# Faculty of

# ENGINEERING

# FACULTY OF ENGINEERING (FE)

## Faculty Administration

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|---|---|
| **Dean** | Dr. Adel El-Kordi |
| **Assistant Dean** | Dr. Yehya Temsah |
| **Director, Tripoli Branch** | Dr. Ahmed El-Lakany |
| **Executive Administrator** | Sereen Hariri |

## History

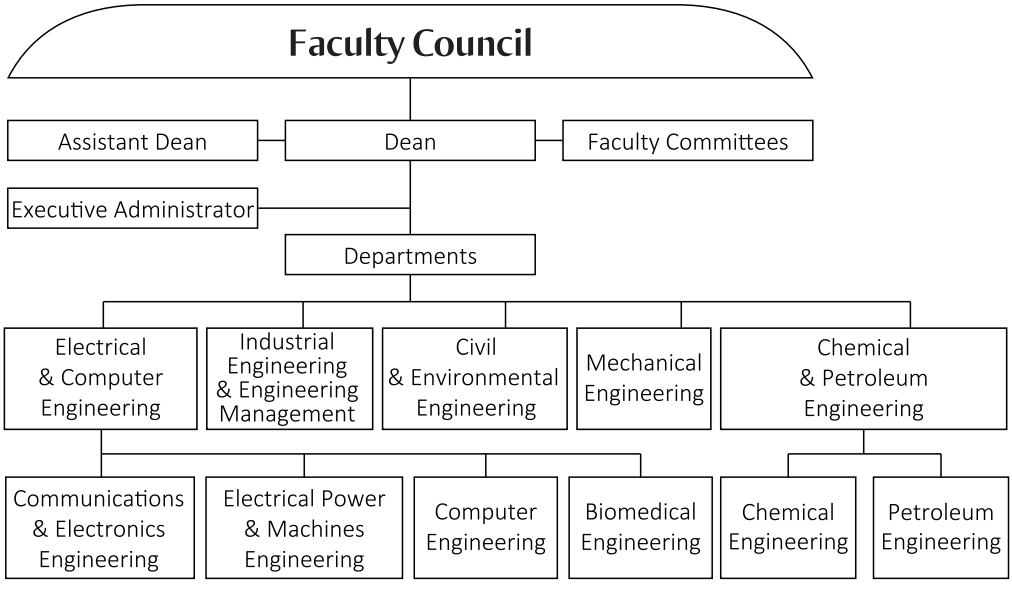
The Faculty of Engineering (FE) at Beirut Arab University was established in recognition of the national and regional need for engineering education in 1975. The Faculty initially offered two degree programs providing opportunities for formal course of study in Electrical and Civil Engineering. The Electrical Engineering Department granted its first Bachelor of Engineering degree to its pioneer-graduates in June 1980, followed by the Civil Engineering Department in June 1981. Two additional departments were established: The Mechanical Engineering Department in 1996 and the Industrial Engineering &Engineering Management Department, established in 2001. The petroleum engineering program was launched in September 2013. The biomedical and chemical engineering programs started in September 2016.

As of 1999, departments of the Faculty of Engineering have updated their curriculum to include a number of courses in humanities, with special emphasis on environmental, economic, managerial, and marketing aspects of engineering. In keeping up with the growing demands for advanced and specialized engineering services, the faculty expanded its programs further by adding both Diploma and Master degree programs. The first Electrical and Civil Engineering Diplomas were awarded in 1986 and the Master degrees in Electrical, Civil and Mechanical Engineering were awarded as of 1994.

In a collaborating effort to provide students with the opportunity to participate in practical projects that exhibit and demonstrate their skills and knowledge, the faculty established mutual incorporation and contacts with various industrial stakeholders. One aspect of this mutual interaction was the instigation of the Engineering Day in 1997. This event involved all faculty, staff and students to display the students respective work projects. The Engineering Day became an annual event to celebrate the faculty's mission of teamwork and creativity. In 2002, the faculty expanded its postgraduate programs further by incorporating a PhD program in all of its four major fields of specialization.
Today, the faculty of Engineering at Beirut Arab University is consistently ranked among the top leading engineering schools in Lebanon and the region. More than 200 BE degrees and 20 ME and Ph.D. degrees are awarded annually. The opportunities for study have expanded so that students may choose from more than 200 engineering courses. There are 30 full-time faculty members graduated from top ranked universities in USA and Europe, with diverse research background and experience. The FE also makes use of more than 15 part-time lecturers on a part-time basis. The faculty has an up-to-date electronic library that includes over 5800 book titles and 230 scientific journal titles, as well as over 15 research laboratories.

## Organizational Structure

The Faculty of Engineering constitutes the following five departments: Civil and Environmental Engineering, Electrical and Computer Engineering, Industrial Engineering and Engineering Management, Mechanical Engineering, and Chemical and Petroleum Engineering. The Electrical and Computer Engineering Department offers three programs: Communications and Electronics Engineering, Computer Engineering, Electrical Power and Machines Engineering, and Biomedical Engineering. The Chemical and Petroleum Engineering Department offers two programs: Chemical Engineering and Petroleum Engineering. The organizational chart of the College is shown below:




## Vision

The vision of the Faculty of Engineering is to be recognized globally as a beacon for quality engineering education in the Middle East and the world.

## Mission

The faculty seeks to serve the engineering educational and professional needs of Lebanon, the region and the international communities. Its mission is to:

- Improve the standard of our graduates through having high caliber faculty members together with quality educational programs and facilities in-line with the rapid technological advancements.
- Provide a balanced regime of quality education that incorporates theoretical and practical education, innovation and creativity as well as freedom of thought and research with emphasis on professionalism and ethical behavior.
- Promote and support research activities over a broad range of academic interests among students and staff.

- Encourage research and technical seminars that contribute to the growth of individual knowledge and prepares for continuous learning.
- Provide an excellent environment for our students that encourages interaction and enriches the educational experience in the faculty.

## Academic Programs

The Faculty of Engineering admits students to the following undergraduate degree programs:

- Bachelor of Engineering in Civil Engineering
- Bachelor of Engineering in Communications and Electronics Engineering
- Bachelor of Engineering in Computer Engineering
- Bachelor of Engineering in Electrical Power and Machines Engineering
- Bachelor of Engineering in Biomedical Engineering
- Bachelor of Engineering in Industrial Engineering
- Bachelor of Engineering in Mechanical Engineering
- Bachelor of Engineering in Petroleum Engineering
- Bachelor of Engineering in Chemical Engineering

## Admission Requirements

The most promising eligible applicants are admitted to first year of engineering. Special attention is given to the following factors:

- Lebanese Secondary Certificate (Baccalaureate)
- Entrance exam to measure the level of proficiency in English, mathematics, physics and logical thinking. The Petroleum Engineering exam also includes a chemistry component.

## Graduation Requirements

To receive a Bachelor of Engineering Degree in any of the engineering programs a student must satisfactorily complete 150 credit hours with an overall minimum grade point average (GPA) of 2.0. Additionally s/he must attain at least a "C" average in specific courses set by each program. The following table summarizes the number of credits required for each Bachelor granting program in the FE.

| Program | Common Requirements | | | Program Requirements | | | Total Credit Hours |
|---|---|---|---|---|---|---|---|
| | General Education | Basic Sciences Mathematics | General Engineering | Major Core | Technical Electives | Internship and FYP* | |
| CVLE | 20 | 26 | 14 | 73 | 12 | 5 | 150 |
| COME | 20 | 26 | 12 | 75 | 12 | 5 | 150 |
| COMP | 20 | 26 | 12 | 75 | 12 | 5 | 150 |
| POWE | 20 | 26 | 16 | 71 | 12 | 5 | 150 |
| BIME | 20 | 26 | 7 | 80 | 12 | 5 | 150 |
| INME | 20 | 26 | 15 | 72 | 12 | 5 | 150 |
| MCHE | 20 | 26 | 15 | 72 | 12 | 5 | 150 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PTRE | 20 | 30 | 15 | 68 | 12 | 5 | 150 |
| CHME | 20 | 39 | 15 | 59 | 12 | 5 | 150 |

CVLE: Civil Engineering

COME: Communications and Electronics Engineering
COMP: Computer Engineering
POWE: Electrical Power and Machines Engineering
BIME: Biomedical Engineering
INME: Industrial Engineering
MCHE: Mechanical Engineering
PTRE: Petroleum Engineering
CHME: Chemical Engineering

*FYP: Final Year Project

## Common Requirements

The following are the descriptions of the curricular components that are common to all programs offered in the Faculty of Engineering.

**I.General Education**

Student working for a BE degree in an engineering program must complete a total of 20 credit hours of general education (university and faculty) requirements distributed as follows:

**I.A. General Education Core (12 credits)**

This curricular component includes 6 courses comprising 12 credits; 3 courses (total of 5 credits) are University Requirements (UR) and 4 courses (total of 7 credits) are Faculty requirements (FR) as listed in the following table:

| Course | Title | Credits | Prerequisite |
|---|---|---|---|
| **University Requirement** | | | |
| ARAB 001 | Arabic Language | 2 | |
| BLAW 001 | Human Rights | 1 | |
| ENGL 001 | English Language | 2 | |
| **Faculty Requirement** | | | |
| ENGL 211 | Advanced Writing | 2 | ENGL 001 |
| ENGL 300 | Speech Communications | 2 | ENGL 211 |
| MGMT 002 | Entrepreneurship I | 2 | |
| ENGR 001 | Engineering Ethics | 1 | Finish ≥ 90 credits |

## Descriptions of the General Education core courses are given below.

**ARAB 001 ARABIC LANGUAGE (2Crs.: 2Lec,0Lab)**

تقديم إطار عام للغة العربية لغير المتخصصين، وتتناول الموضوعات التالية: العربية بين لغات العالم، النظام الصوتي، النظام الصرفي، النظام النحوي والنظام الكتابي، كما تتناول العربية والتعريب، والعربية والحاسوب، ثم كيف تكتب مقالاً علمياً.

**BLAW 001 HUMAN RIGHTS (1Cr.: 1Lec,0Lab)**

This course aims at introducing students to the principles of human rights and its foundations. The importance of human rights in our societies, not only from a theoretical point of view but rather more from a practical one, is highlighted. Special attention is given to certain global themes on human rights, which touch on critical topics related to our society. It also covers the following topics: Human rights, key values of human rights and other values, characteristics of human rights, history of human rights, some problematic cases, the evolution of human rights, the implementation of human rights and NGOs, human rights in Lebanon, children, citizenship, democracy, discrimination and xenophobia, education, and gender equality. Lectures are in English.

**ENGL 001 ENGLISH LANGUAGE (2Crs.: 2Lec,0Lab)**

A general course that enhances the language skills and provides coverage of basic grammar, vocabulary, reading, and writing for foundation students. It deals with basic competence in reading, through exercises on getting main ideas, guessing meaning from context, understanding details, predicting and inferencing. Writing development from paragraph to composition, proceeding through writing is the focus of the course. Writing and reading build vocabulary through exercises and dictionary use and clause exercises. The latter develop grammar where the use of nouns, verbs, adjectives, and adverbs, transition signals, the reconstructing of sentences and main and subordinating clauses is practiced.

**ENGL 211 ADVANCED WRITING (2Crs.: 2Lec,0Lab)**

Students write essays on different topics related to argumentation or presentation of concepts and ideas in an organized manner. This is in addition to descriptive, narrative, reflective, and creative writing. Topics chosen are related to the students' culture diagram as well as current affairs. The ability of students to write academically and classify and organize ideas is stressed. Pre-req.: ENGL 001.

**ENGL 300 SPEECH COMMUNICATIONS (2Crs.: 2Lec,0Lab)**

Basic oral communication principles and theories; body, intonation, and stress language considerations; speaker-listener relationship; speech topic, context and audience; planning, preparing and delivering of platform speeches; showcase and spotlight ideas; group interactions; projects and formal presentations.
Pre-req.: ENGL 211.

**MGMT 002 ENTREPRENEURSHIP I (2Crs.: 2Lec, 0Lab)**

An introductory course designed around the development of business plan. The course examines how to formulate business ideas, select a location, select a legal form of organization, locate financing source, assess the market, and develop a human resources management system.

**ENGR 001 ENGINEERING ETHICS (1Crs.: 1Lec, 0Lab)**

Ethical issues in the practice of engineering, corporate responsibility; personal rights; honesty, ethical aspects of safety, risk and liability and conflicts of interest; environmental issues and sustainability; codes of ethics; emphasis on developing the capacity for independent ethical analysis of real cases. Pre-req.: earned 90 crs.

**I.B. General Education Electives (8 credits)**

This component encompasses 8 Credits of General Elective courses selected from the University Elective Courses listed in the University Section of this catalog.

**II.Basic Sciences and Mathematics Courses**

The Basic Sciences and Mathematics component for all engineering majors except the PTRE program consists of 26 credits (27 credits for the PTRE program and 36 credits for the CHEM program) distributed as follows:

| Course | Title | Credits | Prerequisite |
|---|---|---|---|
| CHEM 241 | Principles of Chemistry | 3 | |
| CHEM 207/CHEM 405 | Environmental Chemistry/Solid State Chemistry | 2 | |
| MATH 281 | Linear Algebra | 3 | |
| MATH 282 | Calculus | 3 | |
| MATH 283 | Differential Equations | 3 | MATH 281, 192 |
| MATH 284 | Numerical Analysis | 3 | MATH 283 |
| MATH 381 | Probability and Statistics | 3 | MATH 282 |
| PHYS 281 | Electricity and Magnetism | 3 | |
| PHYS 282 | Materials Properties and Heat | 3 | |

Instead of the CHEM 207/CHEM405 and the CHEM 241 courses, the PTRE program requires the following three 9-credits chemistry courses instead:

- CHEM 281: Principles of Chemistry I (3 Credits)
- CHEM 282: Principles of Chemistry II (3 Credits)
- CHEM 331: Organic Chemistry (3 Credits)

Instead of the CHEM 207/CHEM405 and the CHEM 241 courses, the CHME program requires the following six 18-credits chemistry courses instead:

- CHEM 248: Physical Chemistry I (3 Credits)

- CHEM 281: Principles of Chemistry I (3 Credits)
- CHEM 282: Principles of Chemistry II (3 Credits)
- CHEM 331: Organic Chemistry (3 Credits)
- CHEM 345: Inorganic Chemistry (3 Credits)
- CHEM 358: Surface and Colloid Chemistry (3 Credits)

Descriptions of the required mathematics and basic sciences courses are given below.

**CHEM 207 ENVIRONMENTAL CHEMISTRY (2Crs.: 2Lec,0Lab)**
Chemistry of ozone layer in the atmosphere; particulate matter and control of air pollution; global warming; waste management, treatment and disposal; mass-energy transfer; risk, dose response and human exposure assessment; hazard identification; risk characterization; water resources and pollutants; BOD and waste water.

**CHEM 241 PRINCIPLES OF CHEMISTRY (3Cr.:3 Lec)**
A study of the fundamental concepts of chemistry including matter and measurement, atoms, molecules, ions, moles, nomenclature, atomic and molecular weights. Stoichiometry. Chemical reactions, quantitative calculations. Periodic table, atomic structure, periodic properties of the elements, chemical bonding, molecular structure. The gaseous, liquid, and solid states of matter. Properties of solutions, aqueous reactions and solution stoichiometry. Thermochemistry, chemical thermodynamics, chemical kinetics, chemical equilibrium, acids, bases and ionic equilibria, and nuclear chemistry.

**CHEM 248 PHYSICAL CHEMISTRY I (3Crs.:3Lec)**
The course covers principles and applications of the first and second laws of thermodynamics. Third law of thermodynamics, entropy and free energy changes in chemical reactions, thermodynamics of solutions. Phase Equilibria in heterogeneous systems. Phase rule and its application in one, two and three component system. Pre-req.: CHEM 282

**CHEM 281 PRINCIPLES OF CHEMISTRY I (3Crs.: 3Lec,0Lab)**
Introduction to the basic concepts and principles of chemistry including: Atoms, molecules, mole concept, chemical reactions and calculations, stoichiometry. Periodic table and properties of the elements, nomenclature. Theories of atomic structure, atomic spectra. Theories of chemical bonding. Covalent bonding and molecular structure: molecular geometry, VSEPR theory, valence bond theory, hybrid orbital and molecular orbital theory.

**CHEM 282 PRINCIPLES OF CHEMISTRY II (3Crs.: 3Lec,0Lab)**
Topics discussed are the three physical states of matter (gases, liquids and solids). Properties of solutions. Chemical equilibrium. Ionic equilibria. Rates of chemical reactions. Introduction to the basic chemical thermodynamics and thermo-chemistry. Pre-req.:CHEM281.

**CHEM 331 ORGANIC CHEMISTRY (3Crs.:2Lec,2Lab)**
Introduction to organic chemistry. A new mechanistic approach to the study of the chemical reactions and a survey of hydrocarbons, alcohols and ethers. Detailed study of aromatic compounds, aldehydes, ketones, carboxylic acids and their derivatives, and amines. The course also introduces students to spectroscopic identification of organic compounds. Applied experiments related to the above topics. Pre-req.: CHEM281.

**CHEM 345 INORGANIC CHEMISTRY I (3Crs.:3Lec,0Lab)**
Brönsted and Lewis acid and base. Chemistry of main group elements. Basic concepts of coordination compounds: nomenclature, bonding, structure, stability, magnetic properties, stereochemistry. Crystal and ligand field theories. Pre-req.: CHEM 282.

**CHEM 358 SURFACE AND COLLOID CHEMISTRY (3Crs.:3Lec)**
Basic terms in surface and colloid chemistry, the kinetic properties of disperse systems, interfacial phenomena, the optical and electrical properties of colloids, the preparation and stability of colloids, properties of gels, emulsion, foams and aerosol. Pre-req.: CHEM248

**CHEM 405 SOLID STATE CHEMISTRY (2Crs.: 2Lec,0Lab)**
Bonding in solids; crystal structures; x-ray diffraction; electron models; band theory; crystal defects; electrical, thermal, optical and magnetic properties of solid state materials from a chemical perspective; fabrication techniques and modern applications.

**MATH 281 LINEAR ALGEBRA (3Crs.: 3Lec,0Lab)**
Partial fractions; binomial theorem; roots of polynomial equations; convergence of series; Matrices: Determinants, rank, eigen values, eigenvectors, block decomposition, axes transformation solution of linear system of equations; introduction to complex analysis; conic sections; engineering applications.

**MATH 282 CALCULUS (3Crs.: 3Lec,0Lab)**
Hyperbolic functions; implicit and logarithmic differentiation; derivatives of higher order functions; Leibniz theorem; mean value theorem; partial differentiation and applications; Taylor expansion; methods of integration; improper integrals; multiple Integrals; engineering applications.

**MATH 283 DIFFERENTIAL EQUATIONS (3Crs.: 3Lec,0Lab)**
First- and second-order differential equations with constant and variable coefficients; simultaneous system of differential equations; series solution; Introduction to partial differential equations; Fourier series; Laplace transforms; shifting theorems; convolution theorem; engineering applications. Pre-req.: MATH 281, MATH 282.

**MATH 284 NUMERICAL ANALYSIS (3Crs.: 3Lec, 0Lab)**
Curve fitting; function approximation; iterative method for finding roots; solution of systems of linear equations; numerical differentiation and integrations; numerical

solution for ordinary differential equations (first order, simultaneous system, second order); special functions; numerical analysis software; engineering applications.
Pre-req.: MATH 283.

**MATH 381 PROBABILITY AND STATISTICS (3Crs.: 3Lec, 0Lab)**
Probability space, conditional probability and independence, and probability theorems; Random variables, and density functions, joint probability; expectation, variance and covariance, moments and moment generating functions: Discrete and continuous distributions; statistical measures: mean, mode, variance, standard deviation; statistical distribution: t- distribution, chi- distribution; sampling theory; Theory of estimation, confidence intervals; probability and statistical software.
Pre-req.: MATH 282.

**PHYS 281 ELECTRICITY AND MAGNETISM (3Crs.: 3Lec, 0Lab)**
Electric charges and Coulomb's Law; Electric field and potential of various charge distributions; electric dipoles; Gauss's Law in electricity; Capacitance and Dielectrics; Electric conduction current; Resistance and Temperature; Magnetic field of a solenoid; Gauss's Law in Magnetism; Electromotive force; Electromagnetic induction; Faraday's law; Self induction and inductance.

**PHYS 282 MATERIAL PROPERTIES AND HEAT (3Crs.: 2Lec,2Lab)**
Properties of materials: units, dimensions, experimental errors, circular motion of rigid bodies, moment of inertia, compound pendulum, elasticity of materials, Hook's law, relations between stresses and strains, elastic energy, torsion, gravitation and gravity, satellite motion, pressure measurements, flow of ideal fluids, streamlines and equation of continuity, Bernoulli's equation and its applications, viscosity of fluids, flow in capillary tubes; Heat: heat and temperature, temperature measurements, specific heat and latent heat, heat transfer by conduction, heat convection, heat transfer by radiation and black body radiation.

**III.General Engineering**
The general engineering component includes 15 credits (12 credits for the ECE programs) distributed as follows:

| Course | Title | Credits | Prerequisite |
|---|---|---|---|
| COMP 208 | Programming I | 3 | |
| CVLE 210 | Statics* | 3 | |
| INME 221 | Engineering Economy | 3 | |
| MCHE 201 | Engineering Drawings and Graphics* | 3 | |
| MCHE 213 | Dynamics | 3 | |

*Not included in the curriculum of ECE programs, replaced by INME 423 Project Planning and Management (3 credits)
** Not included in the curriculum of Civil Engineering Program.

**COMP 208 PROGRAMMING I (3Crs.: 2Lec,2Lab)**
Computer fundamentals. Computer system components: hardware and software. Problem solving and flowcharts/pseudocode. High level programming: data types, structured programming constructs, input and output, expressions and assignments, selection, repetition, arrays.

**CVLE 210 STATICS (3Crs.: 3Lec,0Lab)**
Force vectors (analytical and graphical methods), free-body diagrams; equilibrium of particles and rigid bodies in two and three dimensions; structural elements and supports; plane and space trusses; axial, shear, and moment diagrams of beams; Cable-supported structures. Friction; center of gravity and centroid; moment of inertia. Applications.

**INME 221 ENGINEERING ECONOMY (3Crs.: 3Lec,0Lab)**
Basics principles and techniques of economic analysis of engineering project, time value of money, cost allocation and estimation, evaluation of engineering projects and investments, depreciation, inflation, bond and loan financing, after tax cash flow analysis, sensitivity analysis, selection among mutually exclusive alternatives using present worth, annual worth, internal rate of return, benefit-cost.

**MCHE 201 ENGINEERING DRAWING AND GRAPHICS (3Crs.: 1Lec,4Lab)**
Constructional Geometry-constructing tangents. Plane curves and polygons. Orthographic drawing and theory of sketching shapes and surface identification. Orthographic projection of views. Sectional views and conventions. Pictorial drawing. Applications of Auto-CAD software for 2D drawings.

**MCHE213 DYNAMICS (3Crs.: 3Lec,0Lab)**
Dynamics of a particle, system of particles, and planar rigid bodies using Newton's law of motion. Work and energy principle, impulse and momentum principle. Free-body diagram and concept of equilibrium. Inertia properties of rigid bodies.

## Program Requirements

Requirements for the Bachelor of Engineering degree are program-specific. They encompass three categories: Major specific core courses, major specific elective courses, and engineering courses chosen from outside the major. The program requirements for the bachelor degrees in the different engineering majors are given hereafter. Details and titles of relevant courses are included in the Student's Study Plan (SSP) that is distributed to all engineering students.

# DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

## Academic Staff

| | |
|---|---|
| **Chairperson** | Adnan Masri |
| **Professors** | Adel El Kordi, Yehia Temsah, Hamdi Seif, Issam Gouda<br>Oussama Baalbaki, Jamal Khatib |
| **Associate Professors** | Youssef Attallah |
| **Assistant Professors** | Zaher Abou Saleh, Hassan Ghanem, Ayman Trad, Hussein Kassem<br>Wael Sleika, Diala Tabbal, Mohamad Dandachy, Mohamad Khawly |
| **Part-time Lecturers** | R. Sammoura, M. Kahil, M. Mashaaka, Wafic Ajam, Amani Abdallah<br>Samer Ahmad |
| **Full-time Instructors** | Lina Jaber |
| **Part-time Instructors** | W. Hajj, Hanadi El Khansa, Y. Al-Rawi, Sandy Chaaban, Nour Wehbi<br>Ghida Hakim, Safwan Shahal, Ali Jahami |

## Mission

The mission of the Civil and Environmental Engineering Department is dedicated to educate and graduate commendable civil engineers by providing a high-standard education delivered in a stimulating and supportive environment that expose students to a broad balanced program of theoretical and practical learning; to prepare graduates to build skills, competencies, leadership qualities, professionalism and ethics, in addition to cultivate a sense of creativity as well as team-work innovations to impart professional services of the highest quality to the community and the environment; and to instill in them a passion to continuous and lifelong learning (LLL) to surmount problems encountered in a rapidly changing and challenging world, for a better lifelong productive career.

## Objectives

The Civil and Environmental Engineering Department offers a program that aims to develop graduates who are practical, numerate, articulate, imaginative, versatile and confident. The specific objectives are to:

1. provide graduates to acquire and impart a sound understanding of the fundamental principles and concepts of civil engineering, and continuously develop their intellectual skills by endorsing independent and creative thinking leading to novel technologies and advanced innovative research and solutions and meeting prevailing technical challenges.
2. enable graduates to pursue and develop their professional career, ability to research a civil engineering subject, professional and communication skills, and are prepared to assume leading roles in the profession and the community while emphasizing the issues of professional and ethical conduct.
3. exhibit commitment to the wellbeing including health and safety of the community and the environment in pursuant of relevant solutions and better service to the society.

## Learning Outcomes

The graduates of the CEE program will acquire each of the following characteristics and abilities, which constitute the program outcomes in conformity with the objectives. The student will

a. Apply knowledge of mathematics, science and engineering.
b. Design and conduct experiments, as well as to analyze and interpret data.
c. 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.
d. Function on multidisciplinary teams.
e. Identify, formulate and solve engineering problems.
f. Understanding of professional and ethical responsibility.
g. Be able to communicate effectively.
h. Develop the broad education necessary to understand the impact of engineering in a global, economic, environmental, and societal context.
i. Recognize the need for, and an ability to engage in life-long learning.
j. Demonstrate a knowledge of contemporary issues.
k. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

## Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Civil Engineering (CEE) consists of 150 credit-hours of course work + ICDL, where the standard duration of study is 10 semesters.

## Career Opportunities

The demand for civil engineers has been consistently high, in the Middle East and the Gulf region, during the last decade. Engineers have been involved primarily in large public and private development projects. The emerging reconstruction activity in Lebanon and the Gulf offers ever increasing and expanding opportunities for civil engineers for even decades to come. Graduating civil engineers are benefiting from very stimulating work experiences in the region, many of which are related to mega projects in the building and infrastructure sectors; this has resulted in a booming job market and in highly competitive salaries for civil engineers. Potential senior students are on high demand for recruitment by leading engineering companies for practical training, prior to their graduation, and eventually hired as practicing engineers.

The civil engineering graduate can generally work either in the private sector or in government agencies. Civil engineers attain a broad spectrum of skills sought by almost every profession. The fields of work applied to civil engineering are in form of design and consultation, contracting and supervision, or management and quality control. Being interrelated, it is not unusual that these fields are combined during the performance of a project. The civil engineer can work as an employee, partner, or owner in consulting design offices (local or regional) in the departments of structures, transportation and planning, geotechnical engineering, environmental engineering, water resources, and computer software, and in contracting firms and construction management consultant offices.

## Program Overview

The Student's Study Plan is provided to every CEE student upon his/her enrollment. The CEE curriculum consists of 150 total credits divided into the following components:

| **I. Common Requirements ( 60 credits )** | **Credits** |
|---|---|
| General Education Requirements | 20 (12 Comp and 8 Elect) |
| Basic Sciences and Mathematics | 26 |
| General Engineering courses | 14 |
| **II. CEE Program-Specific Requirements ( 90 credits )** | **Credits** |
| **A.** Course from Industrial Engineering (INME 423) | 3 |
| **B.** Civil Engineering Core Courses | 70 |
| **C.** Civil Engineering Technical Electives | 12 |
| **D.** Internship (Approved Experience / Independent Study) | 1 |
| **E.** Final Year Project (FYP) | 4 |

**I. Common Requirements**

The list of Common Requirement courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog.

**II. CEE Program-Specific Requirements**

**A.Engineering topics from outside the major**

This part of the CE curriculum includes a 3-credits course offered by Industrial Engineering &Engineering Management department (INME).The course is listed below.

| **Course** | **Title** | **Credits** | **Pre-/Co-requisites** |
|---|---|---|---|
| INME 423 | Project Planning and Management | 3 | |

A description of the INME-designated course is given in the catalogue section of the Industrial Engineering program.

**B. Civil Engineering Core Courses**

The Civil Engineering core courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| CVLE 210* | Statics | 3 | |
| CVLE 211 | Mechanics of Materials | 3 | Pre: CVLE 210 |
| CVLE 213 | Structures I | 3 | Pre: CVLE 211 |
| CVLE 214 | Structures II | 3 | Pre: CVLE 213 |
| CVLE 222 | Construction Materials I | 3 | Pre: CVLE 211 |
| CVLE 231 | Engineering Geology | 2 | |
| CVLE 260 | Engineering Surveying I | 2 | |
| CVLE 261 | Engineering Surveying II | 2 | Pre: CVLE 260 |
| CVLE 263 | Transportion and Traffic Engineering | 3 | |
| CVLE 270 | Civil Engineering Drawings and Detailing | 2 | Pre: MCHE 201 |
| CVLE 323 | RC Structures I | 3 | Pre: CVLE 213 |
| CVLE 324 | RC Structures II | 3 | Pre: CVLE 323 |
| CVLE 325 | Construction Materials II | 3 | Pre: CVLE 222 |
| CVLE 333 | Soil Mechanics | 3 | Pre: CVLE 211 and CVLE 231 |
| CVLE 341 | Hydraulics I | 3 | |
| CVLE 342 | Hydraulics II | 3 | Pre: CVLE 341 |
| CVLE 354 | Environmental Engineering | 2 | Pre: CHEM207 |
| CVLE 372 | Structural Modeling | 2 | Pre: CVLE 213 |
| CVLE 425 | Steel I | 3 | Pre: CVLE 213 |
| CVLE 426 | Steel II | 3 | Pre: CVLE 425 |
| CVLE 427 | Building Information and Modeling | 3 | Pre: CVLE 324 |
| CVLE 432 | Foundation Engineering | 3 | Pre: CVLE 323, CVLE 333 |
| CVLE 441 | Hydrology | 2 | Pre: CVLE342 |
| CVLE 453 | Sanitary Engineering | 3 | Pre: CVLE354 |
| CVLE 464 | Highway Engineering | 3 | Pre: CVLE263 and CVLE 333 |
| CVLE 482 | Contracts, Quantities and Specifications | 3 | |
| CVLE 500 | Research Methodology | 2 | Pre: ENGL300 |

*General Engineering Course

**Description of Core Courses**

**ENGR 002 INTRODUCTION TO ENGINEERING (2 Crs: 2Lec)**

Introducing the student to the engineering profession in general and the learning objectives that new students should attain, as aligned with the ABET requirements. Covering the basics of the engineering profession and engineering ethics. Introduction to the different engineering majors and to the learning objectives as specified by ABET. Insight into different engineering courses that are not technical in nature (e.g., engineering economy) Engineering design tasks that allow the student to start thinking as engineers: problem definition, specification of constraints, investigation of different solution alternatives, implementation of best solution, writing technical reports. Fundamental tools and numerical software used in engineering. The tools and software covered could be generic or specific to a major.

**CVLE 210 STATICS (3Crs: 3Lec)**

Force vectors (analytical and graphical methods), free-body diagrams; equilibrium of particles and rigid bodies in two and three dimensions; structural elements and supports; plane and space trusses; axial, shear, and moment diagrams of beams; Cable-supported structures. Friction; center of gravity and centroid; moment of inertia. Applications.

**CVLE 211 MECHANICS OF MATERIALS (3Crs: 3Lec)**

Center of Gravity. Moments of Inertia. Stresses, strains, stress-strain relationships. Axial Stress and deformation, Pure bending., Deflection due to bending, Stresses due to Combined Bending and Axial force, Direct Shear, Torsion, Shear stresses and deformation due to torsion, Combined stresses. Stress transformation and Mohr's circle. Pre-req: CVLE 210

**CVLE 213 STRUCTURES I (3Crs: 3Lec)**

Types of loads, structural elements and supports. Stability and determinacy of structures. Analysis of simple, cantilever and overhanging ended beams. Axial, shear, and bending moment diagrams. Analysis of compound and inclined Beams,& frames. Elastic deformation (slope and deflection) of beams by double-integration method; Moment-area theorems; and Conjugate Beam Method. Pre-req: CVLE 211

**CVLE 214 STRUCTURES II (3Crs: 3Lec)**

Strain energy theorems – Slopes and deflection of beams, frames and trusses utilizing principle of virtual work. Flexibility method for analysis of indeterminate structures. Matrix analysis of structures. Effect of temperature change and yielding of supports. Three Moment Equations and applications. Slope-deflection method for analysis of beams and rigid frames. Concept of Moment distribution methods and applications on continuous beams, and frames with and without side-sway. Pre-req: CVLE 213

**CVLE 222 CONSTRUCTION MATERIALS I (3Crs: 2Lec and 2Lab)**

Portland cement: Processing, Specifications, Properties, Types. Aggregates:

Processing, Properties, Grading, Testing. Water, Admixtures, Concrete mix design (mixture proportioning), Properties and Testing of fresh concrete (Workability tests), Hard Concrete Testing. Batching, Mixing and Placing, Pre-req: CVLE 211

**CVLE 231 ENGINEERING GEOLOGY (2Crs: 2Lec)**
Earth-structure, 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; reservoirs, dam sites, and construction of tunnels.

**CVLE 260 ENGINEERING SURVEYING I (2Crs:1Lec and 2Lab)**
Basic principles, linear surveying and scales, maps plotting, compass surveying, theodolite surveying: Vernier, optical and digital, traverses: open, closed, link, and traverse network, adjustment and plotting, engineering and precise leveling, contouring.

**CVLE 261 ENGINEERING SURVEYING II (2Crs: 1Lec and 2Lab)**
Distance measurements, stadia system, tangential system, and double image system, Basics of electromagnetic distance measurements EDM, total Station, introduction to GPS, areas and volumes for earthworks, mass hauk diagrams, curve ranging simple, compound, reversed, transition, and vertical curves. Pre-req: CVLE 260

**CVLE 263 TRANSPORTATION AND TRAFFIC ENGINEERING (3Crs: 3Lec)**
Introduction to urban transportation planning, travel behavior, transportation demand models, public transport planning, line capacity, headways, operation principles, traffic engineering principles, traffic control, traffic management, transportation infrastructure and facilities, transport and the environment, air pollution, traffic noise, energy consumption, evaluating alternative transportation plans: Technical, environmental, economic criteria.

**CVLE 270 CIVIL ENGINEERING DRAWING AND DETAILING (2Crs:1Lec and 2Lab)**
Graphical analysis of engineering drawings, computer-aided drafting and work drawing, applications: RC slabs, beams, stairs, retaining walls, footing, RC bridges, weirs, earth slopes, roads, interchanges and sections. AutoCAD Applications. Pre-req: MCHE 201

**CVLE 323 RC STRUCTURES I (3Crs: 3Lec)**
Introduction, working stress and limit state methods of design. Sections subjected to: normal force, bending moment, and shear, eccentric force, torsion, bond development and anchorage, code requirements, detailing, applications: columns and beams. Pre-req: CVLE 213

**CVLE 324 RC STRUCTURES II (3Crs: 3Lec)**
Serviceability limit state: deflection, cracking and exposure to fire resistance, floor systems: solid slabs, ribbed slabs, flat plate, and slabs, waffle slabs, and paneled beam floor slabs, design methods: Direct design method, and equivalent frame method,

loads transmitted from floors to the supported beams, code requirements, detailing, and applications. Pre-req: CVLE 323

**CVLE 325 CONSTRUCTION MATERIALS II (3Crs: 2Lec and 2Lab)**
Supplementary Cementitious Materials, Field investigation, Hot-weather concreting, Cold-weather concreting, Special types of concrete; High-strength concrete, Mass concrete, High performance concrete, Analysis of fresh concrete, Analysis of hard concrete, Concrete Durability, Concrete problems and defects,. Building Construction Materials (Blocks, Tiles, Reinforcing Bars,..), Pre-req: CVLE 222.

**CVLE 333 SOIL MECHANICS (3Crs: 2Lec and 2Lab)**
Origin and nature of soil, clay minerals and soil structure, phase relationships, grain size analysis, consistency and soil classification. Soil Hydraulics: Principle of effective stresses, capillarity, permeability, pumping wells, 1-D and 2-D seepage, flow nets, filter design. Stress distribution, Mohr circles and pole method. Compressibility of soil, theory of consolidation. Failure criteria. Shear strength of soil slope stability, mass procedures and methods of slices. Laboratory testing and reports. Pre-req: CVLE 211 and CVLE 231

**CVLE 341 HYDRAULICS I (3Crs: 2Lec and 2Lab)**
Properties of liquids. Hydrostatic, measurements of liquid pressures, buoyancy, principles of liquid kinematics and dynamics, continuity, energy, and momentum equations, application: steady flow, flow in pipes, velocity and discharge measurements, laminar and turbulent flow, head losses, pipe networks, emptying of tanks, laboratory experiments.

**CVLE 342 HYDRAULICS II (3Crs: 2Lec and 2Lab)**
Open channel hydraulics: Classification of open channel flow. Flow resistance equations, velocity distribution, boundary shear stress distribution and critical shear, design of channel cross-section, hydraulic jump, gradually varied flow, flow measurement, hydraulic models, pumps: function, types and performance curves. Main specifications of pumps, economical design of pumps and piping system, pumps in parallel and series, selection of pumps, installation, priming, and water hammer. Intake design. Laboratory experiments. Pre-req: CVLE 341

**CVLE 354 ENVIRONMENTAL ENGINEERING (2Crs:2Lec)**
Saltwater intrusion: Ghyben-Herzberg interface, limiting conditions, hydrodynamic effects, control methods. Outdoor air pollution: meteorology effects, atmospheric dispersion, point-source Gaussian plume model. Solid waste management: landfill disposal and design, liners and cover systems, use of geosynthetics, vertical barriers, slope stability and settlement analyses. Groundwater pollution: contaminant transport, cone of depression, capture–zone curves, control of groundwater plumes, remediation techniques. Environmental impacts of highways and dams projects.
Pre-req: CHEM207

**CVLE 372 STRUCTURAL MODELING (2Crs:1Lec and 2Lab)**
Programming: routines of elements stiffness, overall matrix, bandwidth, solution of equations and calculation of elements internal forces, use of available packages (SAP 2000, STAAD, ROBOT, etc.) Pre-req: CVLE 213

**CVLE 425 STEEL I (3Crs: 3Lec)**
Introduction - Structural Framing Floor Systems - Stability and Bracing Systems - Tension Members - Compression Members - Bolted Truss Connections - Welded Truss Connections - Laterally Supported Beams - Lateral Torsion Buckling of Beams - Specifications and Detailing. Pre-req: CVLE 213

**CVLE 426 STEEL II (3Crs: 3Lec)**
Beam-Column Members. -Built-up Columns - Eccentrically Loaded Connections – High Tensile Bolts - Frame Connections – Column Bases - Simply Supported Slab-Girder Roadway Bridges - Built-up Plate Girders. Specifications and Detailing. Pre-req: CVLE 425

**CVLE 427 BUILDING INFORMATION AND MODELING (3Crs: 3Lec)**
BIM uses for Architecture, Engineering and Construction (AEC) industry, create 3D representations of structures on Autodesk Revit, explore spatial relationships between different components of the model, model building information, obtain bills of quantities (BOQ) and bar bending schedules (BBS), document projects and understand the value of the BIM process and what it offers. Pre-req. 324.

**CVLE 432 FOUNDATION ENGINEERING (3Crs: 3Lec)**
Soil investigation, sampling and in-situ testing. Shallow foundation: types, bearing capacity and settlement, design of isolated, combined and raft foundations. Groundwater control and dewatering. Deep foundations: bearing capacity and settlement / displacement of axially-and laterally-loaded piles, driving formulas, pile load tests, negative skin friction, pile groups; structural design of pile caps. Code requirements, computer applications. Pre-req: CVLE 323 and CVLE 333

**CVLE 441 HYDROLOGY (2Crs: 2Lec)**
The hydrologic cycle, precipitation, system flow, evaporation, transpiration, hydrograph analysis, estimating volume runoff, runoff from snow, reservoir engineering, and channel routing, groundwater: occurrence, aquifers, hydraulics of wells, surface and subsurface investigations of groundwater. Water harvesting, surface and ground water case studies. Pre-req: CVLE 342

**CVLE 453 SANITARY ENGINEERING (3Crs.:3Lec)**
Sources of water supply, quality of water, water and diseases, water consumptions, collection works and water purification, chlorination and distribution systems, quantity of sewage, sewage systems, and appurtenances, and methods of sewage disposal, sewage treatment: necessity and methods. Pre-req: CVLE 354

**CVLE 464 HIGHWAY ENGINEERING (3Crs.:3Lec)**

Elements of highway transportation planning, traffic engineering, geometric design of highways, highway planning, vertical and horizontal Alignment, transition curves, super-elevation, and intersections, highway materials: mineral aggregates and bituminous materials, structural design of rigid and flexible pavements: bituminous pavements, base courses, concrete pavements. Pre-req: CVLE 263 and CVLE 333

**CVLE 482 CONTRACTS, QUANTITIES AND SPECIFICATIONS (3Crs: 3Lec)**

Structure of the construction documents and their inter-relationships, building requirements, General and particular contract conditions, Areas and methods of measurement used in engineering projects. Quality measurements and schedules, specifications for constructions. Cost analysis and estimation.

**CVLE 500 RESEARCH METHODOLOGY (2Crs.:2Lec):**

Steps for conducting a successful research: formulating a research problem, conceptualizing a research design, constructing an instrument for data collection, writing a research proposal, collecting data, processing and displaying data, writing a research report. Pre-req.: ENGL300.

**CVLE 501 FINAL YEAR PROJECT I (1Cr) / CVLE 502 FINAL YEAR PROJECT II (3Crs)**

After completing 110 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters; beginning in Fall-semester (Pre-req.: ENGL300) and ending in the following Spring-semester (Pre-req. CVLE500). The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student creativity and critical thinking, and build skills in formulating, designing, developing, building, communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world.

**CVLE 499 INTERNSHIP (1Cr)**

This is a professional training which should not be less than four weeks. The training is followed by a presentation session where the students are supposed to present what they have learned.

**C. Civil Engineering Technical Electives**

The CE curriculum includes three 3-credit hour courses as technical electives. The courses are chosen from the courses listed in the table below, with their descriptions given thereafter.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| CVLE 510 | Non-Destructive Concrete Testing | 3 | Pre: CVLE 222 |
| CVLE 511 | Photogrammetry and Geodesy | 3 | Pre: CVLE 261 |

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|---|---|---|---|
| CVLE 512 | Advanced Surveying | 3 | Pre: CVLE 261 |
| CVLE 513 | Computer Application for Surveying | 3 | Pre: CVLE 261 |
| CVLE 514 | Advanced Structural Analysis | 3 | Pre: CVLE 214 |
| CVLE 515 | Advanced Mechanics of Materials | 3 | Pre. CVLE 325 |
| CVLE 516 | Inelastic Analysis of Structure | 3 | Pre: CVLE 214 |
| CVLE 517 | Earthquake Engineering | 3 | Pre: CVLE 213 |
| CVLE 518 | Materials Technology | 3 | Pre: CVLE 222 |
| CVLE 520 | Structural Modeling of Buildings | 3 | Pre: CVLE 372 |
| CVLE 521 | Steel Bridges | 3 | Pre: CVLE 426 |
| CVLE 522 | Reinforced Concrete Bridges | 3 | Pre: CVLE 324 |
| CVLE 523 | Advanced Reinforced Concrete | 3 | Pre: CVLE 324 |
| CVLE 524 | Tall Building Structure | 3 | Pre: CVLE 324 |
| CVLE 525 | Pre-Stressed Concrete Structure | 3 | Pre: CVLE 323 |
| CVLE 526 | Design with Geosynthethics | 3 | Pre: CVLE 432 |
| CVLE 527 | Retaining Structures | 3 | Pre: CVLE 432 |
| CVLE 528 | Soil and Site Improvement | 3 | Pre: CVLE 333 |
| CVLE 529 | Feasibility Study and Marketing | 3 | |
| CVLE 530 | Railway Engineering | 3 | Pre: CVLE 263 |
| CVLE 531 | Harbor Engineering | 3 | Pre: CVLE 432 |
| CVLE 532 | Road Traffic Safety | 3 | Pre. CVLE 263 |
| CVLE 533 | Pavement Analysis and Design | 3 | Pre. CVLE 464 |
| CVLE 534 | Advanced Highway Engineering | 3 | Pre: CVLE 464 |
| CVLE 535 | Airports Engineering | 3 | Pre: CVLE 464 |
| CVLE 536 | HMA for Highways and Airports | 3 | Pre. CVLE 464 |
| CVLE 537 | Irrigation and Drainage Engineering | 3 | Pre: CVLE 441 |
| CVLE 538 | Hydraulic Structures | 3 | Pre: CVLE 342 |
| CVLE 539 | Hydraulic and Hydrologic Modeling | 3 | Pre: CVLE 441 |
| CVLE 540 | Public Transport Systems | 3 | Pre. CVLE 263 |
| CVLE 541 | Water Treatment and Water Desalination | 3 | Pre. CVLE 453 |
| CVLE 542 | Water and Wastewater Treatment | 3 | Pre: CVLE 342 and CVLE 453 |
| CVLE 543 | Water and Wastewater Network | 3 | Pre: CVLE 342 |
| CVLE 546 | Environmental Process Engineering | 3 | Pre: CVLE 354 |

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|---|---|---|---|
| CVLE 561 | Building Construction and Safety | 3 | Pre. CVLE 211 |
| CVLE 563 | Engineering Statistics | 3 | Pre. MATH 381 |
| CVLE 564 | Quality Control in Concrete Construction | 3 | Pre. CVLE 222 |
| CVLE 565 | Materials Technology | 3 | Pre. CVLE 325 |
| CVLE 566 | Introduction to Finite Elements | 3 | Pre. CVLE 214 |
| CVLE 567 | Advanced RC Structures | 3 | Pre. CVLE 324 |
| CVLE 581 | Mechanical for Civil Engineers | 3 | |
| CVLE 582 | Electrical for Civil Engineers | 3 | |

**Description of Technical Elective Courses**

**Elective Courses - Structural Sequence**

**CVLE 510 NON-DESTRUCTIVE CONCRETE TESTING (3Crs.:3Lec)**

Types, calibration and maintenance. Analysis of fresh concrete. Accelerated testing methods. Analysis of hardened concrete. Core drilling and testing. Partially destructive testing. Non-destructive testing. Load testing. Assessment of reinforcement condition. Standards, Specifications and Code of Practice of existing documents relevant to preceding items and discussion of their relevance. Pre-req: CVLE 222.

**CVLE 514 ADVANCED STRUCTURAL ANALYSIS (3Crs.:3Lec)**

Force and Displacement Methods for analysis of indeterminate structures. Flexibility and Stiffness matrix method for analysis of indeterminate trusses, beams, and frames. Grid beams and structures on elastic supports. Influence lines of indeterminate structure utilizing concepts of virtual work and moment distribution methods – Qualitative and Quantitative approaches. Pre-req: CVLE 214.

**CIVE 515 ADVANCED MECHANICS OF MATERIALS. (3Cr.: 3Lec).**

Stresses and strain analysis, elaso-plastic analysis, buckling of columns, strain energy method, shear flow and shear center, impact loads, deflection of beams, fracture mechanics: crack initiation and propagation. Fatigue of metals. Pre-req: CVLE 325

**CVLE 516 INELASTIC ANALYSIS OF STRUCTURE (3Crs.:3Lec,)**

Plastic analysis: concept of plastic analysis, plastic hinges, incremental load method (step by step), mechanism method, upper bound, lower bound, and uniqueness theorems, combined mechanisms, beams, multistory, multiply and gable frames, computer implementation. Pre-req: CVLE 214.

**CVLE 517 EARTHQUAKE ENGINEERING (3Crs.:3Lec,)**

Earthquake causes and measures, earthquake faults and waves, plate tectonics, structural dynamics of single and multi-degree of freedom systems, dynamic response spectra, equivalent static lateral force method, lateral loads resistive systems, mitigation of earthquake forces. Pre-req: CVLE 213.

**CVLE 518 MATERIALS TECHNOLOGY (3Crs.:3Lec,)**
Theory of composites: Micro-composite and Macro–composite, Engineering applications of fibers, Design of Composite sections, Nonlinear analysis, Fracture Mechanics: crack initiation and propagation. Pre-req: CVLE 222.

**CVLE 520 STRUCTURAL MODELING OF BUILDINGS (3Crs.:3Lec,)**
The course include the modeling technique for the numerical structural analysis of building with a review of the basic Structural systems in buildings, the loadings (Gravity, Lateral, temperature, settlement…..), the modeling of space truss structures, of building skeletons, of slabs and shear walls of walls and deep beams as pier and spandrel. Pre-req: CVLE 372.

**CVLE 521 STEEL BRIDGES (3Crs.:3Lec)**
Types of Steel Bridges – Loads – Bracing Systems – Multi-Span Roadway and Railway Bridges – Composite Construction of Girder- Slab Bridges. Design of splices and bearings. Design of Truss Bridges and Arched Bridges. Specifications and Detailing. Pre-req: CVLE 426.

**CVLE 522 REINFORCED CONCRETE BRIDGES (3Crs.:3Lec,)**
Introduction, types of bridges, and loads, slab type hollow-type bridges, box-type bridges, girder type bridges, bearing pads, code requirements, detailing applications. Pre-req: CVLE 422.

**CVLE 523 ADVANCED RC STRUCTURES (3Crs:3Lec)**
Design of framed structures, hinges, corbels and brackets, beam ledges, and shear friction, slender columns, biaxial bending, reinforced concrete stairs, water tightness, applications: ground, underground and elevated tanks, deep beams, circular beams, code requirements. Detailing. Pre-req: CVLE 324

**CVLE 524 TALL BUILDING STRUCTURE (3Crs.:3Lec,)**
Introduction, types of structural resisting systems, structural walls, cantilever columns, rigid frames, dual systems, code requirements, detailing. Pre-req: CVLE 324.

**CVLE 525 PRE-STRESSED CONCRETE STRUCTURE (3Crs.:3Lec,)**
Definitions, methods of prestressing, materials and their properties, losses of prestress, elastic behavior and stress distribution under different load stages, analysis and design of homogeneous sections, care of simply supported members. Pre-req: CVLE 323.

**CVLE 561 BUILDING CONSTRUCTION AND SAFETY (3Crs.:3Lec)**
Building process and frameworks, foundation, concrete, masonry, and metals. Roof types and decks. Thermal, aqoustical, and moisture protection. Doors and windows. Finishes. Construction safety, engineering principles to control hazards, maintaining optimally safe systems, applications of engineering principles to process safety and hazards analysis, mitigation, and prevention. Pre-req. CVLE 211

**CVLE 566 INTRODUCTION TO FINITE ELEMENTS: (3Crs.:3Lec)**

Review of matrix Algebra, 1-dimensional elements, basic elements: interpolation and shape function formulation techniques: variational methods, Galerkin and weighted residual methods, isoparametric elements, numerical integration, finite element in structure dynamics, use of FE software. Pre-req. CVLE 214

**CVLE 567 Advanced RC Structures (3Crs.:3Lec,0Lab)**

Design of framed structures, hinges, corbels and brackets, beam ledges, and shear friction, slender columns, biaxial bending, reinforced concrete stairs, water tightness, applications: ground, underground and elevated tanks, deep beams, circular beams, code requirements. Detailing. Pre-req: CVLE 324.

**CVLE 581 MECHANICAL ENGINEERING, (3Cr.: 3Lec).**

Water supply for buildings (rise and pumping system), heat losses and thermal insulation, ventilation, sound insulation.., and air conditioning. Lifts and escalators. Soil and waste systems for buildings (sump-pump).

**CVLE 582 ELECTRICAL ENGINEERING, (3Cr.: 3Lec)**

Direct-current circuits. Alternating current circuits. Wiring specifications. Building connection diagrams. Switching boards. Protective devices. Motors: types, use, connections, power, and energy calculations. Power factor improvement and electrical consumption Cables: types and selections.

**Elective Courses - Geotechnical Sequence**

**CVLE 526 DESIGN WITH GEOSYNTHETICS (3Crs.:3Lec,)**

Overview on geosynthetic products: geotextiles, geogrids, geonets, geomembranes and geocomposites; physical, mechanical, hydraulic and environmental properties. Functions: separation, reinforcement, filtration, and drainage. Applications: unpaved and paved roads, reinforced-earth walls, embankments, foundations, slope stabilization, drainage behind retaining walls, erosion control, landfill liners and caps, earth dams, and wick drains. Construction methods, techniques, and specifications. Computer applications. Pre-req: CVLE 432.

**CVLE 527 RETAINING STRUCTURES (3Crs.:3Lec)**

Lateral earth pressures: at rest, active and passive states, limit equilibrium methods and theory of elasticity, seismic conditions, hydrostatic and seepage pressures. Retaining walls: design of gravity, cantilever, and basement walls. Sheet-piles: cantilever and anchored bulkheads, free- and fixed-earth support methods, moment reduction, anchorage design. Braced cuts: pressure envelopes, design of sheeting, wale beams and struts, stability against bottom heave or piping. Shoring systems: types, control of groundwater, construction stages, anchors prestressing and testing, ground settlement around excavations. Code requirements, computer applications. Pre-req: CVLE 432.

**CVLE 528 SOIL AND SITE IMPROVEMENT (3Crs.:3Lec)**
Mechanical methods: compaction theory, properties of compacted soils, laboratory tests, field equipment, compaction specifications and control, dynamic compaction, vibroflotation, blasting techniques. Hydraulic methods: theory of wells, dewatering systems, drainage of slopes, preloading and use of vertical sand/wick drains. Physical and chemical methods: granular admixtures, Portland cement, lime, calcium chloride, fly ash, bitumen, grouting materials and techniques. Inclusion methods: reinforced earth with steel strips or geosynthetics, soil nails and rock bolts. Laboratory and computer applications. Pre-req: CVLE 333.

**CVLE 564 QUALITY CONTROL IN CONCRETE CONSTRUCTION (3Crs.:3Lec)**
Guides for Quality Management System, Quality Assurance, Quality Control Procedure, Evaluation of Strength, Inspection of Ready Mix Plant, Standard Specifications for Ready Mix Plant, Site Investigation, Assessment of Existing Structures. Pre-req: CVLE 222

**CVLE 565 MATERIALS TECHNOLOGY (3Crs.:3Lec):**
Theory of composites: Micro-composite and Macro–composite, Engineering applications of fibers, Composite Materials, Design of Composite sections, Nonlinear analysis,. Pre-req: CVLE 325.

**Elective Courses - Environmental and Water Resources Sequence**

**CVLE 537 IRRIGATION AND DRAINAGE ENGINEERING (3Crs.:3Lec)**
Irrigation: planning and design of canals networks, field irrigations, sprinkler irrigation system, drip irrigation system, drainage: importance of drainage, open drainage design and planning, tile drainage design and planning, canal lining design. Pre-req: CVLE 441.

**CVLE 538 HYDRAULIC STRUCTURES (3Crs.:3Lec.)**
Hydraulic and structural design of drainage structures, design of dams, environmental considerations, design of pumping stations, design of control structures, design of drop structures, applications. Pre-req: CVLE 342

**CVLE 539 HYDRAULIC AND HYDROLOGIC MODELING (3Crs.:3Lec,)**
Hydraulic modeling: Physical modeling, numerical modeling, hydrologic modeling, application of deterministic and probabilistic concept to simulate and analyze hydrologic systems; discussion of the theory and application of linear and non-linear, lumped, and distributed systems techniques in modeling the various phases of the hydrologic cycle. Pre-req: CVLE 441.

**CVLE 541 WATER TREATMENT AND WATER DESALINATION, (3Crs.:3Lec)**
Physical, chemical and biological water quality parameters determinations and standards; water treatment units: screens; sedimentation, coagulation/flocculation processes, filtration, and disinfection. This course will also survey the commonly used thermal and membrane based desalination technologies. Environmental, sustainability and economic factors which may influence the performance, affordability and more wide-spread use of desalination systems for fresh water production and reuse will be highlighted. Pre-req. CVLE 453

**CVLE 542 WATER AND WASTE WATER TREATEMENT (3Crs.:3Lec)**
Water networks quality of raw water, intakes, pumping raw water to treatment plant, plain and chemical sedimentation, filtration, disinfection, ground tank, characteristics of wastewater, aerobic and anaerobic processes-preliminary, primary and tertiary treatment-biological filtration, activated sludge-oxidation ditches, stabilization ponds-aerated, lagoons-sludge treatment and Re-use. Pre-req: CVLE 342 and CVLE 453.

**CVLE 543 WATER AND WASTE WATER NETWORKS (3Crs.:3Lec)**
Storage of water, ground and elevated storage, equalization between consumption rates and storage, high lift pumps, distribution network (pipe lines, valves, connections, and hydrants), construction and maintenance of collection works.(Domestic, storm, industrial and filtration wastewater), design of collection gravity systems, sewer appurtenances, safety of maintenance of collection works, pumping wastewater to treatment and recycle locations. Pre-req: CVLE 342

**CVLE 546 ENVIRONMENTAL PROCESS ENGINEERING (3Crs.:3Lec)**
An introduction to analysis, characterization, and modeling of environmental, physical, chemical, and biological processes and reactor configurations commonly used for water quality control; applications to the development and design of specific water and wastewater treatment operations; discussion of economic and legislative constraints and requirements. Pre-req: CVLE 354

**Elective Courses - Transportation Sequence**

**CVLE 511 PHOTOGRAMMETRY AND GEODESY (3Crs.:3Lec,)**
Principles of photography, types of photographs, aerial cameras, vertical photographs: scale, ground coordinates, relief displacement, project planning: end and side lap-flying height, ground coverage, and flight map-stereoscopic viewing, figure of the earth, geodetic coordinates system, theory of errors, methods of least squares, triangulation network, trilateration network, types of conditions, adjustment network. Pre-req: CVLE 261.

**CVLE 512 ADVANCED SURVEYING (3Crs.:3Lec,)**
Astronomical observations for geodesy, Surveying by total station. Positioning by intersection and resection: with angles and with distances. Trilateration system. Adjustment of trilateration network. Adjustment by variation of coordinates. The use of laser beam in surveying. Global positioning system GPS. Pre-req: CVLE 261.

**CVLE 513 COMPUTER APPLICATION FOR SURVEYING (3Crs.:3Lec)**
Route surveying and geometric design, topographic site surveys and mapping, civil engineering and construction surveys, layout of industrial plants, building, pipelines and manufacturing machinery, horizontal curves ,circular curve layout by different methods, special circular curve problems, compound and reverse curves, vertical curves. General software for surveying: CivilCad, SURFER, SDR, software for GPS surveying. Pre-req: CVLE 261.

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**CVLE 530 RAILWAY ENGINEERING (3Crs.:3Lec,)**
Train dynamics (Tractive Effort, Train Resistances, Ruling Gradient, Acceleration and Deceleration, Braking and Stopping distances), Design of Railway tracks (Subgrade, Ballast Section, Sleepers, Rails, fastenings and rail joints, Stresses in Track Components), Track alignment (Cant - Transition Curves - Longitudinal and Cross sections, Track junctions (turnouts- crossings- crossover- double cross over- slips, planning dimensions of track junctions), Stations (passenger stations- freight stations- planning of marshalling yards- locomotive and wagons yards), Control of Train Movement and Signaling (types of Signaling systems- Mechanical and Electrical signaling systems- automatic block sections- green wave). Pre-req: CVLE 263.

**CVLE 531 HARBOR ENGINEERING (3Crs.:3Lec,)**
Theory of Waves, wave refraction and diffraction, wave forces on vertical walls, Port Planning, water and land areas, breakwaters, temporary and fixed breakwaters, submerged and ruble mound breakwaters, wall breakwaters composite breakwaters, gravity quay walls, plain concrete blocks Quay walls, cantilever and anchored sheet piles, Marine platforms supported by group piles. Pre-req: CVLE 432.

**CVLE 535 AIRPORTS ENGINEERING (3Crs.:3Lec,)**
Principles of Airport Planning, Components of Airports (airside, landside), Aircraft characteristics, Airport operations, Airport System planning, Site selection, Land use, Airport terminal area and airport access, Airport Capacity and delays, Airport geometric design (Runways, Taxiways, Aprons), Safety Surfaces (Obstacle limitation surfaces: approach, take-off, transition, conical, horizontal), Airport pavement (types, design, construction). Pre-req: CVLE 464.

**CVLE 532 ROAD TRAFFIC SAFETY (3Crs.:3Lec,)**
The course is intended to introduce topics in traffic safety. Included will be information on how to understand and utilize crash data, safety analysis methods described in the Highway Safety Manual, statistical methods in safety analysis, human factors and crash causality, and an overview of other emerging safety issues and resources. Pre-req: CVLE 263.

**CVLE 536 HMA FOR HIGHWAYS AND AIRPORTS (3Crs.:3Lec,)**
The course covers the origin, production, specifications, properties, and characterization of various material constituents incorporated in the construction of highway and parking pavements. It covers the practices and techniques used in evaluation of asphalt binders, aggregates, and mixtures with emphasis on different approaches for asphalt mix designs. Quality control, material production, and construction technologies will be described.. Pre-req: CVLE 464.

**CVLE 533 PAVEMENT ANALYSIS AND DESIGN : (3Crs.:3Lec0)**
The course introduces the concepts of analysis, behavior, performance, and structural design of flexible and rigid pavements for highways and airports. It covers pavement performance, stress in pavements, pavement behavior under moving loads, traffic

loading analysis, types of materials used in pavement layers, climatic factors, drainage, and an introduction to pavement management concepts. The course covers both empirical and mechanistic-empirical design methodologies. Pre-req: CVLE 464.

**CVLE 563 ENGINEERING STATISTICS: (3Crs.:3Lec,)**
Role of statistics in engineering with the fundamental ideas and techniques of statistical analysis and regression in reference to decision taking in engineering applications. Methodology required for efficiently plan, conduct, present, analyze, and interpret the results from experimental and observational studies. Tools required for dealing with the uncertainties present in making interferences and decisions based on sample data. The covered topics descriptive statistics, distributions, hypothesis testing, regression models, and non-parametric tests. . Pre-req: MATH 381.

**CVLE 540 PUBLIC TRANSPORT SYSTEMS: (3Crs.:3Lec,)**
Evolution and role of urban public transportation modes, systems and services. Technical characteristics and their impacts on capacity, service quality, and cost. Current practice and new methods for data collection and analysis. Performance evaluation, route and network design, frequency determination. Effects of pricing policy and service quality on ridership, methods for estimating costs associated with proposed service changes, organizational models for delivering public transportation service including finance and operations, fare policy and technology, operations management. Pre-req: CVLE 263.

**Elective Courses - Construction Management Sequence**

**CVLE 529 FEASIBILITY STUDY AND MARKETING (3Crs.:3Lec)**
Economics: cost nature and concepts, cost definition, material, labor cost, factory overhead, direct cost, indirect cost, variable cost, fixed cost, semi-variable semi-fixed cost, differential and increment cost, and opportunity cost, cost measurement and equations, cost reports, profits, consumption, risk, financial institutions, long-term contract, Labor's law, Insurance.

**D.Internship (Approved Experience/ Independent Study)**

This is a professional training which should not be less than four weeks. The training is followed by a presentation session where the students are supposed to present what they have learned.
Refer to the department policy for further details.

**E.Final Year Project**

After completing 110 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters. The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student creativity and critical thinking, and build skills in formulating, designing, developing, building, communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world.
Refer to the Final Year Project Policy for more details.

## Study Plan

**Bachelor of Engineering in Civil and Enviromental Engineering(150 Credits)**

| First Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CVLE | 210 | Statics | 3 | |
| MATH | 281 | Linear Algebra | 3 | Pre: MATH112 |
| PHYS | 282 | Material Properties and Heat | 3 | |
| MCHE | 201 | Engineering Drawing and Graphics | 3 | |
| INME | 221 | Engineering Economy | 3 | |
| ENGR | 002 | Introduaction to Engineering | 2 | |
| BLAW | 001 | Human Rights | 1 | |

| Second Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CVLE | 211 | Mechanics of Materials | 3 | Pre: CVLE 210 |
| CVLE | 260 | Engineering Surveying I | 2 | |
| CVLE | 270 | Civil Engineering Drawing and Detailing | 2 | Pre: MCHE 201 |
| CHEM | 207 | Environmental Chemistry | 2 | Pre: CHEM110 |
| MATH | 282 | Calculus | 3 | Pre:MATH111 |
| PHYS | 281 | Electricity and Magnetism | 3 | Pre:PHYS120 |
| COMP | 208 | Programming I | 3 | |

| Summer I (8 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ENGL | 001 | English Language | 2 | Pre: Int Eng 4 |
| ARAB | 001 | Arabic Language | 2 | |
| GENE | xxx | General Electives | 4 | |

| Third Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CVLE | 213 | Structures I | 3 | Pre: CVLE 211 |
| CVLE | 231 | Engineering Geology | 2 | |
| CVLE | 261 | Engineering Surveying II | 2 | Pre: CVLE 260 |
| CVLE | 263 | Transportation and Traffic Engineering | 3 | |
| CVLE | 341 | Hydraulics I | 3 | |
| MATH | 283 | Differential Equations | 3 | Pre: MATH 281 and MATH 282 |
| ENGL | 211 | Advanced Writing | 2 | Pre: ENGL 001 |

| Fourth Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CVLE | 214 | Structures II | 3 | Pre: CVLE 213 |
| CVLE | 222 | Construction Materials I | 3 | Pre: CVLE 211 |
| CVLE | 342 | Hydraulics II | 3 | Pre: CVLE 341 |
| MATH | 284 | Numerical Analysis | 3 | Pre: MATH 283 |
| CHEM | 241 | Principles of Chemistry | 3 | |
| ENGL | 300 | Speech Communications | 2 | Pre: ENGL 211 |

| Summer II (6 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MGMT | 002 | Enterpreneurship I | 2 | |
| GENE | xxx | General Electives | 4 | |

| Fifth Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CVLE | 325 | Construction Materials II | 3 | Pre: CVLE 222 |
| CVLE | 323 | RC Structures I | 3 | Pre: CVLE 213 |
| CVLE | 333 | Soil Mechanics | 3 | Pre: CVLE 211 and CVLE 231 |
| CVLE | 425 | Steel I | 3 | Pre: CVLE 213 |
| CVLE | 441 | Hydrology | 2 | Pre: CVLE 342 |
| MATH | 381 | Probability and Statistics | 3 | Pre: MATH 282 |

| Sixth Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CVLE | 324 | RC Structures II | 3 | Pre: CVLE 323 |
| CVLE | 354 | Environmental Engineering | 2 | Pre: CHEM 207 |
| CVLE | 372 | Structural Modeling | 2 | Pre: CVLE 213 |
| CVLE | 426 | Steel II | 3 | Pre: CVLE 425 |
| CVLE | 432 | Foundation Engineering | 3 | Pre: CVLE 323 and CVLE 333 |
| CVLE | 464 | Highway Engineering | 3 | Pre: CVLE 263 and CVLE 333 |

| Summer III (0 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| | | Practical Training | | |

| Seventh Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CVLE | 501 | Final Year Project I | 1 | Pre: ENGL 300 |
| CVLE | 427 | Building Information and Modeling | 3 | Pre: CVLE 324 |
| CVLE | 453 | Sanitary Engineering | 3 | Pre: CVLE 354 |
| CVLE | 499 | Internship (Approved Experience / Independent Study) | 1 | |
| CVLE | 500 | Research Methodology | 2 | Pre: ENGL 300 |
| CVLE | xxx | Technical Electives | 6 | |

| Eighth Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CVLE | 502 | Final Year Project II | 3 | Pre: CVLE 501 |
| CVLE | 482 | Contracts, Quantities and Specifications | 3 | |
| CVLE | xxx | Technical Electives | 6 | |
| INME | 423 | Project Planning and Management | 3 | |
| ENGR | 001 | Engineering Ethics | 1 | (Completed 90 crds) |

[1] Selected from any Engineering program offered courses (as per restriction indicated in footnote (3) below).
[2] Must have completed 110 Credits including ENGL 300 in order to take a department technical elective or Final Year Project.

## Courses offered for other majors only

The Civil and Environmental Engineering Department offers four courses for other engineering majors. These courses are described below.

**CVLE 201 THEORY OF STRUCTURES FOR ARCHITECTS (2Crs.:1Lec,2Lab)**
Theory and concepts of structures to emphasize an intuitive comprehension of the fundamental principles of structural behavior including loading, shear and bending moments. Calculation of internal forces in simple structures such as cantilevers, simples beams, and overhanging beams. Calculation of internal forces in truss members.

**CVLE 202 SURVEYING FOR ARCHITECTS (2Crs.:1Lec,2Lab)**
Technology discussion of the major topics in surveying engineering technology including field instrumentation, boundary surveying, topographic surveying. Measurement of distances, directions and angles, using the tape, level, compass, transit and theodlit. Computation of areas and traverses, lines and grades. Introduction to construction surveys, and an introduction to GPS measurement.

**CVLE 301 CONCRETE AND STEEL STRUCTURES (2Crs.:1Lec,2Lab):**

Combined course addressing two technical fields:

• Review of concrete and steel structure systems. Reinforced concrete fundamentals, reviewing basics of reinforced concrete behavior and introducing methods of design used in current engineering practice. Basic mechanics of structural concrete introduced in examining bending, shear, and axial forces. Topic areas including beams, slab systems, columns, foundations, retaining walls, and an introduction to pre-stressed concrete.

• Review of statics and strengths of materials, review of tension, compression and bending steel members. Design of trusses, columns, and beams structural elements.

**CVLE 303 SOIL MECHANICS AND FOUNDATIONS, AND TESTING AND PROPERTIES OF MATERIALS (2Crs.:1Lec,2Lab):**

Combined course addressing two technical fields:

• Introduction to soil mechanics: Soil formation and soil structure; soil composition; grain size analysis; plasticity of soils; effective stress concept; shear strength, stress distribution; bearing capacity of shallow foundation; theory of consolidation; settlement; soil exploration. Foundations: shallow, deep foundations, and pile caps.

• Introduction to testing and properties of materials: strength characteristics of building materials and material assemblies; stresses and strains; rigidity and deformation; temperature effects; torsion effects; combined loading of elements and systems.

## DEPARTMENT OF ELECTRICAL and COMPUTER ENGINEERING

| | |
|---|---|
| **Chairperson** | Ziad Osman |
| **Professors** | Soubhi Abou Chahine, Ali Haidar, |
| **Associate Professors** | Hamza Issa, Mohamad Tarnini, Wassim Itani, Chadi Nohra |
| **Assistant Professors** | Rola Kassem, Nabil Abdel Karim, Hiba Abdallah, Khaled Chahine Hilal El Misilmani, Ahmad El Hajj, Youmni Ziadeh, Bilal Youssef Abdul Rahman El Falou |

## Communications and Electronics Engineering Program

### Mission

The educational mission of Communications and Electronics Engineering (CEE) Program is to deliver high quality undergraduate education which combines balanced theoretical and practical topics in Communications and Electronics Engineering. Graduates of the program will have a mastery of fundamental knowledge in a variety of Communications and Electronics Engineering fields, management, and entrepreneurial skills. Graduates will be qualified to pursue successful careers in their profession or graduate studies in different areas.

### Objectives

The educational objectives of the program are determined to support career advancement of the graduates as they pursue their career goals. The graduates will:

1.Design, optimize and maintain communication systems in tune with community needs and environmental concerns
2.Be able to develop and integrate new technologies as they emerge
3.Engage in a technical/managerial role in diverse teams
4.Pursue entrepreneurial initiatives and launch startup companies
5.Communicate effectively and use resources skillfully in projects development

### Learning Outcomes

UPON COMPLETION OF THE PROGRAM GRADUATES SHALL HAVE:

a.An ability to apply knowledge of mathematics, science, and engineering
b. An ability to design and conduct experiments, as well as to analyze and interpret data
c.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
d.An ability to function on multi-disciplinary teams
e.An ability to identify, formulate, and solve engineering problems
f.An understanding of professional and ethical responsibility
g.An ability to communicate effectively
h.The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i.A recognition of the need for, and an ability to engage in life-long learning
j.A knowledge of contemporary issues
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

## Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Communications and Electronics Engineering consists of 150 credit-hours of course work + ICDL, where the standard duration of study is 10 semesters.

## Career opportunities

The Communications and Electronics Career Field encompasses the functions of installing, modifying, maintaining, repairing, and overhauling ground television, telephone and mobile equipment, ground weather equipment, air traffic control, aircraft control and warning, automatic tracking radar equipment, simulator and training systems, microwave, fixed and mobile radio equipment, space communications systems equipment, high-speed general and special purpose data processing equipment, automatic communications and cryptographic machine system, electromechanical equipment, and electronic equipment associated to all the previous mentioned systems. Most of these applications find place in several companies in Lebanon, the Arab world and the whole world in general, providing, hence, the possibility for the CEE program students to find jobs in the field they like most and almost everywhere in the world.

## Program Overview

The Student's Study Plan is given to every CEE student upon his/her enrollment. The CEE curriculum consists of the following components:

| **I. Common Requirements** | **Credits** |
|---|---|
| General Education Requirements | 20 |
| Basic Sciences and Mathematics | 26 |
| General Engineering topics | 12 |
| **II. BME Program-Specific Requirements** | **Credits** |
| A. Engineering topics from outside the program | 21 |
| B. CEE Core | 54 |
| C. CEE Technical Electives | 12 |
| D. Final Year Project | 4 |
| E. Internship | 1 |

**I. Common Requirements**

The list of the Common Requirement courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog.

**II.CEE Program-Specific Requirements**

**A. Engineering Topics from outside the major**

This part of the CEE curriculum includes 21-credits courses offered by other engineering programs. These courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| COMP 210 | Programming II | 3 | Pre: COMP 208 |
| COMP 225 | Digital Systems I | 3 | |
| COMP 226 | Digital Systems II | 3 | COMP 225 |
| COMP 328 | CPU Design | 3 | COMP 226 |
| COMP 426 | Microprocessor Interfacing | 3 | COMP 328 |
| POWE 212 | Electric Circuits I | 3 | |
| POWE 271 | Electromagnetic Fundamentals | 3 | Pre: PHYS 281 |

**Descriptions of this group of courses are given below:**

**COMP 210 PROGRAMMING II (3Crs.: 2Lec, 2Lab)**

Recursion. Arrays, sorting and searching. Pointers. Functions (call by reference). Character and strings. Structures, union, and bit manipulation. File operations, sequential and random. Preprocessing directives. Pre-requisite.: COMP 208.

**COMP 225 DIGITAL SYSTEMS I (3Crs.: 2Lec,2Lab)**

Number systems and coding, Binary systems. Conversion from decimal to other bases. BCD numbers. Boolean algebra. Logic gates. Function minimization, Tabular method, Karnaugh mapping. Arithmetic functions and circuits designs (HA, FA, and ALU). Combinational functions and circuits design (decoder, encoder, multiplexer and de-multiplexer). Sequential circuits definitions and designs (Latches, RS-FF, D-FF, JK-FF, T-FF). Several laboratory experiments will be based on the simple logic gates.

**COMP 226 DIGITAL SYSTEMS II (3Crs.: 2Lec,2Lab)**

Latches and flip-flops. Synchronous and Asynchronous sequential systems. Registers and Counters. Control and Data path units. Serial data transfer for multiple register. Types of RAM and ROM. Cache concept. ALU functions and circuits (addition, subtraction, increment, decrement, transfer, AND, OR, XOR, NOT, etc.). Binary multiplier. BCD functions and circuits. Flags. Control unit. None binary logic. Several laboratory experiments and projects will be based on the simple logic gates to design micro-digital systems. Pre-req.: COMP 225.

**COMP 328 CPU DESIGN (3Crs.:2Lec,2Lab)**

This course introduces the design of a generic central processing unit (CPU), focusing on its role as the core of computer systems. Topics include arithmetic logic unit design, control unit design, registers, address, data, and control buses, with reference to standard implementations. Single and multi-core processors. Machine and assembly languages of a standard microprocessor are used to illustrate the design and its interface

with upper layers such as operating systems, control drivers, and compilers. Several laboratory experiments will be based on microcontrollers. Pre-requisite.: COMP 226.

**COMP 426 MICROPROCESSOR INTERFACING (3Crs.: 2Lec,2Lab)**

Topics include assembly language programming, microprocessor software applications, PPI and interfacing techniques: I/O port design and handshaking protocols; I/O programming, I/O interface design, Direct Memory Access, data communications, interrupt control systems; parallel and serial interfaces; timers. Several laboratory experiments will be based on microprocessors and/or microcontrollers. Pre-requisite: COMP 328.

**POWE 212 ELECTRIC CIRCUITS I (3Crs.: 3Lec,0Lab)**

Circuit variables: voltage, current, power, and energy. Circuit elements: resistors, inductors, capacitors, voltage sources, and current sources. Circuit reduction techniques: series and parallel resistors and delta-to-wye transformation. Ohm's law. Kirchhoff's laws. DC and AC circuit analysis techniques: node-voltage and mesh-current methods, source transformations, Thévenin and Norton equivalent circuits, and maximum power transfer. Self and mutual inductances. AC steady-state power calculations. Balanced three-phase circuits.

**POWE 271 ELECTROMAGNETIC FUNDAMENTALS (3Crs.: 3Lec,0Lab)**

Three-dimensional orthogonal coordinate systems: Cartesian, Cylindrical and Spherical. Vector Analysis: Gradient, Divergence and Curl of fields, Divergence theorem, Stokes's theorem. Fundamental Postulates of Electrostatics in free space, Coulomb's Law in space, Gauss's Law in space. Material Media: Conductors and Dielectrics, Polarization, Electric Flux Density. Boundary Conditions. Capacitors and Electrostatic Energy. Poisson's Equation, Laplace's Equation, Method of Images, Boundary Value Problems, Steady Electric Currents: conduction and convection currents, equation of continuity, boundary conditions for current density. Resistance and Power calculations. Fundamental Postulates of Magnetostatics in free space, Biot-Savart law in space, Ampere's Law in space. Magnetic materials: Magnetization, Inductance and Magnetostatic Energy. Magnetic circuit analysis. Introduction to Magnetic Forces and Torques. Time varying fields: Faraday's Law for Electromagnetic Induction (stationary circuit in a time-varying magnetic field, Transformers, moving circuit in steady and time-varying magnetic fields), Maxwell's Equations, Electromagnetic boundary conditions. Pre-requisite.: PHYS 281.

**B.Communications and Electronics Engineering Program Core**

The CEE program core courses are listed in the table below:

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| ENGR 002 | Introduction to Engineering | 2 | |
| COME 214 | Electric Circuits II | 3 | Pre: POWE 212 |
| COME 212L | Electric Circuits Lab | 1 | Co: COME 214 |
| COME 221 | Electronic Circuits I | 3 | Pre: POWE 212 |

| | | | |
|---|---|---|---|
| COME 222 | Electronic Circuits II | 3 | Pre: COME 221 |
| COME 222L | Electronic Circuits Lab | 1 | Co: COME 222 |
| COME 372 | Propagation and Antennas I | 4 | Pre: POWE 271 |
| COME 381 | Signals and Systems | 3 | |
| COME 380 | Communication Theory and Systems I | 3 | Pre: COME 381, MATH 381 |
| COME 384 | Digital Signal Processing | 3 | Pre: COME 381 |
| COME 411 | Instrumentation | 3 | Pre: COME 222 |
| COME 473 | Propagation and Antennas II | 3 | Pre: COME 372 |
| COME 473L | Propagation and Antennas Lab | 1 | Co: COME 473 |
| COME 472 | Microwave Engineering | 3 | Pre: COME 372 |
| COME 485 | Communication Theory and Systems II | 3 | Pre: COME 380 |
| COME 485L | Communication Lab | 1 | Co: COME 485 |
| COME 500 | Research Methodology | 2 | Pre: ENGL 300 |
| COME 576 | Optical Communications | 3 | Pre: POWE 271 |
| COME 573L | Microwave Lab | 1 | Pre: COME 472 |
| COME 580 | Communication Networks | 3 | Pre: COME 485 |
| COME 580L | Communication Networks Lab | 1 | Co: COME 580 |
| COME 588 | Wireless Communications | 3 | Pre: COME 485 |
| COME 588L | Wireless Communications Lab | 1 | Co: COME 588 |

**Description of Core Courses**

**ENGR 002 INTRODUCTION TO ENGINEERING (2Crs.: 2Lec,0Lab)**

Introducing the student to the engineering profession in general and the learning objectives that new students should attain, as aligned with the ABET requirements. Covering the basics of the engineering profession and engineering ethics. Introduction to the different engineering majors and to the learning objectives as specified by ABET. Insight into different engineering courses that are not technical in nature (e.g., engineering economy) Engineering design tasks that allow the student to start thinking as engineers: problem definition, specification of constraints, investigation of different solution alternatives, implementation of best solution, writing technical reports. Fundamental tools and numerical software used in engineering. The tools and software covered could be generic or specific to a major.

**COME 214 ELECTRIC CIRCUITS II (3 Crs.:3Lec,0Lab)**

Transient analysis, Laplace transform and its application to circuit analysis, two-port networks, frequency selective passive and active circuits. Pre-requisite: POWE 212.

**COME 212L ELECTRIC CIRCUITS LAB (1Cr.:0Lec,2Lab)**
The content of this lab is directly related to the courses POWE 212, COME 214. Co-requisite.: COME 214.

**COME 221 ELECTRONIC CIRCUITS I (3Crs.: 3Lec,0Lab)**
Introduction to semiconductor physics, junction diodes: construction, I-V characteristics, circuit models, applications, special purpose diodes: Zener diodes. Bipolar junction transistors (BJT) and field effect transistors (FET): types, physical structures, basic configurations, characteristic curves, circuit models, biasing circuits, small-signal amplifiers. Pre-requisite.: POWE 212.

**COME 222 ELECTRONIC CIRCUITS II (3Crs.: 3Lec,0Lab)**
BJT and FET amplifiers: Types, circuit models, frequency response, differential and multistage amplifiers, large signal analysis and power amplifiers, operational amplifiers: Characteristics, applications, imperfections, feedback amplifiers, sinusoidal oscillators and multi-vibrators. Pre-requisite: COME 221.

**COME 222L ELECTRONIC CIRCUITS LAB (1Cr.:0Lec,2Lab)**
The content of this lab is directly related to the courses COME 221, COME 222. Co-requisite: COME 222.

**COME 372 ANTENNAS AND PROPAGATION I (4Crs.:4Lec,0Lab)**
Review of Maxwell's equations. Plane waves in material media. Polarization of waves. Poynting vector. Reflection and transmission of waves. Normal and oblique incidence. Propagation of electromagnetic waves in the atmosphere. High frequency transmission lines. Smith chart. Matching techniques. Rectangular and cylindrical waveguides. Antennas: propagation mechanism. Antennas parameters and radiation potentials. Linear antennas (elementary dipole, short dipole, linear dipole), antenna arrays. Pre-requisite.: POWE 271.

**COME 381 SIGNALS AND SYSTEMS (3Crs.:3Lec,0Lab)**
Signals and systems properties and classifications. Continuous and Discrete Linear Time-Invariant systems. Analytical and graphical convolution. Fourier series and Fourier Transform. Hilbert transform, pre-envelope, complex envelope. Frequency spectra, energy and power spectra. Frequency response and transfer function, impulse response and step response. Filter design. Butterworth and Chebyshev filters.

**COME 380 COMMUNICATION THEORY AND SYSTEMS I (3Crs.:3Lec,0Lab)**
Transmission and reception of analog signals (AM, FM, PM). Performance of analog modulation schemes in the presence of noise. Building block of a digital transmission system and the differences with analog transmission. Digital communication concepts: analog to digital conversion, pulse coded modulation, transmission and reception of digital signals; pulse shaping and digital modulation. Pre-requisite.: COME 381, MATH 381.

**COME 384 DIGITAL SIGNAL PROCESSING (3Crs.:2Lec,2Lab)**
Sampling, Quantization and SQNR. Signal Reconstruction and anti-aliasing filter. Discrete time signals. Difference equations and impulse responses. BIBO stability. Digital convolution. Discrete Fourier Transform and Fast Fourier Transform. Z-transform. Digital filter frequency response and transfer function. Z-plane stability. Realization of digital filters. Methods of FIR and IIR filter designs. Digital Butterworth and Chebyshev filter designs. Pre-requisite: COME 381.

**COME 411 INSTRUMENTATION (3Crs.:2lec,2lab)**
Different types of transducers and their applications. Instruments used in measuring electrical quantities. Display instruments. Signal generators. Digital to analog and analog to digital conversion. Data acquisition systems components, hardware and software. Pre-requisite: COME 221.

**COME 473 ANTENNAS AND PROPAGATION II (3Crs.:3Lec,0Lab)**
Coaxial transmission lines, Microstrip transmission lines. Cavity resonators. Special Antennas: Loop antenna, Traveling wave antenna. Helical antenna. Yagi antenna, Aperture principles. Microwave antennas: Horn, parabolic and microstrip antennas. Introduction to radar systems. Introduction to line of sight radio links. Introduction to satellite systems. Pre-requisite: COME372.

**COME 473L PROPAGATION AND ANTENNAS LAB (1Cr.:0Lec,2Lab)**
The contents of this lab are directly related to the courses COME 372, COME 473. Co-requisite: COME 473.

**COME 472 MICROWAVE ENGINEERING (3Crs.:3Lec,0Lab)**
Scattering parameters. Microwave instrumentations: Reflection coefficient measurements, transmission coefficient measurements, S-parameters measurements, power measurements, dielectric constant measurements, and frequency measurements. Microwave passive components design: T-junction, attenuators, isolators, circulators, couplers, filters. Microstrip components: Power dividers, hybrid couplers, coupled transmission lines, filters. Pre-requisite: COME372.

**COME 485 COMMUNICATION THEORY AND SYSTEMS II (3Crs.:3Lec,0Lab)**
Data transmission through information theoretic concepts: entropy and its use in the design of source coding algorithms, mutual information and its use in the definition of channel capacity, channel coding. Spectral and power efficiency of digital modulation schemes and their performance in the presence of noise. Advanced Intersymbol interference mitigation techniques (e.g., equalizers). Pre-requisite: COME 380.

**COME 485L COMMUNICATION LAB (1Cr.:0Lec,2Lab)**
The contents of this lab are directly related to the courses COME 380, COME 485. Co-requisite: COME 485.

**COME 499 INTERNSHIP (1Cr)**

This is a professional training which should not be less than four weeks. The training is followed by a presentation session where the students are supposed to present what they have learned. Refer to the department policy for further details.

**COME 500 RESEARCH METHODOLOGY (2Crs.:2Lec,0Lab)**

Why to Conduct Scientific Research, Stepping in: Research Methodology, formulating a research problem, conceptualizing a research design, constructing an instrument for data collection, selecting samples, writing a research proposal, collecting data, processing and displaying data, writing a research report. Conducting Scientific Research at the faculty of Engineering. Pre-requisite: ENGL 300

**COME 501 FINAL YEAR PROJECT I (1Cr) / COME 502 FINAL YEAR PROJECT II (3Crs)**

After completing 120 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters; beginning in Fall-semester and ending in the following Spring-semester. The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student creativity and critical thinking, and build skills in formulating, designing, developing, building, communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world. Pre/Co-requisite: COME 500. Refer to the Final Year Project Policy for more details.

**COME 576 OPTICAL COMMUNICATIONS (3Crs.:3Lec,0Lab)**

Review of basic communication systems. Introduction to optical communication systems. Fiber characteristics. Impact of different types of dispersion on bit rates. Optical transmitters and receivers. Lasers. Optical amplifiers. Long haul and multi-channel systems. Pre-requisite: POWE 271.

**COME 573L MICROWAVE LAB (1Cr.:0Lec,2Lab)**

The contents of this lab are directly related to the courses COME 472. Pre-requisite: COME 472.

**COME 580 COMMUNICATION NETWORKS (3Crs.:3Lec,0Lab)**

Networking topologies and architecture. TCP/IP protocol stack: application layer, transport layer, network layer, data link layer, physical layer. Network security. Implementation of networking concepts in current communication technologies. Introduction to emerging topics in communication networks.

**COME 580L COMMUNICATION NETWORKS LAB (1Cr.:0Lec,2Lab)**

This lab covers topics discussed in COME 580. Co-requisite: COME 580.

**COME 588 WIRELESS COMMUNICATIONS (3Crs.:3Lec,0Lab)**

Fundamental theoretical concepts in wireless communication systems. Characterization

and modeling of the wireless channel, Performance of digital communication schemes over wireless fading channels, spread spectrum techniques, diversity techniques, orthogonal frequency division multiplexing (OFDM). multiple-input multiple output (MIMO). Introduction to emerging topics in wireless communications. Pre-requisite: COME 485.

**COME 588L WIRELESS COMMUNICATIONS LAB (1Cr.:0Lec,2Lab)**
This lab covers topics discussed in COME 588. Co-requisite: COME 588.

**C. Communications and Electronics Engineering Program Technical Electives**
The CEE curriculum includes 12-credit hour courses as technical electives. The courses are chosen from the courses listed in the table below, with their descriptions given thereafter.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| COME 423 | Digital Integrated Circuits | 3 | COME 221 |
| COME 470 | Acoustics | 3 | COME 372 |
| COME 478 | Microwave Transmission Networks | 3 | COME 485 |
| COME 528 | Radio Frequency Communication Circuits | 3 | COME 222, COME 473 |
| COME 520 | Advanced Antenna Design | 3 | COME 473 |
| COME 535 | Embedded Systems | 3 | COMP 426 |
| COME 537 | VLSI Design | 3 | COME 221 |
| COME 564 | Semiconductor Devices | 3 | |
| COME 576 | Millimeter Wave Integrated Circuit (MMIC) Design | 3 | COME 472 |
| COME 589 | Cellular Communications | 3 | COME 485 |

**Description of Technical Elective Courses**

**COME 423 DIGITAL INTEGRATED CIRCUITS (3Crs.:3Lec,0Lab)**
Overview of switching characteristics of bipolar and field effect transistors. BJT digital ICs: TTL, Schottky TTL, ECL, IIL. MOS digital ICs: NMOS, CMOS. A/D and D/A converters. Pre-requisite: COME 221.

**COME 470 ACOUSTICS (3Crs.:3Lec,0Lab)**
Fundamentals of sound. Acoustic wave equation. Sound levels and Decibel. Perception of sound. Loudness. Reverberation. Control of interfering noise. Absorption of sound. Reflection, diffraction, and refraction of sound. Acoustics design of enclosed spaces. Pre-requisite: COME 372.

**COME 478 MICROWAVE TRANSMISSION NETWORKS (3Crs.:3Lec,0Lab)**
Network topologies, systems configurations, frequency bands, performance planning objectives and available ITU recommendations, path profile and line of sight analysis,

link budget and link performance prediction, diversity (types and improvement calculation), radio equipment and microwave antennas, frequency planning and interference calculation, introduction to microwave links planning tools. Pre-requisite: COME 485.

**COME 520 ADVANCED ANTENNA DESIGN (3 Crs.:3Lec,0Lab)**
Antenna measurements. Antenna arrays design and feeding networks. Smart antennas. Antennas beamforming. Antennas for wireless cellular networks. High power microwave antennas. Pre-requisite: COME 473.

**COME 528 RADIO FREQUENCY COMMUNICATION CIRCUITS (3Crs.:3Lec,0Lab)**
Radio frequency (RF) passive integrated circuit components: resistors, capacitors, inductors. Noise in electronic circuits. Low noise amplifier (LNA) design. RF mixers. RF power amplifiers. RF phase locked loops. RF oscillators and synthesizers. Use of computer aided design tools for RF design and simulation. Pre-requisite: COME 222 and COME 473.

**COME 535 EMBEDDED SYSTEMS (3Crs.:3Lec,0Lab)**
Overview of embedded systems: architecture, custom single purpose processors. Peripherals: Digital I/O, timers, counters, watchdog timers, interrupts, real time clocks, Serial protocols, interfacing, programming, interrupt driven routines, Applications. Pre-requisite: COMP 426.

**COME 537 VLSI DESIGN (3 Crs.:3Lec,0Lab):**
MOS and BiCMOS technology. MOS and BiCMOS circuit design processes: MOS layers, Stick diagrams, design rules and layout. Basic VLSI circuit concepts: layer sheet resistance, layer area capacitance, delay unit, propagation delays, wiring capacitances. Structured design of combinational and sequential logic circuits. VLSI testability. Use of computer aided design tools for VLSI design and simulation. Pre-requisite: COMP 225.

**COME 564 SEMICONDUCTOR DEVICES (3 Crs.:3Lec,0Lab)**
Carrier transport phenomena in semiconductors. Operation principles and device modeling of p-n junctions, metal-semiconductor contacts, bipolar and MOS transistors, and related devices. Silicon device fabrication technology: crystal growth, oxidation, diffusion, lithography, contacts and interconnections.

**COME 576 MILLIMETER WAVE INTEGRATED CIRCUIT (MMIC) DESIGN (3Crs.:3Lec,0Lab)**
Introduction to mm-Wave systems and applications. Introduction to MMIC Design: Merits, Limitations and Applications. Types of MMICs. Types of MMICs, Fabrication Techniques and Processes. Passive MMIC Elements: Capacitors, Inductors, Transmission line, Via holes, Power Dividers/Combiners and Couplers. Testing Passive MMIC Elements. Introduction to mmWave active elements. Pre-requisite: COME 472.

**COME 589 CELLULAR COMMUNICATIONS (3Crs.:3Lec,0Lab)**
Cellular concept, cellular architecture and terminology, cellular network dimensioning, radio network planning and optimization. Cellular handover types that occur in real cellular systems. Drivers and advanced techniques for cellular evolution. Properties of 2G,3G, 4G technologies. Introduction to beyond 5G cellular technologies. Pre-requisite: COME 485.

## Study Plan

**Bachelor of Engineering in Communications and Electronics Engineering (150 Credits)**

| First Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 281 | Linear Algebra | 3 | Pre: MATH112 |
| MATH | 282 | Calculus | 3 | Pre: MATH111 |
| MCHE | 213 | Dynamics | 3 | |
| PHYS | 281 | Electricity and Magnetism | 3 | |
| ENGR | 002 | Introduction to Engineering | 2 | |
| BLAW | 001 | Human Rights | 1 | |
| ARAB | 001 | Arabic Language | 2 | |

| Second Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 225 | Digital Systems I | 3 | |
| MATH | 283 | Differential Equations | 3 | Pre: MATH 281, MATH 282 |
| PHYS | 282 | Material Properties and Heat | 3 | |
| COMP | 208 | Programming I | 3 | |
| POWE | 212 | Electric Circuits I | 3 | |
| ENGL | 001 | English Language | 2 | |

| Summer I (9 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CHEM | 241 | Principles of Chemistry | 3 | |
| ENGL | 211 | Advanced Writing | 2 | |
| | | Elective(General) | 2 | |
| | | Elective(General) | 2 | |

| Third Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 210 | Programming II | 3 | Pre: COMP 208 |
| COME | 221 | Electronic Circuits I | 3 | Pre: POWE 212 |
| COME | 214 | Electric Circuits II | 3 | Pre: POWE 212 |
| COME | 212L | Electric Circuits LAB | 1 | Co: COME 214 |
| POWE | 271 | Electromagnetic Fundamentals | 3 | Pre: PHYS281 |
| COMP | 222 | Digital Systems II | 3 | Pre: COMP 225 |

| Fourth Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 381 | Probability and Statistics | 3 | Pre: MATH 282 |
| MATH | 284 | Numerical Analysis | 3 | Pre: MATH 283 |
| COMP | 328 | CPU Design | 3 | Pre: COMP 226 |
| COME | 222 | Electronic Circuits II | 3 | Pre: COME 221 |
| COME | 222L | Electronic Circuits LAB | 1 | Co: COME 222 |
| INME | 221 | Engineering Economy | 3 | |
| ENGL | 300 | Speech Communications | 2 | Pre: ENGL 211 |

| Summer II (9 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CHEM | 405 | Solid State Chemistry | 2 | Pre: CHEM 241 |
| ENGR | 001 | Engineering Ethics | 1 | |
| | | Elective(General) | 2 | |
| MGMT | 002 | Entrepreneurship | 2 | |
| | | Elective (General) | 2 | |

| Fifth Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COME | 411 | Instrumentation | 3 | Pre: COME 222 |
| COMP | 426 | Microprocessor Interfacing | 3 | Pre: COMP 328 |
| INME | 423 | Project Planning and Management | 3 | |
| COME | | Propagation and Antennas I | 4 | Pre: POWE 271 |
| COME | | Signals and Systems | 3 | |

| Sixth Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COME | 473 | Propagation and Antennas II | 3 | Pre: COME 372 |
| COME | 473L | Propagation and Antennas Lab | 1 | Co: COME 473 |
| COME | 380 | Communication Theory and Systems I | 3 | Pre: COME 381, MATH 381 |
| COME | 580 | Communication Networks | 3 | |
| COME | 580L | Communication Networks LAB | 1 | Co: COME 580 |
| COME | 384 | Digital Signal Processing | 3 | Pre: COME 381 |
| | | Technical Elective | 3 | |

| Seventh Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COME | 576 | Optical Communications | 3 | Pre: POWE 271 |
| COME | 472 | Microwave Engineering | 3 | Pre: COME 372 |
| COME | 485 | Communication Theory and Systems II | 3 | Pre: COME 380 |
| COME | 485L | Communication LAB | 1 | Co: COME 485 |
| COME | 499 | Internship (Approved Experience / Independent Study) | 1 | |
| COME | 500 | Research Methodology | 2 | Pre: ENGL 300 |
| COME | 501 | Final Year Project I | 1 | Pre/Co: COME 500 |
| | | Technical Elective | 3 | |

| Eighth Semester (14 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COME | 502 | Final Year Project II | 3 | Pre: COME 501 |
| COME | 588 | Wireless Communications | 3 | Pre: COME 485 |
| COME | 588L | Wireless Communications LAB | 1 | Co: COME 588 |
| COME | 573L | Microwave LAB | 1 | Pre: COME 472 |
| | | Technical Elective | 3 | |
| | | Technical Elective | 3 | |

# DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

## Computer Engineering Program

## Mission

The mission of the Computer Engineering (CE) Program is to prepare students for rewarding careers and higher education, engage in scientific research pushing the frontiers of the field even further, and get involved in local community issues requiring specialist participation.

## Objectives

The Computer Engineering Program is designed such that its students upon graduation will:

1. Possess the highest level of technical robustness in the field of computer engineering that will earn them recognition and esteem among their colleagues.
2. Have the knowledge and skills to invent novel technology, provide creative designs, and suggest innovative solutions to challenging problems.
3. Stay abreast of emerging technologies, continually learning new theory and skills to nourish ever-developing careers.
4. Demonstrate good citizenship, fulfilling their professional responsibilities towards their communities, Lebanon, and the World at large.
5. Excel on multi-disciplinary and multi-cultural teams, and effectively employ their oral and written communication skills to resolve problems.

## Learning Outcomes

Upon completion of the program graduates shall have:

a. An ability to apply knowledge of mathematics, science, and engineering
b. An ability to design and conduct experiments, as well as to analyze and interpret data
c. 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
d. An ability to function on multi-disciplinary teams
e. An ability to identify, formulate, and solve engineering problems
f. An understanding of professional and ethical responsibility
g. An ability to communicate effectively
h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. A recognition of the need for, and an ability to engage in life-long learning
j. A knowledge of contemporary issues
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

## Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Computer Engineering consists of 150 credit-hours of course work + ICDL, where the standard duration of study is 10 semesters.

## Career Opportunities

The computer engineering career encompasses opportunities in a wide range of environments such as industrial, military, communications, aerospace, business, scientific, and medical. Specific jobs include the functions of designing, installing, modifying, maintaining, repairing, and overhauling computer systems, digital control subsystems, logic circuits, and microprocessor-based interfaces. Furthermore, the graduates are able to analyze, design, test, and evaluate network systems, including local area networks (LAN), wide area networks (WAN), Internet, intranet, sensor networks, and other data communications systems. Additionally, they can develop, create, and modify general security schemes, including cryptography, intrusion detection and prevention, counter attacks for phishing, snooping, sniffing, and viruses, as well as computer applications software or specialized utility programs at large. Also, they are capable of doing research, design, development, and testing of operating systems-level software, compilers, and network distribution. Moreover, they have the competencies to design, develop, administer large-scale database systems and set standards for operations, programming, and security. Finally, they can supervise the manufacturing and installation of computer or computer-related equipment and components.

## Program Overview

The Bachelor of Computer Engineering consists of 150 credit-hours of course work. The Student's Study Plan is given to every CE student upon his/her enrollment. The CE curriculum consists of the following components:

| **I. Common Requirements** | **Credits** |
|---|---|
| General Education Requirements | 20 |
| Basic Sciences and Mathematics | 26 |
| General Engineering topics | 12 |
| **II. BME Program-Specific Requirements** | **Credits** |
| A.Engineering topics from outside the program | 6 |
| B.CE Core | 74 |
| C.Technical Electives | 12 |

**I.Common Requirements**

The list of the Common Requirement courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog.

**II.CE Program-Specific Requirements**

**A.Engineering Topics from outside the major**

This part of the CE curriculum includes 6 credits courses offered by other engineering programs. These courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| POWE 212 | Electric Circuits I | 3 | |
| INME 423 | Project Planning and Management | 3 | |
| | | 6 | |

**B.Computer Engineering Program Core**

The CE program core courses are listed in the following table:

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| ENGR 002* | Introduction to Engineering | 2 | |
| COMP 210* | Programming II | 3 | Pre: COMP 208 |
| COMP 211 | Introductory Web Programming | 3 | Pre: COMP 208 |
| COMP 225* | Digital Systems I | 3 | |
| COMP 226* | Digital Systems II | 3 | Pre: COMP 225 |
| COMP 231 | Discrete Structures | 3 | Pre: MATH 282 |
| COMP 232** | Data Structures | 3 | Pre: COMP 210, COMP 231 |
| COMP 311** | Object Oriented Programming | 3 | Pre: COMP 210 |
| COMP 328* | CPU Design | 3 | Pre: COMP 226 |
| COMP 333** | Computer Algorithms | 3 | Pre: COMP 231 |
| COMP 344** | Database Systems | 3 | Pre: COMP 232 |
| COMP 361 | Control Systems for Computer Engineers | 3 | Pre: MATH 283 |
| COMP 423 | Computer Architecture | 3 | Pre: COMP 226 or COMP 326 |
| COMP 431 | Queuing and Modeling | 3 | Pre: MATH 381 |
| COMP 442** | Software Engineering | 3 | Pre: COMP 311 |
| COMP 443** | Operating Systems | 3 | Pre: COMP 423 |
| COMP 452** | Compilers | 3 | Pre: COMP 311 |
| COMP 453 | Transmission and Processing of Digital Signals | 3 | Pre: COMP 231 |
| COMP 454 | Computer Networks | 3 | Pre: COMP 225 |
| COMP 454L | Computer Networks Lab | 1 | Co: COMP 454 |
| COMP 499 | Internship | 1 | |

| | | | |
|---|---|---|---|
| COMP 500 | Research Methodology | 2 | ENGL 300 |
| COMP 501 | Final Year Project I | 1 | Pre/Co: COMP 500 |
| COMP 502 | Final Year Project II | 3 | Pre: COMP 500 |
| COMP 521 | Microprocessor-based Systems | 3 | Pre: COMP 328 |
| COMP 543 | Cryptography and Information Security | 3 | Pre: COMP 333 |
| COMP 543L | Cryptography and Information Security Lab | 1 | Co: COMP 543 |
| COMP 533 | Computer Graphics | 3 | Pre: COMP 311 |
| | | 74 | |

*: The following table lists the credits that are common with the CE and EE programs.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| ENGR 002 | Introduction to Engineering | 2 | |
| COMP 210 | Programming II | 3 | |
| COMP 225 | Digital Systems I | 3 | |
| COMP 226 | Digital Systems II | 3 | |
| COMP 328 | CPU Design | 3 | |
| | | 14 | |

**: The following table lists the credits that are equivalent to courses offered by the Computer Science program

| Course | Title | Credits | Equivalent |
|---|---|---|---|
| COMP 232 | Data Structures | 3 | CMPS 347 |
| COMP 311 | Object Oriented Programming | 3 | CMPS 242 |
| COMP 333 | Computer Algorithms | 3 | CMPS 441 |
| COMP 344 | Data Base Systems | 3 | CMPS 342 |
| COMP 442 | Software Engineering | 3 | CMPS 344 |
| COMP 443 | Operating Systems | 3 | CMPS 442 |
| COMP 452 | Compilers | 3 | CMPS 348 |
| | | 21 | |

**Description of Core Courses**

**ENGR 002 INTODUCTION TO ENGINEERING (2Crs.:2Lec,0Lab)**

Introduction the student to the engineering profession in general and the learning objectives that new students should attain, as aligned with the ABET requirements. Covering the basics of the engineering profession and engineering ethics. Introduction to the different engineering majors and to the learning objectives as specified by ABET. Insight into different engineering courses that are not technical in nature (e.g., engineering economy)

Engineering design tasks that allow the student to start thinking as engineers: problem definition, specification of constraints, investigation of different solution alternatives, implementation of best solution, writing technical reports. Fundamental tools and numerical software used in engineering. The tools and software covered could be generic or specific to a major.

**COMP 210 PROGRAMMING II (3Crs.:2Lec,2Lab)**

Recursion. Arrays, sorting and searching. Pointers. Functions (call by reference). Character and strings. Structures, union, and bit manipulation. File operations, sequential and random. Preprocessing directives. Pre-req.: COMP 208.

**COMP 211 INTRODUCTORY WEB PROGRAMMING (3Crs.:2Lec,2Lab)**

Introduction to HTML, CSS and JavaScript. Packages for web-page design. Pre-req.: COMP 208.

**COMP 225 DIGITAL SYSTEMS I (3Crs.:2Lec,2Lab)**

Number systems and coding, Binary systems. Conversion from decimal to other bases. BCD numbers. Boolean algebra. Logic gates. Function minimization, Tabular method, Karnaugh mapping. Arithmetic functions and circuits designs (HA, FA, and ALU). Combinational functions and circuits design (decoder, encoder, multiplexer and de-multiplexer). Sequential circuits definitions and designs (Latches, RS-FF, D-FF, JK-FF, T-FF). Several laboratory experiments will be based on the simple logic gates.

**COMP 226 DIGITAL SYSTEMS II (3Crs.:2Lec,2Lab)**

Latches and flip-flops. Synchronous and Asynchronous sequential systems. Registers and Counters. Control and Data path units. Serial data transfer for multiple register. Types of RAM and ROM. Cache concept. ALU functions and circuits (addition, subtraction, increment, decrement, transfer, AND, OR, XOR, NOT, etc.). Binary multiplier. BCD functions and circuits. Flags. Control unit. None binary logic. Several laboratory experiments and projects will be based on the simple logic gates to design micro-digital systems. Pre-req.: COMP 225.

**COMP 231 DISCRETE STRUCTURES (3Crs.:3Lec,0Lab)**

Logic and predicates. Mathematical induction. Sets and Power sets. Functions and Relations. Partial and total orders. Sequences. Counting. Multinomial theorems. Inclusion/exclusion principle. Recurrence relations and generating functions. Hardness of problems. Tress and Graphs. Groups, Rings and Fields. Lattices. Pre-req.: MATH 282.

**COMP 232 DATA STRUCTURES (3Crs.:2Lec,3Lab)**
Complexity measures and big O. Elementary data types. Arrays. Linked lists. Queues. Stacks. Trees: traversal, Binary search trees. Binary heaps, Balanced trees: AVL trees, B trees. Binomial queues. Fibonacci queue. Hashing. File Structure Pre-req.: COMP 210, COMP 231.

**COMP 311 OBJECT ORIENTED PROGRAMMING (3Crs.:2Lec,2Lab)**
Object–oriented design versus structured design. Classes and objects. Inheritance. Polymorphism. Information hiding and abstract data types. Overloading. Abstract classes. Exception handling. Pre-req.: COMP 210.

**COMP 328 CPU DESIGN (3Crs.:2Lec,2Lab)**
This course introduces the design of a generic central processing unit (CPU), focusing on its role as the core of computer systems. Topics include arithmetic logic unit design, control unit design, registers, address, data, and control buses, with reference to standard implementations. Single and multi-core processors. Machine and assembly languages of a standard microprocessor are used to illustrate the design and its interface with upper layers such as operating systems, control drivers, and compilers. Several laboratory experiments will be based on microcontrollers. Pre-req.: COMP 226.

**COMP 333 COMPUTER ALGORITHMS (3Crs.:2Lec,3Lab)**
The P=NP question. Time complexity of algorithms. The classes PNP. Solving recurrences. Divide and-conquer. Greedy algorithms. Dynamic programming. Graph algorithms. Geometric algorithms. Algorithms on matrices and polynomials. Number theoretic algorithms. Reductions between problems. Theory of NP completeness. Examples of NP complete problems. Some approximation algorithms. Pre-req.: COMP 231.

**COMP 344 DATABASE SYSTEMS (3Crs.:2Lec,3Lab)**
Components of database systems: DBMS functions. Database architecture and data integrity. Data modeling: conceptual models, relational data model, conceptual schema, relational schema, relational algebra and relational calculus. Database query languages: SQL functional dependency, decomposition, normal forms. Higher normal forms. Transaction processing: Transactions; Failure and recovery systems; Physical database design: Storage and file structure; Indexed files; Hashed files; Signature files; B-trees. Query processing. Query optimization. Pre-req.: COMP 232.

**COMP 361 CONTROL SYSTEMS FOR COMPUTER ENGINEERS (3Crs.:2Lec,2Lab)**
Types of control systems. Advantages and limitations of using digital processors in control systems. System representation: transfer function, block diagram, signal-flow-graph. Time domain analysis: steady state and transient analysis. Frequency domain analysis. Writing programs for solving problems in control systems. Pre-req.: MATH 283.

**COMP 423 COMPUTER ARCHITECTURE (3Crs.:2Lec,2Lab)**
Organization vs Architecture. Fundamentals of computer design, Von-Neuman machine. Computer evolution and performance. Computer function and interconnection.

Memory systems (Internal, external and cache). Input/Output modules. Instruction Sets: Characteristics, functions, addressing modes and formats. RISC and CISC. Assembly and machine languages. Processor implementation techniques. Pipelining. Performance enhancements. Pre-req.: COMP 226 or COMP 326.

**COMP 431 QUEUING AND MODELING (3Crs.:2Lec,2Lab)**

Random variables, Performance measures. Markov processes. Birth/death processes. Solving Markov models. Continuous and discrete queuing models: M/M/1, M/M/m, M/M/m/m, M/M/1/K, M/G/1. Little's law. Networks of queues. Burke's theorem. Jackson's theorem. Stochastic Petri nets. GSPN. Pre-req.: MATH 381.

**COMP 442 SOFTWARE ENGINEERING (3Crs.:2Lec,3Lab)**

Concepts of software development. Life-cycle of software. Requirements and specification. Data model. Process model. Design and coding. Verification, validation and testing. Software evolution. Pre-req.: COMP 311.

**COMP 443 OPERATING SYSTEMS (3Crs.:2Lec,2Lab)**

Overview, functionalities and characteristics of OS, CPU states, I/O channels, memory hierarchy, process, operations on processes, UNIX process control and management, PCB, signals, forks and pipes, Interrupt processing, operating system organization, OS kernel, Job and processor scheduling, scheduling algorithms, critical sections, mutual exclusion, synchronization, deadlock, Semaphores, Interprocess Communication (IPC), Message Passing, Deadlock: prevention, detection, avoidance, banker's algorithm, Memory organization and management, storage allocation, Virtual memory concepts, paging and segmentation, address mapping, File organization. Pre-req.: COMP 423.

**COMP 452 COMPILERS (3Crs.:2Lec,2Lab)**

Introduction to language translation. Language translation phases. Generators. Lexical analysis: Regular expressions; NFA; DFA. Syntactic analysis: Formal definition of grammars; BNF and EBNF; bottom-up vs. top-down parsing; Tabular vs. recursive-descent parsers; Error handling; Models of execution control. Declaration, modularity, and storage management: Code generation. Pre-req.: COMP 311.

**COMP 453 TRANSMISSION AND PROCESSING OF DIGITAL SIGNALS (3Crs.:2Lec,2Lab)**

Sampling and discrete time signals. The z-transform. Quantization. Histograms. Recursive and non- recursive digital filters. Frequency response and the Discrete Fourier Transform. Processing in 2 dimensions. Finite precision implementation errors. Encoding digital signals. Modulation. Multiplexing. The physical layer of the OSI model. Synchronous and asynchronous transmission. The RS232 interface. Modems. Error detection with checksums. Cyclic redundancy checks. Pre-req.: COMP 231.

**COMP 454 COMPUTER NETWORKS (3Crs.:3Lec,0Lab)**

The OSI Model. Data link layer. Frame format: character stuffing, bit stuffing. Error control. Automatic-repeat request and sliding-window protocols. Data-link protocols: HDLC, BSC, PPP. The MAC sublayer. Local area networks: Ethernet, token ring and FDDI, wireless LANs. Circuit switching versus packet switching. Routing algorithms. Pre-req.: COMP 225.

**COMP 454L COMPUTER NETWORKS Lab (1Cr.:0Lec,3Lab)**
The lab materials cover topics discussed in COMP 454. Co-req.: COMP 454.

**COMP 499 INTERNSHIP (1Cr)**
This is a professional training which should not be less than four weeks. The training is followed by a presentation session where the students are supposed to present what they have learned.
Refer to the department policy for further details.

**COMP 500 RESEARCH METHODOLOGY (2Crs.:2Lec,0Lab)**
Why to Conduct Scientific Research, Stepping in: Research Methodology, Formulating a research problem, conceptualizing a research design, constructing an instrument for data collection, Selecting samples, writing a research proposal, collecting data, processing and displaying data, writing a research report. Conducting Scientific Research at the faculty of Engineering. Pre-req.: ENGL 300

**COMP 521 MICROPROCESSOR-BASED SYSTEMS (3Crs.:2Lec,2Lab)**
Interfacing microprocessors to memory and I/O devices. Supporting chips: buffers, decoders, system clock generator. Interfacing techniques: serial, parallel, timer, Interrupts and interrupt controller. DMA. I/O ports. Memory shadows and expending. Hardware software co-design. Computer applications. Several laboratory experiments will be based on microprocessors and/or microcontrollers. Pre-req.: COMP 328.

**COMP 543 CRYPTOGRAPHY AND INFORMATION SECURITY (3Crs.:3Lec,0Lab)**
Measures of information. Elementary ciphers. Complexity measures. Designing a generic block cipher. Modes of operation. Attacks against block ciphers. Message digests. Cryptographic hash functions. Public key. cryptography. Diffie-Hellman key exchange. RSA. Digital signature schemes. Forging digital signatures. Pseudo-random bit generators. Authentication techniques. Applications. Pre-req.: COMP 333.

**COMP 543L CRYPTOGRAPHY AND INFORMATION SECURITY LAB (1Cr.:0Lec,2Lab)**
The lab materials cover topics discussed in COMP 543. Co-req.: COMP 543.

**COMP 533 COMPUTER GRAPHICS (3Crs.:2Lec,2Lab)**
Open GL, Computer graphique algorithmes, Global illumination. Ray tracing. The graphics pipeline. Transformations. Texture mapping. Shadows. Sampling. Hidden line and surface removal, clipping Splines. Coloring. Animation. Pre-req.: COMP 311.

**COMP 501 FINAL YEAR PROJECT I (1Cr) / COMP 502 FINAL YEAR PROJECT II (3Crs)**
After completing 120 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters; beginning in Fall-semester and ending in the following Spring-semester. The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student creativity and critical thinking,

and build skills in formulating, designing, developing, building, communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world. Pre/Co-req.: COMP 500 Refer to the Final Year Project Policy for more details.

**C.Computer Engineering Program Technical Electives**

The CE curriculum includes 12 credits as technical electives. The courses are chosen from the courses listed in the following table:

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| COMP 438 | Performance Evaluation | 3 | Pre: MATH 283 |
| COMP 444 | System Programming | 3 | Pre: COMP 328 |
| COMP 455 | Mobile Computing | 3 | Pre: COMP 210 |
| COMP 462 | Artificial Intelligence | 3 | Pre: COMP 231 |
| COMP 464 | Operations Research for Computer Engineering | 3 | Pre: COMP 231 |
| COMP 477 | Emerging Trends in Computer Engineering | 3 | Pre: COMP 226 |
| COMP 510 | Internet Engineering | 3 | Pre: COMP 454 |
| COMP 511 | Cloud Computing | 3 | Pre: COMP 454 |
| COMP 512 | Web Programming | 3 | Pre: COMP 211 |
| COMP 532 | Information Theory and Coding | 3 | Pre: COMP 333, MATH 381 |
| COMP 534 | Pattern Recognition | 3 | Pre: COMP 231 |
| COMP 535 | Digital Image Processing | 3 | Pre: COMP 333 |
| COMP 541 | Software Development | 3 | Pre: COMP 311 |
| COMP 555 | Wireless Security | 3 | Pre: COMP 454 |
| COMP 556 | Sensor Networks | 3 | Pre: COMP 454 |
| COMP 561 | Digital Control | 3 | Pre: COMP 361 |
| POWE 214 | Electric and Electronic Measurements | 3 | Pre: POWE 212 |
| MCHE 461 | Applied Robotics | 3 | Pre: MCHE 213 and (MCHE 302 or COME 431 or COMP 328 |

**Description of Technical Elective Courses:**

**COMP 410 e-GOVERNMENT (3Crs.:2Lec,2Lab)**
This course introduces the technology of e-government with an in-depth analysis of successful and influential implementations in the region and globally. Several topics are covered in the course: technical and business challenges for deploying e-government solutions, e-government Web architectures and their requirements, hosting e-government service models, developing effective e-government administrators, and managing the security and privacy risks of implementing e-government services in the cloud. Pre-req.: COMP 211.

**COMP 438 PERFORMANCE EVALUATION (3Crs.:3Lec,0Lab)**
Work load performance indices. Single and multiple job processing models. Scheduling policies. Paging techniques. Network protocols. Routing policies. Pre-req.: MATH 283.

**COMP 444 SYSTEM PROGRAMMING (3Crs.:2Lec,2Lab)**
Programming in assembly language, macro assembler, loaders, linkers, languages for system programming. Pre-req.: COMP 238

**COMP 455 MOBILE COMPUTING (3Crs.:2Lec,2Lab)**
A general introduction to mobile computing with a strong focus on application development for the Android operating system. Students will complete a major project with the objective of publishing an application/service on the Google Play store. Android development environment, user interfaces, activities, intents, persistence, networking, location, sensors, graphics, and other Android features, tools, and capabilities. Pre-req.: COMP 210.

**COMP 462 ARTIFICIAL INTELLIGENCE (3Crs.:2Lec,2Lab)**
Fundamental issues. Rule-based systems, logic programming, Search and constraint satisfaction. Knowledge representation and reasoning. Search: algorithms. Knowledge representation and reasoning: temporal and spatial reasoning, uncertainty, knowledge representation for diagnosis. Machine learning and neural networks. Pre-req.: COMP 231.

**COMP 464 OPERATIONS RESEARCH FOR COMPUTER ENGINEERS (3Crs.:3Lec,0Tut)**
Linear programming: Graphical solution; Simplex method; Duality and sensitivity analysis; Polynomial-time solutions. Decision making and game theory. Network flows. Optimization techniques. Non-linear programming. Transportation. Project management PERT/CPM. Pre-req.: COMP 231.

**COMP 477 EMERGING TRENDS IN COMPUTER ENGINEERING (3Crs.:2Lec,2Lab)**
This course covers current technology in computer Engineering. Topics will vary every year. Pre-req.: COMP222.

**COMP 510 INTERNET ENGINEERING (3Crs.:2Lec,2Lab)**

This course provides a comprehensive coverage of the major advancements in the Internet architecture with a focus on routing protocols and their design and a deep analysis of the internals of the Transmission Control Protocol (TCP) and the Internet Protocol (IP). The course also discusses recent developments on the Internet such as software-defined networking. Pre-req.: COMP 454.

**COMP 511 CLOUD COMPUTING (3Crs.:2Lec,2Lab)**

The course presents a general overview of cloud computing, from applications and administration to programming and infrastructure. Its main emphasis is on programming techniques for cloud computing and large scale distributed systems which form the basis of the cloud infrastructure such as Hadoop and Map-Reduce. The topics include: overview of cloud computing, cloud systems, distributed processing in the cloud, storage systems, virtualization, and security. Students will study practical cloud solutions developed by Google, Amazon, Oracle, Microsoft, VMWare, etc. Pre-req.: COMP 454.

**COMP 512 WEB PROGRAMMING (3Crs.:2Lec,2Lab)**

Server-side programming : Web Servers, Web-Server Scripting language (PHP/ASP/JSP), Web-Site development using CMS. Pre-req.: COMP 211.

**COMP 532 INFORMATION THEORY AND CODING (3Crs.:3Lec,0Lab)**

Zero-memory and Markov information sources. Entropy. Block codes. Minimum-redundancy codes. Bounds on the average length of the code. Information channels. Channel capacity. Error detection. Shannon's fundamental theorem. Hamming distance. Decoding schemes. Error correcting codes: parity check codes, cyclic codes. Pre-req.: COMP 333 and MATH 381.

**COMP 534 PATTERN RECOGNITION (3Crs.:3Lec,0Tut)**

Reconstruction from projections. Scene understanding. Matching and recognition. Methods for reconstructing three-dimensional scene information using techniques such as depth from stereo, structure from motion, and shape from shading. Motion and video analysis. Three-dimensional object recognition. Pre-req.: COMP 231.

**COMP 535 DIGITAL IMAGE PROCESSING (3Crs.:3Lec,0Lab)**

Image formation and perception. Image representation. Transformations on digital images. Enhancement and restoration. Segmentation. Encoding and data compression. Pre-req.: COMP 333.

**COMP 541 SOFTWARE DEVELOPMENT (3Crs.:1Lec,4Lab)**

Covers current technology in computer software. Topics will vary every year. Pre-req.: COMP311.

**COMP 556 SENSOR NETWORKS (3Crs.:2Lec,2Lab)**

Wireless communication fundamentals, Short range radio communication standards (IEEE802.15.x protocols, e.g., Bluetooth, ZigBee), Architecture of wireless sensor networks (Node structure, types, network topologies), Operating systems for wireless sensor networks (TinyOS, Contiki), Network supported process measurements, MAC protocols for sensor networks, Routing protocols for sensor networks, Transport protocols for sensor networks. Pre-req.: COMP 454.

**COMP 561 DIGITAL CONTROL (3Crs.:2Lec,2Lab)**

Compensation of control system. Design of compensators. Nonlinear control systems: phase-plane analysis and describing-function analysis. State-space representations. Linear state-space equations and their solutions. Computing the fundamental matrix. Properties of the state-space models: stability, controllability, observability. Pole placement and observers principles. Digital systems: advantages and disadvantages of using a digital processor. Sampling and reconstruction. Analysis of discrete-time systems. Design of digital controllers. Pre-req.: COMP 361.

**COMP 555 WIRELESS SECURITY (3Crs.:2Lec,2Lab)**

A course that discusses wireless network security protocols and applications. Security challenges in mobile and cellular networks. Security problems facing current and future wireless networks. Security attacks on mobile adhoc networks, vehicular networks, naming, addressing, and routing. Trust and privacy in the context of wireless networks. Wireless sensor network security challenges and solutions. Pre-req.: COMP 454.

**POWE 214 ELECTRIC AND ELECTRONIC MEASURMENTS (3Crs.:2Lec,2Lab)**

Introduction to instrumentation and measurements (Errors, precision, accuracy, measurement statistics, etc.), Analog instrumentation (Permanent magnet moving coil PMMC, Moving Iron MI, Electrodynamometer), bridges (AC, DC), Oscilloscopes (functions and controls, voltage, time, and frequency measurements), Conversion (D/A, A/D, etc.), Electrical transducers, signal conditioning, data acquisition.
Pre-req.: POWE 212.

**MCHE 461 APPLIED ROBOTICS (3Crs.:2Lec,2Lab)**

Robot architecture, subsystems, and applications; mechanisms and drives; forward and inverse kinematics; trajectory planning; dynamics and control; actuators and drive electronics; sensors and interface; mobile robots and navigation; intelligence; collaborative learning; team project. Pre-req.: MCHE 213 and either MCHE 302 or COME 431 or COMP 328.

## Study Plan

**Bachelor of Engineering in Computer Engineering (150 Credits)**

| First Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 281 | Linear Algebra | 3 | Pre: MATH112 |
| MATH | 282 | Calculus | 3 | Pre: MATH111 |
| PHYS | 281 | Electricity and Magnetism | 3 | |
| ENGR | 002 | Introduction to Engineering | 2 | |
| MCHE | 213 | Dynamics | 3 | |
| ARAB | 001 | Arabic Language | 2 | |

| Second Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| PHYS | 282 | Material Properties and Heat | 3 | |
| MATH | 283 | Differential Equations | 3 | Pre: MATH 281, MATH 282 |
| COMP | 208 | Programming I | 3 | |
| COMP | 225 | Digital Systems I | 3 | |
| POWE | 212 | Electric Circuits I | 3 | Pre: PHYS 281 |
| ENGL | 001 | English Language | 2 | |

| Summer I (9 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ENGL | 211 | Advanced Writing | 2 | Pre:ENGL001 |
| CHEM | 241 | Principles of Chemistry | 3 | |
| BLAW | 001 | Human Rights | 1 | |
| | | General Elective | 3 | |

| Third Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 210 | Programming II | 3 | Pre: COMP 208 |
| COMP | 211 | Introductory Web Programming | 3 | Pre: COMP 208 |
| COME | 223 | Digital Electronics | 3 | Pre: POWE 212 |
| COMP | 226 | Digital Systems II | 3 | Pre: COMP 225 |
| COMP | 231 | Discrete Structures | 3 | Pre: MATH 282 |
| ENGL | 300 | Speech Communications | 2 | Pre: ENGL211 |

| Fourth Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 284 | Numerical Analysis | 3 | Pre: MATH 283 |
| MATH | 381 | Probability and Statistics | 3 | Pre: MATH 282 |
| COMP | 232 | Data Structures | 3 | Pre: COMP 231 |
| COMP | 311 | Object Oriented Programming | 3 | Pre: COMP 210 |
| COMP | 328 | CPU Design | 3 | Pre: COMP 226 |
| INME | 221 | Engineering Economy | 3 | |

| Summer II (9 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MGMT | 002 | Entrepreneurship | 2 | |
| CHEM | 405 | Solid State Chemistry | 2 | |
| ENGR | 001 | Engineering Ethics | 1 | |
| | | General Elective | 4 | |

| Fifth Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 333 | Computer Algorithms | 3 | Pre: COMP 231 |
| COMP | 423 | Computer Architecture | 3 | Pre: COMP 226 or COMP 326 |
| COMP | 361 | Control Systems for Computer Engineers | 3 | Pre: MATH 283 |
| COMP | 431 | Queuing and Modeling | 3 | Pre: MATH 381 |
| COMP | 453 | Transmission and Processing of Digital Signals | 3 | Pre: COMP 231 |
| | | Technical Elective 1 | 3 | |

| Sixth Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 344 | Database Systems | 3 | Pre: COMP 232 |
| COMP | 442 | Software Engineering | 3 | Pre: COMP 311 |
| COMP | 454 | Computer Networks | 3 | Pre: COMP 225 |
| COMP | 454L | Computer Networks Lab | 1 | Co: COMP 454 |
| | | Technical Elective 2 | 3 | |
| INME | 423 | Project Planning and Management | 3 | |
| | | General Elective | 1 | |

| Seventh Semester (14 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 443 | Operating Systems | 3 | Pre: COMP 423 |
| COMP | 499 | Internship (Approved Experience / Independent Study) | 1 | Pre: COMP 500 |
| COMP | 500 | Research Methodology | 2 | Pre: ENGL300 |
| COMP | 501 | Final Year Project I | 1 | Pre/Co: COMP 500 |
| COMP | 543 | Cryptography and Information Security | 3 | Pre: COMP 333 |
| COMP | 543L | Cryptography and Information Security Lab | 1 | Co: COMP 543 |
| | | Technical Elective 3 | 3 | |

| Eighth Semester (15 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 542 | Compilers | 3 | Pre: COMP 311 |
| COMP | 502 | Final Year Project II | 3 | Pre: COMP 500 |
| COMP | 521 | Microprocessor-based Systems | 3 | Pre: COMP 328 |
| COMP | 533 | Computer Graphics | 3 | Pre: COMP 311 |
| | | Technical Elective 4 | 3 | |

## Courses offered for other majors

The CE program offers four courses for other engineering majors. The courses are described below.

**COMP 208 PROGRAMMING I (3Crs.:2Lec,2Lab)**

Computer fundamentals. Computer system components: hardware and software. Problem solving and flowcharts/pseudocode. High level programming: data types, structured programming constructs, input and output, expressions and assignments, selection, repetition, functions (call by value), introduction to arrays.

**COMP 210 PROGRAMMING II (3Crs.:2Lec,2Lab)**

Recursion. Arrays, sorting and searching. Pointers. Functions (call by reference). Character and strings. Structures, union, and bit manipulation. File operations, sequential and random. Preprocessing directives. Pre-req.: COMP 208.

**COMP 211 INTRODUCTORY WEB PROGRAMMING (3Crs.:2Lec,2Lab)**

Introduction to HTML, Java, Java Script, JSP, ASP and PHP. Packages for web-page design. Pre-req: COMP 208.

**COMP 225 DIGITAL SYSTEMS I (3Crs.:2Lec,2Lab)**

Number systems and coding, Binary systems. Conversion from decimal to other bases. BCD numbers. Boolean algebra. Logic gates. Function minimization, Tabular method, Karnaugh mapping. Arithmetic functions and circuits designs (HA, FA, and ALU). Combinational functions and circuits design (decoder, encoder, multiplexer and de-multiplexer). Sequential circuits definitions and designs (Latches, RS-FF, D-FF, JK-FF, T-FF). Simple buffer registers. Counters.

**COMP 226 DIGITAL SYSTEMS II (3Crs.:2Lec,2Lab)**

Latches and flip-flops. Synchronous and Asynchronous sequential systems. Registers and Counters. Control and Data path units. Serial data transfer for multiple register. Types of RAM and ROM. Cache concept. ALU functions and circuits (addition, subtraction, increment, decrement, transfer, AND, OR, XOR, NOT, etc.). Binary multiplier. BCD functions and circuits. Flags. Control unit. None binary logic. Several laboratory experiments and projects will be based on the simple logic gates to design micro-digital systems. Pre-req.: COMP 225.

**COMP 326 INTRODUCTION TO MICROPROCESSOR WITH APPLICATIONS (3Crs.:3Lec,0Lab)**

An introduction to basic computer organizations: Memory, Registers and Counters. Control and Data path units. Data transfer for multiple register. RAM and ROM. Instruction sets; assembly and machine languages. Detailed study of a particular microcomputer architecture and instruction set; assembly language programming and techniques; interrupt control systems; parallel and serial interfaces; the design of various types of digital as well as analog interfaces. Pre-req: COMP 225.

**COMP 326L INTRODUCTION TO MICROPROCESSOR WITH APPLICATIONS Lab (1Crs.:0Lec,2Lab)**

Laboratory provides practical hands-on experience with microprocessor and/or microcontrollers software application and interfacing techniques. Pre-req: COMP 225 and Co-req: COMP 226.

**COMP 426 MICROPROCESSOR INTERFACING (3Crs.:2Lec,2Lab)**

Topics include assembly language programming, microprocessor software applications, PPI and interfacing techniques: I/O port design and handshaking protocols; I/O programming, I/O interface design, Direct Memory Access, data communications, interrupt control systems; parallel and serial interfaces; timers. Several laboratory experiments will be based on microprocessors and/or microcontrollers. Pre-req: COMP 328.

**COMP 335 MICROPROCESSORS FOR BIOMEDICAL ENGINEERING (3Crs.:2Lec,2Lab)**

The course focuses on the principle of microprocessors and microcontrollers and their applications in Biomedical Engineering. Introduction to hardware system: CPU, Memory, Input/Output Interfacing, and System Bus. Instruction sets; assembly and machine languages. Fetch Cycle, Execution cycle, Instruction cycle. Detailed study of a particular Microprocessor or Microcontroller architecture: Instruction set; assembly language programming, Programming techniques, Loops, Delays, parallel and serial interfaces, interrupt control systems; Timers. Pre-req: COMP 226.

## Courses offered as university electives

The CE program offers two courses as General (University) Electives. The courses are described below.

**COMP 007 Website Development (2Crs.:2Lec,0Lab)**

This course covers the basic concepts needed to develop a website. The topics include: Internet and Web concepts, Creating web pages, Configuring images and multimedia on web pages, Web design best practices, Accessibility, usability and search engine optimizations, Obtaining a domain name and web host, Publishing to the Web.

**COMP 008 Programming basics (2Crs.:2Lec,0Lab)**

This course introduces the craft of computer basics: organization, architecture and programming. This course introduces newest developments of digital systems. Analyze problems, prepare flow charts and write, run and debug structured programs. Build application program for educational purposes.

# DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

## Electrical Power and Machines Program

## Mission

The Department of Electrical and Computer Engineering offers a Bachelor of Engineering in Electrical Power and Machines (EPM). The EPM program focuses on both the theoretical and practical aspects of power engineering by addressing the fundamental concepts of engineering mathematics, physical sciences, electrical machines, power electronic circuits, electrical power system analysis, and high voltage engineering. The department plays a vital role in providing Lebanon and the region with qualified electrical power engineers. The department also offers Master and Ph.D. degrees in electrical power engineering to cater for working professionals in electrical power companies, utilities, manufacturing establishments and the energy sector in Lebanon.

## Objectives

The educational objectives of the program are determined to support career advancement of the graduates and as they pursue their career goals, the graduates will:

1. Advance in engineering careers involving the design, optimization, and implementation of electrical systems, take innovative entrepreneurial ventures, and /or successfully pursue an advanced degree.
2. Acquire new knowledge and adapt to emerging technologies.
3. Assume leadership roles in multidisciplinary teams and promote sustainable eco-solutions in contemporary issues.
4. Communicate effectively and demonstrate ethical and professional behavior in a multicultural work environment.

## Learning Outcomes

Upon completion of the program graduates shall have:

a. An ability to apply knowledge of mathematics, science, and engineering;
b. An ability to design and conduct experiments, as well as to analyze and interpret data;
c. 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;
d. An ability to function on multi-disciplinary teams;
e. An ability to identify, formulate, and solve engineering problems;
f. An understanding of professional and ethical responsibility;
g. An ability to communicate effectively;
h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
i. A recognition of the need for, and an ability to engage in life-long learning;
j. A knowledge of contemporary issues;
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

## Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Electrical Power and Machines consists of 150 credit-hours of course work + ICDL, where the standard duration of study is 10 semesters.

## Career Opportunities

Electrical power engineers are involved in a wide variety of technology ranging from huge global positioning systems that can pinpoint the location of a moving vehicle to gigantic electrical power generators. These engineers are responsible for designing, developing, testing as well supervising the production of electrical and electronic equipment and machinery. Electric motors, controls of machinery, lights and wiring in building complexes, vehicles, aircrafts, power generations, control and transmission devices used by electric utilities are all examples of equipment built by these engineers. Electrical power engineers may choose to specialize in various areas like power generation, transmission and distribution, manufacture of electrical equipment or one particular specialty within these areas. These engineers are involved in designing new products, writing requirements for their performance, as well as developing maintenance schedules and charts. Testing equipment and machinery, solving operations problems, estimating time and cost of electrical and electronic products also come under their job.

## Program Overview

The Student's Study Plan is given to every EPM student upon his/her enrollment. The EPM curriculum consists of the following components:

| **I.Common Requirements** | **Credits** |
|---|---|
| General Education Requirements | 20 |
| Basic Sciences and Mathematics | 26 |
| General Engineering Topics | 9 |
| **II.EPM Program-Specific Requirements** | **Credits** |
| A. Engineering Topics from Outside the Major | 20 |
| B. Electrical Power and Machines Core | 58 |
| C. Electrical Power and Machines Technical Electives | 12 |
| D. Final Year Project | 4 |
| E. Internship | 1 |

**I.Common Requirements**

The list of the common requirement courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog.

**II.EPM Program-Specific Requirements**

**A.Engineering topics from outside the major**

This part of the EPM curriculum includes 20 credits offered by other engineering programs. These courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| ENGR 002 | Introduction to Engineering | 2 | |
| INME 423 | Project Planning and Management | 3 | |
| COME 212 | Electric Circuits II | 3 | Pre: POWE 212 |
| COME 212L | Electric Circuits Lab | 1 | Co: COME 212 |
| COME 221 | Electronic Circuits I | 3 | Pre: POWE 212 |
| COME 221L | Electronic Circuits I Lab | 1 | Co: COME 221 |
| COMP 225 | Digital Systems I | 3 | |
| COMP 326 | Intro. to Microprocessor with Applications | 3 | Pre: COMP 225 |
| COMP 326L | Intro. to Microprocessor with Applications Lab | 1 | Co: COMP 326 |

**Description of this group of courses is given below:**

**ENGR 002 INTRODUCTION TO ENGINEERING (2Crs.:2Lec)**

Introduction the student to the engineering profession in general and the learning objectives that new students should attain, as aligned with the ABET requirements. Covering the basics of the engineering profession and engineering ethics. Introduction to the different engineering majors and to the learning objectives as specified by ABET. Insight into different engineering courses that are not technical in nature (e.g., engineering economy). Engineering design tasks that allow the student to start thinking as engineers: problem definition, specification of constraints, investigation of different solution alternatives, implementation of best solution, writing technical reports. Fundamental tools and numerical software used in engineering. The tools and software covered could be generic or specific to a major.

**INME 423 PROJECT PLANNING AND MANAGEMENT (3Crs.:3Lec)**

Principles of project planning, project identification, time frame, project objectives, network construction (activity on arrows, activity on nodes), CPM and PERT applications, cost estimation, earned value analysis, project quality management, crashing of schedules, resource allocation and leveling, computer-based project management.

**COME 212 ELECTRIC CIRCUITS II (3Crs.:3Lec)**

Transient analysis, Laplace transform and its application to circuit analysis, two-port networks, frequency selective passive and active circuits. Pre-req.: POWE 212.

**COME 212L ELECTRIC CIRCUITS LAB (1 Cr.:2Lab)**

This lab serves the COME 212 course. Co-req.: COME 212.

**COME 221 ELECTRONIC CIRCUITS I (3 Crs.:3Lec)**

Introduction to semiconductor physics, junction diodes: construction, I-V characteristics, circuit models, applications, special purpose diodes: Zener diodes. Bipolar junction transistors (BJT) and field effect transistors (FET): types, physical structures, basic configurations, characteristic curves, circuit models, biasing circuits, small-signal amplifiers. Pre-req.: POWE 212.

**COME 221L ELECTRONIC CIRCUITS I LAB (1Cr.:2Lab)**

This lab serves the COME 221 course. Co-req.: COME 221.

**COMP 225 DIGITAL SYSTEMS I (3Crs.:2Lec,2Lab)**

Number systems and coding, Binary systems. Conversion from decimal to other bases. BCD numbers. Boolean algebra. Logic gates. Function minimization, Tabular method, Karnaugh mapping. Arithmetic functions and circuits designs (HA, FA, and ALU). Combinational functions and circuits design (decoder, encoder, multiplexer and de-multiplexer). Sequential circuits definitions and designs (Latches, RS-FF, D-FF, JK-FF, T-FF). Several laboratory experiments will be based on the simple logic gates.

**COMP 326 INTRODUCTION TO MICROPROCESSOR WITH APPLICATIONS (3Crs.:3Lec)**

An introduction to basic computer organizations, design and implementation of a simple computer; microprocessor instruction sets; assembly and machine languages. Detailed study of a particular microcomputer architecture and instruction set; assembly language programming and techniques; I/O port design; interrupt control systems; parallel and serial interfaces; the design of various types of digital as well as analog interfaces. Laboratory provides practical hands-on experience with microprocessor and/or micro-controllers software application and interfacing techniques. Pre-req.: COMP 225.

**COMP 326L INTRODUCTION TO MICROPROCESSOR WITH APPLICATIONS LAB (1Cr.:2Lab)**

This lab serves the COMP 326 course. Co-req.: COMP 326.

**B.Electrical Power and Machines Engineering Core**

The Electrical Power and Machines Engineering core courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| POWE 212 | Electric Circuits I | 3 | |
| POWE 271 | Electromagnetic Fundamentals | 3 | Pre: PHYS 281 |
| POWE 342 | Control Systems I | 3 | Pre: MATH 281, MATH 381, COME212 |
| POWE 342L | Control Systems Lab | 1 | Co: POWE 342 |

| | | | |
|---|---|---|---|
| POWE 324 | Electrical Power Systems | 3 | Pre: POWE 271 |
| POWE 324L | Electrical Power Systems Lab | 1 | Co: POWE 324 |
| POWE 344 | Instrumentation and Measurement | 3 | Pre: COME 221 |
| POWE 445 | Control Systems II | 3 | Pre: POWE 342 |
| POWE 435 | Electric Machinery I | 3 | Pre: POWE 271 |
| POWE 435L | Electric Machinery I Lab | 1 | Co: POWE 435 |
| POWE 423 | Electrical Power System Analysis | 3 | Pre: MATH 284, POWE 324 |
| POWE 433 | Power Electronic Circuits I | 3 | Pre: COME 221 |
| POWE 433L | Power Electronic Circuits Lab | 1 | Co: POWE 433 |
| POWE 436 | Electric Machinery II | 3 | Pre: POWE 435 |
| POWE 436L | Electric Machinery II Lab | 1 | Co: POWE 436 |
| POWE 420 | Electrical Power System Protection | 3 | Pre: POWE 423 |
| POWE 420L | Electrical Power System Protection Lab | 1 | Co: POWE 420 |
| POWE 434 | Power Electronic Circuits II | 3 | Pre: POWE 433 |
| POWE 500 | Research Methodology | 2 | Pre: ENGL 300 |
| POWE 543 | Industrial Automation | 3 | Pre: COMP 208, POWE 344 |
| POWE 543L | Industrial Automation Lab | 1 | Co: POWE 543 |
| POWE 531 | Electric Drives | 3 | Pre: POWE 434 |
| POWE 531L | Electric Drives Lab | 1 | Co: POWE 531 |
| POWE 528 | Electrical Power Generation | 3 | Pre: POWE 436 |
| POWE 526 | Introduction to Renewable Energy | 3 | Pre: POWE 436, POWE 434 |

**Description of Core Courses**

**POWE 212 ELECTRIC CIRCUITS I (3Crs:3Lec)**

Circuit variables: voltage, current, power, and energy. Circuit elements: resistors, inductors, capacitors, voltage sources, and current sources. Circuit reduction techniques: series and parallel resistors and delta-to-wye transformation. Ohm's law. Kirchhoff's laws. DC and AC circuit analysis techniques: node-voltage and mesh-current methods, source transformations, Thévenin and Norton equivalent circuits, and maximum power transfer. Self and mutual inductances. AC steady-state power calculations. Balanced three-phase circuits.

**POWE 271 ELECTROMAGNETIC FUNDAMENTALS (3Crs.:3Lec)**

Three-dimensional orthogonal coordinate systems: Cartesian, Cylindrical and Spherical.

Vector Analysis: Gradient, Divergence and Curl of fields, Divergence theorem, Stokes's theorem. Fundamental Postulates of Electrostatics in free space, Coulomb's Law in space, Gauss's Law in space. Material Media: Conductors and Dielectrics, Polarization, Electric Flux Density. Boundary Conditions. Capacitors and Electrostatic Energy. Poisson's Equation, Laplace's Equation, Method of Images, Boundary Value Problems, Steady Electric Currents: conduction and convection currents, equation of continuity, boundary conditions for current density. Resistance and Power calculations. Fundamental Postulates of Magnetostatics in free space, Biot-Savart law in space, Ampere's Law in space. Magnetic materials: Magnetization, Inductance and Magnetostatic Energy. Magnetic circuit analysis. Introduction to Magnetic Forces and Torques. Time varying fields: Faraday's Law for Electromagnetic Induction (stationary circuit in a time-varying magnetic field, Transformers, moving circuit in steady and time-varying magnetic fields), Maxwell's Equations, Electromagnetic boundary conditions. Pre-req.: PHYS 281.

**POWE 342 CONTROL SYSTEMS I (3Crs.:3Lec)**

History and role of control systems. Transfer function models. Block diagram representation and reduction. Transient and steady-state response analyses. Root-locus analysis and design. Frequency-response analysis and design. Simulation using MATLAB. Pre-req.: MATH 281, MATH 381, COME 212.

**POWE 342L CONTROL SYSTEMS LAB (1Cr.:2Lab)**

This lab serves the POWE 342 course. Co-req.: POWE 342.

**POWE 324 ELECTRICAL POWER SYSTEMS (3Crs.:3Lec)**

Power networks structure. Overhead transmission lines: parameters, constants, performance, loadability and compensation. Insulators and corona effect. Mechanical design. Underground power cables. Distribution systems: design, equipment and layouts. Reactive compensation and power factor correction. Pre-req.: POWE 271.

**POWE 324L ELECTRICAL POWER SYSTEMS LAB (1Cr.:2Lab)**

This lab serves the POWE 324 course. Co-req.: POWE 324.

**POWE 344 INSTRUMENTATION AND MEASUREMENT (3Crs.:2Lec,2Lab)**

Measurement errors. Measuring elements. Analogue and digital measuring instruments: voltmeter, ammeter, power meter, and energy meter. Instrument transformers. Measuring amplifiers. Analogue and digital oscilloscopes. Measurement of electrical quantities. Measurement systems: sensors and transducers. Installation and calibration of instruments. Pre-req.: COME 221.

**POWE 445 CONTROL SYSTEMS II (3Crs.:3Lec)**

Modern control versus classical control. State-space representation of dynamic systems. Matrix algebra. Analysis of linear state equations. Equilibrium points and stability. Controllability and observability. State equations and transfer function matrices. Pole-placement design. Simulation using MATLAB. Pre-req.: POWE 342.

**POWE 435 ELECTRIC MACHINERY I (3Crs.:3Lec)**

History of Electric Machinery. Magnetic circuits. Principles of energy conversion. Single-phase transformers: construction, theory of operation, equivalent circuit, power flow, regulation and testing, autotransformer, tap-change transformer. Three-phase transformers: connections, per-unit equivalent circuit and special connections. DC Machines: construction, theory of operation, armature reaction and commutation, induced voltage, developed torque and equivalent circuits for separately excited, series, parallel and compound DC generators and DC motors, starting methods of DC motors. PMDC motors and brushless DC motors: construction, theory of operation and applications. Introduction to DC motor drives. Pre-req.: POWE 271.

**POWE 435L ELECTRIC MACHINERY I LAB (1Cr.:2Lab)**

This lab serves the POWE 435 course. Co-req.: POWE 435.

**POWE 423 ELECTRICAL POWER SYSTEM ANALYSIS (3Crs.:3Lec)**

Power system modeling. Per-unit systems. Power flow analysis. Network stability analysis. Balanced faults. Symmetrical components and short circuit analysis. Introduction to economic dispatch and control of generation. Use of power system simulation packages. Pre-req.: MATH 284, POWE 324.

**POWE 433 POWER ELECTRONIC CIRCUITS I (3Crs.:3Lec)**

Introduction to power switches: diode, thyristor, triac, diac, GTO, BJT, MOSFET, IGBT, characteristics, modes of operation, selection of switches, firing circuit design and application, analysis and design of suitable circuits and subsystems for practical applications such as dimmer circuit and dc motor control circuit, calculation of switching losses, evaluation of THD and associated power losses. Rectifying circuits: single-phase and three-phase, uncontrolled, half-controlled and fully-controlled rectifiers for different types of passive loads, evaluation and demonstration of steady state voltages and currents, calculation of efficiency, PF and THD of such converters. Circuit analysis software such as PSIM, PROTEUS or MATLAB. Pre-req.: COME 221.

**POWE 433L POWER ELECTRONIC CIRCUITS LAB (1Cr.:2Lab)**

This lab serves the POWE 433 course. Co-req.: POWE 433.

**POWE 436 ELECTRIC MACHINERY II (3Crs.:3Lec)**

Three-phase AC machines: winding connections, rotating magnetic field theory, three phase induced voltages and torque. Three-phase induction motors: construction, theory of operation, equivalent circuit, power flow and regulation, starting and testing, torque speed analysis. Synchronous generators and motors: construction, theory of operation, induced voltage, equivalent circuit, voltage regulation, electrical and mechanical diagrams, and parallel operation. Single phase induction motor: construction, theory of operation, equivalent circuit, different types of starting methods and applications. Variable reluctance machines: switched reluctance, synchronous reluctance, and stepper motor. Hysteresis motor. Linear machine: induction, synchronous reluctance. Universal motor: construction theory of operation. Pre-req.: POWE 435.

**POWE 436L ELECTRIC MACHINERY II LAB (1Cr.:2Lab)**
This lab serves the POWE 436 course. Co-req.: POWE 436.

**POWE 420 ELECTRICAL POWER SYSTEM PROTECTION (3Crs.:3Lec)**
Protective relaying fundamentals, relay and switchgear characteristics, over-current relays. Zone of protection. Reclosers and fuses. High voltage distance protection and carrier schemes. Differential relays. Protection of generators, motors, transformers, and busbars. Relay coordination. Pre-req.: POWE 423.

**POWE 420L ELECTRICAL POWER SYSTEM PROTECTION LAB (1Cr.:2Lab)**
This lab serves the POWE 420 course. Co-req.: POWE 420.

**POWE 434 POWER ELECTRONIC CIRCUITS II (3Crs.:3Lec)**
Single and three phase AC voltage controllers for different types of loads. Introduction to induction motor speed control and static VAR control. DC to DC converters: linear voltage regulation, design consideration for buck, boost and cuk converters, modes of operation, effect of ripples, single, two and four-quadrant operation of DC motor speed control, design of buck-boost circuit for PV panels. Single phase and three phase inverters: square wave inverter, Fourier analysis and THD calculation, single phase and three phase multilevel inverter, bipolar and unipolar PWM technique, voltage control through pulse amplitude and PWM techniques, three phase PWM inverter and induction motor application. Circuit analysis software such as PSIM, PROTEUS or MATLAB. Pre-req.: POWE 433.

**POWE 500 RESEARCH METHODOLOGY (2Crs.:2Lec)**
Why to Conduct Scientific Research, Stepping in: Research Methodology, formulating a research problem, conceptualizing a research design, constructing an instrument for data collection, selecting samples, writing a research proposal, collecting data, processing and displaying data, writing a research report. Conducting Scientific Research at the faculty of Engineering. Pre-requisite: ENGL 300

**POWE 543 INDUSTRIAL AUTOMATION (3Crs.:3Lec)**
Automation and the economy. Hardwired logic versus programmable logic. Control system components. Industrial motor control: starting, braking, reversal, and sequencing. Introduction to programmable logic controllers. PLC hardware and memory organization. Ladder logic. Sequential and combinational logic instructions. Timers and counters programming. Data manipulation instructions. Math instructions. Installation practices and troubleshooting. Pre-req.: COMP 208, POWE 344.

**POWE 543L INDUSTRIAL AUTOMATION LAB (1Cr.:2Lab)**
This lab serves the POWE 543 course. Co-req.: POWE 543.

**POWE 531 ELECTRIC DRIVES (3Crs.:3Lec)**

History of electric drives and their elementary components, types of loads and dynamics of motor load combination, thermal limitation, considerations and classification of electric motors, analysis of different types of duties in drive systems, load cycle and motor rating selection of electric motors, steady-state stability of an electric drive. DC series, shunt, separately excited, characteristics curves with classical methods of speed controls (resistance, voltage and field control), design of chopper fed DC drives, first, second and fourth quadrant drive. Induction motor drives: performance and characteristics of classical drives (rotor resistance, supply voltage and supply voltage-frequency), modern drives (rotor injected voltage, slip power control, slip power recovery, stator voltage-current and frequency control), modern and classical methods for starting and braking of induction motors, industrial applications of electric drives. Pre-req.: POWE 434, POWE 436.

**POWE 531L ELECTRIC DRIVES LAB (1Cr.:2 Lab)**

This lab serves the POWE 531 course. Co-req.: POWE 531.

**POWE 528 ELECTRICAL POWER GENERATION (3Crs.:3 Lec)**

Overview of thermodynamics. Characteristics and operation of thermal units. Introduction to optimization techniques. Economic dispatch of thermal units and methods of solution. Unit commitment and forward dynamic programming. Generation with limited energy supply. Hydrothermal coordination. Demand forecast and reliability of generation. Pre-req.: POWE 436.

**POWE 526 INTRODUCTION TO RENEWABLE ENERGY (3Crs.:3Lec)**

Modeling, analysis, design, construction, efficiency and application of photovoltaic and wind energy systems. Introduction to fuel cells and hydrogen cycle. Introduction to business and career opportunities in renewable energy.
Pre-req.: POWE 434, POWE 436.

**POWE 501 FINAL YEAR PROJECT I (1 Cr) / POWE 502 FINAL YEAR PROJECT II (3Crs)**

After completing 120 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters; beginning in Fall-semester and ending in the following Spring-semester. The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student creativity and critical thinking and build skills in formulating, designing, developing, building, communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world.
Pre/Co-req.: POWE 500.
Refer to the Final Year Project Policy for more details.

**POWE 499 INTERNSHIP (1Cr)**

This is a professional training which should not be less than four weeks. The training is followed by a presentation session where the students are supposed to present what they have learned. Refer to the department policy for further details.

**C.Electrical Power and Machine Engineering Technical Electives**

The EPM curriculum includes two 12-credit hours as technical electives. The courses are chosen from the courses listed in the table below, with their descriptions given thereafter.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| POWE 428 | Electrical Design in Commercial and Industrial Buildings | 3 | Pre: POWE 324 |
| POWE 444 | Digital Control | 3 | Pre: POWE 445 |
| POWE 522 | High Voltage Engineering | 3 | Co: POWE 420, POWE 423 |
| POWE 533 | Specialized Modes of Machine Operation | 3 | Pre: POWE 436 |
| POWE 523 | Power System Planning | 3 | Pre: POWE 423 |
| POWE 534 | Advanced Topics In Power Electronic Circuits | 3 | Pre: POWE 434 |
| POWE 524 | Power System Control and Operation | 3 | Pre: POWE 445, POWE 423 |
| POWE 536 | Solid-State Drives | 3 | Pre: POWE 434 |
| POWE 529 | Wind Energy Systems | 3 | Pre: POWE 434, POWE 436 |

**Description of Technical Elective Courses**

**POWE 428 ELECTRICAL DESIGN IN COMMERCIAL AND INDUSTRIAL BUILDINGS (3Crs.:3Lec)**

Load characteristics. Local distribution grid. System design and analysis. Wiring for residential and industrial buildings. Hazards in industry and electrical safety considerations. Power quality of utility and building systems. Building Management Systems. Illumination. Pre-req.: POWE 324.

**POWE 444 DIGITAL CONTROL (3Crs.:3Lec)**

Introduction to digital control. Difference equations. The z-transform. Time-response and frequency-response of discrete-time systems. Sampling theorem. Modeling of digital control systems. Stability analysis. z-domain root locus. z-domain design. Differencing methods. Pole-zero matching. Bilinear transformation. Frequency-response design. Direct control design. Pre-req.: POWE 445.

**POWE 523 POWER SYSTEM PLANNING (3Crs.:3Lec)**
Short and long term load forecasting. Power system expansion planning: transmission and distribution. Generation and transmission reliability analysis. Outage simulation and optimum reliability level. Estimation of outage costs: residential and industrial. Power system security. Pre-req.: POWE 423.

**POWE 524 POWER SYSTEM CONTROL AND OPERATION (3Crs.:3Lec)**
Control problems in interconnected power systems. Modelling power system components and dynamic simulation. Excitation control systems. Q-V control channel. Generation control systems. P-f control channel. Review of energy management systems. Real time modelling: the SCADA system, system security, monitoring and control. Pre-req.: POWE 445, POWE 423.

**POWE 533 SPECIALIZED MODES OF MACHINE OPERATION (3Crs.:3Lec)**
Induction machine modes of operation: generation, plugging and braking, unbalanced operation. Induction regulator: single and three-phase, Selsyns and Synchros. Unsymmetrical operation of two-phase induction motor. AC tachogenerator. Pre-req.: POWE 436.

**POWE 534 ADVANCED TOPICS IN POWER ELECTRONIC CIRCUITS (3Crs.:2Lec,2Lab)**
Twelve-pulse converters. Switching mode power supplies. Current source inverters. Switching and conduction losses in power switches. Cooling of switching devices. Introduction to Protection of power switches. Induction furnace. Harmonic analysis. Active power filters. Multi-level inverters. Pre-req.: POWE 434.

**POWE 536 SOLID STATE DRIVES (3Crs.:3Lec)**
DC drives: ac to dc converter drives, dc to dc converter drive, coordinated control, performance. AC drives: ac voltage controller drives, slip energy recovery, inverter fed drives. Vector controlled induction machines. Simulation using MATLAB/SIMULINK. Pre-req.: POWE 434.

**POWE 522 HIGH VOLTAGE ENGINEERING (3Crs.:2Lec,2Lab)**
Introduction to high voltage engineering. Generation of testing signals and measurements. Electric breakdown mechanisms. Bus bar arrangement and system grounding. Surge arresters and insulation coordination. Traveling waves and Lattice diagram. Transient analysis. HV circuit breakers and switchgears. Protection against lightning. Co-req.: POWE 420, POWE 423.

**POWE 529 Wind Energy Systems (3Crs.:3Lec)**
Revision of wind energy system types, operation, modeling and analysis. Wind speed and sites for wind energy generation. Comparison and study of common wind turbine types. Analysis of power electronic circuits used in wind energy systems. Vector analysis of synchronous and induction machines. Operation, stability, control and protection of types one, two, three and four of wind turbines. Problems and challenges associated with the stability of wind energy systems. Pre-req.: POWE 434, POWE 436.

## Study Plan

Bachelor of Engineering in Electrical Power and Machines (150 Credits)

| First Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 281 | Linear Algebra | 3 | |
| MATH | 282 | Calculus | 3 | |
| PHYS | 282 | Properties of Materials, Mechanics and Heat | 3 | |
| CHEM | 241 | Principles of Chemistry | 3 | |
| ENGR | 002 | Introduction to Engineering | 2 | |
| | | General Elective | 2 | |

| Second Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| POWE | 212 | Electric Circuits I | 3 | |
| MATH | 283 | Differential Equations | 3 | Pre: MATH 281, MATH 282 |
| PHYS | 281 | Electricity and Magnetism | 3 | |
| MCHE | 213 | Dynamics | 3 | |
| MATH | 381 | Probability and Statistics | 3 | |
| CHEM | 405 | Solid-State Chemistry | 2 | |

| Summer I (8 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ARAB | 001 | Arabic Language | 2 | |
| ENGL | 001 | English Language | 2 | |
| | | General Elective | 2 | |
| | | General Elective | 2 | |

| Third Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COME | 212 | Electric Circuits II | 3 | Pre: POWE 212 |
| COME | 212L | Electric Circuits Lab | 1 | Co: COME 212 |
| MATH | 284 | Numerical Analysis | 3 | Pre: MATH 283 |
| POWE | 271 | Electromagnetic Fundamentals | 3 | Pre: PHYS 281 |
| COME | 221 | Electronic Circuits I | 3 | Pre: POWE 212 |
| COME | 221L | Electronic Circuits Lab | 1 | Co: COME 221 |
| COMP | 225 | Digital Systems I | 3 | |

| Fourth Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| POWE | 342 | Control Systems I | 3 | Pre: MATH 281, MATH 381, COME 212 |
| POWE | 342L | Control Systems Lab | 1 | Co: POWE 342 |
| POWE | 324 | Electrical Power Systems | 3 | Pre: POWE 271 |
| POWE | 324L | Electrical Power Systems Lab | 1 | Co: POWE 324 |
| POWE | 344 | Instrumentation and Measurement | 3 | Pre: COME 221 |
| COMP | 326 | Intro. to Microprocessor with Applications | 3 | Pre: COMP 225 |
| COMP | 326L | Intro. to Microprocessor with Applications Lab | 1 | Co: COMP 326 |
| ENGL | 211 | Advanced Writing | 2 | Pre: ENGL 001 |

| Summer II (8 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ENGR | 001 | Engineering Ethics | 1 | |
| BLAW | 001 | Human Rights | 1 | |
| MGMT | 002 | Entrepreneurship I | 2 | |
| ENGL | 300 | Speech Communication | 2 | Pre: ENGL 211 |
| | | General Elective | 2 | |

| Fifth Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| POWE | 445 | Control Systems II | 3 | Pre: POWE 342 |
| POWE | 435 | Electric Machinery I | 3 | Pre: POWE 271 |
| POWE | 435L | Electric Machinery I Lab | 1 | Co: POWE 435 |
| POWE | 423 | Electrical Power System Analysis | 3 | Pre: MATH 284, POWE 324 |
| POWE | 433 | Power Electronic Circuits I | 3 | Pre: COME 221 |
| POWE | 433L | Power Electronic Circuits Lab | 1 | Co: POWE 433 |
| INME | 221 | Engineering Economy | 3 | |

| Sixth Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 208 | Programming I | 3 | |
| POWE | 436 | Electric Machinery II | 3 | Pre: POWE 435 |
| POWE | 436L | Electric Machinery II Lab | 1 | Co: POWE 436 |
| POWE | 420 | Electrical Power System Protection | 3 | Pre: POWE 423 |

| | | | | |
|---|---|---|---|---|
| POWE | 420L | Electrical Power System Protection Lab | 1 | Co: POWE 420 |
| POWE | 434 | Power Electronic Circuits II | 3 | Pre: POWE 433 |
| INME | 423 | Project Planning and Management | 3 | |

| **Seventh Semester (18 Credits)** | | | **Crs.** | **Pre-co/requisites** |
|---|---|---|---|---|
| POWE | 543 | Industrial Automation | 3 | Pre: COMP 208, POWE 344 |
| POWE | 543L | Industrial Automation Lab | 1 | Co: POWE 543 |
| POWE | 531 | Electric Drives | 3 | Pre: POWE 434, POWE 436 |
| POWE | 531L | Electric Drives Lab | 1 | Co: POWE 531 |
| POWE | 499 | Internship | 1 | |
| POWE | 500 | Research Methodology | 2 | Pre: ENGL 300 |
| POWE | 501 | Final Year Project I | 1 | Pre/Co: POWE 500 |
| | | Technical Elective | 3 | |
| | | Technical Elective | 3 | |

| **Eighth Semester (15 Credits)** | | | **Crs.** | **Pre-co/requisites** |
|---|---|---|---|---|
| POWE | 528 | Electrical Power Generation | 3 | Pre: POWE 436 |
| POWE | 526 | Introduction to Renewable Energy | 3 | Pre: POWE 434, POWE 436 |
| POWE | 502 | Final Year Project II | 3 | Pre: POWE 501 |
| | | Technical Elective | 3 | |
| | | Technical Elective | 3 | |

## Courses offered to other majors

The Electrical Engineering Department offers two courses for other engineering majors. These courses are described below.

**POWE 211 ELECTRIC CIRCUITS (for mechanical engineering students) (3 Crs.: 3 Lec)**
Circuit variables. Ohm's law. Kirchhoff's laws. Series and parallel resistors. Voltage and current divider circuits. Delta-to-Wye transformation. Node-voltage and mesh-current methods. Thevenin equivalent circuit. Operational amplifiers. Sinusoidal steady-state analysis and power computations. Balanced-three phase circuits. Active filter circuits. Pre-req.: PHYS 281.

**POWE 333 ELECTRIC DRIVES (for mechanical engineering students) (2 Crs.: 2 Lec,)**
DC motors, DC motor drives, single-phase and three-phase induction motors, induction motor drives, synchronous motors, stepping motors, universal motor, switched-reluctance motors. Pre-req.: MCHE 214, Co-req.: MCHE 414.

## Elective University Requirement Course

The EPM program offers one course as General (University) Elective. The course is described below.

**POWE 001 ELECTRIC SAFETY (2 Crs.: 2 Lec)**
Hazards of electrical installations. Safety requirements. Recognition, evaluation and controlling electrical hazards. Physiological effects of electrical current. Good wiring practices. Color coding and grounding. Load calculation. Selecting proper overcurrent protective devices. Children protection. Emergency systems. Fire alarm systems.

# DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

## Biomedical Engineering Program

## Mission

The educational mission of Biomedical Engineering (BME) Program is to deliver high quality undergraduate education which combines balanced theoretical and practical topics in Biological, Medical and Electrical systems. Graduates of the program will have a mastery of fundamental knowledge in a variety of Biomedical Engineering fields, management, and entrepreneurial skills. Graduates will be qualified to pursue successful careers in their profession or graduate studies in different areas.

**Objectives**

The educational objectives of the program are determined to support career advancement of the graduates as they pursue their career goals. The graduates will:

1. Design, optimize and maintain biomedical systems in tune with community needs and environmental concerns
2. Be able to develop and integrate new technologies as they emerge
3. Engage in a technical/managerial role in diverse teams
4. Pursue entrepreneurial initiatives and launch startup companies
5. Communicate effectively and use resources skillfully in projects development

## Learning Outcomes

UPON COMPLETION OF THE PROGRAM GRADUATES SHALL BE ABLE TO:

a. An ability to apply knowledge of mathematics, science, and engineering
b. An ability to design and conduct experiments, as well as to analyze and interpret data
c. 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
d. An ability to function on multi-disciplinary teams
e. An ability to identify, formulate, and solve engineering problems
f. An understanding of professional and ethical responsibility
g. An ability to communicate effectively
h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. A recognition of the need for, and an ability to engage in life-long learning
j. A knowledge of contemporary issues
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

## Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Biomedical Engineering consists of 150 credit-hours of course work + ICDL, where the standard duration of study is 10 semesters.

## Career opportunities

Biomedical engineers are responsible for the creation of artificial organs, automated patient monitoring, blood chemistry sensors, advanced therapeutic and surgical devices, application of expert systems and artificial intelligence to clinical decision making, design of optimal clinical laboratories, medical imaging systems, computer modeling of physiological systems, biomaterials design, and biomechanics for injury and wound healing, among many others.

## Program Overview

The Student's Study Plan is given to every BME student upon his/her enrollment. The BIME curriculum consists of the following components:

| **I. Common Requirements ( 55 credits )** | **Credits** |
|---|---|
| General Education Requirements | 20 |
| Basic Sciences and Mathematics | 26 |
| General Engineering topics | 9 |
| **II. BME Program-Specific Requirements ( 95 credits )** | **Credits** |
| A. Engineering topics from outside the major | 5 |
| B. Basic Electrical, Computer and Communications Engineering | 38 |
| C. BME Core | 35 |
| D. BME Technical Electives | 12 |
| E. Final Year Project | 4 |
| F. Internship | 1 |

**I.Common Requirements**

The list of the Common Requirement courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog.

**II.BME Program-Specific Requirements**

**A.Engineering topics from outside the major**

This part of the biomedical engineering curriculum includes 5 credits offered by other engineering programs. These courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| ENGR 002 | Introduction to Engineering | 2 | |
| INME 423 | Project Planning and Management | 3 | |

## Descriptions of this group of courses are given below:

**ENGR 002 INTRODUCTION TO ENGINEERING (2Crs.:2Lec,0Lab)**

Introduction the student to the engineering profession in general and the learning objectives that new students should attain, as aligned with the ABET requirements. Covering the basics of the engineering profession and engineering ethics. Introduction to the different engineering majors and to the learning objectives as specified by ABET. Insight into different engineering courses that are not technical in nature (e.g., engineering economy)

Engineering design tasks that allow the student to start thinking as engineers: problem definition, specification of constraints, investigation of different solution alternatives, implementation of best solution, writing technical reports. Fundamental tools and numerical software used in engineering. The tools and software covered could be generic or specific to a major.

**INME 423 PROJECT PLANNING AND MANAGEMENT (3Crs.:3Lec)**

Principles of project planning, project identification, time frame, project objectives, network construction (activity on arrows, activity on nodes), CPM and PERT applications, cost estimation, earned value analysis, project quality management, crashing of schedules, resource allocation and leveling, computer-based project management.

**B.Basic Electrical, Computer and Communication Engineering**

This part of the BME curriculum includes 38-credits courses offered by the Electrical and Computer Engineering Department. These courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| POWE 212 | Electric Circuits I | 3 | |
| POWE 271 | Electromagnetic Fundamentals | 3 | Pre: PHYS 281 |
| COME 214 | Electric Circuits II | 3 | Pre: POWE 212 |
| COME 212L | Electric Circuits Lab | 1 | Pre: POWE 212, Co: COME 214 |
| COME 221 | Electronic Circuits I | 3 | Pre: POWE 212 |
| COME 222 | Electronic Circuits II | 3 | Pre: COME 221 |
| COME 222L | Electronic Circuits Lab | 1 | Pre: COME 221, Co: COME 222 |
| COME 381 | Signals and Systems | 3 | |
| COME 384 | Digital Signal Processing | 3 | Pre: COME 381 |
| COMP 225 | Digital Systems I | 3 | |
| COMP 226 | Digital Systems II | 3 | Pre: COMP 225 |

| | | | |
|---|---|---|---|
| COMP 335 | Microprocessors for Biomedical Engineering | 3 | Pre: COMP 226 |
| COMP 534 | Pattern Recognition | 3 | |
| COMP 535 | Digital Image Processing | 3 | |

**Descriptions of this group of courses are given below:**

**POWE 212 ELECTRIC CIRCUITS I (3Crs.:3Lec,0Lab)**
Circuit variables: voltage, current, power, and energy. Circuit elements: resistors, inductors, capacitors, voltage sources, and current sources. Circuit reduction techniques: series and parallel resistors and delta-to-wye transformation. Ohm's law. Kirchhoff's laws. DC and AC circuit analysis techniques: node-voltage and mesh-current methods, source transformations, Thévenin and Norton equivalent circuits, and maximum power transfer. Self and mutual inductances. AC steady-state power calculations. Balanced three-phase circuits.

**POWE 271 ELECTROMAGNETIC FUNDAMENTALS (3 Crs.: 3Lec,0Lab)**
Three-dimensional orthogonal coordinate systems: Cartesian, Cylindrical and Spherical. Vector Analysis: Gradient, Divergence and Curl of fields, Divergence theorem, Stokes's theorem. Fundamental Postulates of Electrostatics in free space, Coulomb's Law in space, Gauss's Law in space. Material Media: Conductors and Dielectrics, Polarization, Electric Flux Density. Boundary Conditions. Capacitors and Electrostatic Energy. Poisson's Equation, Laplace's Equation, Method of Images, Boundary Value Problems, Steady Electric Currents: conduction and convection currents, equation of continuity, boundary conditions for current density. Resistance and Power calculations. Fundamental Postulates of Magnetostatics in free space, Biot-Savart law in space, Ampere's Law in space. Magnetic materials: Magnetization, Inductance and Magnetostatic Energy. Magnetic circuit analysis. Introduction to Magnetic Forces and Torques. Time varying fields: Faraday's Law for Electromagnetic Induction (stationary circuit in a time-varying magnetic field, Transformers, moving circuit in steady and time-varying magnetic fields), Maxwell's Equations, Electromagnetic boundary conditions. Pre-requisite: PHYS 281

**COME 214 ELECTRIC CIRCUITS II (3Crs.:3Lec,0Lab)**
Transient analysis, Laplace transform and its application to circuit analysis, two-port networks, frequency selective passive and active circuits. Pre-requisite: POWE 212

**COME 212L ELECTRIC CIRCUITS LAB (1Cr.:0Lec,2Lab)**
The content of this lab is directly related to the courses POWE 212, COME 214. Co-requisite.: COME 214.

**COME 221 ELECTRONIC CIRCUITS I (3Crs.:3Lec,0Lab)**

Introduction to semiconductor physics, junction diodes: construction, I-V characteristics, circuit models, applications, special purpose diodes: Zener diodes. Bipolar junction transistors (BJT) and field effect transistors (FET): types, physical structures, basic configurations, characteristic curves, circuit models, biasing circuits, small-signal amplifiers. Pre-requisite.: POWE 212.

**COME 222 ELECTRONIC CIRCUITS II (3Crs.:3Lec,0Lab)**

BJT and FET amplifiers: Types, circuit models, frequency response, differential and multistage amplifiers, large signal analysis and power amplifiers, operational amplifiers: Characteristics, applications, imperfections, feedback amplifiers, sinusoidal oscillators and multi-vibrators. Pre-requisite.: COME 221.

**COME 222L ELECTRONIC CIRCUITS LAB (1Cr.:0Lec,2Lab)**

The content of this lab is directly related to the courses COME 221, COME 222.Co-requisite: COME 222.

**COME 381 SIGNALS AND SYSTEMS (3Crs.:3Lec,0Lab)**

Signals and systems properties and classifications. Continuous Linear Time-Invariant systems. Analytical and graphical convolution. Fourier series and Fourier Transform. Hilbert transform, pre-envelope, complex envelope. Frequency spectra, energy and power spectra. Laplace transform. Frequency response and transfer function, impulse response and step response. Filter design. Butterworth and Chebyshev filters

**COME 384 DIGITAL SIGNAL PROCESSING (3Crs.:2Lec,2Lab)**

Sampling, Quantization and SQNR. Signal Reconstruction and anti-aliasing filter. Discrete time signals. Discrete Linear Time-Invariant systems. Difference equations and impulse responses. BIBO stability. Digital convolution. Discrete Fourier Transform and Fast Fourier Transform. Z-transform. Digital filter frequency response and transfer function. Z-plane stability. Realization of digital filters. Methods of FIR and IIR filter designs. Digital Butterworth and Chebyshev filter designs. Pre-requisite: COME 381.

**COMP 225 DIGITAL SYSTEMS I (3Crs.:2Lec,2Lab)**

Number systems and coding, Binary systems. Conversion from decimal to other bases. BCD numbers. Boolean algebra. Logic gates. Function minimization, Tabular method, Karnaugh mapping. Arithmetic functions and circuits designs (HA, FA, and ALU). Combinational functions and circuits design (decoder, encoder, multiplexer and de-multiplexer). Sequential circuits definitions and designs (Latches, RS-FF, D-FF, JK-FF, T-FF). Simple buffer registers. Counters.

**COMP 226 DIGITAL SYSTEMS II (3Crs.: 2Lec, 2Lab)**

Latches and flip-flops. Synchronous and Asynchronous sequential systems. Registers and Counters. Control and Data path units. Serial data transfer for multiple register. Types of RAM and ROM. Cache concept. ALU functions and circuits (addition, subtraction, increment, decrement, transfer, AND, OR, XOR, NOT, etc.). Binary multiplier.

BCD functions and circuits. Flags. Control unit. None binary logic. Several laboratory experiments and projects will be based on the simple logic gates to design micro-digital systems. Pre-requisite.: COMP 225.

**COMP 335 MICROPROCESSORS FOR BIOMEDICAL ENGINEERING (3Crs.: 2Lec, 2Lab)**
The course focuses on the principle of microprocessors and microcontrollers and their applications in Biomedical Engineering. Introduction to hardware system: CPU, Memory, Input/Output Interfacing, and System Bus. Instruction sets; assembly and machine languages. Fetch Cycle, Execution cycle, Instruction cycle. Detailed study of a particular Microprocessor or Microcontroller architecture: Instruction set; assembly language programming, Programming techniques, Loops, Delays, parallel and serial interfaces, interrupt control systems; Timers. Pre-requisite: COMP 226.

**COMP 534 PATTERN RECOGNITION (3Crs.:3Lec)**
Reconstruction from projections. Scene understanding. Matching and recognition. Methods for reconstructing three-dimensional scene information using techniques such as depth from stereo, structure from motion, and shape from shading. Motion and video analysis. Three-dimensional object recognition.

**COMP 535 DIGITAL IMAGE PROCESSING (3Crs.:3Lec)**
Image formation and perception. Image representation. Transformations on digital images. Enhancement and restoration. Segmentation. Encoding and data compression.

**C.Biomedical Engineering Program Core**
The BME program core courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| HESC 201 | Human Anatomy and Physiology | 3 | |
| HESC 202 | Health Care Profession and Bio Ethics | 1 | |
| BIOL 231 | Biology I | 3 | |
| PHYS 352 | Biophysics | 3 | |
| CHEM 234 | Organic Chemistry | 3 | |
| BIME 310 | Biomedical Instrumentation I | 3 | |
| BIME 411 | Biomedical Instrumentation II | 3 | Pre: BIME 310 |
| BIME 441 | Biomedical Sensors | 3 | Pre: COME 222 |
| BIME 411L | Biomedical Instrumentation Lab | 1 | Pre: BIME 310, Co: BIME 411 |
| BIME 421 | Biomedical Imaging I | 3 | Pre: COMP 534, COMP 535 |
| BIME 422 | Biomedical Imaging II | 3 | Pre: BIME 421 |
| BIME 422L | Biomedical Imaging Lab | 1 | Co: BIME 422 |

| | | | |
|---|---|---|---|
| BIME 432 | Biological Materials | 3 | Pre: BIOL 231 |
| BIME 500 | Research Methodology | 2 | |

## Description of Core Courses

**HESC 201 HUMAN ANATOMY AND PHYSIOLOGY (3Cr:2Lec,2Lab,0Tut)**

This course studies the structure (brief anatomy) and function (detailed physiology) of the following body systems: muscular, nervous, endocrine, blood, lymphatic, cardiovascular, respiratory, digestive, urinary, and reproductive. The student is also introduced to topics in metabolism, nutrition, and general heredity within a physiological and homeostatic environment.

**HESC 202 HEALTHCARE PROFESSION AND BIOETHICS (1Cr:1Lec,0Lab,0Tut)**

The major centers around the globe that have a health profession in interest are involved with understanding the significance of healthcare law and bioethics. The major components of this course are: Introduction to medical law, ethics, and bioethics; The legal system and its environment; Importance of the legal system for the physician and the healthcare professional; Today's healthcare environment; The CLS–Patient relationship; Professional liability and medical/biomedical malpractice; Public duties of the healthcare professional; Workplace law and ethics; The medical record; Ethical and bioethical issues in medicine; Ethical issues relating to life.

**BIOL 231 BIOLOGY I (3Crs.:3Lec)**

This course introduces the students to fundamental concepts in biology. Topics to be covered include the cellular and chemical basis of life, organization of life, energy transfer through living organisms, evolution, diversity of life with emphasis on the animal and plant kingdoms and their interaction with the environment.

**PHYS 352 BIOPHYSICS (3Crs.:3Lec)**

Fluids: Circulation of the blood, blood pressure, power produced by heart. Heat: transfer of heat, transport of molecules by diffusion, respiratory system, surfactants and breathing, diffusion and contact lenses. Thermodynamics of living systems, energy from food, regulation of body temperature, evaporation, resistance to cold, heat and soil. Sound: hearing and the ear, clinical uses of sound, ultrasonic waves. Electricity: the nervous system, electricity in plants, electricity in bone, electric fish, electrocardiograph, physiological effects of electricity, sensory aids. Optics: structure of the eye, accommodation, eye and the camera, retina, defects in vision, fiber optics. X-rays: computerized tomography CT. Lasers: lasers surgery. Nuclear Physics: magnetic resonance imaging, radiation therapy, food preservation by radiation, isotopic tracers.

**CHEM 234 ORGANIC CHEMISTRY (3Cr.:3Lec)**

The course provides the necessary background in organic chemistry in the context of living cells. Nomenclature of chemical compounds, chemical bonding and structure, conformations and stereochemistry, organic reactivity and catalysis, organic acids and bases. Nucleophilic substitution, phosphoryl transfer, nucleophilic carbonyl addition, acyl substitution, electrophilic, oxidation, reduction and radical reactions.

**BIME 441 BIOMEDICAL SENSORS (3Crs.:2Lec,2Lab)**
Introduction to biomedical sensors. Sensors are used for measuring: pressure, temperature, blood flow, motion, PH… Acquisition of biomedical signals, EEG,ECG, EMG…Signal conditioning and noise. Pre-requisite.: COME 222

**BIME 310 BIOMEDICAL INSTRUMENTATION I (3Crs.:3Lec)**
Basic concepts of medical instrumentation, amplifiers and signal processing, biopotential electrodes, biopotential amplifiers, blood pressure and sound phono cardiography, cardiac catheterization, measurement of flow and volume of blood indicator-dilution methods, electromagnetic and ultrasonic flow meters, plethysmograph, measurements of the respiratory system, chemical biosensors.

**BIME 411 BIOMEDICAL INSTRUMENTATION II (3Crs.:3Lec)**
Clinical laboratory instrumentation: spectrophotometry, photometers, fluorometry, automated chemical analyzers, chromatography, electrophoresis, and hematology. Pre-requisite.: BIME 310

**BIME 411L BIOMEDICAL INSTRUMENTATION LAB (1Cr: 3 Lab)**
The content of this lab is directly related to the courses BIME 310, BIME 411.Co-requisite: BIME 411

**BIME 421 BIOMEDICAL IMAGING I(3Crs.:3Lec)**
This course introduces imaging tools like X-ray, computed tomography (CT), magnetic resonance imaging (MRI), nuclear medicine (PET and SPECT), and ultrasound. Introduction to medical image processing and analysis. Pre-requisite: COMP 534, COMP 535.

**BIME 422 BIOMEDICAL IMAGING II (3Crs.:3Lec)**
This course covers magnetic resonance imaging schematics for CT, MRI pulse sequences, MRI instrumentation and equipment, MRI safety. X-ray image geometry, magnification radiography, X-ray site protection. Fluoroscopy, catheterization and endoscopy. Pre-requisite: BIME 421

**BIME 422L BIOMEDICAL IMAGING LAB (1Cr, 3Lab)**
The content of this lab is directly related to the courses BIME 421, BIME 4422.Co-requisite: BIME 422

**BIME 432 BIOLOGIOCAL MATERIALS (3Crs.:2Lec, 2Lab)**
Properties of materials used in medicine, biodegradation and toxic kinetic, sterilization processes, cytotoxicity, interactions with blood, genotoxicity, carcinogenicity. Regulatory aspects of biomaterials. Pre-requisite.: BIOL 231.

**BIME 499 INTERNSHIP (1Cr)**

This is a professional training which should not be less than four weeks. The training is followed by a presentation session where the students are supposed to present what they have learned. Refer to the department policy for further details. Pre-requisite.: BIME500

**BIME 500 RESEARCH METHODOLOGY (2Crs.:2Lec, 0Lab)**

Why to Conduct Scientific Research, stepping in: Research Methodology. Formulating a research problem, conceptualizing a research design, constructing an instrument for data collection. Selecting samples, writing a research proposal, collecting data, processing and displaying data, writing a research report. Conducting Scientific Research at the faculty of Engineering.

**BIME 501 FINAL YEAR PROJECT I (1Cr) / BIME 502 FINAL YEAR PROJECT II (3Crs)**

After completing 120 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters; beginning in Fall-semester and ending in the following Spring-semester. The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student creativity and critical thinking, and build skills in formulating, designing, developing, building, communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world. Pre-requisite.: BIME 500
Refer to the Final Year Project Policy for more details.

**D. Biomedical Engineering Program Technical Electives**

The BME curriculum includes 12-credit hour courses as technical electives. The courses are chosen from the courses listed in the table below, with their descriptions given thereafter.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| BIME 511 | Cell and Tissue Engineering | 3 | Pre: BIOL 231 |
| BIME 514 | Medical Equipment | 3 | Pre: BIME 411 |
| BIME 541 | Telemedicine` | 3 | Pre: BIOL 337, BIME 411 |
| BIME 532 | Introduction to Neuroscience for Engineers | 3 | Pre: BIOL 231 |

## Description of Technical Elective Courses

**BIME 511 CELL AND TISSUE ENGINEERING (3Crs.:3Lec,0Lab)**

Applying engineering principles, combined with molecular cell biology, to develop a fundamental understanding of property-function relationships in cells and tissues. Exploiting this understanding to manipulate cell and tissue properties to alter, restore, maintain, or improve cell and tissue functions; and to design bio-artificial tissue substitutes. Pre-requisite: BIOL 231

**BIME 514 MEDICAL EQUIPMENT (3Crs.:3Lec,0Lab)**
Inspection and preventive maintenance program, hospital and home patient equipment, lab equipment, ventilators, hemodialysis machine, anesthesia machine, diagnosis imaging and radiology machines. Pre-requisite: BIME 411

**BIME 532 INTRODUCTION TO NEUROSCIENCE FOR ENGINEERS (3Crs.:3Lec,0Lab)**
Introduction to the nervous system, with emphasis on the structure and function of the human brain. Functions of nerve cells, sensory systems, control of movement, learning and memory, and diseases of the brain. Review of neuro engineering methods and technologies that enable the study of and therapeutic solutions for diseases or damage of the nervous system. Pre-requisite: BIOL 231

**BIME 541 TELEMEDICINE (3Crs.:3Lec,0Lab)**
Describes and analyses the role of information and communications technologies in enabling remote patient care, health professional collaboration at a distance, and in supporting patient-self management. This is considered with reference to technological, clinical, sociological and policy perspectives. Pre-requisite: BIOL 337, BIME 411

## Study Plan

**Bachelor of Engineering in Biomedical Engineering (150 Credits)**

| First Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 281 | Linear Algebra | 3 | Pre: MATH112 |
| MATH | 282 | Calculus | 3 | Pre: MATH111 |
| MCHE | 213 | Dynamics | 3 | |
| PHYS | 281 | Electricity and Magnetism | 3 | Pre: PHYS120 |
| ENGR | 002 | Introduction to Engineering | 2 | |
| BLAW | 001 | Human Rights | 1 | |
| ARAB | 001 | Arabic Language | 2 | |

| Second Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 225 | Digital Systems I | 3 | |
| MATH | 283 | Differential Equations | 3 | Pre: MATH 281, MATH 282 |
| PHYS | 282 | Material Properties and Heat | 3 | |
| COMP | 208 | Programming I | 3 | |
| POWE | 212 | Electric Circuits I | 3 | |
| ENGL | 001 | English Language | 2 | |

| Summer I (9 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CHEM | 241 | Principles of Chemistry | 3 | |
| ENGL | 211 | Advanced Writing | 2 | ENGL 001 |
| | | Elective(General) | 4 | |

| Third Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| BIOL | 231 | Biology I | 3 | |
| COME | 221 | Electronic Circuits I | 3 | Pre: POWE 212 |
| COME | 214 | Electric Circuits II | 3 | Pre: POWE 212 |
| COME | 212L | Electric Circuits LAB | 1 | Co: COME 214 |
| COMP | 226 | Digital Systems II | 3 | Pre: COMP 225 |
| POWE | 271 | Electromagnetic Fundamentals | 3 | Pre: PHYS281 |

| Fourth Semester (15 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 381 | Probability and Statistics | 3 | Pre: MATH 282 |
| MATH | 284 | Numerical Analysis | 3 | Pre: MATH 283 |
| COME | 222 | Electronic Circuits II | 3 | Pre: COME 221 |
| COME | 222L | Electronic Circuits Lab | 1 | Co: COME 222 |
| INME | 221 | Engineering Economy | 3 | |
| ENGL | 300 | Speech Communications | 2 | Pre: ENGL 211 |

| Summer II (9 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CHEM | 405 | Solid State Chemistry | 2 | CHEM 241 |
| ENGR | 001 | Engineering Ethics | 1 | |
| MGMT | 002 | Entrepreneurship | 2 | |
| | | Elective (General) | 4 | |

| Fifth Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COME | 381 | Signals and Systems | 3 | |
| HESC | 201 | Human Anatomy and Physiology | 3 | |
| INME | 423 | Project Planning and Management | 3 | |
| BIME | 441 | Biomedical Sensors | 3 | Pre: COME 222 |
| COMP | 335 | Microprocessors for Biomedical Engineering | 3 | Pre: COMP 226 |
| | | Technical Elective | 3 | |

| Sixth Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| HESC | 202 | Health Care Profession and Bio Ethics | 1 | |
| PHYS | 352 | Biophysics | 3 | |
| CHEM | 234 | Organic Chemistry | 3 | Pre: COME 381 |
| BIME | 310 | Biomedical Instrumentation I | 3 | |
| COMP | 534 | Pattern Recognition | 3 | |
| COME | 384 | Digital Signal Processing | 3 | Pre: COME 381 |

| Seventh Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 535 | Digital Image Processing | 3 | |
| BIME | 411 | Biomedical Instrumentation II | 3 | Pre: BIME 310 |
| BIME | 411L | Biomedical Instrumentation Lab | 1 | Co: BIME 411 |
| BIME | 421 | Biomedical Imaging I | 3 | Pre: COMP 534, COMP 535 |
| BIME | 499 | Internship (Approved Experience / Independent Study) | 1 | |
| BIME | 500 | Research Methodology | 2 | |
| BIME | 501 | Final Year Project I | 1 | Pre: ENGL 300, ENGR 001 |
| | | Technical Elective | 3 | |

| Eighth Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| BIME | 422 | Biomedical Imaging II | 3 | Pre: BIME 421 |
| BIME | 422L | Biomedical Imaging Lab | 1 | Co: BIME 422 |
| BIME | 432 | Biological Materials | 3 | Pre: BIOL 231 |
| BIME | 502 | Final Year Project II | 3 | Pre: BIME 501 |
| | | Technical Elective | 3 | |
| | | Technical Elective | 3 | |

# DEPARTMENT OF INDUSTRIAL ENGINEERING AND ENGINEERING MANAGEMENT

## Academic Staff

| | |
|---|---|
| **Acting Chairperson** | Akram Tannir |
| **Associate Professors** | Hadi Abou Chakra |
| **Assistant Professors** | Akram Tannir, Ramzi Fayad |
| **Full- time Instructors** | Zeidoun Zeidan |
| **Part-time Lecturers** | Rola Sammoura, |
| **Part-time Instructors** | Abdelkader Elsaiidi, Amina Al Ashi |

## Mission

The Department of Industrial Engineering and Engineering Management (INME) mission is to provide graduates who are technically competent; have basic management and inter-personal skills; contemporary and relevant engineering education to design and improve operations in industry, business, and government for the global economy of the 21st century; and promote life-long learning.

## Objectives

The department offers a bachelor degree in industrial engineering (IE). The IE program has the following objectives:

1. Graduates will be able to identify and implement effective solutions to real problems by applying contemporary industrial engineering tools and cutting-edge technology in production, quality, safety, supply chain, optimization, economic, manufacturing, service and information systems.
2. Graduates will be able to formulate problems accurately, generate alternative solutions, evaluate those alternatives, and present the best solutions to clients or decision makers in a fashion that facilitates decision-making processes.
3. Graduates will be able to assume leadership roles with strong communication skills and will be able to work competently and ethically alone and as team members.

**Learning Outcomes**

Upon completion of the program graduates shall be able to:

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. 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
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

## Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Industrial Engineering and Engineering Management consists of 150 credit-hours of course work + ICDL.

## Career Opportunities

Industrial engineering differs from other branches of engineering in essentially two ways. First, it applies to all types of industrial, commercial, and government activities. Second, it is a branch of engineering that is explicitly concerned with people, products, as well as processes and operations. Industrial engineers learn to make decisions concerning the best use of people, material, and equipment in achieving organizational aims. They are spread across nearly all kinds of manufacturing. Recent data show that employment offerings are especially plentiful in manufacturing and service sectors, management consulting, chemicals, and food processing. Students develop skills in mathematics, the sciences, communications, and humanities. Therefore, an industrial engineering (IE) degree qualifies professionals for a diverse array of jobs, including: Engineering Project Manager, Supply Chain and Operations Manager, Quality Engineer, Industrial Scheduling Engineer, Maintenance and Safety Engineer, Production Process Engineer, Service Process Engineer, Construction Management Engineer, and Industrial Management Engineer. A growing trend in IE profession, especially consulting, is in the services sector of the economy such as banking, transportation, logistics, and government.

## Program Overview

The Student's Study Plan is provided to every IE student upon his/her enrollment. The IE curriculum consists of the following components:

| **I. Common Requirements** | **Credits** |
|---|---|
| General Education Requirements | 20 |
| Basic Sciences and Mathematics | 26 |
| General Engineering topics | 15 |
| **II. CEE Program-Specific Requirements** | **Credits** |
| A. Industrial Engineering core | 72 |
| B. Industrial Engineering Technical Electives | 12 |
| C. Final Year Project | 4 |
| D. Internship | 1 |

**I. Common Requirements**
The list of the Common Requirement courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog.
**II. IE Program-Specific Requirements**
**A. Industrial Engineering Core Courses**
The Industrial Engineering core courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| INME204 | Introduction to Industrial Engineering | 2 | |
| INME211 | Engineering Materials and Technology | 3 | PHYS282 |
| INME212 | Metal Shaping | 3 | INME211 |
| INME214 | Manufacturing Processes | 3 | INME211 |
| INME222 | Operations Research | 3 | MATH281 |
| INME312 | Computer Aided Design and Manufacturing | 3 | MCHE201 |
| INME321 | Management Information Systems | 3 | INME204 |
| INME321L | Management Information Systems | 1 | INME204 Co: INME321 |
| INME322 | Organization Design | 3 | INME204 |
| INME324 | Production and Operation Management | 3 | INME222 |
| INME325 | Stochastic Operations Research | 3 | MATH381 |
| INME332 | Industrial Measurements and Inspection | 3 | MATH284 |
| INME332L | Industrial Measurements and Inspection | 1 | MATH284 Co: INME332 |
| INME333 | Facility Planning and Design | 3 | INME204 |
| INME341 | Engineering Safety | 3 | INME212 and INME214 |
| INME422 | Engineering Logistics and Supply Chain | 3 | INME325 |
| INME423 | Project Planning and Management | 3 | MATH381 |
| INME423L | Project Planning and Management | 1 | MATH381 Co: INME423 |
| INME431 | System Modeling and Simulation | 3 | COMP208 |
| INME431L | System Modeling and Simulation | 1 | COMP208 Co: INME431 |
| INME433 | Maintenance Planning and Technology | 2 | INME204 |
| INME434 | Statistical Quality and Process Control | 3 | MATH381 |
| INME442 | Ergonomics | 2 | CVLE210 |
| INME500 | Research Methodology | 2 | ENGL300 |
| INME521 | Total Quality Management and Six Sigma | 3 | INME434 |
| INME522 | Management of Global Operations | 3 | INME422 |
| INME531 | Production Systems and Automations | 3 | INME333 |
| INME535 | Advanced Engineering Statistics | 3 | MATH381 |

**Description of Core Courses**

**INME 204 INTRODUCTION TO INDUSTRIAL ENGINEERING (2Crs.:2Lec,0Lab)**
The course is designed to familiarize first year students with the concept of, and various aspects of Industrial Engineering. Introduction to selected topics in Industrial Engineering, including: facilities design, project management, production and operation management.

**INME 211 ENGINEERING MATERIALS TECHNOLOGY (3Crs.:2Lec,2Lab)**
Structure of metals, principles of material properties and theory of elasticity, metal alloys, strengthening by heat treatment, atomic diffusion, and material selection for different engineering applications. Pre-req.: PHYS282.

**INME 212 METAL SHAPING (3Crs.:2Lec,2Lab)**
Fundamentals of casting and metal casting processes. Metal forming: bulk and sheet metalworking. Material removal processes. Pre-req.: INME211.

**INME 214 MANUFACTURING PROCESSES (3Crs.:3Lec,0Lab)**
Assembly processes such as welding, brazing, soldering, and fastening. Applications of nontraditional machining processes and thermal cutting processes. Analysis, limitation, economics and process selection of major manufacturing processes of metals. Pre-req.: INME211.

**INME 221 ENGINEERING ECONOMY (3Crs.:3Lec,0Lab)**
Basics principles and techniques of economic analysis of engineering project, time value of money, present worth, annual worth, internal rate of return, benefit-cost, cost allocation and estimation, evaluation of engineering projects and investments, depreciation, inflation, bond and loan financing, after tax cash flow, sensitivity analysis, single and multi-attribute decisions, alternative selection of engineering proposals.

**INME 222 OPERATIONS RESEARCH (3Crs.:3Lec,0Lab)**
Introduction to deterministic operations research models, linear programming, (simplex method and sensitivity analysis), transportation, assignment, waiting line and queuing, deterministic inventory models, software applications and demonstrations. Pre-req.: MATH281.

**INME 312 COMPUTER AIDED DESIGN AND MANUFACTURING (3Crs.:1Lec,4Lab)**
Geometric/solid modeling, design optimization, graphical and computational features of CAD, engineering analysis and design execution and implementation, manual code programming G code, finite element analysis (FEA), contemporary design techniques for solving and analyzing applied design problems using FEA. Pre-req.: MECH201.

**INME 321 MANAGEMENT INFORMATION SYSTEMS (3Crs.:3Lec,0Lab)**
This course covers the classification of Information Systems based on their objectives, an introduction to e-commerce and knowledge management and a preview about supply chain management and customer relationship management systems Pre-req.: INME204.

**INME 321L MANAGEMENT INFORMATION SYSTEMS (1Crs.: 0Lec,2Lab)**
The content of this lab is directly related to the course INME321. Students will implement the concepts of managing information by building simple, real life systems with database management software such as ACCESS and ORACLE. Co-req.: INME321.

**INME 322 ORGANIZATION DESIGN (3Crs.:3Lec,0Lab)**
Study of design, innovation, change and implementation issues in organizations, structure and process approaches in both new and existing manufacturing and service settings and in green field and redesign situations, team work, participation, reward systems, employee involvement, union management relations, new technology, are also included, case studies, visitors and video examples are used for instruction. Pre-req.: INME204.

**INME 324 PRODUCTION AND OPERATIONS MANAGEMENT (3Cr.:3Lec,0Lab)**
Fundamentals of forecasting time series and linear regression, capacity of production systems, inventory control, aggregate planning, material requirement planning MRP, enterprise resource-planning ERP, decision theory and decision tree. Co-req.: INME222.

**INME 325 STOCHASTIC OPERATION RESEARCH (3Cr.:3Lec,0Lab)**
Review of probability and introduction to stochastic processes, Markov chains, first passage times, ergodic and absorbing chains, continuous time processes, birth-death processes, Poisson processes, Markovian and general queue models. Co-req.: MATH381.

**INME 332 INDUSTRIAL MANAGEMENT AND INSPECTION (3Crs.:3Lec,0Lab)**
Theory of measurements with emphasis on standardization, dimensional and geometrical tolerance on part components, principles of amplification in measurements including mechanical, different monitoring systems, vibration monitoring analysis of signals, application of Matlab software to analyze vibration signal. Pre-req.: MATH284.

**INME 332L INDUSTRIAL MANAGEMENT AND INSPECTION (1Crs.:0Lec,2Lab)**
The content of this lab is directly related to the courses INME332. Pre-req.: MATH28 Co-req.: INME332.

**INME 333 FACILITY PLANNING AND DESIGN (3Crs.:3Lec,0Lab)**
Fundamentals of developing efficient layouts of various production/service systems, travel chart, layout procedures, Time Study, Facility Location, single-facility and multi-facility location problem, material handling system design for production facilities. Pre-req.: INME 204.

**INME 341 ENGINEERING SAFETY (2Crs.:2Lec,0Lab)**
Construction and manufacturing safety, engineering principles to control hazards, maintaining optimally safe systems, applications of engineering principles to process safety and hazards analysis, mitigation, and prevention. . Pre-req.: INME212 and INME214.

**INME 422 ENGINEERING LOGISTICS AND SUPPLY CHAIN (3Crs.:3Lec,0Lab)**
Introduction to supply chain management and logistics, managing inventory in the supply chain and risk pooling, designing the distribution network, supply chain integration, strategic partnering, the bullwhip effect and information sharing, and supply chain contracts. Pre-req.: INME222.

**INME 423 PROJECT PLANNING AND MANAGEMENT (3Crs.:3Lec,0Lab)**
Principles of project planning, project identification, time frame, project objectives, network construction (activity on arrows, activity on nodes), CPM and PERT applications, cost estimation, earned value analysis, project quality management, crashing of schedules, resource allocation and leveling, computer-based project management.

**INME 423L PROJECT PLANNING AND MANAGEMENT (1Crs.:0Lec,2Lab)**
The content of this lab is directly related to the courses INME423. Co-req.: INME323

**INME 431 SYSTEM MODELING AND SIMULATION (3Crs.:3Lec,0Lab)**
Principles of simulation, Systems concepts, modeling, design and analysis of network flows for material and information, modeling of discrete and continuous systems, advanced system modeling, case studies with verification and validation. Pre-req.: COMP208.

**INME 431 SYSTEM MODELING AND SIMULATION (1Crs.: Lec,2Lab)**
The content of this lab is directly related to the courses INME431. Pre-req.: COMP208 Co-req.: INME431.

**INME 433 MAINTENANCE PLANNING AND TECHNOLOGY (3Crs.:3Lec,0Lab)**
Maintenance strategy, maintenance organization, maintenance systems, condition based maintenance, maintenance awareness in design, cost of maintenance team, effectiveness, and case studies. Pre-req.: INME204.

**INME 434 STATISTICAL QUALITY AND PROCESS CONTROL (3Crs.:3Lec,0Lab)**
Quality control, quality improvement techniques, Pareto diagrams, cause-effect diagrams, scatter diagrams, run charts, cause and effect diagrams, statistical process control using control charts for variables and attributes, and acceptance sampling plans by attributes and variables. Pre-req.: MATH381.

**INME 442 ERGONOMICS (2Crs.:2Lec,0Lab)**
The biology of work: anatomical and physiological factors underlying the design of equipment and work places. Biomechanical factors governing physical workload and motor performance, circadian rhythms and shift work, measurement and specification of heat, light, and sound with respect to design of the work environment. Pre-req.: CVLE210.

**INME 499 INTERNSHIP (1Cr)**

This is a professional training which should not be less than four weeks. The training is followed by a presentation session where the students are supposed to present what they have learned. Pre-req.: INME500

Refer to the department policy for further details.

**INME 500 RESEARCH METHODOLOGY (2Crs.:2Lec,0Lab)**

Steps for conducting a successful research: formulating a research problem, conceptualizing a research design, constructing an instrument for data collection, writing a research proposal, collecting data, processing and displaying data, writing a research report. Pre-req.: ENGL300.

**INME 501 FINAL YEAR PROJECT I (1Cr) / INME 502 FINAL YEAR PROJECT II (3Crs)**

After completing 120 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters. The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student creativity and critical thinking, and build skills in formulating, designing, developing, building, communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world. Pre-req.: INME500

Refer to the Final Year Project Policy for more details.

**INME 521 TOTAL QUALITY MANAGEMENT AND SIX SIGMA (3Crs.:3Lec,0Lab)**

Total quality systems in manufacturing and services, strategic quality management, quality culture, customer satisfaction and retention, employee empowerment, team work, the six-sigma paradigm, benchmarking, Pareto analysis, flow charts and swim-lane diagrams, cause-effect and system diagrams, and quality function deployment. Pre-req.: INME434.

**INME 522 MANAGEMENT OF GLOBAL OPERATIONS (3Crs.:3Lec,0Lab)**

Introduction to international operations and multi-national enterprises, study of factors affecting operations in a global environment with focus on international economic issues. Pre-req.: INME422.

**INME 531 PRODUCTION SYSTEMS AUTOMATION (3Crs.:3Lec,0Lab)**

Types of automation, production systems, time Study, system efficiency, mathematical models, automation strategies, cost analysis of automated production line, assembly systems, manual assembly lines, and group technology. Pre-req.: INME333.

**INME 535 ADVANCED ENGINEERING STATISTICS (3Crs.:3Lec,0Lab)**

Topics cover advanced statistical tools for engineering that analyze multivariate statistical data. Those include Factor and Component Analysis, Stepwise Regression models and diagnosis, Discriminant and Logistic Regression, MANOVA. Pre-req.: MATH381

**B.Industrial Engineering Technical Elective Courses**

The IE curriculum includes three 3-creidt hour courses as technical electives. The courses are chosen from the courses listed in the table below with their descriptions given thereafter.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| INME331 | Engineering Design | 3 | INME212 and INME214 |
| INME414 | Industrial Scheduling | 3 | INME324 |
| INME416 | Industrial Packaging | 3 | INME214 |
| INME418 | Plastic Engineering | 3 | INME214 |
| INME421 | Reliability | 3 | MATH381 |
| INME432 | Failure Analysis | 3 | MCHE213 |
| INME514 | Business Process Re-engineering | 3 | MATH381 |
| INME516 | Advanced Manufacturing Processes | 3 | INME214 |
| INME518 | Strategic Manufacturing Planning | 3 | INME214 and INME333 |
| INME537 | Analysis of variance and Design of Experiments | 3 | MATH381 |
| INME539 | Reverse Engineering and Prototyping | 3 | INME331 |

## Description of Technical Elective Courses

**INME 331 ENGINEERING DESIGN (3Crs.:3Lec,0Lab)**

General principle of machine design, basic design principle of machine elements, fasteners and fittings, shaft, gears, and bearings selection Pre-req.: INME 212 and INME 214.

**INME 414 INDUSTRIAL SCHEDULING (3Crs.:3Lec,0Lab)**

Basic scheduling models for single machine, parallel machines, flow shops and flexible flow shops, applications in production and services and algorithms will be explained from theoretical and applied perspectives. Pre-req.: INME324.

**INME 416 INDUSTRIAL PACKAGING (3Crs.:3Lec,0Lab)**

Packaging materials' selection, Manufacturing of food packaging, packaging machinery, packaging line, filling systems, packaging materials and containers. Pre-req.: INME331.

**INME 418 PLASTICS ENGINEERING (3Crs.:3Lec,0Lab)**

Plastic materials and their processing, review of the pertinent organic chemistry of polymer materials, classification, properties, characteristics and applications of plastics; applications, process parameters, quality, economics and tooling considerations. Pre-req.: INME214.

**INME 421 RELIABILITY (3Crs.:3Lec,0Lab)**
Life distribution and their applications in reliability, system reliability models, design by reliability and probabilistic design, reliability analysis through FMECA and FTA, reliability estimation and measurement by testing for binomial, exponential and Weibull distribution. Pre-req.: MATH 381.

**INME 432 FAILURE ANALYSIS (3Crs.:3Lec,0Lab)**
Brittle fracture, ductile fracture, stress residual, Groffith's theory and Irwin's theory, crack initiation, crack propagation and spreading, fraction toughness, reasons of failures, procedures of failure analysis, metallurgical failure analysis, fatigue, creep, case studies. Pre-req.: INME 331.

**INME 514 BUSINESS PROCESS RE-ENGINEERING (3Crs.: 3Lec,0Lab)**
Topics include business Process diagnosis, design, and development, organizational restructuring, process simplification, job optimization, management systems modeling, performance improvement. Pre-req.: INME324.

**INME 516 ADVANCED MANUFACTURING PROCESSES (3Crs.: 3Lec,0Lab)**
Advanced topics in manufacturing materials and processes, including metallic/ nonmetallic materials and their fabrication, non-materials, rapid prototyping, and materials' testing. Pre-req.: INME214.

**INME 518 STRATEGIC MANUFACTURING PLANNING (3Crs.:3Lec,0Lab)**
Formulate a framework for developing and implementing a manufacturing strategy, develop a framework for the strategic management of manufacturing, technical tools and frameworks that directly apply to operational decisions and that can be useful in adding value to manufacturing firms. Pre-req.: INME214 and INME333

**INME 537 ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENTS (3Crs.:3Lec,0Lab)**
This course introduces designs of experiment as a statistical tool for engineering problem analysis. Topics include single factor experiments, fixed and random effects model, post hoc analysis, randomized block experiments, Latin-square design, factorial experiments, 2k factorial with confounding and fractional designs. Pre-req.: MATH381.

**INME 539 REVERSE ENGINEERING AND PROTOTYPING (3Crs.:3Lec,0Lab)**
Concept, techniques, analysis and applications of engineering design, fundamentals of design and design principles, conceptual design, importance of sketching, use of computer aided drafting and computer aided design packages, reverse engineering principles, design projects and case studies. Pre-req.: INME331.

## Study Plan

**Bachelor of Engineering in Industrial Engineering (150 Credits)**

| First Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MCHE | 201 | Engineering Drawing and Graphics | 3 | |
| MATH | 281 | Linear Algebra | 3 | Pre: MATH 112 |
| PHYS | 281 | Electricity and Magnetism | 3 | |
| CHEM | 241 | Principle of Chemistry | 3 | |
| MCHE | 213 | Dynamics | 3 | |
| BLAW | 001 | Human Rights | 1 | |

| Second Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 282 | Calculus | 3 | Pre: MATH 111 |
| CHEM | 207 | Environmental Chemistry | 2 | Pre: CHEM 110 |
| PHYS | 282 | Materials properties and Heat | 3 | |
| INME | 204 | Introduction to Industrial Engineering | 2 | |
| CVLE | 210 | Statics | 3 | |
| COMP | 208 | Programming I | 3 | |

| Summer I (8 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ARAB | 001 | Arabic Language | 2 | |
| ENGL | 001 | English Language | 2 | |
| | | Elective (General) | 4 | |

| Third Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 381 | Probability and Statistics | 3 | Pre: MATH 282 |
| MATH | 283 | Differential Equations | 3 | Pre: MATH 281 and MATH 282 |
| INME | 211 | Engineering Materials and Technology | 3 | Pre: PHYS 282 |
| INME | 321 | Management Information Systems | 3 | Pre: INME 204 |
| INME | 321L | Management Information Systems Lab | 1 | Pre: INME 204 Co: INME 321 |
| INME | 221 | Engineering Economy | 3 | |
| ENGL | 211 | Advanced Writing | 2 | Pre: ENGL001 |

| Fourth Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| INME | 312 | Computer Aided Design and Manufacturing | 3 | Pre: MECH 201 |
| MATH | 284 | Numerical Analysis | 3 | Pre: MATH 283 |
| INME | 222 | Operations Research | 3 | Pre: MATH 281 |
| INME | 212 | Metal Shaping | 3 | Pre: INME 211 |
| INME | 214 | Manufacturing Processes | 3 | Pre: INME 211 |
| INME | 322 | Organization Design | 3 | Pre: INME 204 |

| Summer II (8 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MGMT | 002 | Entrepreneurship | 2 | |
| ENGL | 300 | Speech Communications | 2 | Pre: ENGL 211 |
| | | Elective (General) | 4 | |

| Fifth Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| INME | 325 | Stochastic Operations Research | 3 | Pre: MATH 381 |
| INME | 423 | Project Planning and Management | 3 | Pre: MATH 381 |
| INME | 423L | Project Planning and Management | 1 | Pre: MATH 381 Co: INME 423 |
| INME | 341 | Engineering Safety | 2 | Pre: INME 212 and INME 321 |
| INME | 333 | Facility Planning and Design | 3 | Pre: INME 204 |
| | | Technical Elective | 6 | |

| Sixth Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| INME | 422 | Engineering Logistics and Supply Chain | 3 | Pre: INME 325 |
| INME | 434 | Statistical Quality and Process Control | 3 | Pre: MATH 381 |
| INME | 332 | Industrial Measurements and Inspection | 3 | Pre: MATH 284 |
| INME | 332L | Industrial Measurements and Inspection Lab | 1 | Pre: MATH 284 Co: INME 332 |
| INME | 324 | Production and Operation Management | 3 | Pre: INME 222 |
| INME | 442 | Ergonomics | 2 | Pre: CVLE 210 |
| INME | 500 | Research Methodology | 2 | Pre: ENGL 300 |

| Seventh Semester (15 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| INME | 535 | Advanced Engineering Statistics | 3 | Pre: MATH 381 |
| INME | 499 | Internship | 1 | |
| INME | 433 | Maintenance Planning and Technology | 3 | Pre: INME 204 |
| INME | 531 | Production Systems and Automations | 3 | Pre: INME 333 |
| INME | 431 | System Modeling and Simulation | 3 | Pre: COMP 208 |
| INME | 431L | System Modeling and Simulation Lab | 1 | Pre: COMP 208 Co INME 431 |
| INME | 501 | FYP 1 | 1 | Pre: INME 500 |

| Eighth Semester (14 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| INME | 522 | Management of Global Operations | 3 | Pre: INME 422 |
| INME | 521 | Total Quality Management and Six Sigma | 3 | Pre: INME 434 |
| | | Technical Elective | 6 | |
| ENGR | 001 | Engineering Ethics | 1 | |
| INME | 502 | FYP 2 | 3 | Pre: INME 501 |

# DEPARTMENT OF MECHANICAL ENGINEERING

## Academic Staff

| | |
|---|---|
| **Chairperson** | Ali Hammoud |
| **Associate Professors** | Ahmed Abdel-Naby, Mohamad Khamis, Amr Ibrahim |
| **Assistant Professors** | Ossama Mokhiamar, Mohamad Darwiche, Semaan Amine Mohamad Kanaan, Amine Abou Moughlbay, Hassan Assoum Mohamad Ali |
| **Part-time Lecturers** | Bilal Taher, Ziad Naga, Mazen Badawiyeh, Khodor Yassin |

## Mission

The Mechanical Engineering Department is devoted to educating exemplary mechanical engineers by instituting best learning practices that drive knowledge, build skills and competencies, inspire learners to define a purpose, develop a passion to forever learn, cultivate a sense of responsibility toward the profession, society and environment, and attain the ability to confront challenges, and in so doing contribute to the advancement of the community.

## Objectives

The educational objectives of the ME program are determined to support career advancement of the graduates and as they pursue their career goals, the graduates will:

1. be competent to handle complex engineering tasks and provide innovative solutions through the integration of best practices.
2. be recognized for their ability to pursue graduate studies in mechanical engineering and related interdisciplinary areas.
3. demonstrate leadership in their fields of expertise and service to local and international communities.

## Learning Outcomes

Upon completion of the program graduates shall be able to:

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. 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
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

## Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Mechanical Engineering consists of 150 credit-hours of course work in addition to ICDL, where the standard duration of study is 4 years including two summer terms.

## Career Opportunities

Mechanical engineers attain a broad spectrum of skills sought by almost every profession. Industries, enterprises, and service providers requiring mechanical engineering skills include: power generation and distribution, building and construction, medicine and pharmacology, aerospace, automotive, food, process, security, computers and electronics, renewable energy, consulting, entertainment, water resources, sports, environmental institutions, and government. Most importantly, you can imagine something that never was and make it a reality! There is so much work to be done to guarantee the future of mankind and mechanical engineers can tap the possibilities through the spirit of innovation and entrepreneurism.

## Program Overview

The student's study plan is given to every ME student upon his/her enrollment. The ME curriculum consists of the following components:

| **I. Common Requirements** | **Credits** |
|---|---|
| General Education Requirements | 20 |
| Basic Sciences and Mathematics | 26 |
| General Engineering topics | 15 |
| **II. CEE Program-Specific Requirements** | **Credits** |
| A. Engineering topics from outside the major | 11 |
| B. Mechanical Engineering Core | 61 |
| C. Mechanical Engineering Technical Electives | 12 |
| D. Final Year Project | 4 |
| E. Internship | 1 |

**I.Common Requirements**

The list of the Common Requirement courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog.

## General Engineering courses offered by the ME department

The department of Mechanical Engineering offers 6-credit general engineering courses listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| MCHE 201 | Engineering Drawing and Graphics | 3 | |
| MCHE 213 | Dynamics | 3 | |

These two courses are described below.

**MCHE 201 ENGINEERING DRAWING AND GRAPHICS (3Crs.:1Lec,4Lab)**

Constructional Geometry-constructing tangents. Plane curves and polygons. Orthographic drawing and theory of sketching shapes and surface identification. Orthographic projection of views. Sectional views and conventions. Pictorial drawing. Applications of Auto-CAD software for 2D drawings.

**MCHE 213 DYNAMICS (3Crs.:3Lec,0Lab)**

Kinematics of a particle. Kinetics of a particle and system of particles: Free-body diagram and concept of equilibrium, Newton's laws of motion, Work and energy principle, Linear impulse and momentum principle. Planar motion and kinematics of rigid bodies.

**II.ME Program-Specific Requirements**

**A.Engineering topics from outside the major**

This part of the ME curriculum includes 11-credit courses offered by other engineering programs. These courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| INME 211 | Engineering Materials and Technology | 3 | Pre: PHYS 282 |
| INME 212 | Metal Shaping | 3 | Pre: INME 211 |
| POWE 211 | Electric Circuits (for Mechanical Engineering students) | 3 | Pre: PHYS 281 |
| POWE 335 | Electric Drives (for Mechanical Engineering students) | 2 | Pre: MCHE 214<br>Co: MCHE 416 |

## Descriptions of this group of courses are given below.

**INME 211 ENGINEERING MATERIALS AND TECHNOLOGY (3Crs.:2Lec,2Lab)**

Introduction to material and material properties, iron and steel. Structure of metals, principles of materials properties, theory of elasticity, metal alloys, strengthening by heat treatment, material selection for different engineering applications and micro structure of materials, ferrous materials, non-ferrous materials, polymers and composites. Pre-req.: PHYS 282.

**INME 212 METAL SHAPING (3Crs.:2Lec,2Lab)**
Fundamentals of casting and metal casting processes. Metal forming. Bulk and sheet metalworking. Material removal processes. Pre-req.: INME 211.

**POWE 211 ELECTRIC CIRCUITS (for Mechanical Engineering students) (3Crs.:3Lec,0Lab)**
Circuit variables. Ohm's law. Kirchhoff's laws. Series and parallel resistors. Voltage and current divider circuits. Delta-to-Wye transformation. Node-voltage method. Mesh-current method, Thevenin equivalent circuit. Operational amplifiers. Sinusoidal steady-state analysis and power computations. Balanced-three phase circuits. Active filter circuits. Pre-req.: PHYS 281.

**POWE 335 ELECTRIC DRIVES (for Mechanical Engineering students) (2Crs.:2Lec,0Lab)**
DC motors. DC motor drives. Single-phase and three-phase induction motors. Induction motor drives. Synchronous motors. Stepping motors. Universal motor. Switched-reluctance motors. Pre-req.: MCHE 214, Co-req: MCHE 416.

**B.Mechanical Engineering core courses**
The Mechanical Engineering core courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| MCHE 214 | Fundamentals of Mechatronics | 2 | Pre: POWE 211; Co: MCHE 214L |
| MCHE 214L | Fundamentals of Mechatronics Lab | 1 | Co: MCHE 214 |
| MCHE 216 | Dynamics of Machinery I | 3 | Pre: MCHE 213 |
| MCHE 315 | Instrumentation and Measurement | 2 | Pre: COMP 208, MCHE 214; Co: MCHE 315L |
| MCHE 315L | Instrumentation and Measurement Lab | 1 | Co: MCHE 315 |
| MCHE 311 | Mechanics of Materials | 3 | Pre: CVLE 210; Co: INME211 |
| MCHE 312 | Machine Design I | 3 | Pre: MCHE 201, MCHE 311 |
| MCHE 317 | Dynamics of Machinery II | 3 | Pre: MCHE 216 |
| MCHE 321 | Thermodynamics I | 3 | Pre: PHYS 282 |
| MCHE 322 | Thermodynamics II | 3 | Pre: MCHE 321 |
| MCHE 331 | Fluid Mechanics I | 3 | Pre: PHYS 282 |
| MCHE 332 | Fluid Mechanics II | 3 | Pre: MCHE 331 |
| MCHE 411 | Machine Design II | 3 | Pre: MCHE 312, MCHE 317 |

| | | | |
|---|---|---|---|
| MCHE 412 | Dynamic Systems Modeling and Analysis | 3 | Pre: MATH 283, MCHE 317 |
| MCHE 416 | Mechatronics System Design | 2 | Pre: MCHE 315; Co: MCHE 416L, POWE 335 |
| MCHE 416L | Mechatronics System Design Lab | 1 | Co: MCHE 416 |
| MCHE 421 | Heat Transfer | 3 | Pre: MATH 284 MCHE 321 and MCHE 332 |
| MCHE 422 | Refrigeration and Air Conditioning | 3 | Pre: MCHE 421 |
| MCHE 429 | Thermo-fluids Lab | 2 | Pre: MCHE 332; Co: MCHE 421 |
| MCHE 500 | Research Methodology | 2 | Pre: ENGL 300 |
| MCHE 511 | Dynamic Systems Control | 3 | Pre: MCHE 412 |
| MCHE 521 | Thermal Power Stations | 3 | Pre: MCHE 322 |
| MCHE 531 | Pump Technology | 3 | Pre: MCHE 332 |
| MCHE 534 | Fluid Thermal System Design | 3 | Pre: MCHE 531 |

## Description of Core Courses

**MCHE 214 FUNDAMENTALS OF MECHATRONICS (2Crs.:2Lec,0Lab)**

Introduction to mechatronic systems. Basic electronic components. Overview of analogue and digital electronic circuits. Semiconductors and the PN Junction. Diode circuits and applications. Rectification – half- and full-wave. Bipolar junction transistors. IGBT and MOSFET operation and circuits. Motor drives. Operational amplifiers. Applications. Pre-req.: POWE 211; Co-req.: MCHE214L.

**MCHE 214L FUNDAMENTALS OF MECHATRONICS LAB (1Cr.:0Lec,2Lab)**

Passive electronic components. Laboratory instruments. Voltage-divider and bridge circuits. RC filters and lead-lag networks. LEDs. Zener regulator. Diode rectifier circuits. BJT, IGBT, and MOSFET applications. Op-amp circuits. Filters and oscillators. Co-req.: MCHE 214.

**MCHE 216 DYNAMICS OF MACHINERY I (3Crs.:3Lec,0Lab)**

Principles of motion generation and introduction to the concepts of mobility, degrees of freedom and kinematic chains. Kinematics analysis of linkage mechanisms. Types and synthesis of cam-follower mechanisms for specified follower motion. Synthesis of linkage mechanisms for motion, path and function generation. Computer-aided analysis project. Pre-req.: MCHE 213.

**MCHE 315 INSTRUMENTATION AND MEASUREMENT (2Cr.:2Lec,0Lab)**
Elements of a measurement system. Classification of sensors. Sensor characteristics. Sensor types. Statistical analysis of data, curve fitting, and uncertainty analysis. Physical principles. Interfacing concepts - amplification, filtering, A/D conversion. Pre-req.: COMP 208, MCHE 214, Co-req.: MCHE 315L.

**MCHE 315L INSTRUMENTATION AND MEASUREMENT LAB (1Cr.:0Lec,2Lab)**
Introduction to LABVIEW. Experiments to measure various physical quantities. Data acquisition and analysis using NI-ELVIS platform. Typical laboratory experiments involve building signal conditioning circuits for thermocouples, thermistors, photodiodes, strain gauges, accelerometers, etc. Team project to design and develop a measurement system. Co-req.: MCHE 315.

**MCHE 311 MECHANICS OF MATERIALS (3Crs.:3Lec,0Lab)**
Introduction to the mechanics of deformable bodies considering linear material response. Load-stress, stress-strain, and strain-displacement relations. Tension/compression of rods and trusses, torsion of shafts, bending in beams, bucking of columns, and pressure vessels. Analysis of combined loading. Mohr circle analysis. Stress-strain transformations. Statically indeterminate structures. Pre-req.: CVLE 210; Co-req.: INME 211.

**MCHE 312 MACHINE DESIGN I (3Crs.:3Lec,0Lab)**
Overview of the mechanical design process. Analytical concepts and tools for the design of machine elements. Failure theories. Design for strength under static and fatigue loading. Design for rigidity. Design of shafts. Design of non-permanent joints and power screws. Design of permanent joints. Design of mechanical springs. Computer aided applications. Pre-req.: MCHE 201, MCHE 311.

**MCHE 317 DYNAMICS OF MACHINERY II (3Crs.:3Lec,0Lab)**
Types of gears and gear tooth terminology for different types of gears. Force Analysis for spur gearing. Kinematic analysis of ordinary and planetary gear trains. Kinetostatic analysis of rigid mechanisms. Balancing of mechanisms and rotating machinery. Flywheel design. Pre-req.: MCHE 216.

**MCHE 321 THERMODYNAMICS I (3Crs.:3Lec,0Lab)**
Introduction and basic concepts. Properties of pure substances. Energy analysis of closed systems. Mass and energy analysis of control volumes. Second law of Thermodynamics. Heat engines and Carnot cycle. Refrigerators and heat pumps. Entropy. Gas power cycles and ideal cycles for reciprocating engines. Vapor refrigeration cycles. Introduction to psychrometry. Pre-req.: PHYS 282.

**MCHE 322 THERMODYNAMICS II (3Crs.:3Lec,0Lab)**
Rankine cycle. Reheat and regenerative steam power generation plants. Gas turbines and Brayton cycle including regeneration, inter-cooling, and reheat. Cogeneration and combined cycles. Thermodynamic analysis of power plants. Steam flow through nozzles. Steam flow through turbines, Classification of steam turbines, Forces exerted on different types of turbine blades. Computer applications. Pre-req.: MCHE 321.

**MCHE 331 FLUID MECHANICS I (3Crs.:3Lec,0Lab)**
Fluid static, Forces on immersed surfaces, buoyancy and stability of floating bodies, Fluid Flow kinematics, fluid masses subjected to acceleration, vortex motion, hydrodynamics, momentum equation, Euler's and Bernoulli's equations, fluid flow in pipelines. Pre-req.: PHYS 282.

**MCHE 332 FLUID MECHANICS II (3Crs.:3Lec,0Lab)**
Fluid flow kinematics for three-dimensional fluid motions. Elementary hydrodynamics. Basic and combined flow field applications. Dynamics of compressible and incompressible flow. Continuity equation. Navier-Stokes equations, Dimensional analysis using PI- Theorem. Boundary layers. Lift and drag Forces. Fluid film lubrication. Pre-req.: MCHE 331.

**MCHE 411 MACHINE DESIGN II (3Crs.:3Lec,0Lab)**
Analysis and synthesis of various types of gear trains. Geometry and force analysis of helical, bevel and worm gears and gear trains. Design of gear drives for strength using AGMA standards for spur, helical, bevel and worm gearing. Rolling-contact bearings. Design of belt and chain drives. Design of clutches and brakes. Computer-aided applications. Team project to formulate and design a mechanical system for a useful purpose. Pre-req.: MCHE 312, MCHE 317.

**MCHE 412 DYNAMIC SYSTEMS MODELING AND ANALYSIS (3Crs.:3Lec,0Lab)**
Introduction to dynamic modeling of mechanical, electrical, thermal and fluid systems. State-space equations. Analysis of linear systems. Time- and frequency-domain analysis. Laplace transform techniques. Nonlinear systems. Introduction to dynamic systems characteristics and performance. Simulation using Matlab and Simulink. Pre-req.: MATH 283, MCHE 317.

**MCHE 416 MECHATRONICS SYSTEM DESIGN (2Crs.:2Lec,0Lab)**
Introduction to designing mechatronic systems and embedded technology platforms for real-time control. Microcontroller programming. A/D and D/A conversion. Hardware/ software development tools. Programmable timers. Digital circuits and digital logic. Pre-req.: MCHE 315, Co-Req.: POWE 335 and MCHE 416L.

**MCHE 416L MECHATRONICS SYSTEM DESIGN LAB (1Cr.:0Lec,2Lab)**
Introduction to basic electronics, introduction to Arduino, serial connection, analog and digital I/O, motor speed control, data display. Team project to develop a mechatronic system. Co-Req.: MCHE 416

**MCHE 421 HEAT TRANSFER (3Crs.:3Lec,0Lab)**
Concepts and laws of conduction, convection and radiation heat transfer and their application to solving engineering thermal problems. Steady and transient heat conduction. Heat generation. Extended surfaces. External and internal forced convection of laminar and turbulent flows. Natural convection. Heat exchanger principles. Thermal radiation, view factors, and radiation exchange between gray bodies. Boiling and condensation. Computer aided applications. Pre-req.: MATH 284 , MCHE 321 and MCHE 332.

**MCHE 422 REFRIGERATION AND AIR CONDITIONING (3Crs.:3Lec,0Lab)**
Introduction to refrigeration methods: Air refrigeration, steam jet, thermoelectric, absorption, vapor compression system, psychometric processes and cycles, cooling and heating loads, duct design, air conditioning systems, noise criteria, fan selection, air outlet types and selection. Pre-req.: MCHE 421.

**MCHE 429 THERMO-FLUIDS LAB (2Crs.:0Lec,4Lab)**
Experiments relevant to thermodynamics, heat transfer, thermal processes, fluid systems and hydraulic machines. Measurement of thermal conductivity, convective heat transfer coefficients, and heat by radiation. Testing various heat exchangers. Control of thermo-fluid measured variables. Forces on submerged surfaces. Basic flow fields and combined flow. Major and minor loss in pipes. Pre-req.: MCHE 332; Co-req.: MCHE 421.

**MCHE 500 RESEARCH METHODOLOGY (2Crs.:2Lec, 0Lab)**
Steps for conducting a successful research: formulating a research problem, conceptualizing a research design, constructing an instrument for data collection, writing a research proposal, collecting data, processing and displaying data, writing a research report. Pre-req.: ENGL300.

**MCHE 511 DYNAMIC SYSTEMS CONTROL (3Crs.:2Lec,2Lab)**
Modeling of systems in various energy domains. Transfer function. Block reduction techniques and signal flow graph models. Time-domain analyses and the root-locus method. Frequency-domain methods. Stability analysis. Design of PID controllers and dynamic compensators. Frequency response and Bode plots. Control experiments that includes: DC Motor, HVAC system, and inverted pendulum. Applications using Matlab. Team project to model and control of a dynamic system. Pre-req.: MCHE 412.

**MCHE 521 THERMAL POWER STATIONS (3Crs.:3Lec,0Lab)**
Steam power plants. Thermal analysis of steam generators. Water treatment for steam generators. Thermal analysis of condensers. Thermal analysis of cooling towers. Types of feedwater heaters and thermal analysis. Construction of steam turbines. Gas turbines and combined cycles. Overview of solar power plants. Overview of nuclear power plants. Pre-req.: MCHE 322.

**MCHE 531 PUMP TECHNOLOGY (3Crs.:3Lec,0Lab)**

Introduction to pumps. Pump classifications. Centrifugal pump construction. Pump performance curves, operating points, discharge regulation, similarity, speed variation, velocity triangle and cavitation. Pumps in series and parallel. Multi-stage pumps, axial flow pumps. Viscosity density and temperature effect on the pump performance. Effect of air entraining vortex from pump suction side. Priming of pumps.. Axial, radial and mixed flow pumps design. Forces acting on different rotating elements, gland packing seals and mechanical seals. Pre-req.: MCHE 332

**MCHE 534 FLUID THERMAL SYSTEM DESIGN (3Crs.:3Lec,0Lab)**

Specifications of pumps. Design, operation selection, and maintenance of water pumps. Pump stations design. Specifications of fans, compressors, and blowers. Design, operation and fans selection for ventilation systems. Fire pump specifications and safety codes. Mechanical specification codes and standards. Application of thermo-fluid system design in water heating radiators system including boiler and heat exchanger. Chiller piping system applications. Project-1 in design, calculation, and drawing of cold and hot water piping systems in buildings. Project-2 in implementing thermo-fluid systems in ventilation systems in buildings. Pre-req.: MCHE 531.

**C.Mechanical Engineering Technical Electives**

The ME curriculum includes two 3-credit hour courses as technical electives. The courses are chosen from the courses listed in the table below with their descriptions given thereafter.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| MCHE 461 | Applied Robotics | 3 | Pre: MCHE 213 and either MCHE 315 or COMP 431 |
| MCHE 512 | Mechanical Vibrations | 3 | Pre: MCHE 412 |
| MCHE 513 | Finite Element Analysis – Theory and Applications | 3 | Pre: MCHE 312 or CVLE 312 |
| MCHE 514 | Programmable Logic Controllers | 3 | Pre: MCHE 315 |
| MCHE 517 | Design of Planar Mechanisms | 3 | Pre: MCHE 317 |
| MCHE 518 | Product Design and Development | 3 | Pre: MCHE 411 |
| MCHE 523 | Thermal Equipment Design | 3 | Pre: MCHE 421 |
| MCHE 525 | Renewable Energy Technologies | 3 | Pre: MCHE 321 |
| MCHE 526 | Energy Management | 3 | Pre: MCHE 321 |
| MCHE 527 | Gas Turbines Technology | 3 | Pre: MCHE 322 |
| MCHE 533 | Hydraulic Machinery and Stations | 3 | Pre: MCHE 332 |
| MCHE 530 | Pipe-line Engineering | 3 | Pre: MCHE 332 |

| | | | |
|---|---|---|---|
| MCHE 535 | Hydraulic Circuits | 3 | Pre: MCHE 331 |
| MCHE 536 | Hydraulic Equipment | 3 | Pre: MCHE 535 |
| MCHE 537 | Pneumatic Circuits and Applications | 3 | Pre: MCHE 331 |
| MCHE 538 | Compressed Air Technology | 3 | Pre: MCHE 331 |
| MCHE 539 | Gas Dynamics | 3 | Pre: MCHE 321 and MCHE 331 |
| MCHE 561 | Robotic Control and Intelligent Systems | 3 | Pre: MCHE 461 |
| MCHE 562 | Sensors and Actuators | 3 | Pre: MCHE 315 |
| MCHE 563 | Applied Engineering Optimization | 3 | Pre: MCHE 411 |
| MCHE 564 | Automotive Engineering | 3 | |
| MCHE 565 | Technology Ventures | 3 | Pre: MGMT 002 and INME 221 |
| MCHE 571 | Refrigeration and HVAC Applications | 3 | Pre: MCHE 422 |
| MCHE 572 | Water Desalination Technologies | 3 | MCHE 421 |
| MCHE 573 | Operation and management of Thermal Power Stations | 3 | Pre: MCHE 521 |
| MCHE 574 | Acoustical Analysis of Mechanical Systems | 3 | Pre: MCHE 332, MCHE 422 |
| MCHE 581 | Computational Fluid Dynamics | 3 | Pre: MCHE 332 and MCHE 421 |

## Description of Technical Elective Courses

**MCHE 461 APPLIED ROBOTICS (3Crs.:2Lec,2Lab)**
Robot architecture, subsystems, and applications; mechanisms and drives; forward and inverse kinematics; trajectory planning; dynamics and control; actuators and drive electronics; sensors and interface; mobile robots and navigation; intelligence; collaborative learning; team project. Pre-req.: MCHE 213 and either MCHE 315 or COMP 431.

**MCHE 512 ENGINEERING VIBRATIONS (3Crs.:3Lec,0Lab)**
Introduction to vibration and the free response, forced response of un-damped and damped systems, vibration isolation, vibration absorbers, multiple degree of freedom systems, vibration measurement, distributed parameter systems. Pre-req.: MCHE412

**MCHE 513 FINITE ELEMENT ANALYSIS –THEORY AND APPLICATIONS (3Crs.:3Lec,0Lab)**
Introduction to the theoretical basis of finite element method and its application in solving engineering problems. Topics covered include: Overview of the finite element solution; basic finite elements; modeling considerations; static, modal and dynamic analysis of structures and mechanical systems; solution of field problems; commercial finite element software package. Project. Pre-req.: MCHE312 or CVLE 312.

**MCHE 514 PROGRAMMABLE LOGIC CONTROLLERS (3Crs.:2Lec,2Lab)**
PLC operation. PLC memory; Ladder logic; structured logic, flowchart-based, and state-based design; instruction list and structured text programming; Interface of sensors, actuators, and I/O devices; selecting PLC; development of PLC-based systems; lab experiments. Projects. Pre-req.: MCHE 315.

**MCHE 517 DESIGN OF PLANAR MECHANISMS (3Crs.:3Lec,0Lab)**
Kinematics chains, creation of mechanisms, and mobility analysis, synthesis of single- and multi-loop mechanisms for various motion requirements, synthesis of multi-loop mechanisms, synthesis of geared-linkage mechanisms, Synthesis of mechanisms for instantaneous motion generation, Optimum synthesis of mechanisms. Computer-aided analysis and synthesis. Project. Pre-req.: MCHE 317.

**MCHE 518 PRODUCT DESIGN AND DEVELOPMENT (3Crs.:3Lec,0Lab)**
Modern tools and methods involving product design and development process. Product planning; Idea generation; concept generation; concept selection; functional analysis; engineering design process for systems and components; economic and environmental considerations; reliability analysis; product safety; Team project to transform idea into a product. Pre-req.: MCHE 411.

**MCHE 523 THERMAL EQUIPMENT DESIGN (3Crs.:3Lec,0Lab)**
Introduction to heat exchangers. LMTD method. ε-NTU method. Heat transfer and pressure drop correlations. Double-pipe heat exchangers. Shell-and-tube heat exchangers. Compact heat exchanger design (dry cooler, cooling and dehumidifying coil, indirect evaporative cooler). Direct contact heat exchangers. Computer applications. Pre-req.: MCHE 421.

**MCHE 525 RENEWABLE ENERGY TECHNOLOGIES (3Crs.:3Lec,0Lab)**
The course provides students with the fundamentals, design tools, and state-of-the-art alternative energy technologies. Emphasis is given to solar energy fundamentals, design and performance evaluation of solar collectors, passive and active applications of solar energy, thermal and electric energy storage. Other alternative energy technologies such as wind, hydro, geothermal, ocean thermal energy conversion are introduced. The economics of alternative energy and their potential in the Arab region is highlighted. Pre-req.: MCHE 321.

**MCHE 526 ENERGY MANAGEMENT (3Crs.:3Lec,0Lab)**
The course introduces the concepts and techniques of energy management and conservation based on the national statistics of energy supply and demand. Scope of the energy problems and approaches to provide solutions; energy auditing; improving energy utilization in space conditioning and steam, hot water and compressed air systems; energy savings opportunities in refrigeration and cooling systems; insulation; and electrical energy conservation are highlighted. Pre-req.: MCHE 321.

**MCHE 527 GAS TURBINES TECHNOLOGY (3Crs.:3Lec,0Lab)**
Gas turbine cycles for industrial applications. Gas turbine cycles for aircraft engines. Design of centrifugal and axial compressors. Design of radial and axial turbines. Types of combustors. Pre-req.: MCHE 322.

**MCHE 533 HYDRAULIC MACHINERY AND STATIONS (3Crs.:3Lec,0Lab)**
Hydraulic turbines, Pelton wheel, Francis, propeller and Kaplan turbines, construction, design factors, discharge regulation and part load performance, model testing, cavitations and turbine selection, hydropower plants, types, capacity, number of units, pump storage projects, hydro-power plants in Lebanon. Pre-req.: MCHE 332.

**MCHE 530 PIPE-LINE ENGINEERING (3Crs.:3Lec,0Lab)**
Pipes in parallel and series, three pipe reservoirs , Pipe Network single- and two-phase flow for incompressible flow in pipelines, Water Hammer, pipes, fittings, valves, accessories, standards, pipeline installation, operation, monitoring and maintenance. Pre-req.: MCHE 332.

**MCHE 535 HYDRAULIC CIRCUITS (3Crs.:2Lec,2Lab)**
Design of basic hydraulic circuits, elements of hydraulic circuits and design factors, Positive displacement oil pumps as sources of hydraulic power, oil reservoirs, pipes, control valves: pressure, direction and flow control, fluid power actuators: hydraulic cylinders, hydraulic motors, standard symbols according to ANSI Standard and graphical representation, basic hydraulic circuits and applications in practice. Pre-req.: MCHE 331.

**MCHE 536 HYDRAULIC EQUIPMENT (3Crs.:3Lec,0Lab)**
Hydraulic system design, design problems and analysis, applications: hydraulic presses, shearing machines, hydraulic cranes, hydraulic lifts, loaders, excavators, mixers, concrete pump, pile drilling machine, hydraulic equipment maintenance and troubleshooting. Pre-req.: MCHE 535.

**MCHE 537 PNEUMATIC CIRCUITS AND APPLICATIONS (3Crs.:3Lec,0Lab)**
Elements of pneumatic circuits and design factors, Compressed air characteristics, System components, Compressors, Air reservoirs, Actuators, Cylinders, Motors, Pneumatic system control, Standard symbols and graphical representation, Basic pneumatic circuits and applications in practice. Pre-req.: MCHE 331.

**MCHE 538 COMPRESSED AIR TECHNOLOGY (3Crs.:3Lec,0Lab)**
Compressed air system definition and its applications in industry, System components: Compressors, Air reservoirs, Pipes, Air treatment devices: dryers, filters. System leakage resources and Control. Maintenance and Troubleshooting. Pre-req.: MECE 331.

**MCHE 539 GAS DYNAMICS (3Crs.:3Lec,0Lab)**
One-dimensional steady motion with area change, flow in ducts with friction, flow with heating and cooling, normal and oblique shock waves, applications and analysis in aero jet engines and components. Pre-req.: MCHE 321 and MCHE 331.

**MCHE 561 ROBOTIC CONTROL AND INTELLIGENT SYSTEMS (3Crs.:3Lec,0Lab)**
Robotics and robot subsystems and architectures. Kinematics and workspace of serial and parallel-drive manipulators. Static force and torque analysis. Trajectory planning, dynamics and control. Metrics of robot performance. Walking machines and mobile robots. Intelligent systems. Computer-aided analysis. Project. Pre-req.: MCHE461.

**MCHE 562 SENSORS AND ACTUATORS (3Crs.:3Lec,0Lab)**
Introduction to contemporary sensor and actuator technologies. Smart sensor and actuator materials (piezoelectric, shape memory alloys, electro-rheological, etc.). Application Specific Integrated Circuits (ASIC). Smart sensors and sensor fusion. Project. Pre-req.: MCHE 315.

**MCHE 563 APPLIED ENGINEERING OPTIMIZATION (3Crs.:3Lec,0Lab)**
Problem definition, objective functions and constraint; local vs. global optimization methods; deterministic vs. stochastic methods; linear and non-linear programming methods; gradient-based methods; combinatorial optimization techniques: Genetic algorithm, simulated annealing, tabu search, and ant colony; applications to various mechanical engineering problems; computer-aided solutions; project.
Pre-req.: MCHE 411.

**MCHE 564 AUTOMOTIVE ENGINEERING (3Crs.:3Lec,0Lab)**
Engine parts. Fuel systems. Mechanical and electronic ignition systems. Engine performance. Automotive brakes. Suspension systems. Steering systems. Description of power transmission. Cooling and lubrication systems.

**MCHE 565 TECHNOLOGY VENTURES (3Crs.:3Lec,0Lab)**
This course teaches students how to articulate a well-reasoned, easily understood business plan, understand the product realization process, set and achieve targets, prepare budgets, find capital by effectively communicating the idea to those who can finance it, hire the right mix of marketing and technical talent, know the market by engaging in real time market research, and focus on the customer; team project. Pre-req.: MGMT 002 and INME 221.

**MCHE 571 REFRIGERATION AND HVAC APPLICATIONS (3Crs.:2Lec,2Lab)**
Evaporator types and selection, condenser types and selection, compressor types and selection, expansion devices types and selection, refrigeration piping design, HVAC specifications codes and standards, air refrigeration system, absorption refrigeration system, multi-stage compression systems, water piping systems, air duct systems, cold store design. Pre-req.: MCHE 422.

**MCHE 572 WATER DESALINATION TECHNOLOGIES (3Lec,0Lab)**
This course surveys the state-of-the-art in water purification by desalination and filtration. Fundamentals and thermal analyses of desalination plants are introduced; existing desalination technologies including SSE, SSE-VCS, MEV, MSF, and RO systems; factors affecting the performance or the affordability of desalination technologies; economics, operation and maintenance; treatment of corrosion and scale deposits. Pre-req.: MCHE 421.

**MCHE 573 OPERATION AND MANAGEMENT OF THERMAL POWER STATIONS (3Crs.:3Lec,0Lab)**
Various systems and cycles used in producing electrical power. An overview on various types of plants operating on fossil fuels and nuclear energy. Emphasis is on gas turbine, steam turbine, combined cycle plants and traditional steam-generation plants burning fossil fuel such as natural gas or oil. Boiler room operation and management, water treatment, boiler devices and their control systems, boiler testing and maintenance, turbine governing systems types and operation, variable load management and power plants economics and power distribution systems. Pre-req.: MCHE 521.

**MCHE 574 ACOUSTICAL ANALYSIS OF MECHANICAL SYSTEMS (3Crs.:3Lec,0Lab)**
Fundamentals of acoustics and acoustic measurements. Community reaction to noise. Noise control within Buildings. Noise in ductwork systems. Computer software applications. Pre-req.: MCHE 332, MCHE 422

**MCHE 581 COMPUTATIONAL FLUID DYNAMICS (3Crs.:3Lec,0Lab)**
Introduction to the methods and analysis techniques used in computational solutions of fluid mechanics and heat transfer problems; finite difference method; partial differential equations; discretization approaches; stability, consistency, and convergence; finite-volume formulations; explicit and implicit methods; code and solution verification; incompressible flows; validation and uncertainty quantification; simulation and design using commercial CFD code. Pre-req.: MCHE 332 and MCHE 421.

**D.Final Year Project**

MCHE 501 FINAL YEAR PROJECT I (1Cr) / MCHE 502 FINAL YEAR PROJECT II (3Crs) After completing 120 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters; beginning in Fall-semester and ending in the following Spring-semester. The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student innovation and critical thinking, and build skills in formulating, designing, developing, building, communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world.
Refer to the Final Year Project Policy for more details.

**E.INTERNSHIP**

MCHE 499 INTERNSHIP (1Cr) This is a professional training which should not be less than four weeks. The training is followed by a presentation session where the students are supposed to present what they have learned.
Refer to the department policy for further details.

## Study Plan

**Bachelor of Engineering in Mechanical Engineering (150 Credits)**

| First Semester (15 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| BLAW | 001 | Human Rights | 1 | |
| CHEM | 405 | Solid State Chemistry | 2 | |
| MATH | 281 | Linear Algebra | 3 | |
| MCHE | 201 | Engineering Drawing and Graphics | 3 | |
| MCHE | 213 | Dynamics | 3 | |
| PHYS | 282 | Material Properties and Heat | 3 | |

| Second Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 208 | Programming I | 3 | |
| CVLE | 210 | Statics | 3 | |
| INME | 211 | Engineering Materials and Technology | 3 | Pre: PHYS 282 |
| MATH | 282 | Calculus | 3 | |
| MCHE | 216 | Dynamics of Machinery I | 3 | Pre: MCHE 213 |
| PHYS | 281 | Electricity and Magnetism | 3 | |

| Summer I (8 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ARAB | 001 | Arabic Language | 2 | |
| ENGL | 001 | General English | 2 | |
| | | General Electives1 | 4 | |

| Third Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 283 | Differential Equations | 3 | Pre: MATH 281, MATH 282 |
| MCHE | 311 | Mechanics of Materials | 3 | Pre: CVLE 210, Co: INME 211 |
| MCHE | 317 | Dynamics of Machinery II | 3 | Pre: MCHE 216 |
| MCHE | 321 | Thermodynamics I | 3 | Pre: PHYS 282 |
| MCHE | 331 | Fluid Mechanics I | 3 | Pre: PHYS 282 |
| POWE | 211 | Electric Circuits (for Mechanical Engineering students) | 3 | Pre: PHYS 281 |

| Fourth Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CHEM | 241 | Principles of Chemistry | 3 | |
| MATH | 284 | Numerical Analysis | 3 | Pre: MATH 283 |
| MCHE | 214 | Fundamentals of Mechatronics | 2 | Pre: POWE 211 |
| MCHE | 214L | Fundamentals of Mechatronics Lab | 1 | Co: MCHE 214 |
| MCHE | 312 | Machine Design I | 3 | Pre: MCHE 311, MCHE 201 |
| MCHE | 322 | Thermodynamics II | 3 | Pre: MCHE 321 |
| MCHE | 332 | Fluid Mechanics II | 3 | Pre: MCHE 331 |

| Summer II (8 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ENGL | 211 | Advanced Writing | 2 | Pre: ENGL 001 |
| MGMT | 002 | Entrepreneurship I | 2 | |
| | | General Electives[1] | 4 | |

| Fifth Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ENGL | 300 | Speech Communications | 2 | Pre: ENGL 211 |
| MATH | 381 | Probability and Statistics | 3 | Pre: MATH 282 |
| MCHE | 315 | Instrumentation and Measurement | 2 | Pre: COMP 208, MCHE 214, Co: MCHE 315L |
| MCHE | 315L | Instrumentation and Measurement Lab | 1 | Co: MCHE 315 |
| MCHE | 411 | Machine Design II | 3 | Pre: MCHE 312, MCHE 317 |
| MCHE | 421 | Heat Transfer | 3 | Pre: MATH 284, MCHE 321, Co: MCHE 429 |
| MCHE | 429 | Thermo-fluids Lab | 2 | Pre: MCHE 332, Co: MCHE 421 |

| Sixth Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| INME | 212 | Metal Shaping | 3 | Pre: INME 211 |
| MCHE | 412 | Dynamic Systems Modeling and Analysis | 3 | Pre: MATH 283, MCHE 317 |
| MCHE | 416 | Mechatronics System Design | 2 | Pre: MCHE 315, Co: MCHE 416L, POWE 335 |
| MCHE | 416L | Mechatronics System Design Lab | 1 | Co: MCHE 416 |
| MCHE | 422 | Refrigeration and Air Conditioning | 3 | Pre: MCHE 421 |
| POWE | 335 | Electric Drives (for Mechanical Engineering) | 2 | Pre: MCHE 214, Co: MCHE 416 |
| | | Technical Elective[2] | 3 | |

| Seventh Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MCHE | 499 | Internship | 1 | |
| MCHE | 500 | Research Methodology | 2 | Pre: ENGL 300 |
| MCHE | 501 | Final Year Project I | 1 | Pre: ENGL 211, Co: MCHE 500 |
| MCHE | 511 | Dynamic Systems Control | 3 | Pre: MCHE 412 |
| MCHE | 521 | Thermal Power Stations | 3 | Pre: MCHE 322 |
| MCHE | 531 | Pump Technology | 3 | Pre: MCHE 332 |
| | | Technical Elective2 | 3 | |

| Eighth Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ENGR | 001 | Engineering Ethics | 1 | |
| INME | 221 | Engineering Economy | 3 | |
| MCHE | 502 | Final Year Project II | 3 | Pre: MCHE 501 |
| MCHE | 534 | Fluid Thermal System Design | 3 | Pre: MCHE 531 |
| | | Technical Electives2 | 6 | |

[1] selected form the list of university elective courses.
[2] selected form the list of Mechanical Engineering elective courses.

## Courses offered for other majors

The Mechanical Engineering Department offers three courses for other engineering majors. These courses are described below.

**MCHE 202 MECHANICAL ENGINEERING FOR BUILDINGS (3Crs.:3Lec,0Lab)**
Water supply for buildings; pumping systems; waste systems; sump pumps; heat losses and thermal insulation; ventilation and air conditioning; sound insulation; elevators and escalators, and fire fighting.

**MCHE 301 HVAC AND SANITATION FOR ARCHITECTS (2Crs.:1Lec,2Lab)**
This course addresses two technical fields, HVAC and Sanitation. HVAC: Introduction to air conditioning and mechanical installations in buildings and indoor spaces, general consideration, various heating and cooling systems, ventilation and air conditioning of various types, Installations and control of systems. Sanitation: Sanitary engineering issues, dampness: Sources and methods of insulation, water supply treatment and distribution, sanitary fixtures, installation and connections, treatment of soiled water, rainwater drainage and storm sewers.

**MCHE 407 THERMAL AND HYDRO POWER STATIONS (3Crs.:3Lec,0Lab)**
Thermal Power Stations: Introduction to power generation; modern power plant layouts; gas fired, combined cycle, nuclear, and renewable energy; thermodynamic principles including Carnot cycle, Rankine cycle, Brayton cycle, and combined cycles; combustion processes, steam generations and boiler systems; steam turbines systems; gas turbine systems, combined cycle power plants and cogeneration; condensers and cooling technologies. Fluid Mechanics and Hydraulics Applications: Introduction to fluid mechanics and application fields, fluid Properties; fluid statics: pressure measurements and forces on submerged surfaces; fluid flow kinematics: velocity, acceleration, flow field types and applications; fluid dynamics: mass and energy conservation, continuity, Bernoulli's equation, fluid flow measurements, flow through pipes; fluid mechanics and hydraulic applications: pumps, turbines and fluid system design (water supply and fire fighting system).

# DEPARTMENT OF CHEMICAL AND PETROLEUM ENGINEERING

## Academic Staff

**Acting Chairperson** Dr. Rami Harkouss
**Assistant Professors** Dr. Rami Harkouss
**Full-time Instructors** Hussein Ghorayeb
Eng. Shareef El-Mustafa

## Petroleum Engineering Program

## Mission

The Chemical and Petroleum Engineering Department is devoted to educating exemplary petroleum engineers by instituting best learning practices that drives knowledge, build skills and competencies, and inspire the learner to define a purpose, develop a passion to forever learn, cultivate a sense of responsibility toward the profession, society and the environment, and attain the ability to confront challenges, and in so doing contribute to the advancement of the community, immediate and beyond.

## Objectives

The educational objectives of the Petroleum Engineering (PE) program are determined to support career advancement of the graduates and as they pursue their career goals, the graduates will:

1. Be competent to handle complex petroleum engineering tasks requiring multifaceted skills.
2. Be recognized for their ability to pursue innovative solutions through creative integration of best practices.
3. Demonstrate career advancement and exhibit the habits and personal attributes to handle management and leadership roles.
4. Exhibit commitment to the wellbeing of the community and the environment in pursuant of relevant solutions.

## Learning Outcomes

Upon completion of the program graduates shall be able to:

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. 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
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

## Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Petroleum Engineering consists of 150 credit-hours of course work + ICDL, where the standard duration of study is 6 semesters.

## Career Opportunities

Petroleum engineers attain a broad spectrum of skills sought by almost every relevant profession. Industries, enterprises, and service providers requiring petroleum engineering skills include: oil and gas production, refining and distribution, excavation, process, consulting, environmental institutions, and government. Most importantly, you can imagine something that never was and make it a reality! There is so much work to be done to guarantee the future of mankind and petroleum engineers can tap the possibilities through the spirit of innovation and entrepreneurism.

## Program Overview

The Student's Study Plan is given to every student upon his/her enrollment. The PTRE curriculum consists of the following components:

| **I. Common Requirements** | **Credits** |
|---|---|
| General Education Requirements | 20 |
| Basic Sciences and Mathematics | 30 |
| General Engineering topics | 15 |
| **II. PTRE Program-Specific Requirements** | **Credits** |
| A. Petroleum Engineering Core | 59 |
| B. Engineering topics from outside the major | 9 |
| C. Petroleum Engineering Technical Electives | 12 |
| D. Final Year Project | 4 |
| E. Internship | 1 |

**I.Common Requirements**

The list of the Common Requirement courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog.

**II.PTRE Program-Specific Requirements**

**A.Petroleum Engineering Core Courses**

The Petroleum Engineering core courses are listed in the table below.

| **Course** | **Title** | **Credits** | **Pre-/Co-requisites** |
|---|---|---|---|
| GEOL201 | Physical Geology | 3 | |
| GEOL205 | Geophysical Techniques | 3 | PHYS281 |
| GEOL206 | Principles of petroleum geology | 3 | GEOL201, MCHE201 |

| | | | |
|---|---|---|---|
| GEOL401 | Geology of Lebanon and Levantine Region | 3 | GEOL206 |
| PTRE201 | Introduction to Petroleum Engineering | 3 | |
| PTRE202 | Reservoir Rock Properties | 3 | PTRE201 |
| PTRE206 | Petroleum Drilling Systems | 3 | PTRE201 |
| PTRE301 | Reservoir Fluids | 3 | PTRE202, MCHE339 |
| PTRE303 | Well Logging | 3 | GEOL206 |
| PTRE306 | Petroleum Geo-mechanics | 3 | MCHE319 |
| PTRE308 | Petroleum Production Technology | 3 | PTRE206 |
| PTRE405 | Well Testing | 3 | PTRE301 |
| PTRE409 | Reservoir Simulation | 3 | PTRE301, MATH284, COMP208 |
| PTRE410 | Reservoir Characterization | 3 | PTRE202, PTRE303 |
| PTRE412 | Drilling Technology | 3 | PTRE206 |
| PTRE414 | Gas Production Engineering | 3 | PTRE308 MCHE329 |
| PTRE500 | Research Methodology | 2 | ENGL300 |
| PTRE511 | Petroleum Refining Operations | 3 | CHEM331 |
| PTRE512 | Environment and Safety | 3 | PTRE306 |
| PTRE513 | Reservoir Engineering | 3 | PTRE301 |

## Description of Core Courses

**GEOL 201 PHYSICAL GEOLOGY (3Crs.:2Lec,2Lab)**

An introduction to the composition and structure of the earth from the atomic scale of minerals to the global scale of plate tectonics. Topics include the composition of minerals and rock, volcanism, earth structures, earthquakes, erosion and surface processes, geologic time, geologic hazards, and plate tectonics. In this course, attention will focus on the rocks, landscapes, surface erosional and depositional features, the agents that form them and scenic areas of Lebanon and Levantine region.

**GEOL205 GEOPHYSICAL TECHNIQUES (3Crs.:2Lec,2Lab)**

Introduction to geophysics; Principles of exploration seismology and field procedures; Seismic reflection: how an image of the subsurface is generated and how to interpret it. The theory, instrumentation and field procedure of the magnetic techniques The reduction and interpretation of magnetic data. The theory, instrumentation and field procedure of the gravity technique. The reduction and interpretation of gravity data. Pre-req.: PHYS281.

**GEOL 206 PRINCIPLES OF PETROLEUM GEOLOGY (3Crs.:2Lec,2Lab)**

Geological characteristics of the Earth, sedimentary rock fill of depositional basins,

fundamental principles of petroleum geology, different settings in which accumulations of conventional oil and gas are found, Fundamentals source rock, reservoir, and trap studies; well log and seismic interpretation, petroleum geochemistry, and mapping. Migration pathways and reservoir traps, procedures adopted for assessing resources and reserves. Pre-req.: GEOL201, MCHE201

**GEOL 401 GEOLOGY OF LEBANON AND LEVANTINE REGION (3Crs.:3Lec,0Lab)**
The main features of Lebanon, the landscape, folds, faults, igneous features, rock types in Lebanon, fossils of Lebanon, minerals of Lebanon, Lebanon in its regional plate tectonic setting, resources of Lebanon, geologic hazards of Lebanon, the subsurface geology of Lebanon, The geology of Levantine region in regional scale. Pre-req.: GEOL206.

**PTRE 201 INTRODUCTION TO PETROLEUM ENGINEERING (3Crs.:3Lec,0Lab)**
Overview and history of the petroleum industry and petroleum engineering; Petroleum reserves, production and consumption statistics of the world; Structure of the petroleum industry; Composition, origin, migration and accumulation of petroleum; Oil traps. Petroleum exploration methods; Nature of oil and gas wells; Drilling History; Types of drilling rigs; Drilling equipment's; Introduction to drilling fluids; Special problems in Drilling; Cost; Data acquisition during drilling; Reservoir properties; Reservoir pressure and evaluation; properties and behaviors of reservoir fluids; Oil and gas production; The production system, Methods of oil production; Fundamentals of oil refining.

**PTRE 202 RESERVOIR ROCK PROPERTIES (3Crs.:2Lec,2Lab)**
Understanding the basic properties of reservoir rocks and how they relate to the storage and production of oil and gas. Important concepts such as heterogeneity, capillary pressure, relative permeability, resistivity are included as part of the course. Pre-req.:. PTRE201

**PTRE 206 PETROLEUM DRILLING SYSTEMS (3Crs.:3Lec,0Lab)**
Introduction to petroleum drilling systems, including fundamental petroleum engineering concepts, quantities and unit systems, drilling rig components, drilling fluids, pressure loss calculations, casing and well cementing. Pre-req: PTRE201

**PTRE 301 RESERVOIR FLUIDS (3Crs.:2Lec,2Lab)**
Organic chemistry applied to Petroleum Engineering, Thermodynamics behavior of naturally occurring hydrocarbon mixtures; Evaluation and correlation of physical properties of petroleum reservoir fluids, including laboratory and empirical methods. Equations of State, Phase equilibria, and properties, Pressure Volume Temperature Analysis (PVT). Pre-req.:PTRE202, MCHE339

**PTRE 303 WELL LOGGING (3Crs.:3Lec,0Lab)**
Basic formation evaluation concepts, borehole environment, principles of resistivity, radiation, thermal and elastic wave measurements and measuring tools, applications to formation evaluation using commercial software package. Lithology plots. Saturation, irreducible saturation and permeability studies from well logs. Shale sand analysis.

Complex reservoir analysis. Wire-line Formation Testing. Integration of core, log, well test and seismic data evaluation. Cementing quality monitoring. Gun perforating. Production Monitoring. Pre-req.: GEOL206

**PTRE 306 PETROLEUM GEOMECHANICS (3Crs.:3Lec,0Lab)**
Introduction to applications of Geomechanics in oil and gas industry; stress/strain: estimation, transformation and Mohr circle representation; rock behavior under stress; rock index properties; rock mechanics lab tests; in-situ stresses and effective stresses; calculation of induced stresses around a wellbore using Kirsh's equations; mud weigh windows determination to mitigate wellbore failures; hydraulic fracturing. Pre-req.: MCHE319.

**PTRE 308 PETROLEUM PRODUCTION TECHNOLOGY (3Crs.:3Lec,0Lab)**
Overview of oil and gas properties. Engineering design of oil and gas processing equipment. Well completion design, reservoir deliverability and well flow performance concepts, tubing design and selection, completion equipment, artificial lift, production optimization, well stimulation. Pre-req.: PTRE206

**PTRE 405 WELL TESTING (3Crs.:3Lec,0Lab)**
Flow in porous media, pseudo-state, steady-state, unsteady-state flow, well testing methods used to determine well and reservoir parameters (DST, Build-Up, Drawdown tests...); Type curve analysis, Models for well testing, Evaluation of well performance by Saphir Simulation. Pre-req.: PTRE301

**PTRE 410 RESERVOIR CHARACTERIZATION (3Crs.:2Lec,2Lab)**
Definition of petroleum reservoir heterogeneity using conventional methods and possible improvements to these methods. Reservoir rock properties and their spatial variations; estimation of reserves; introduction to theory and application of geostatistics to reservoir characterization; presentation of fundamental geostatistical concepts including: variogram analysis, estimation variance, kriging and stochastic simulations. Impact of geologic structure on oil recovery methods. Review of basic statistical concepts and methods. Reservoir rock and fluid property evaluation by statistical methods. Scale-up and simulator data Preparation. Emerging methods in petroleum reservoir characterization. Pre-req.: PTRE202, PTRE303.

**PTRE 409 RESERVOIR SIMULATION (3Crs.:2Lec,2Lab)**
Solution of production and reservoir engineering problems using state-of-the-art commercial reservoir simulation software, using data commonly available in industry. Emphasis on reservoir description, reservoir model design and calibration, production forecasting and optimization, economic analysis and decision making under uncertainty. Pre-req.: PTRE301, MATH284, COMP208.

**PTRE 412 DRILLING TECHNOLOGY (3Crs.:2Lec,2Lab)**
Well planning Design, trajectory design, Rig systems and Rig components and their functions; Types of formation pressures; Drilling Fluid Technology including laboratory

experiments and empirical methods; Casing and primary cementing equipment; Hole conditions; Fishing tools; Directional and Horizontal Drilling and applications; ERD; Calculations to build sections; Kicks and blow outs; Well control methods. Pre-req.: PTRE206

**PTRE 414 GAS PRODUCTION ENGINEERING (3Crs.:3Lec,0Lab)**
Vapor-liquid equilibrium, natural gas flow in wellbores and pipelines, networks, gas well unloading and solutions, metering, compressor design, special topics. Pre-req.: PTRE308, MCHE329.

**PTRE 499 INTERNSHIP (1Cr)**
This is a professional training which should not be less than four weeks. The training is followed by a presentation session where the students are supposed to present what they have learned. Pre-req.: PTRE500
Refer to the department policy for further details.

**PTRE 500 RESEARCH METHODOLOGY (2Crs.:2Lec,0Lab)**
Steps for conducting a successful research: formulating a research problem, conceptualizing a research design, constructing an instrument for data collection, writing a research proposal, collecting data, processing and displaying data, writing a research report. Pre-req.: ENGL300

**PTRE 501 FINAL YEAR PROJECT I (1Cr) / PTRE 502 FINAL YEAR PROJECT II (3Crs)**
After completing 120 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters; beginning in Fall-semester and ending in the following Spring-semester. The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student creativity and critical thinking, and build skills in formulating, designing, developing, building, communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world. Pre-req.: PTRE500
Refer to the Final Year Project Policy for more details.

**PTRE 511 PETROLEUM REFINING OPERATIONS (3Crs.:3Lec,0Lab)**
Refining and associated downstream processing technologies, Refinery Products and Test methods, Refinery Units, Atmospheric and Vacuum distillation; Fluid Catalytic Cracking, Hydro-treating and Catalytic Reforming processes. Pre-req.: CHEM331

**PTRE 513 RESERVOIR ENGINEERING (3Crs.:3Lec,0Lab)**
Determination of reserves; material balance methods; aquifer models; fractional flow and frontal advance; displacement, pattern and vertical sweep efficiencies in waterfloods; enhanced oil recovery processes; design of optimal recovery processes; introduction and performance analysis of unconventional reservoirs. Pre-req.:PTRE301.

**PTRE 512 ENVIRONMENT AND SAFETY (3Crs.:3Lec,0Lab)**
Environmental control technology for oilfield processes, crude oil and petroleum product terminals; storage tanks; EHS guidelines; wastewater treatment and disposal, chemical hazards; EHS for offshore oil and gas development; Golden rules to prevent accidents. Pre-req.: PTRE306

**B.Engineering topics from outside the major**
This part of the PTRE curriculum includes 9-credits courses offered by other engineering programs. These courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| MCHE 319 | Mechanics of Materials for PE | 3 | Pre: CVLE 210 |
| MCHE329 | Thermodynamics for PE | 3 | Pre: PHYS 282 |
| MCHE339 | Fluid mechanics for PE | 3 | Pre: PHYS 282 |

## Descriptions of this group of courses are given below.

**MCHE 319 MECHANICS OF MATERIALS for PE (3Crs.:3Lec,0Lab)**
Introduction to the mechanics of deformable bodies considering linear material response. Load-stress, stress-strain, and strain-displacement relations. Tension/ compression of rods and trusses, torsion of shafts, bending in beams, bucking of columns, and pressure vessels. Analysis of combined loading. Mohr circle analysis. Stress-strain transformations. Statically indeterminate structures. Pre-req.: CVLE210.

**MCHE 329 THERMODYNAMICS for PE (3Crs.:3Lec,0Lab)**
Introduction and basic concepts. Properties of pure substances. Energy analysis of closed systems. Mass and energy analysis of control volumes. Second law of Thermodynamics. Entropy, gas power cycle, vapor power cycle, vapor refrigeration cycle, real gas, Gas-vapor mixtures and air conditioning. Pre-req.: PHYS282

**MCHE 339 FLUID MECHANICS for PE (3Crs.:3Lec,0Lab)**
Fluid static, Forces on immersed surfaces,, buoyancy and stability of floating bodies, Fluid kinematics, fluid masses subjected to acceleration, vortex motion, hydrodynamics, momentum equation, Euler's and Bernouilli equations, fluid flow in pipelines, PI-Theorem. Pre-req.: PHYS282.

**C.Petroleum Engineering Technical Electives**
The PTRE curriculum includes four 3-credit hour courses as technical electives. The courses are chosen from the courses listed in the table below with their descriptions given thereafter.

| Elective Courses | | | |
|---|---|---|---|
| **Course** | **Title** | **Credits** | **Pre-/Co-requisites** |
| PTRE413 | Natural Gas Engineering | 3 | PTRE308 |
| PTRE415 | Fire Control Engineering | 3 | PTRE412 |

| | | | |
|---|---|---|---|
| PTRE417 | Hydrocarbon Phase Behavior | 3 | MCHE329 |
| PTRE419 | Petroleum Economy, Risk and Management | 3 | MATH381 |
| PTRE 503 | Crude Oil Processing | 3 | CHEM331 |
| PTRE506 | Process Instrumentation and Control | 3 | POWE212, MATH284 |
| GEOL203 | Sedimentary Rocks | 3 | GEOL202 |
| GEOL314 | Marine Geology | 3 | GEOL201 |
| GEOL316 | Carbonate Sedimentology | 3 | GEOL201 |
| GEOL318 | Petroleum Geology of Middle East | 3 | GEOL401, GEOL205 |
| GEOL504 | Seismic (3D) Stratigraphy and Interpretation | 3 | GEOL205 |
| GEOL506 | Structural Geology and Tectonics | 3 | PTRE303 |
| GEOL507 | Seismic Exploration | 3 | GEOL202 |
| GEOL508 | Fund. of Seismic Acquisition, Processing and Interpretation | 3 | GEOL507 |
| GEOL509 | Basin Evolution and Hydrocarbon Resources | 3 | GEOL206 |
| CMPS322 | Digital Image Processing for Petroleum Engineering | 3 | COMP208 |

## Description of Technical Elective Courses

**CMPS 322 DIGITAL IMAGE PROCESSING FOR PETROLEUM ENGINEERING (3Crs.:2Lec,2Lab)**
Introduction; image sensing and acquisition; some basic gray level transformations for oil slick image enhancement; image contrast enhancement using histogram processing for oil slick; image smoothing using spatial filters; image sharpening using Spatial filters; point, line and edge detection for oil slick; optimal global and adaptive thresholdings for oil slick Image Segmentation. Pre-req.: COMP208

**GEOL 203 SEDIMENTARY ROCKS (3Crs.:3Lec,0Lab)**
Provides a general introduction to sedimentary rocks, sedimentary processes, and the depositional environments in which these rocks form. The course covers classification and knowledge of sedimentary rocks, sedimentary processes and environments, and the relationship of sedimentary rocks and plate tectonics. Laboratories focus on the identification of sedimentary rocks and structures in hand specimen. Pre-req.: GEOL202.

**GEOL 314 MARINE GEOLOGY (3Crs.:3Lec,0Lab)**
Introduction to marine geology, a brief review of the formation of the ocean basins is presented, followed by a detailed study of the ocean margins. Sedimentary processes operating in the fluvial, estuarine, near shore and continental-shelf regions will be discussed, as well as sea-level history. Pre-req.: GEOL201.

**GEOL 316 CARBONATE SEDIMENTOLOGY (3Crs.:3Lec,0Lab)**
Discussion of the origins, classification, and criteria of recognition of carbonate accumulations from different depositional environments. Pre-req.: GEOL201.

**GEOL 318 PETROLEUM GEOLOGY OF MIDDLE EAST (3Crs.:3Lec,0Lab)**
Provides an integrated tectonic, stratigraphic, paleogeographic, and structural framework for the region to evaluate known and frontier petroleum areas. Pre-req.: GEOL401, GEOL205.

**GEOL 504 SEISMIC STRATIGRAPHY AND INTERPRETATION (3D SEISMIC) (3Crs.:3Lec,0Lab)**
The stratigraphic significance of seismic reflectors –Identification of depositional sequences – Age determination of depositional sequences – Recognition and analysis of the seismic facies present in terms of reflector geometry, continuity and amplitude and mapping their distribution- Interpretations of relative changes of sea-levels. Hands-on exercises provide practice in: identifying examples of reflection terminations (onlap, downlap, toplap), identifying depositional sequence boundaries on seismic sections on the basis of reflector terminations, determining the age of seismic sequences, identifying different seismic facies on seismic sections, and constructing chronostratigraphic summary chart from suitable seismic sections or geological cross-sections. Pre-req.: GEOL205.

**GEOL 506 STRUCTURE GEOLOGY AND TECTONICS (3Crs.:3Lec,0Lab)**
Fundamental concepts, principles and methods in global tectonics and structural geology. The course covers global plate tectonics and analytical methods in plate kinematics, including an understanding of tectonic motions on a sphere. The structure and geodynamics of the mantle are examined in relation to the driving forces of plate tectonics, and to the principles of isostasy. Gravity measurements and modeling are used to examine uplift and erosion. The structural geology part of the covers aspects of stress, strain, rock failure, rock deformation, rheology, and the origin and significance of commonly observed brittle and ductile structures in rocks. Pre-req.: PTRE303.

**GEOL 507 SEISMIC EXPLORATION (3Crs.:3Lec,0Lab)**
Principles of the seismic method; exploration objectives and requirements of seismic data acquisition; the seismic pulse – its generation and transmission; partition of seismic energy at an interface; seismic energy reflection, refraction, attenuation, and travel time – distance functions; reflection time corrections; field testing and procedures with emphasis on multiple coverage and design of source and receiver arrays for signal enhancement; well velocity survey; the synthetic seismogram and the convolution model. Pre-req.: GEOL202.

**GEOL 508 FUNDAMENTAL OF SEISMIC ACQUISITION, PROCESSING AND INTERPRETATION (3Crs.:2Lec,2Lab)**
Fundamentals; Introduction to Seismic exploration; Overview of non-seismic geophysical techniques; Wave Propagation; Reflection Principles and Resolution; Signal Analysis; Migration Principles Acquisition; Principles of data acquisition; 3D Survey Design • QA/QC Processing; Principles and Processing Flows. Prestack Analysis and Signal Corrections; Velocity/ Normal Move out Analysis; Static Corrections; Migration and Imaging Interpretation; Trap Definition; Structural Mapping; Stratigraphic Interpretation; Amplitude Interpretation. Pre-req.: GEOL507.

**GEOL 509 BASIN EVOLUTION AND HYDROCARBON RESOURCES (3Crs.:3Lec,0Lab)**
Origin of sedimentary basins; structural styles of basins and their expression in seismic data; lateral variations of sedimentary facies in differing basin settings; models of external controls on depositional and seismic architectures; an introduction to sequence stratigraphy; burial histories and the derivation of tectonic subsidence/uplift histories from stratigraphic data; an overview of the petroleum play system; the petroleum charge system; reservoir, top seal and trap; quantifying risk in hydrocarbon exploration; petroleum geology Middle East. Pre-req.:GEOL206.

**PTRE 413 NATURAL GAS ENGINEERING (3Crs.:3Lec,0Lab)**
Natural Gas Composition and Phase Behavior, Natural Gas and Liquid Separation, Gas Sweetening, Water and Gas Removal, Liquefied Natural Gas LNG, Gas to Liquids GTL. Pre-req.: PTRE308

**PTRE 415 FIRE CONTROL ENGINEERING (3Crs.:3Lec,0Lab)**
Aspects involved in the control from fire, explosion, and other related hazards. Protective considerations and building design and construction. Fire and explosive protection organization including fire detection and control. Pre-req.: PTRE412

**PTRE 417 HYDROCARBON PHASE BEHAVIOR (3Crs.:3Lec,0Lab)**
Thermodynamics fundamentals, petroleum reservoir fluids, cubic equations of state, C7+ characterization and lumping, viscosity measurements, sampling, pressure/temperature (P/T) flash calculations, prediction of transport properties, pressure-volume-temperature (PVT) experiments, regression to experimental PVT data, evaluation of PVT reports and field experience. Pre-req.: MCHE329.

**PTRE 419 PETROLEUM ECONOMY, RISK AND MANAGEMENT (3Crs.:3Lec,0Lab)**
This unit aims to teach the student about the economics and risk management of petroleum asset development, supply and demand economics, profit maximization, depreciation and all aspects of oil field project management required to fully understand the risk involved in exploration, production, capital cost and expenditure on assets. Pre-req.: MATH381.

**PTRE 503 CRUDE OIL PROCESSING (3Crs.:3Lec,0Lab)**
Crude Oil Composition and Classification, Fundamentals of a Refinery Plant, Oil processing, Role of Catalyst in Refineries, Desalting of Crude Oil, Conversion Processes, Distillation Unit, Coking Process, Flexicoking Process, Catalytic Process, Fundamentals of phase separators. Pre-req.: CHEM331.

**PTRE 506 PROCESS INSTRUMENTATION AND CONTROL (3Crs.:2Lec,2Lab)**
Control loop hardware.; Mathematical modeling of chemical processes for control purposes.; Dynamic behavior of processes.; Development of dynamic models from experimental data for control purposes; Introduction to strain gauges; Basic components of control systems.; Design of single-loop control systems.; Controller tuning techniques.; Introduction to frequency domain methods.; Experimental rigs on process control.

Block diagrams. Transient behavior of closed-loop control systems. Stability analysis. Controller tuning. Controller design: direct synthesis and frequency response methods. General comments on other types of controllers. Pre-req.: POWE212, MATH284

## Study Plan

**Bachelor of Engineering in Petroleum Engineering (150 Credits)**

| First Semester (15 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 208 | Programming I | 3 | |
| MATH | 281 | Linear Algebra | 3 | |
| CVLE | 210 | Statics | 3 | |
| PHYS | 282 | Material Properties and Heat | 3 | |
| MCHE | 210 | Engineering Drawing and Graphics | 3 | |

| Second Semester (15 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 282 | Calculus | 3 | Pre: MATH111 |
| MCHE | 213 | Dynamics | 3 | |
| PHYS | 281 | Electricity and Magnetism | 3 | |
| PTRE | 201 | Introduction to Petroleum Engineering | 3 | |
| CHEM | 281 | Principles of Chemistry I | 3 | Pre: CHEM110 |

| Summer I (9 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ARAB | 001 | Arabic Language | 2 | |
| ENGL | 011 | English Language | 2 | |
| BLAW | 001 | Human Rights | 1 | |
| | | Elective (General) | 4 | |

| Third Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 283 | Differential Equations | 3 | Pre: MATH281 + MATH282 |
| MCHE | 339 | Fluid Mechanics for PE | 3 | Pre: PHYS282 |
| ENGL | 211 | Advanced Writing | 2 | Pre: ENGL001 |
| PTRE | 202 | Reservoir Rock Properties | 3 | Pre: PTRE201 |
| GEOL | 205 | Geophysical Techniques | 3 | Pre: PHYS281 |
| GEOL | 201 | Physical Geology | 3 | |

| Fourth Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 284 | Numerical Analysis and Techniques | 3 | Pre: MATH283 |
| CHEM | 282 | Principles of Chemistry II | 3 | Pre: CHEM281 |
| PTRE | 206 | Petroleum Drilling Systems | 3 | Pre: PTRE201 |
| PTRE | 301 | Reservoir Fluids | 3 | Pre: PTRE202 + MCHE339 |
| GEOL | 206 | Principles of Petroleum Geology | 3 | Pre: GEOL201 + MCHE201 |
| CHEM | 331 | Organic Chemistry | 3 | Pre: CHEM281 |

| Summer II (8 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ENGL | 300 | Speech Communication | 2 | Pre: ENGL211 |
| MGMT | 002 | Entrepreneurship | 2 | |
| | | Elective (General) | 4 | |

| Fifth Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| PTRE | 303 | Well Logging | 3 | Pre: GEOL206 |
| MCHE | 319 | Mechanics of Materials for PE | 3 | Pre: CVLE210 |
| MCHE | 329 | Thermodynamics for PE | 3 | Pre: PHYS282 |
| PTRE | 405 | Well Testing | 3 | Pre: PTRE301 |
| PTRE | 409 | Reservoir Simulation | 3 | Pre: PTRE301 + MATH284 + COMP208 |
| | | Technical Elective | 3 | |

| Sixth Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| PTRE | 308 | Petroleum Production Technology | 3 | Pre: PTRE206 |
| PTRE | 410 | Reservoir Characterization | 3 | Pre: PTRE202 + PTRE303 |
| PTRE | 412 | Drilling Technology | 3 | Pre: PTRE206 |
| MATH | 381 | Probability and Statistics | 3 | Pre: MATH282 |
| PTRE | 306 | Petroleum Geomechanics | 3 | Pre: MCHE319 |
| PTRE | 500 | Research Methodology | 2 | Pre: ENGL300 |

| Seventh Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| PTRE | 513 | Reservoir Engineering | 3 | Pre: PTRE301 |
| PTRE | 501 | Final Year Project 1 | 1 | Pre: PTRE500 |
| PTRE | 511 | Petroleum Refining Operations | 3 | Pre: CHEM331 |
| PTRE | 499 | Internship (Approved Experience / Independent Study) | | Pre: PTRE500 |
| GEOL | 401 | Geology of Lebanon and Levantine Region | 3 | Pre: GEOL206 |
| INME | 221 | Engineering Economy | 3 | |
| | | Technical Elective | 3 | |

| Eighth Semester (16 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| PTRE | 502 | Final Year Project 2 | 3 | Pre: PTRE501 |
| PTRE | 512 | Environment and Safety | 3 | Pre: PTRE306 |
| PTRE | 414 | Natural Gas Production | 3 | Pre: MCHE329 + PTRE308 |
| ENGR | 001 | Engineering Ethics | 1 | |
| | | Technical Elective | 3 | |
| | | Technical Elective | 3 | |

# DEPARTMENT OF CHEMICAL AND PETROLEUM ENGINEERING

## Chemical Engineering Program

## Mission

The Chemical and Petroleum Engineering Department is devoted to educating exemplary chemical engineers by instituting best learning practices that drives knowledge, build skills and competencies, and inspire the learner to define a purpose, develop a passion to forever learn, cultivate a sense of responsibility toward the profession, society and the environment, and attain the ability to confront challenges, and in so doing contribute to the advancement of the community, immediate and beyond.

## Objectives

The educational objectives of the Chemical Engineering (ChE) program are determined to support career advancement of the graduates and as they pursue their career goals. Chemical Engineering program objectives are:

1.Provide Students with the education and training in the field of chemical engineering through the study of chemical manufacturing or industrial processes by transforming raw materials into consuming products through the design, construction and management of factories

2.Supply the student with basic Chemical Engineering knowledge necessary for industrial practices.

3.Meet the growing needs to face future difficulties in the Lebanese and Middle East Chemical industries

## Learning Outcomes

Upon completion of the program graduates shall be able to:

a.an ability to apply knowledge of mathematics, science, and engineering

b.an ability to design and conduct experiments, as well as to analyze and interpret data

c.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

d.an ability to function on multidisciplinary teams

e.an ability to identify, formulate, and solve engineering problems

f.an understanding of professional and ethical responsibility

g.an ability to communicate effectively

h.the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

i.a recognition of the need for, and an ability to engage in life-long learning

j.a knowledge of contemporary issues

k.an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

## Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Chemical Engineering consists of 150 credit-hours of course work + ICDL or its equivalent, where the standard duration of study is 10 semesters.

## Career Opportunities

Chemical engineers bridge sciences and manufacturing by applying the principles of science and engineering, to solve problems involving modification of raw materials into required products in a variety of industries including: oil and gas; pharmaceuticals; energy; water treatment; food and drink; plastics; and toiletries.

## Program Overview

The Student's Study Plan is given to every student upon his/her enrollment. The CHME curriculum consists of the following components:

| **III. Common Requirements** | **Credits** |
|---|---|
| General Education Requirements | 20 |
| Basic Sciences and Mathematics | 39 |
| General Engineering topics | 15 |
| **II. CHME Program-Specific Requirements ( 00 credits )** | **Credits** |
| A. Chemical Engineering Core | 44 |
| B. Engineering topics from outside the major | 15 |
| C. Chemical Engineering Technical Electives | 12 |
| D. Final Year Project | 4 |
| E. Internship | 1 |

**I.Common Requirements**

The list of the Common Requirement courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog.

**II.CHME Program-Specific Requirements**

**A.Chemical Engineering Core Courses**

The Petroleum Engineering core courses are listed in the table below.

| **Course** | **Title** | **Credits** | **Pre-/Co-requisites** |
|---|---|---|---|
| CHME202 | Introduction to Chemical Engineering | 3 | |
| CHME301 | Separation Processes | 3 | Pre: MCHE322 |
| CHME302 | Chemical Engineering Reaction | 3 | Pre: MCHE322 +CHEM246 |
| CHME302L | Chemical Engineering Reaction Lab | 1 | Co-req: CHME302 |
| CHME304 | Membrane Science | 3 | Pre: CHME301 |
| CHME402 | Unit Operation | 3 | Pre: CHME302 |
| CHME402L | Unit Operation Lab | 1 | Co-req: CHME402 |
| CHME403 | Process Control | 3 | Pre: CHME301 |

| | | | |
|---|---|---|---|
| CHME403L | Process Control Lab | 1 | Co-req: CHME403 |
| CHME404 | Transportation of Hydrocarbons | 3 | Pre: MCHE332 |
| CHME405 | Reactor Design | 3 | Pre: CHME302 |
| CHME406 | Catalytic Processes | 3 | Pre: CHEM345 |
| CHME407 | Mass transfer | 3 | Pre: MCHE421 |
| CHME408 | Chemical Process Design | 3 | Pre: CHME304 + CHME407 |
| CHME499 | Internship | 1 | Pre: CHME500 |
| CHME500 | Research Methodology | 2 | Pre: ENGL300 |
| CHME501 | Final Year Project I | 1 | Pre: CHEM500 |
| CHME502 | Final Year Project II | 3 | Pre: CHEM501 |
| CHME511 | Polymer Engineering | 3 | Pre: CHEM 246 |
| CHME507 | Process Optimization | 3 | Pre: CHME403 |

## Description of Core Courses

**CHME 202 INTRODUCTION TO CHEMICAL ENGINEERING (3Crs:3Lec)**
Overview of chemical engineering and its applications. Overall staged separations. Concepts of rate processes. Energy and mass transport. Material and energy balances. Kinetics of chemical reactions.

**CHME 301 SEPARATION PROCESSES (3Crs.:3Lec,0Lab)**
Concepts on the thermodynamics, mechanisms, processes and design of equilibrium separation processes such as adsorption, ion exchange, membrane separations, chromatography and crystallization. Pre-req.: MCHE322

**CHME 302 CHEMICAL ENGINEERING REACTION (3Crs.: 3Lec)**
Principles of reaction engineering. Stoichiometry applications in combination with a rate. Continuous stirred-tank. Plug-flow, Different types of chemical reactors. Continuous-operation and batch-operation reactors. Heterogeneous reactors, catalytic systems and fluidized beds. Pre-req.: MCHE322+CHEM246

**CHME 302L CHEMICAL ENGINEERING REACTION (1Cr.: 2Lab)**
The content of this lab is directly related to the courses. Co-req.: CHEM302

**CHME 304 MEMBRANE SCIENCE (3Crs.:3Lec)**
Membrane processes used for engineering materials and systems. Knowledge in a membrane technology area from medicine to wastewater engineering. Pre-req.: CHME301

**CHME 402 UNIT OPERATION (3Crs: 3Lec)**
Principles of unit operations with emphasis on distillation, absorption, extraction, and fluid-solid systems. Principles of heat exchanger design, multi-component fractionation, absorption, stripping and extraction. Property prediction of multi-component fluids. Pre-req.: CHME302

**CHME 402L UNIT OPERATION (1Cr: 2Lab)**
The content of this lab is directly related to the courses. Co-req.: CHEM402

**CHME 403 PROCESS CONTROL (3Crs.: 3Lec)**
Key concepts in automatic control and instrumentation of process plants. Commonly used sensing, transmission and final control elements in piping and Instrumentation Diagrams. First order, second order, and integrating systems including dead time are treated with basic controller algorithms. Pre-req.: CHME301

**CHME 403L PROCESS CONTROL Lab (1Cr.: 2Lab)**
The content of this lab is directly related to the courses. Co-req.: CHEM403

**CHME 404 TRANSPORTATION OF HYDROCARBONS (3Crs.:3Lec,0Lab)**
Storage Tanks of crude Oil. Incompressible and compressible fluid flow. pumps and compressors, Piping system design, gas gathering systems; Petroleum shipping, maintenance and repair. Pre-req.: MCHE332

**CHME 405 REACTOR DESIGN (3Crs.3Lec,0Lab)**
Basic principles of chemical reaction engineering. Principles of catalysis. Reaction engineering principles in modern technologies. Analysis of kinetic data. Basic (Ideal) reactor description modeling and design. Isothermal and non-isothermal reactor design. Pre-req.: CHME302

**CHME 406 CATALYTIC PROCESSES (3Crs.3Lec,0Lab)**
Fundamentals of catalytic science; catalyst properties, preparation and characterization. Industrial catalytic processes: Hydrogen Production and Synthesis Gas Reactions (Fischer-Tropsch Synthesis), Hydrogenation and dehydrogenation of organic compounds, Oxidation of organic and inorganic compounds. Catalytic reactor design and catalyst deactivation. Pre-req.: CHEM345

**CHME 407 MASS TRANSFER (3Crs:3Lec,0Lab)**
Diffusion, convective and interfacial mass transfer, and its application to continuous contact operation. Gas-liquid absorption and stripping, liquid-liquid extraction, and humidification. Design of equilibrium-stage separation processes including distillation. Pre-req.: MCHE421

**CHME 408 CHEMICAL PROCESS DESIGN (3Crs.:3Lec,0Lab)**
Implementation of real engineering projects and comparing alternatives. Basic concepts and methodology for making rational decisions. Design of plants and processes representative of the chemical and related process industries. Transfer knowledge of a flow sheet into a suitable form for simulation and design. Pre-req.: CHME304 + CHME407

**CHME 499 INTERNSHIP (1Cr)**
This is a professional training which should not be less than four weeks. The training is followed by a presentation session where the students are supposed to present what they have learned. Pre-req.: CHEM500

**CHME 500 RESEARCH METHODOLOGY (2Crs.:2Lec,0Lab)**
Steps for conducting a successful research: formulating a research problem, conceptualizing a research design, constructing an instrument for data collection, writing a research proposal, collecting data, processing and displaying data, writing a research report. Pre-req.: ENGL300

**CHME 501 FINAL YEAR PROJECT I (1Cr) / CHME 502 FINAL YEAR PROJECT II (3Crs)**
After completing 120 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters; beginning in Fall-semester and ending in the following Spring-semester. The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student creativity and critical thinking, and build skills in formulating, designing, developing, building, communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world. Pre-req.: CHEM500

**CHME 507 PROCESS OPTIMIZATION (3Crs.3Lec,0Lab)**
Process flowschemes. Modifying equipment internals. Upgrading process. Technical solutions to reduce energy consumption. Various methods and techniques to optimize processing energy efficiency in process plants Pre-req.: CHME403

**CHME 511 POLYMER ENGINEERING (3Crs.:3Lec,0Lab)**
This course provides a good understanding of the synthesis of polymers and their commercial applications. Important properties that these materials possess, including their molecular, physical, chemical, thermal, mechanical, and electrical properties are reviewed. The forming techniques for plastics (compression molding, injection molding…) and the different parameters leading to the degradation of polymers will also be covered. Pre-req.: CHEM 246

**B.Engineering topics from outside the major**
This part of the ChE curriculum includes 15-credits courses offered by other engineering programs. These courses are listed in the table below.

| Course | Title | Credits | Pre-/Co-requisites |
|---|---|---|---|
| MCHE321 | Thermodynamics I | 3 | Pre: PHYS 282 |
| MCHE 322 | Thermodynamics II | 3 | Pre: MCHE321 |
| MCHE 331 | Fluid Mechanics I | 3 | Pre: PHYS282 |
| MCHE 332 | Fluid Mechanics II | 3 | Pre: MCHE331 |

| | | | |
|---|---|---|---|
| MCHE 421 | Heat Transfer | 3 | Pre: MATH284, MCHE321 and MCHE332 |

## Descriptions of this group of courses are given below.

**MCHE 321 THERMODYNAMICS I (3Crs.:3Lec,0Lab)**
Introduction and basic concepts. Properties of pure substances. Energy analysis of closed systems. Mass and energy analysis of control volumes. Second law of Thermodynamics. Entropy, gas power cycle, vapor power cycle, vapor refrigeration cycle, real gas, Gas-vapor mixtures and air conditioning. Pre-req.: PHYS282

**MCHE 322 THERMODYNAMICS II (3Crs.:3Lec,0Lab)**
Reheat and regenerative steam power generation plants. Thermal energy conversion into mechanical. Steam flow through nozzles and forces exerted on different types of turbine blades. Gas turbine (Regeneration, inter-cooling, and reheat cycles) and reciprocating engines. Thermodynamic analyses of power plants. Computer applications. Pre-req.: MCHE 321.

**MCHE 331 FLUID MECHANICS I (3Crs.:3Lec,0Lab)**
Fluid static, Forces on immersed surfaces, buoyancy and stability of floating bodies, Fluid kinematics, fluid masses subjected to acceleration, vortex motion, hydrodynamics, momentum equation, Euler's and Bernoulli's equations, fluid flow in pipelines, PI-Theorem. Pre-req.: PHYS 282

**MCHE 332 FLUID MECHANICS II (3Crs.:3Lec,0Lab)**
Fluid flow kinematics for three-dimensional fluid motions. Elementary hydrodynamics. Basic and combined flow field applications. Dynamics of compressible and incompressible flow. Continuity equation. Navier-Stokes equations. Boundary layers. Lift and drag. Fluid film lubrication. Pre-req.: MCHE 331.

**MCHE 421 HEAT TRANSFER (3Crs.:3Lec,0Lab)**
Concepts and laws of conduction, convection and radiation heat transfer and their application to solving engineering thermal problems. Steady and transient heat conduction. Heat generation. Extended surfaces. External and internal forced convection of laminar and turbulent flows. Natural convection. Heat exchanger principles. Thermal radiation, view factors, and radiation exchange between gray bodies. Boiling and condensation. Computer aided applications. Pre-req.: MATH 284 , MCHE 321 and MCHE 332.

**C.Chemical Engineering Technical Electives**

The CHME curriculum includes two 3-credit hour courses as technical electives. The courses are chosen from the courses listed in the table below with their descriptions given thereafter.

| **Elective Courses** | | | |
|---|---|---|---|
| **Course** | **Title** | **Credits** | **Pre-/Co-requisites** |
| PTRE511 | Petroleum Refining Operations | 3 | Pre: CHEM331 |
| PTRE419 | Petroleum Economics and Management | 3 | Pre: MATH381. |
| PTRE503 | Crude Oil Processing | 3 | Pre: CHEM331 |
| CHEM355 | Petro-chemistry | 3 | |
| CHME503 | Biomass Engineering | 3 | Pre: CHME403 + CHME408 |
| CHME512 | Chemical Product design | 3 | Pre: CHME403 |
| CHME513 | Water and Waste Management | 3 | Pre: CHME304 |
| CHME514 | Air-Pollution Problems And Control | 3 | |

## Description of Technical Elective Courses

**PTRE 511 PETROLEUM REFINING OPERATIONS (3Crs.:3Lec,0Lab)**

Students study oil refining and associated downstream processing technologies, operations and economics; process safety and operations integrity; and methods for the optimal design of process systems; the program combines petroleum refining (technologies, operations and economics) and systems engineering (modeling and simulation, optimization, and process design and integration); in addition, it provides opportunities for students to learn about the general economics of the energy sector, oil exploration and production, as well as renewable energy systems; furthermore, study of the various aspects of petroleum refining are augmented by unique work assignments at a virtual oil refining and chemical company. Pre-req.: CHEM331

**PTRE 419 PETROLEUM ECONOMY, RISK AND MANAGEMENT (3Crs.:3Lec,0Lab)**

This unit aims to teach the student about the economics and risk management of petroleum asset development, supply and demand economics, profit maximization, depreciation and all aspects of oil field project management required to fully understand the risk involved in exploration, production, capital cost and expenditure on assets. Pre-req.: MATH381.

**PTRE 503 CRUDE OIL PROCESSING (3Crs.:3Lec,0Lab)**

Introduction to crude oil processing, Two phase separators, Three phase separators, Emulsion Treatment and Dehydration, Desalting of Crude Oil, Stabilization and sweetening, Storage tanks, Produced Water Treatment, Choosing a Line Size and Wall Thickness, Organizing the project, Flow Assurance, Flow in wells &pipes. Pre-req.: CHEM331.

**CHEM 355 PETROCHEMISTRY (3Crs.:3 Lec)**
A study of the chemicals obtained directly and indirectly from petroleum, including their chemistry and their industrial production and applications.

**CHME503 BIOMASS ENGINEERING (3Crs.:3Lec,0Lab)**
Fundamental principles and practical applications of biomass-to renewable energy processes. Biodiesel production from plant oils. Thermo-conversion of biomass and waste materials for renewable energy production. Bioethanol production from starch and lingo cellulosic materials. Anaerobic digestion of agricultural and industrial wastes for biogas and hydrogen production. Pre-req.: CHME403 + CHME408

**CHME512 CHEMICAL PRODUCT DESIGN (3Crs.:3Lec,0Lab)**
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. Pre-req.: CHME403

**CHME513 WATER AND WASTE MANAGEMENT (3Crs.:3Lec,0Lab)**
Quality and treatment methods of water and wastewater; testing for physical, chemical, and biological parameters. Pre-req.: CHME304

**CHME514 AIR-POLLUTION PROBLEMS AND CONTROL (3Crs.:3Lec,0Lab)**
Advanced concepts on air-pollutant identification and control technology; estimation of pollutant transport, dispersion, and conversion; design of control units using computer simulation applications.

## Study Plan

**Bachelor of Engineering in Chemical Engineering (150 Credits)**

| First Semester (15 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| COMP | 208 | Programming I | 3 | |
| MATH | 281 | Linear Algebra | 3 | |
| CVLE | 210 | Statics | 3 | |
| PHYS | 281 | Electricity and Magnetism | 3 | |
| MCHE | 210 | Engineering Drawing and Graphics | 3 | |

| Second Semester (15 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 282 | Calculus | 3 | Pre: MATH111 |
| MCHE | 213 | Dynamics | 3 | |
| PHYS | 282 | Material Properties and Heat | 3 | |
| CHME | 202 | Introduction to Chemical Engineering | 3 | |
| CHEM | 281 | Principles of Chemistry I | 3 | Pre: CHEM110 |

| Summer I (9 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ARAB | 001 | Arabic Language | 2 | |
| ENGL | 001 | English Language | 2 | |
| BLAW | 001 | Human Rights | 1 | |
| | | Elective (General) | 4 | |

| Third Semester (17 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 283 | Differential Equations | 3 | Pre: MATH281 + MATH282 |
| MCHE | 331 | Fluid Mechanics I | 3 | Pre: PHYS282 |
| MCHE | 321 | Thermodynamics I | 3 | Pre: PHYS282 |
| CHEM | 331 | Organic Chemistry | 3 | Pre: CHEM281 |
| CHEM | 282 | Principles of Chemistry II | 3 | Pre: CHEM281 |
| ENGL | 211 | Advanced Writing | 2 | Pre: ENGL001 |

| Fourth Semester (15 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 284 | Numerical Analysis and Techniques | 3 | Pre: MATH283 |
| MCHE | 332 | Fluid Mechanics II | 3 | Pre: MCHE331 |
| MCHE | 322 | Thermodynamics II | 3 | Pre: MCHE321 |
| CHEM | 345 | In-organic Chemistry I | 3 | Pre: CHEM282 |
| CHEM | 248 | Physical Chemistry I | 3 | Pre: CHEM282 |

| Summer II (8 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| ENGL | 300 | Speech Communication | 2 | Pre: ENGL211 |
| MGMT | 002 | Entrepreneurship | 2 | |
| | | Elective (General) | 4 | |

| Fifth Semester (19 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| MATH | 381 | Probability and Statistics | 3 | Pre: MATH282 |
| CHME | 406 | Catalytic Processes | 3 | Pre: CHEM345 |
| CHME | 301 | Separation Processes | 3 | Pre: MCHE322 |
| CHME | 302 | Chemical Engineering Reaction | 3 | Pre: MCHE322 + CHEM246 |
| CHME | 302L | Chemical Engineering Reaction Lab | 1 | Co-req: CHME302 |
| MCHE | 421 | Heat Transfer | 3 | Pre: MATH284 + MCHE321 |
| | | Technical Elective | 3 | |

| Sixth Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| INME | 221 | Engineering Economy | 3 | |
| CHME | 403 | Process Control | 3 | Pre: CHME301 |
| CHME | 403L | Process Control Lab | 1 | Co-req: CHME403 |
| CHME | 304 | Membrane Science | 3 | Pre: CHME301 |
| CHME | 405 | Reactor Design | 3 | Pre: CHME302 |
| CHME | 407 | Mass transfer | 3 | Pre: MCHE421 |
| CHME | 500 | Research Methodology | 2 | Pre: ENGL300 |

| Seventh Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CHME | 404 | Transportation of Hydrocarbons | 3 | Pre: MCHE332 |
| CHME | 402 | Unit Operation + lab | 3 | Pre: CHME302 |
| CHME | 402L | Unit Operation Lab | 1 | Co-req: CHME402 |
| CHME | 408 | Chemical Process Design | 3 | Pre: CHME304 + CHME407 |
| CHEM | 358 | Surface and Colloid Chemistry | 3 | Pre: CHEM248 |
| CHME | 501 | Final Year Project 1 | 1 | Pre: CHME500 |
| CHME | 499 | Internship (Approved Experience / Independent Study) | 1 | Pre: CHME500 |
| | | Technical Elective | 3 | |

| Eighth Semester (18 Credits) | | | Crs. | Pre-co/requisites |
|---|---|---|---|---|
| CHME | 502 | Final Year Project 2 | 3 | Pre: CHME501 |
| CHME | 507 | Process Optimization | 3 | Pre: CHME403 |
| CHME | 511 | Polymer Engineering | 3 | Pre: CHEM246 |
| ENGR | 001 | Engineering Ethics | 1 | |
| | | Technical Elective | 3 | |
| | | Technical Elective | 3 | |

## Minors offered at The Faculty of Engineering

These minors give students the opportunity to focus on a growing national and international issue by taking only 18 Credits in the intended minor track. The minor tracks at the Faculty of Engineering provide a basic foundation for university students in general, and most importantly for students enrolled in the Engineering programs. The minors aim at increasing the students' employment prospects in their field of study.

**1)Department of Electrical and Computer Engineering**

**a-Minor Course Requirements in Electric Machines and Drives**

| Core Requirements (18 Credits) | | | |
|---|---|---|---|
| **Code** | **Course** | **Cr.** | **Pre-requisite** |
| POWE 271 | EM Fundamentals | 3 | |
| POWE 331 | Machines I | 3 | POWE 271 |
| POWE 334 | Machine II | 3 | POWE 331 |
| POWE 332 | Power Elec. I | 3 | |
| POWE 431 | Power Elec. II | 3 | POWE 332 |
| POWE 531 | Electric Drive | 3 | POWE 431 |

**b- Minor Course Requirements in Electric Power System**

| **Core Requirements (18 Credits)** | | | |
|---|---|---|---|
| **Code** | **Course** | **Cr.** | **Pre-requisite** |
| POWE 271 | EM Fundamentals | 3 | |
| POWE 321 | Power I | 3 | POWE 271 |
| POWE 332 | Power Elec. I | 3 | |
| POWE 322 | Power II | 3 | POWE 321 |
| POWE 421 | Protection I | 3 | POWE 321 |
| POWE 222L | Power Sys.Analysis | 3 | POWE 322 |

**c- Minor Course Requirements in Software Engineering for Communication and Electronics Engineering Program**

| **Core Requirements (15 Credits)** | | | |
|---|---|---|---|
| **Code** | **Course** | **Cr.** | **Pre-requisite** |
| COMP 232 | Data structure | 3 | COMP 210 |
| COMP 311 | Object Oriented Programming | 3 | COMP 210 |
| COMP 344 | Data Base Systems | 3 | COMP 232 |
| COMP 443 | Operating Systems | 3 | COMP 210 |
| COMP 442 | Software Eng. | 3 | COMP 210 |
| **Technical Elective Course (3 Credits)** | | | |
| COMP 512 | Web Programming | 3 | COMP 211 |

**2) Department of Mechanical Engineering**
**Minor Course Requirements in Mechatronics**

| **Core Requirements (18 Credits)** | | |
|---|---|---|
| **Code** | **Course** | **Cr.** |
| MCHE2l6 | Dynamics of Machinery I | 3 |
| MCHE311 | Mechanics of Materials | 3 |
| MCHE 312 | Machine Design I | 3 |
| MCHE4ll | Machine Design II | 3 |
| MCHE302 | Measurement and Instrumentation | 3 |
| MCHE4l4 | Applied Mechatronics | 3 |

**3) Department of Civil Engineering**
**Minor Course Requirements in Water & Environmental Engineering**

| **Core Requirements (18 Credits)** | | |
|---|---|---|
| **Code** | **Course** | **Cr.** |
| CVLE 231 | Engineering Geology | 2 |
| CVLE 341 | Hydraulics I | 3 |
| CVLE 342 | Hydraulics II | 3 |
| CVLE 441 | Hydrology | 2 |
| CVLE 354 | Environmental Engineering | 2 |
| CVLE 453 | Sanitary Engineering | 3 |
| CVLE 546 | Environmental Process Engineering | 3 |

**4) Department of Industrial Engineering and Engineering Management**
**a- Minor Course Requirements in Engineering Management**

| **Core Requirements (18 Credits)** | | |
|---|---|---|
| **Code** | **Course** | **Cr.** |
| INME222 | Operations Research | 3 |
| INME321 | Management Information Systems | 3 |
| lNME322 | Organization Design | 3 |
| INME324 | Production and Operation Management | 3 |
| INME423 | Project Planning and Management | 3 |
| INME422 | Engineering Logistics and Supply Chain | 3 |

**b-Minor Course Requirements in Industrial Engineering**

| **Core Requirements (18 Credits)** | | |
|---|---|---|
| **Code** | **Course** | **Cr.** |
| lNME222 | Operations Research | 3 |
| lNME333 | Facility Planning and Design | 3 |
| INME324 | Production and Operation Management | 3 |
| INME421 | Reliability | 3 |
| INME431 | System Modeling and Simulation | 3 |
| INME434 | Statistical Quality and Process Control | 3 |