coherent academic framework between the ECE and ME departments in the areas of control, instrumentation, and robotics. This track is open to all undergraduate ME and ECE students.

Track I: Thermal and Fluid Engineering		**Credits**
MECH 310	Thermodynamics I	3
MECH 314/ CHEN 311	Introduction to Fluids Engineering	3
MECH 414	Thermodynamics II	3
MECH 410L	Thermal/Fluid Systems Laboratory	1
MECH 412	Heat Transfer	3
MECH 501	Final Year Project I and	1
MECH 502	Final Year Project II	4
MECH 510	Design of Thermal Systems	3

Technical Elective Courses (at least three technical electives are selected)		**Credits**
MECH 511	Intermediate Fluid Mechanics	3
MECH 512	Internal Combustion Engines	3
MECH 513	Air Conditioning	3
MECH 514	Gas Turbines	3
MECH 515	Steam Turbines	3
MECH 516	Aerodynamics	3

MECH 603	Solar Energy	3
MECH 604	Refrigeration	3
MECH 606	Aerosol Dynamics	3
MECH 607	Micro Flows Fundamentals and Applications	3
MECH 609	Experimental Fluid Dynamics	3
MECH 663	Computational Fluid Dynamics	3
MECH 671	Renewable Energy Potential, Technology and Utilization in Buildings	3
MECH 672	Modeling Energy Systems	3
MECH 673	Energy Efficient Building with Good Indoor Air Quality	3
MECH 677	Heat Pumps	3
MECH 678	Solar Electricity	3
MECH 679	Energy Audit Lab	3
MECH 680	HVAC and Refrigeration Systems Lab	3
MECH 682	Principles of Integrative Building design, construction, and operation for sustainability	3
MECH 683	Wind Turbines: Design and Applications	3

Track II: Design, Materials, and Manufacturing		**Credits**
CIVE 210	Statics	3
MECH 201	Computer Aided Drawing and Design (CADD)	3
MECH 320	Mechanics of Materials	3
MECH 332	Mechanics of Machines	3
MECH 340	Engineering Materials	3
MECH 341L	Materials Lab	1
MECH 420	Mechanical Design I	3

MECH 421	Manufacturing Processes I	3
MECH 501	Final Year Project I	1
MECH 502	Final Year Project II	4
MECH 525	Product Design and Development	3

Technical Elective Courses (at least three technical electives are selected)		**Credits**
MECH 520	Mechanical Design II	3
MECH 521	Manufacturing Processes II	3
MECH 522	Mechanical CAD/CAE/CAM	3
MECH 540	Selection of Properties of Materials	3
MECH 550	Computer Applications in Mechanical Engineering	3
MECH 615	Continuum Mechanics	3
MECH 617	Smart Materials and Structures	3
MECH 622	Modeling of Machining Processes and Machines	3
MECH 624	Mechanics of Composite Materials	3
MECH 625	Fatigue of Materials	3
MECH 626	Metals and Their Properties	3
MECH 627	Polymers and Their Properties	3
MECH 628	Design of Mechanisms	3
MECH 630	Finite Element Methods in Mechanical Engineering	3
MECH 633	Biomechanics	3
MECH 634	Biomaterials and Medical Devices	3
MECH 638	Materials Selection and Design	3

Track III: Mechatronics		Credits
MECH 230	Dynamics	3
EECE 210	Electric Circuits	3
EECE 312	Electronics (for Mechanical Engineering students)	3
EECE 312L	Circuits and Electronics Lab	1
MECH 430	Instrumentation and Measurements	3
MECH 436	Control Systems	3
MECH 501	Final Year Project I	1
MECH 502	Final Year Project II	4

Technical Elective Courses (at least three technical electives are selected)		Credits
MECH 530	Mechatronics System Design	3
MECH 531	Mechanical Vibrations	3
MECH 628	Design of Mechanisms	3
MECH 631	Micro-Electro Mechanical Systems [MEMS]	3
MECH 634	Biomaterials and Medical Devices	3
MECH 641	Robotics	3
MECH 642	Computer Vision	3
MECH 643	Mechatronics and Intelligent Machines Eng. II	3
MECH 644	Modal Analysis	3
MECH 645	Noise and Vibration Control	3
MECH 648	Nonlinear Systems: Analysis, Stability, and Control	3
MECH 653	Systems Analysis and Design	3
MECH 654	Adaptive Control	3
MECH 655	Optimal Control	3

MECH 656	System Identification	3
MECH 650	Autonomous Mobile Robotics	3
MECH 659	Aerial Robotics	3

ME Focus Area in Control and Robotics

Students choosing to enroll in the Control and Robotics Focus (CRF) area should satisfy the following course requirements:

Two core courses and one laboratory in their respective departments (listed in the table below)

Core Courses Electronics		**Credits**
MECH 430	Process Instrumentation and Measurements	3
MECH 432	Dynamic System Analysis	2
MECH 436	Control Systems	3

Three elective courses from either department (ECE/ME) (listed in the tables below) provided they obtain the necessary prerequisites for any given course. At least one course from each of lists A (Control Theory) and B (Robotics) must be chosen, and one elective from either list A, B or C.

Technical Elective Courses (List A: Control)		**Credits**
MECH 648/ EECE 669	Nonlinear Systems: Analysis, Stability, and Control	3
MECH 653/ EECE 660	System Analysis and Design	3
MECH 655/ EECE 662	Optimal Control	3
MECH 656/ EECE 663	System Identification	3
MECH 654/ EECE 665	Adaptive Control	3
MECH 657	Vehicle Dynamics and Control	3

Technical Elective Courses (List B: Robotics)		Credits
MECH 530/ EECE 530	Mechatronics	3
MECH 641/ EECE 661	Robotics	3
MECH 646/ EECE 697	Wheeled Mobile Robotics	3
MECH 650/ EECE 698	Autonomous Mobile Robotics	3
MECH 659	Aerial Robotics	3

Technical Elective Courses (List C)		Credits
MECH 555/ EECE 463	Artificial Intelligence for Control Systems	3
MECH 642/ EECE 692	Computer Vision	3
MECH 647/ EECE 699	Hydraulic Servo Systems	3
MECH 691/ EECE 648/ ENMG 628	Convex Optimization	3

Minor in Applied Energy

The minor in applied energy is open to all MSFEA 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 administered by the Department of Mechanical Engineering.

Students who have completed at least 60 credits at the sophomore level and higher and who have a cumulative GPA of 2.3 or more may apply by completing a minor application. The minor will be indicated on the transcript of the students who complete all the requirements described below. A minimum grade of C+ is required for a course to count towards the fulfillment of the minor.

Applied Energy Minor Program Structure

Students wishing to complete the minor are required to complete a minimum of 18 credits: 6 credits from the list of core courses and 12 credits from the list of elective courses.

The first are two core courses (6 credits) that provide a foundation for the understanding of energy science and technology and its economy.

The second component is a number of elective courses (12 credits), selected by the students in close consultation with their academic adviser for the applied energy minor.

Required Courses (6 credits)

- MECH 671 Renewable Energy Potential, Technology and Utilization in Buildings 3 cr., or EECE 675 Renewable Energy Systems 3 cr., or ENST 300 The Science and Technology of Energy 3 cr.
- ECON 333 Energy Economics and Policy 3 cr.

Elective Courses (Minimum of 12 credits)

CHEN 417	Reactor Engineering and Reactor Design	3 cr.
CHEN 470	Chemical Process Design	3 cr.
CHEN 471	Chemical Product Design	3 cr.
CHEN 541	Biochemical and Bioprocess Engineering	3 cr.
CHEN 570	Process Synthesis and Optimization	3 cr.
CHEN 612	Desalination	3 cr.
EECE 670	Power System Planning	3 cr.
EECE 671	Environmental Aspects of Energy Systems	3 cr.
EECE 672	Energy Planning and Policy	3 cr.
EECE 675	Renewable Energy Systems	3 cr.
ENST 320	Energy Laws and Case Studies	3 cr.
MECH 513	Air Conditioning	3 cr.
MECH 603	Solar Energy	3 cr.
MECH 631	Micro-Electro Mechanical Systems	3 cr.

MECH 670	Laboratory for Renewable Energy in Buildings	3 cr.
MECH 672	Modeling Energy Systems	3 cr.
MECH 673	Energy Efficient Building with Good Indoor Air Quality	3 cr.
MECH 676	Passive Building Design	3 cr.
MECH 677	Heat Pumps	3 cr.
MECH 678	Solar Electricity	3 cr.
MECH 679	Energy Audit Lab	3 cr.
MECH 681	Green Building Basics and LEED Practices	3 cr.
MECH 683	Wind Turbines: Design and Applications	3 cr.

Minor in Integrated Product Design

Integrated product design is an interdisciplinary minor, located at the intersection of design, engineering, business, art, humanities, and social sciences. The minor in integrated product design is open to all AUB students who are interested in expanding their knowledge of design and obtaining a deeper understanding of the design process of goods, systems, and services from research and conceptualization, to design development and prototyping, and to marketing and branding. It is a minor for students who are inspired to become social entrepreneurs to design and develop products that can be implemented and scaled to trigger positive systemic change. Through the minor, students are exposed to a range of design skills and methods, from visualization of ideas to creative problem-solving, and transformative design thinking. They also learn to work with multidisciplinary teams on hands-on projects and in a studio environment.

Students must earn 18 credits to satisfy the requirements for the minor in integrated product design. These are distributed as follows:

1. 6 credits of foundational design skills. Students must select 3 credits in basic design methods courses and 3 credits in visualization courses (see list 1).
2. 6 credits of core product design and development. Students must select 6 credits in product design courses (see list 2).
3. 6 credits of thematic field electives. Students must select 6 credits in two of the thematic areas A, B, C, and D (see list 3).

Students will follow AUB's regulations while pursuing the minor. University minimum requirements for a minor are as follows:

- A minimum of 15 credit hours earned on the basis of regular graded courses (not tutorial or special project type courses) is required for a minor (refer to the requirements of each faculty/school).
- At least 9 credit hours of coursework must be completed at AUB.
- Each minor must have at least 6 credits exclusive to it, 9 credits may be common with the program requirements of the major field(s) of study.
- Minor courses may not be taken on a pass/fail basis at AUB.

List 1: Foundational courses with a focus on basic design, visualization, and prototyping. Students should take 6 credits from this list.

ENMG 664	Introduction to Human-Centered Design	3 cr.
ARCH 100	Basic Design	6 cr.
MECH 201	Computer-Aided Drawing and Design (CADD)	3 cr.
MECH 421	Manufacturing Processes I Prerequisites: MECH 320, MECH 340	3 cr.
MECH 522	Mechanical CAD/CAE/CAM Prerequisites: MECH 320, MECH 420, and MECH 432	3 cr.
ARCH 111	Drawing I	3 cr.
ARCH 112	Drawing II Prerequisite: ARCH 111	3 cr.
ARCH 313	Digital Tools Prerequisite: ARCH 112	3 cr.
GRDS 111	Drawing	3 cr.
GRDS 141	Computer Graphics	3 cr.

List 2: Core courses with a focus on product design and development. Students should take 6 credits from this list.

MECH 525	Product Design and Development Prerequisites: MECH 332, MECH 420	3 cr.
MECH 510	Design of Thermal Systems Prerequisites: MECH 410L, MECH 412, and MATH 251	3 cr.
ARDS 400	Systems Thinking Prerequisite: ENMG 698E	3 cr.
ENMG 663	Product Design and Development	3 cr.
BMEN 501	Bioengineering Design Fundamentals	3 cr.
CHEN 571	Chemical Product Design Prerequisite: CHEM 470	3 cr.

GRDS 305	Graphic Design V Prerequisite: GRDS 304	6 cr.
MECH 502, EECE 502, INDE 502, CHEN 502, CIVE 402	Approval of adviser	3 cr.

List 3: Field electives. Students must take 6 cr. from at least two categories (A-D)

Category A

INDE 412	Engineering Entrepreneurship	3 cr.
ARCH 068	Design Innovation and Entrepreneurship	3 cr.
ENMG 654	Technology-Based Entrepreneurship	3 cr.
ENMG 655	Management of Technology	3 cr.
ENMG 656	Management of Technological Innovations	3 cr.
MKTG 312	Consumer Behavior Prerequisite: MKTG 306	3 cr.
MKTG 311	Applied Market Research	3 cr.
DCSN 310	Operations and Process Management	3 cr.
DCSN 340	Supply Chain Management Prerequisite: DCSN 310	3 cr.
EMBA 521	Digital Marketing	3 cr.
ENTM 320	Social Entrepreneurship	3 cr.
ENTM 220	Entrepreneurship and Business Planning	3 cr.
INFO 220/ MKTG 220	Electronic Marketing Prerequisites: MKTG 210, INFO 200	3 cr.
FINA 211	Introduction to Finance for Engineers Prerequisite: ACCT 210	3 cr.
INFO 227/ MKTG 227	Social Media in Digital Management Prerequisite: MKTG 210, Permission of the instructor for non-OSB students	3 cr.

ENTM 230	Decision-Making Skills for Entrepreneurs Prerequisite: MNGT 215	3 cr.
MKTG 234	Marketing for Social Change Prerequisite: MKTG 210 (or equivalent). Permission of instructor for non-OSB students	3 cr.
ENTM 270	Launching a New Venture Prerequisite: MNGT 215, FINA 210	3 cr.

Category B

MECH 617	Smart materials and structures	3 cr.
MECH 631	Micro-Electro Mechanical Systems (MEMS) Prerequisite: MECH 430	3 cr.
MECH 632	Structural health monitoring Prerequisites: MECH 320, MECH 430	3 cr.
MECH 798C	Sustainable Materials	3 cr.
MECH 634/ BMEN 608	Biomaterial and Medical Devices Prerequisite: MECH 340 or consent of instructor	3 cr.
ARCH 040	“Making It”: Models and Prototypes of Complex Structures	3 cr.
ARCH 060	Algorithm and Iteration	3 cr.
ARCH 063	Do It, Then Fix It As You Go	3 cr.
ARCH 069	New Territories	3 cr.
GRDS 040	3D Animation	3 cr.
GRDS 043	Advanced Digital Animation	3 cr.
EECE 625/425	Embedded and IOT Systems Prerequisite: EECE 321	3 cr.
EECE 652	Web Server Design and Programming	3 cr.
EECE 680	Antennas for Wireless Communications Prerequisite: EECE 380	3 cr.
EECE 684	Microwave Engineering	3 cr.

EECE 487/687	Radio-Frequency Integrated Circuit (RFIC) Design Prerequisites: EECE 380, EECE 311	3 cr.
EECE 685	Radio Frequency (RF) Circuits Design Prerequisites: ECE 311, EECE 340, EECE 380	3 cr.
EECE 686	Radio-Frequency (RF) Transceiver Design Prerequisites: EECE 311, EECE 380	3 cr.
EECE 687/487	Radio-Frequency Integrated Circuit (RFIC) Design Prerequisites: EECE 380, EECE 311	3 cr.
EECE 697/ MECH 646	Wheeled Mobile Robotics	3 cr.
EECE 698/ MECH 650	Autonomous Mobile Robotics Prerequisites: EECE 230, EECE 312, and MECH 436; or EECE 230 and EECE 460	3 cr.
CHEN 619	Sustainability Science: Human and Environment Interaction	3 cr.

Category C

GRDS 062	Brand Inc.	3 cr.
MKTG 225	Strategic Brand Management Prerequisites: MKTG 210. Students cannot receive credit for both SOAN 231 and MKTG 225 or both SOAN 235 and MKTG 225	3 cr.
MKTG 210	Principles of Marketing Corequisite ENGL 204	3 cr.

Category D

GRDS 033	Pre-Brand: A History of Identity Design	3 cr.
GRDS 331	Introduction to Visual Theory	3 cr.

Course Descriptions

FEAA 200 Introduction to Engineering and Architecture 3 cr.
The course is designed to familiarize first year students with the different disciplines in engineering and architecture including: architecture, civil, mechanical, electrical, chemical, industrial and technologies used in the fields. The course takes a unique interdisciplinary approach to the field and introduces the related disciplines in the world of engineering and architecture. One key objective is to promote interdisciplinary interaction and innovative thinking. The course is organized into modules covering the different disciplines within the Maroun Semaan Faculty of Engineering and Architecture (MSFEA). The last module of the class showcases interdisciplinary projects demonstrating interactions among the different fields. The lectures explain as applicable to each discipline, through examples, notions of problem solving, design thinking, process of invention and innovation, environmental and civic responsibility, and measures of success in aesthetics and performance. The course project is a key component of the course. It is interdisciplinary in nature bringing ideas and solutions from all disciplines in engineering and architecture. Annually.

MECH 201 Computer Aided Drawing and Design (CADD) 3 cr.
The course aims to prepare mechanical engineering students to communicate through graphics, technical drawings, and design databases via Computer Aided Drawing (CAD) software (such as AutoCAD®) and 3D Computer Aided Design software (such as Creo Parametric). Orthographic projection, auxiliary views, sectional views, dimensioning and tolerancing, drawing formats. Part geometric construction. Assemblies and exploded assemblies. Parts and assemblies working drawings. Engineering symbols. CADD project.

MECH 220 Engineering Graphics 1 cr.
The course aims at preparing the future engineer 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. Prerequisites: CIVE 210 and MATH 201.

MECH 310/CHEN 214 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 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. This course is considered equivalent to CHEN 214; hence, students cannot receive credits for both MECH 310 and CHEN 214.

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, pressure field and viscous effects; applications of Bernoulli's equation, Navier-Stokes and modeling; flow in ducts, potential flows and boundary layer flows. Prerequisite: MECH 310. This course is considered equivalent to CHEN 311; hence, students cannot receive credit for both MECH 314 and CHEN 311.

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. Prerequisites: MECH 230 and MECH 201.

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. Prerequisites: MECH 310 and MECH 314.

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 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 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 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 EECE 312.

MECH 432 Dynamic System Analysis 3 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: EECE 210 and CIVE 210.

MECH 436 Control Systems 3 cr.
A course that teaches the fundamentals of designing classical feedback control systems. The course has a lecture and a lab component. The two components are graded separately, and students must pass both in order to pass the course. Topics covered in the lecture component include: review of modeling and dynamic system analysis, introduction to feedback systems, performance specifications, transient and steady-state response analyses, transfer functions, root locus analysis and design, frequency response analysis and design, lag/lead/lead-lag compensators, and PID controllers. In the hands-on lab component, students use MATLAB/Simulink for modeling, simulating, analyzing, and designing control systems and conduct experiments on hardware setups. Prerequisites: EECE 210, MECH 430, and MECH 432.

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 term. The course may be counted once as a technical elective. Prerequisites: completion of 65 required credits in the major and a cumulative GPA of 3.3 or above.

MECH 500 Approved Experience 6 cr. ; 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, MECH 420, MECH 525, and MATH 251.

MECH 502 Final Year Project II 4 cr.
Researched and planned in MECH 501. Prerequisite: MECH 501.

MECH 503 Special Topics in Mechanical Engineering 3 cr.
Special topics in mechanical engineering.

MECH 503A/MECH 798J Data-Driven Methods in Science and Engineering 3 cr.
This course provides a broad introduction to machine learning methods with applications in science and engineering. Topics include: supervised learning (linear/logistic regression, neural networks, support vector machines etc.), unsupervised learning (clustering, PCA, autoencoders), reinforcement learning, and learning theory (variance/bias trade-off, approximation/estimation errors, etc.). The course will emphasize engineering and scientific applications, including: control theory, nonlinear dynamics, fluid dynamics, and materials science. Recent developments in physics-informed machine learning techniques will be discussed, including: sparse identification of nonlinear dynamics (SINDy), dynamic mode decomposition (DMD), and physics-informed neural networks (PINNs). Prerequisites: MATH 201, MATH 218, STAT 230, EECE 230.

MECH 510 Design of Thermal Systems 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 provides 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. Students will gain 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. Prerequisites: MECH 410L, MECH 412, and MATH 251.

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 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; use of engine cycle models for performance predictions; and social implications of motorization. Pre/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/corequisites: MECH 314 and MECH 414.

MECH 516 Aerodynamics 3 cr.
This course introduces the fundamental principles of aerodynamics, focusing on the behavior of airflow around bodies, the calculation of lift and drag using analytical and computational tools, and the application of these principles to the design and performance analysis of aircraft. The course includes both theoretical and practical components, with emphasis on understanding the physical phenomena and applying them to real-world problems. Prerequisites: 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 410L.

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.
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 EECE 312.

MECH 521 Manufacturing Processes II 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 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 525 Product Design and Development 3 cr.
Product design and development focuses on every aspect of the design process from defining a challenge to ideation, prototyping, testing, and production. A major focus will be on the development of skills to have a functional product. Further, this course is designed to broaden the student's knowledge of materials classes, properties, limitations, and application. To enhance students' learning experience, many design case studies will be presented and analyzed. This course will also guide the students to develop their designs (working individually or in groups). Prerequisites: MECH 332 and MECH 420.

MECH 530/EECE 560 Mechatronics System Design 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, 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 Intermediate Dynamics with Applications 3 cr.
This course examines the dynamics of systems of particles and rigid bodies moving in three dimensions using the Newton-Euler and Lagrange equations of motion. The equivalence between these formulations of the equations of motions and others such as the Gibbs-Appell and Kane equations is established. Topics include tensor calculus, curvilinear coordinates, Euler angles and parameters, and constraints. Applications of the material range from vibrations of multi-degree of freedom systems to robotics. Numerical simulations and animations are included. Prerequisites: MECH 230 and EECE 230. Corequisites: MATH 202 and MATH 218.

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 534/658/ EECE490/690 Intro to Machine Learning 3 cr.
The course provides an overview of machine learning theory and algorithms that learn from experience to predict or control yet to be seen instances. The course discusses the intuition and the theory of some selected modern machine learning concepts as well as practical know-how to successfully apply them to new problems. It covers topics in supervised learning such as parametric/ non-parametric, generative/ discriminative algorithms for classification and regression and in unsupervised learning for clustering, dimensionality reduction and reinforcement learning. The course also includes case studies and applications so that students can gain practice on regularization, model selection, parameter estimation, Bayesian networks, hidden Markov models, support vector machines, reinforcement learning, neural networks, and deep learning. Students cannot receive credit for both MATH 218 and 219. Prerequisites: MATH 218 or MATH 219, and STAT 230 or STAT 233.

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 436.

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 nonlinear 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/EECE 463 Artificial Intelligence for Control Systems 3 cr.
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 436.

MECH 600/CHEN 690 Reservoir Engineering 3 cr.
This course will cover both fundamental and applied reservoir engineering concepts. It aims at understanding the rock and fluid properties and how these properties interact to affect production from a hydrocarbon reservoir. From a practical standpoint, the course will focus on classical reservoir engineering, reservoir drive mechanisms, well testing and well test analysis as well as the use of reservoir simulation to assist the reservoir engineer at different stages of a hydrocarbon reservoir lifecycle. Prerequisites: MECH 310 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; and energy management programs. 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 consent of instructor.

MECH 607 Micro Flows Fundamentals and Applications 3 cr.
A course on the 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 3 cr.
This course introduces the advanced 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; Buckly-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 that introduces 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 coursework. Prerequisite: MECH 314.

MECH 611/BMEN 611 Computational Modeling of Biomechanics 3 cr.
This course is open to engineering, science and medical students wanting a glimpse into the world of computational finite element modeling and simulation to investigate and solve biomedical problems. Students will take a journey through the processes involved in producing a computational finite element model in the biomedical field, starting at construction of model geometry from medical imaging data (CT/MRI), through to model creation, simulation and visualization using finite element analysis software (ANSYS Workbench). Students will also be exposed to a selection of experimental lab techniques in biomechanics and physiology to acquire data required for model development and validation. In pursuit of developing an appreciation for the areas covered, the course will incorporate a mix of theory, demonstrations, practice, real-world modeling applications and research seminars. Prerequisites: MATH 201 and consent of instructor.

MECH 615 Continuum Mechanics 3 cr.
The course offers a unified presentation of continuum mechanics such as fluids, elasticity, plasticity, and viscoelasticity. The general concepts and principles applicable to all continuous media are presented followed by defining equations for a particular medium. Topics include fundamentals of tensor calculus, stress, deformation and strain, general principles, constitutive equations for solids and fluids; applications. Prerequisites: MECH 320, MATH 218 (or equivalent), MATH 212 (or equivalent), or graduate level standing.

MECH 617 Smart Materials and Structures 3 cr.
This course presents the fundamentals of modeling, analysis, and design of smart materials and structures. Students will be exposed to the state of the art of smart materials and systems, spanning piezoelectrics, shape memory alloys, electroactive polymers, and fiber optics. Students will explore the application of such materials in structural systems from the aeronautic, automotive, biomedical, and nautical industry. Smart materials are a class of materials varying in chemical composition and physical state that have one or more physical or physiochemical properties that can be significantly changed by external stimuli, such as pressure, temperature, electric or magnetic field, etc. Each student will participate in a group project. Under the guidance of the professor, the student will learn to develop a proposal, do the project investigation, and prepare and carry out the technical communications (writing and oral). In any of these scenarios, the student is directly responsible for the progress and quality of the results. At the end of the term, the student is required to submit a written project report and to give a seminar presenting the aims and achievements of the project.

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 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 619 Quality Control in Manufacturing Systems 3 cr.
The course covers the foundations of modern methods of quality control and improvement that may be applied to manufacturing industries. It aims to introduce students to the tools and techniques of quality control used in industrial applications and develop their ability to apply the tools and techniques to develop solutions for industrial problems. Emphasis is given to the application of quality management techniques to solve industrial case problems. The course emphasizes the philosophy and fundamentals of quality control, the statistical foundations of quality control, statistical process control, acceptance sampling, and product and process design. Prerequisites: STAT 230 and MECH 421.

MECH 622 Modeling of Machining Processes and Machines 3 cr.
This course covers the principles and technology of metal machining; mechanics of orthogonal and 3D metal cutting; static deformations, forced and self-excited vibrations and chatter; and design principles of metal cutting CNC machines. Prerequisite: MECH 421.

MECH 624 Mechanics of Composite Materials 3 cr.
A course on anisotropic elasticity and laminate theory, analysis of various members of composite materials, energy methods, failure theories and micromechanics. Materials and fabrication processes are introduced. Prerequisites: MECH 320 or CIVE 310, and MECH 340; or equivalent.

MECH 625 Fatigue of Materials 3 cr.
A course that deals with high cycle fatigue; low cycle fatigue; S-N curves; notched members; fatigue crack growth; cycling loading; Manson-Coffin curves; damage estimation; creep and damping. Prerequisite: MECH 320 or CIVE 310.

MECH 626 Metals and Their Properties 3 cr.
A course that investigates ferrous and non-ferrous alloys; industrial equilibrium diagrams; heat treatment of metals; surface properties of metals; plastic deformation of metals; elements of fracture mechanics; process-structure-properties relations. Prerequisite: MECH 340.

MECH 627 Polymers and Their Properties 3 cr.
The course will cover selected topics in polymer structure and properties, rubber elasticity, viscoelasticity, time-temperature superposition, dynamic mechanical analysis, polymer rheology, thermoplastic polymer converting and compounding, commercial polymers, testing and characterization, and design & selection of polymer materials. The students will be exposed to hands-on fabrication methods, industrial tours, and industrial-level R&D novelty. Prerequisite: MECH 340.

MECH 628 Design of Mechanisms 3 cr.
A course involving graphical and analytical synthesis of single-and multi-loop linkage mechanisms for motion, path, and function generation through 2-3-4- and 5-precision positions; optimum synthesis of linkage mechanisms; synthesis of cam-follower mechanisms; synthesis of gear trains. Prerequisite: MECH 332.

MECH 630 Finite Element Methods in Mechanical Engineering 3 cr.
A course on the classification of machine components; displacement-based formulation; line elements and their applications in design of mechanical systems; isoparametric formulation; plane stress, plane strain, axi-symmetric, and solid elements and their applications; modeling considerations and error analysis; introduction to potential energy and Galerkin approaches; and analysis of field problems. Prerequisites: MECH 420 and MATH 251.

MECH 631 Micro Electro Mechanical Systems (MEMS) 3 cr.
A course that deals with materials for micro-sensors and micro-actuators, materials for micro-structures, microfabrication techniques and processes for micromachining, computer-aided design and development of MEMS, commercial MEMS structures and systems, packaging for MEMS, future trends, and includes a team project. Prerequisite: MECH 430.

MECH 632 Structural Health Monitoring 3 cr.
The general concepts of structural health monitoring will be introduced. The commonly used techniques to provide continuous monitoring will be discussed (vibration and ultrasonic wave-based methods). Further, determination of critical measurement types and location; data acquisition systems and instruments; and design of measurement setup will be discussed. Handling data with advanced machine learning algorithm, such as artificial neural networking and support vector machine will be introduced. Students will also be introduced to the damage detection and condition assessment process. Prerequisites: MECH 320 and MECH 430.

MECH 633 Biomechanics 3 cr.
A course on the study of 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 skeleto-motor 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: CIVE 210, MECH 320, CIVE 310, or consent of instructor.

MECH 634/BMEN 608 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 on 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, dermatological, and dental applications. Experts from the medical community will be invited to discuss the various applications. Prerequisite: MECH 340 or consent of instructor.

MECH 635/BMEN 601 Computational Modeling of Physiological Systems 3 cr.
This course focuses on the quantitative modeling of different physiological systems. It provides students with current concepts of the mathematical modeling, and different quantitative descriptions of cellular and organ physiology. At the subcellular/cellular level, we will examine mechanisms of regulation and homeostasis. At the system level, the course will cover basic aspects of anatomical and pathophysiological features of the nervous, neural, cardiovascular, and respiratory systems. Several physiological processes are treated as case studies for increasing complexity in modeling dynamical systems. Prerequisites: MATH 202, EECE 230 or 231, or consent 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 638 Material, Selection for Design 3 cr.
This course describes the procedures for material selection in mechanical design, in order to ensure that the most suitable materials for a given application are identified from the full range of materials available. It targets both senior undergraduate and graduate students and investigates a vast number of conventional, unconventional, and hybrid materials used in the industry, as well as their selection and design processes that are followed by new product development departments around the world. Factors such as working environment, design requirements, fabrication type, cost, recyclability, and others are covered. Additionally, simulations of stress analysis during the manufacturing and application modes are investigated. Prerequisite: MECH 340 Engineering Materials.

MECH 641/EECE 661 Robotics 3 cr.
A course covering the fundamentals of robotics, emphasizing recent advancements. The curriculum encompasses key topics such as robot architecture, mechanics of robots, kinematics, dynamics, trajectory planning, and control of end effector motion. The scope extends beyond serial manipulators to include various architectures like parallel and legged robots. The hands-on lab involves programming and using robotic middleware for robot coordination and control. Engaging projects are an integral part of the course, providing opportunities to apply learned concepts in real-world scenarios, including the coordination and control of diverse types of robots in different tasks. Corequisite: MECH 436 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 or EECE 231.

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 in-depth coverage of wheeled mobile robots. The material covers: non-holonomy 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 throughout the course: car-like, cart-like, omnidirectional wheeled, mobile wheeled pendulums and bike-like robots. Prerequisite: senior or graduate standing.

MECH 647 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 436, or MECH 314 and EECE 460.

MECH 648/EECE 669 Nonlinear Systems: Analysis, Stability and Control 3 cr.
Introduction to the theory of systems of coupled, nonlinear, time-varying ordinary differential equations. Topics include existence and uniqueness of solutions, stability of equilibria, nonlinear stability theory, Lyapunov analysis, Barbalat's lemma, input-to-state stability, input-output stability, nonlinear control design techniques, feedback linearization, backstepping, and sliding mode control. Prerequisite: MECH 436 or EECE 460.

MECH 650/EECE 698 Autonomous Mobile Robotics 3 cr.
This course is designed to provide engineering graduate- and fourth-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 230/1, EECE 312 and MECH 435; or EECE 230 and EECE 460.

MECH 653/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: MECH 436 or EECE 460 or equivalent.

MECH 654/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 or MECH 436, 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.

MECH 656/EECE 663 System Identification 3 cr.
This course 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.

MECH 657 Vehicle Dynamics and Control 3 cr.
A course designed for seniors and graduate students. This course of advanced vehicle dynamics begins with whole vehicle motion, including acceleration, braking, aerodynamics, steering, rollover, and extends to vehicle component dynamics, including tire, drive train, and steering, and suspension. Automotive active safety control systems (e.g., anti-lock braking, traction control, cruise control, vehicle stability control) will be introduced. An outlook into autonomous ground vehicles, and their main components and technology enablers, will be provided at the end of the course. Prerequisite: MECH 436.

MECH 658/534 Intro to Machine Learning 3 cr.
The course provides an overview of machine learning theory and algorithms that learn from experience to predict or control yet to be seen instances. The course discusses the intuition and the theory of some selected modern machine learning concepts as well as practical know-how to successfully apply them to new problems. It covers topics in supervised learning such as parametric/ non-parametric, generative/ discriminative algorithms for classification and regression and in unsupervised learning for clustering, dimensionality reduction and reinforcement learning. The course also includes case studies and applications so that students can gain practice on regularization, model selection, parameter estimation, Bayesian networks, hidden Markov models, support vector machines, reinforcement learning, neural networks, and deep learning. Students cannot receive credit for both MATH 218 and 219. Prerequisites: MATH 218 or MATH 219, and STAT 230 or STAT 233.

MECH 659/EECE 666 Aerial Robotics 3 cr.
This course provides a comprehensive understanding of aerial robotics, focusing on the design, control, and application of unmanned aerial vehicles (UAVs). Students will gain hands-on experience with UAV systems, delve into advanced control algorithms, and explore real-world applications of aerial robotics. The technology is set to have a profound impact on society from delivering packages to watering crops and inspecting and repairing building structures, etc. This course will introduce the topic of aerial robotics and provide the foundations to be skilled in their design and control, as well as operational aspects such as ethical & legal considerations. Prerequisites: MECH 436, MECH 201, MECH 420, EECE 230 and MATH 202 or EECE 460, EECE 320, PHYS 210, PHYS 210L, EECE 230 and MATH 202.

MECH 663 Computational Fluid Dynamics 3 cr.
A course that deals with the 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.

MECH 665 Unsteady Gas Flow 3 cr.
A course examining equations of unsteady continuous adiabatic multidimensional flows, unsteady continuous one-dimensional flow of a perfect gas with and without discontinuity, applications, and pressure exchangers. Prerequisite: MECH 414.

MECH 670 Laboratory for Renewable Energy in Buildings 2 cr.
A laboratory course that investigates means of reducing building energy consumption first through green building design, giving consideration to building orientation, thermal massing, wind- and buoyancy-driven flows, “urban heat island” 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 term but will normally include mathematical modeling and experimental measurement components organized around aspects of building physics. Prerequisite: MECH 430.

MECH 671 Renewable Energy Potential, Technology and Utilization in Buildings 3 cr.
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 or ENST 300.

MECH 672 Modeling Energy Systems 3 cr.
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.

MECH 673 Efficient Buildings with Good Indoor Air Quality 3 cr.
A course covering energy consumption standards and codes in buildings and energy conservation measures in built-in environments 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, ASHRAE, 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 also 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. Pre/corequisite: MECH 310 or equivalent.

MECH 674/ENST 305/ECON 333 Energy Economics and Policy 3 cr.
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 provide 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: INDE 301. Students cannot receive credit for both MECH 674 and ENST 305 or ECON 333.

MECH 675 Building Energy Management Systems 3 cr.
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 energy in 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.

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 310.

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. 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 students "hands-on" experience in 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 will then be applied to deduce possible savings and their economic value. Pre/corequisite: MECH 672.

MECH 680 HVAC and Refrigeration Systems Lab 3 cr.
The focus is on HVAC design optimization and energy conservation measures in built-in environment. It includes concepts of district cooling/heating systems, dehumidification, and personalized ventilation systems. This course has a major component of hands-on experience with building energy systems design, operation and efficiency. Students will learn how to use and develop test equipment and plan for assessing system performance. Experiments and lab projects will span a series of advanced modules on sustainable, energy-efficient HVAC and refrigeration systems as laboratory topics. Lab topics may vary every term. Prerequisites: Advanced standing and MECH 310.

MECH 681/CIVE 686/ARCH 073 Sustainable Built Environments 3 cr.
A course that enhances knowledge about the past present and future conditions of the built environment. The course starts with a general overview of global/regional environmental, social and economic issues. Then, focusing on the built environment, students are introduced to climate responsive and environmentally friendly concepts in planning and design. The impact of using construction materials and their environmental impact throughout the building's lifecycle will also be discussed. Students will gain critical knowledge through interactive lectures, case study analysis and the proposal of concepts relating to a particular theme. Upon completing the course, students will be equipped with the necessary knowledge that will enable them to make informed project-related design decisions in their careers.

MECH 682 Principle of Integrative Building Design, Construction and Operation for Sustainability 3 cr.
This course centers on issues surrounding the integration of passive design principles into conceptual and practical building design sing basic design rules, simulation tools and conservation measures and protocols as means to improve building energy performance. Topics include: i) Building loads from envelop characteristics/materials including fenestration, building orientation and window location, type and area/ shading and associated direct solar gains, people schedules/activities, lighting, infiltration; ii) building indoor requirements of thermal comfort and air quality; iii) passive design practices. Impact on building inherent load of passive design interventions including envelop, fenestration, shading orientation, shape, energy storage, trombe wall, natural and mixed ventilation, and other potential practices will be studied. Open-source software is used to model a base building in regional climate and impact of various measures on energy performance and comfort requirements inside the building. The full building simulation is performed using case study occupancy data, equipment, lights, and building envelope. Energy conservation is then applied to deduce possible savings, their economic value and contribution to reduced greenhouse gas emissions and a sustainable building design.

MECH 683 Wind Turbines: Design and Applications 3 cr.
This course offers an overview of key aspects in wind energy technology and the engineering principles underlying the operation of wind turbines. It covers the essentials of wind turbine systems, their working principle, power curve characteristics, speed control, and calculation. It also covers an overview of wind resource and historical development of wind. This course demonstrates how to apply fundamental principles of thermodynamic and fluid mechanics to wind turbine engineering. It also introduces fundamental concepts in materials and show how these concepts are applied to analyze stresses in airfoils and other wind turbine components. It also provides a summary of the electrical aspects of wind energy conversion, particularly regarding the actual generation and conversion of the electricity. Finally, this course examines wind turbine control system, explain the control system components in general, and covers common turbine operating strategies that are found in modern turbines. At the end of the course, students will achieve a basic solid understanding of the aerodynamics, dynamics, mechanics, electricity production, and control of wind turbines. Prerequisites: MECH 314 and MECH 320.

MECH 691/ENMG 628/EECE 648 Convex Optimization 3 cr.
Advanced course that covers topics such as convex sets, convex functions, convex optimization problems, scalarization for vector optimization, duality theory, optimality conditions. Example problems include least-squares, maximum likelihood estimation, minimax, and extremal volume problems. Prerequisite: MATH 218.

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Undergraduate