FACULTY OF ENGINEERING (FE)

Faculty Administration

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

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.

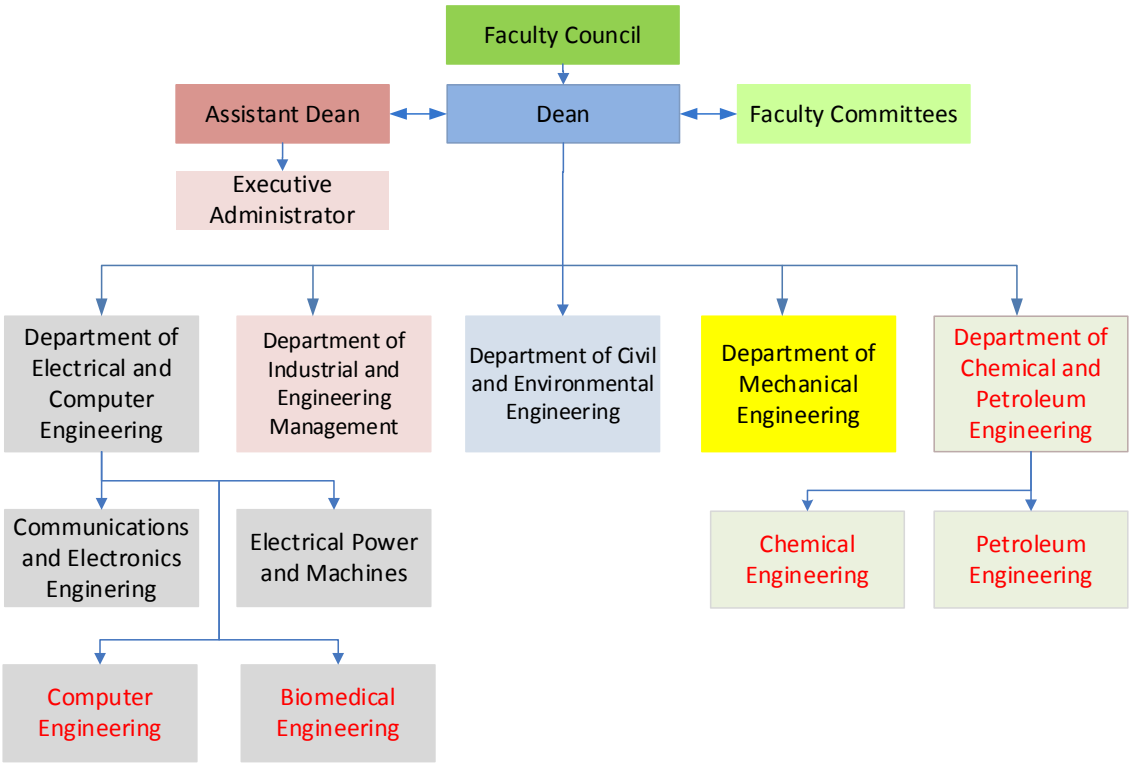
As of 1999, departments of the Faculty of Engineering have updated their curriculum to include a number of courses in humanities, with special emphasis on environmental, economic, managerial, and marketing aspects of engineering. In keeping up with the growing demands for advanced and specialized engineering 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**	**Free Engineering and Major Technical Electives**	**Internship & 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 Crs

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	CHEM110
CHEM 207/CHEM 405	Environmental Chemistry/Solid State Chemistry	2	
MATH 281	Linear Algebra	3	Pre: MATH 112
MATH 282	Calculus	3	MATH111
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	PHYS120
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. .***Pre-eq.:CHEM110.***

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, Thermodynamic of solutions. Phase equilibria in heterogenous systems. Phase rule and its application in one, two and three component systems. 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. ***Pre-req.: MATH112***

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. ***Pre-req.: MATH111***

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 284Numerical 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. ***Pre-req.: PHYS120***

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)

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 ELECTRICAL & COMPUTER ENGINEERING

Chairperson	*Ziad Osman*
Professors	*Soubhi Abou Chahine, Ali Haidar*
Associate Professors	*Issam Damaj, Hamza Issa, Mohamad Tarnini, Chadi Nohra ; Khaled Chahine*
Assistant Professors	*Rola Kassem, Hiba Abdallah, , Hilal El Misilmani, Ahmad El Hajj, Youmni Ziadeh, Bilal Youssef, Abdul Rahman El Falou,Hiba Halabi, Manal Fattoum,Amira Zaylaa, Alaa Daher*
Full time Instructors :	*Abdallah Ghali*

Communications and Electronics Engineering Program

Mission

The educational mission of Communications & Electronics Engineering (CEE) Program is to deliver high quality undergraduate education which combines balanced theoretical and practical topics in Communications & Electronics Engineering. Graduates of the program will have a mastery of fundamental knowledge in a variety of Communications & 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:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

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 + IC003, 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	9
II. CEE Program-Specific Requirements	**Credits**
A. Engineering topics from outside the program	24
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. In particular, the CEE curriculum includes 9 credits offered as general engineering topics. These courses are listed in the table below.

Code	**Name**	**Crs.**
MCHE 213	Dynamics	3
COMP 208	Programming I	3
INME 221	Engineering Economy	3

II. CEE Program-Specific Requirements

A. Engineering Topics from outside the major

This part of the CEE curriculum includes 24 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
POWE 425	Introduction to Electrical Power Systems	3	Pre: POWE 212, POWE 271

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 (3 Crs.: 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 (3 Crs.: 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***.

POWE 425 INTRODUCTION TO ELECTRICAL POWER SYSTEMS (3 Crs.: 3 Lec): Overview of power system structure, single-phase and three-phase transformers, synchronous generators, transmission lines and induction motors. Low-voltage power distribution in residential buildings. ***Pre-req: POWE 212, POWE 271.***

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, MATH 284
COME 411	Instrumentation	3	Pre: COME 222 or COME 223
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 (2 Crs.: 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.

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 (1 Cr.: 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 (3 Crs.: 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 (3 Crs.: 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 & PROPAGATION I (4 Crs.: 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 (3 Crs.: 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 (3 Crs.: 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 (3 Crs.: 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, MATH 284***~~,~~.

COME 411 INSTRUMENTATION (3 Crs. : 2 lec, 2 lab) : 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 or COME 223***.

COME 473 ANTENNAS & PROPAGATION II (3 Crs.: 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 (1 Cr.: 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 (3 Crs.: 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 (3 Crs.: 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 (1 Cr.: 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 (2 Crs.: 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 & 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*** ***Pre: ENGR003***. *Refer to the Final Year Project Policy for more details.*

COME 576 OPTICAL COMMUNICATIONS (3 Crs.: 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 (1 Cr.: 0Lec, 2Lab): The contents of this lab are directly related to the courses COME 472. ***Pre-requisite: COME 472***.

COME 580 COMMUNICATION NETWORKS (3 Crs.: 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 (1 Cr.: 0Lec, 2Lab): This lab covers topics discussed in COME 580. ***Co-requisite: COME 580***.

COME 588 WIRELESS COMMUNICATIONS (3 Crs.: 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 (1 Cr.: 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
ENGR 003	Project Planning and Management	3	Pre: ENGL 300

Description of Technical Elective Courses

COME 423 DIGITAL INTEGRATED CIRCUITS (3 Crs.: 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 (3 Crs.: 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 (3 Crs.: 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 528 RADIO FREQUENCY COMMUNICATION CIRCUITS (3 Crs.: 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 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 535 EMBEDDED SYSTEMS (3 Crs.: 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 (3 Crs.: 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 (3 Crs.: 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***.

ENGR 003 ENGINEERING PROJECT MANAGEMENT (3Crs.: 3Lec, 0Lab) The course covers the characteristics, techniques and challenges associated with initiating, planning, executing, controlling and closure of projects. Project management skills are discussed as they apply to projects, with special focus on leadership, teaming, and coordinating individual and group efforts. MS Project is introduced to provide hands-on practical skills with building a project plan, scheduling tasks, assigning resources, managing dependencies, monitoring progress and costs, keeping projects on track, and communicating project data through Gantt charts. ***Pre: ENGL 300***

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	MATH 112
MATH 282	Calculus	3	MATH 111
MCHE 213	Dynamics	3	
PHYS 281	Electricity and Magnetism	3	PHYS 120
ENGR 002	Introduction to Engineering	2	
BLAW001	Human Rights	1	
ARAB001	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	
ENGL001	English Language	2	

Summer I (9 Credits)		**Crs.**	**Pre/Co-requisites**
CHEM 241	Principles of Chemistry	3	CHEM 110
ENGL 211	Advanced Writing	2	Pre: ENGL001
	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 226	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	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	COME 222 or COME 223
COMP 426	Microprocessor Interfacing	3	Pre: COMP 328
POWE 425	Introduction To Electrical Power Systems	3	Pre: POWE 212, POWE 271.
COME 372	Propagation and Antennas I	4	Pre: POWE 271
COME 381	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
COME384	Digital Signal Processing	3	Pre: COME 381, MATH 284
	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 ENGR 003
	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

2- Electrical Power and Machines Engineering Program

Mission

The Department of Electrical and Computer Engineering offers a Bachelor of Engineering in Electrical Power and Machines Engineering (EPME). The EPME 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.

Student Outcomes

Upon completion of the program graduates shall have:

a. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
b. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
c. An ability to communicate effectively with a range of audiences.
d. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
e. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
f. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
g. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Electrical Power and Machines Engineering consists of 150 credit-hours of course work + IC3, 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 EPME student upon his/her enrollment. The EPME curriculum consists of the following components:

I. Common Requirements	**Credits**
General Education Requirements	20
Basic Sciences and Mathematics	26
General Engineering Topics	9
II. EPME Program-Specific Requirements	**Credits**
A. Engineering Topics from Outside the Major	20
B. Electrical Power and Machines Engineering Core	58
C. Electrical Power and Machines 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. In particular, the EPME curriculum includes 9 credits offered as general engineering topics. These courses are listed in the table below.

Code	Name	Crs.
MCHE 213	Dynamics	3
COMP 208	Programming I	3
INME 221	Engineering Economy	3

II. EPME Program-Specific Requirements

A. Engineering topics from outside the major

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

Code	Name	Crs.	Pre-/Co-requisites
ENGR 002	Introduction to Engineering	2	
ENGR 003	Engineering Project Management	3	Pre: ENGL 300
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 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
COME 483	Discrete-Time Signals and Systems	3	Pre: POWE 342

Description of this group of courses is given below:

ENGR 002 INTODUCTION TO ENGINEERING (2Crs.: 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.

COME 214 ELECTRIC CIRCUITS II (3 Crs.: 3 Lec): 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.: 2 Lab): This lab serves the COME 212 course. ***Co-req.: COME 214***.

COME 221 ELECTRONIC CIRCUITS I (3 Crs.: 3 Lec): 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 (1 Cr.: 2 Lab): This lab serves the COME 221 course. ***Co-req.: COME 221*.**

COMP 225 DIGITAL SYSTEMS I (3 Crs.: 2 Lec, 2 Lab): 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 (3 Crs.: 3 Lec): 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 (1 Cr.: 2 Lab): This lab serves the COMP 326 course**.** ***Co-req.: COMP 326.***

COME 483 DISCRETE-TIME SIGNALS AND SYSTEMS (3 Crs.: 3 Lec): Digital signal processing scheme, sampling and quantization, digital signals properties and useful operations, digital systems properties and classifications, digital convolution. Discrete Fourier transform, fast Fourier transform, *z*-transform: properties, solution of difference equation and convolution using *z*-transform. Difference equations and digital filters, *z*-plane pole-zero plot stability, digital filter frequency response. Design of digital filters: FIR using Fourier transform design and window method, IIR using bilinear transformation design method. ***Pre-req: POWE 342.***

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 283, COME 214
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: MATH 381, 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 525	Introduction to Renewable Energy	3	Pre: POWE 436, POWE 434
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

Description of Core Courses

POWE 212 ELECTRIC CIRCUITS I (3 Crs: 3 Lec): 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.: 3 Lec): 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 (3 Crs.: 3 Lec): 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 283, COME 214.***

POWE 342L CONTROL SYSTEMS LAB (1 Cr.: 2 Lab): This lab serves the POWE 342 course. ***Co-req.: POWE 342.***

POWE 324 ELECTRICAL POWER SYSTEMS (3 Crs.: 3 Lec): 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 (1 Cr.: 2 Lab): This lab serves the POWE 324 course. ***Co-req.: POWE 324.***

POWE 344 INSTRUMENTATION AND MEASUREMENT (3 Crs.: 2 Lec, 2 Lab): 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.: MATH 381, COME 221.***

POWE 445 CONTROL SYSTEMS II (3 Crs.: 3 Lec): 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 (3 Crs.: 3 Lec): 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 (1 Cr.: 2 Lab): This lab serves the POWE 435 course. ***Co-req.: POWE 435.***

POWE 423 ELECTRICAL POWER SYSTEM ANALYSIS (3 Crs.: 3 Lec): 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 (3 Crs.: 3 Lec): 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 (1 Cr.: 2 Lab): This lab serves the POWE 433 course. ***Co-req.: POWE 433.***

POWE 436 ELECTRIC MACHINERY II (3 Crs.: 3 Lec): 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 (1 Cr.: 2 Lab): This lab serves the POWE 436 course. ***Co-req.: POWE 436.***

POWE 420 ELECTRICAL POWER SYSTEM PROTECTION (3 Crs.: 3 Lec): 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 (1 Cr.: 2 Lab): This lab serves the POWE 420 course. ***Co-req.: POWE 420.***

POWE 434 POWER ELECTRONIC CIRCUITS II (3 Crs.: 3 Lec): 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 (2 Crs.: 2 Lec): 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 & displaying data, writing a research report. Conducting Scientific Research at the faculty of Engineering. ***Pre-requisite: ENGL 300***

POWE 525 INTRODUCTION TO RENEWABLE ENERGY (3 Crs.: 3 Lec): 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 543 INDUSTRIAL AUTOMATION (3 Crs.: 3 Lec): 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 (1 Cr.: 2 Lab): This lab serves the POWE 543 course. ***Co-req.: POWE 543.***

POWE 531 ELECTRIC DRIVES (3 Crs.: 3 Lec): 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 (1 Cr.: 2 Lab): This lab serves the POWE 531 course. ***Co-req.: POWE 531.***

POWE 528 – ELECTRICAL POWER GENERATION (3 Crs.: 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 501 FINAL YEAR PROJECT I (1 Cr) / POWE 502 FINAL YEAR PROJECT II (3 Crs): 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.: ENGR003, Co-req: POWE500.***
Refer to the Final Year Project Policy for more details.

POWE 499 INTERNSHIP (1 Cr): 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 Machines Engineering Technical Electives

The EPME 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
ENGR 003	Engineering Project Management	3	Pre: ENGL 300
POWE 428	Electrical Design in Commercial and Industrial Buildings	3	Pre: POWE 324
POWE 444	Digital Control	3	Pre: POWE 445, COME 483
POWE 522	High Voltage Engineering	3	Co: POWE 420, POWE 423
POWE 523	Power System Planning	3	Pre: POWE 423
POWE 524	Power System Control and Operation	3	Pre: POWE 445, POWE 423
POWE 526	Advanced Photovoltaic Systems	3	Pre: POWE 525
POWE 529	Wind Energy Systems	3	Pre: POWE 434, POWE 436
POWE 530	Electric Vehicles	3	Pre: POWE 433, POWE 436
POWE 533	Specialized Modes of Machine Operation	3	Pre: POWE 436
POWE 534	Advanced Topics In Power Electronic Circuits	3	Pre: POWE 434
POWE 536	Solid-State Drives	3	Pre: POWE 434

Description of Technical Elective Courses

ENGR 003 ENGINEERING PROJECT MANAGEMENT (3 Crs.: 3 Lec): The course covers the characteristics, techniques and challenges associated with initiating, planning, executing, controlling and closure of projects. Project management skills are discussed as they apply to projects, with special focus on leadership, teaming, and coordinating individual and group efforts. MS Project is introduced to provide hands-on practical skills with building a project plan, scheduling tasks, assigning resources, managing dependencies, monitoring progress and costs, keeping projects on track, and communicating project data through Gantt charts. ***Pre-req.: ENGL 300***.

POWE 428 ELECTRICAL DESIGN IN COMMERCIAL AND INDUSTRIAL BUILDINGS (3 Crs.: 3 Lec): 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 (3 Crs.: 3 Lec): 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. Representation and properties of discrete-time state-space models. ***Pre-req.: POWE 445, COME 483.***

POWE 522 HIGH VOLTAGE ENGINEERING (3 Crs.: 2 Lec, 2 Lab): 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 523 POWER SYSTEM PLANNING (3 Crs.: 3 Lec): 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 (3 Crs.: 3 Lec): 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 526 ADVANCED PHOTOVOLTAIC SYSTEMS (3 Crs.: 3 Lec): Overview of solar resources, solar cell materials and fundamentals of PV solar systems, sources of losses and prevention, estimating power and energy demand, site selection, land requirements, choice of modules. Economic considerations and environmental impacts. Electric wiring of PV systems and electric load analysis. Applications of on-grid and off-grid systems including power electronic converters design and installation. PV system efficiency. Maximum power point tracking methods. Heat impact, cooling, maintenance and safety including leakage current calculation and protection. PV quality and process standards. Design simulation (MATLAB, PSIM). Energy storage systems. ***Pre-req.: POWE 525.***

POWE 529 Wind Energy Systems (3 Crs.: 3 Lec): 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.***

POWE 530 ELECTRIC VEHICLES (3 Crs.: 3 Lec): Field-Oriented Control, direct torque control of induction motors. Permanent magnet brushless, switched reluctance, stator-permanent magnet, and Vernier permanent magnet drive. Hybrid EV: series, parallel, series-parallel, complex hybrid. Electric Variable Transmission Systems. Batteries and chargers technologies. Specifications and safety issues. Topology selection for levels 1, 2 and 3 AC chargers: interleaved, bridgeless front-end AC–DC converter topologies, isolated DC–DC converter topologies. Vehicle-to-grid technology, fuel cell electric vehicle. Braking system of EV, parallel hybrid braking system. Optimal braking performance system with maximum regenerative braking. ***Pre-req.: POWE 433, POWE 436.***

POWE 533 SPECIALIZED MODES OF MACHINE OPERATION (3 Crs.: 3 Lec): 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 (3 Crs.: 2Lec, 2 Lab): 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 (3 Crs.: 3 Lec): 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.***

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

First Semester (16 credits)		**Crs.**	**Pre/Co-requisites**
MATH 281	Linear Algebra	3	Pre: MATH 112
MATH 282	Calculus	3	Pre: MATH 111
PHYS 282	Material Properties and Heat	3	
CHEM 241	Principles of Chemistry	3	Pre: CHEM 110
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	Pre: PHYS 120
MCHE 213	Dynamics	3	
MATH 381	Probability and Statistics	3	Pre: MATH 282
CHEM 405	Solid-State Chemistry	2	Pre: CHEM 241

Summer I (8 credits)		**Crs.**	**Pre/Co-requisites**
ARAB 001	Arabic Language	2	
ENGL 001	General English	2	
	General Elective	2	
	General Elective	2	

Third Semester (17 credits)		**Crs.**	**Pre/Co-requisites**
COME 214	Electric Circuits II	3	Pre: POWE 212
COME 212L	Electric Circuits Lab	1	Co: COME 214
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 283, COME 214
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: MATH381, 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
COME 483	Discrete-Time Signals and Systems	3	Pre: POWE 342

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 221	Engineering Economy	3	

Seventh Semester (18 credits)		**Crs.**	**Pre/Co-requisites**
POWE 525	Introduction to Renewable Energy	3	Pre: POWE 434, POWE 436
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: ENGR 003, Co: POWE 500
	Technical Elective	3	

Eighth Semester (15 credits)		**Crs.**	**Pre/Co-requisites**
POWE 528	Electrical Power Generation	3	Pre: POWE 436
POWE 502	Final Year Project II	3	Pre: POWE 501
	Technical Elective	3	
	Technical Elective	3	
	Technical Elective	3	

Courses offered to other majors

The EPME program 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 335 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.***

POWE 425 INTRODUCTION TO ELECTRICAL POWER SYSTEMS (for communications and electronics engineering students) (3 Crs.: 3 Lec): Overview of power system structure, single-phase and three-phase transformers, synchronous generators, transmission lines and induction motors. Low-voltage power distribution in residential buildings. ***Pre-req: POWE 212, POWE 271.***

Elective University Requirement Course

The EPME 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 & COMPUTER ENGINEERING

3- 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:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Computer Engineering consists of 150 credit-hours of course work + IC003, where the standard duration of study is 10 semesters.

Career Opportunities

The Computer Engineering career encompasses opportunities in a wide range of areas such as industry, military, communications, aerospace, business, government, medicine, to name but a few. Computer engineering is in steady progress with an ever-expanding job market. Specific jobs include the functions of designing, analyzing, and maintaining computer systems. Furthermore, graduates can analyze, design, test, and evaluate network systems. In addition, they can develop, create, and modify general information security schemes. In addition, they can develop, and test systems and application software programs. Trending areas in computer engineering comprise artificial intelligence and machine learning, cybersecurity, smart cities, autonomous driving, vehicular networks, and more. Indeed, computer engineers enjoy high job satisfaction as reflected in market studies. In modern terms, computer engineers are digital transformation and world smartification leaders, believers in sustainable development, technology entrepreneurs and professionals with an engineering mindset!

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	9
II. CE Program-Specific Requirements	**Credits**
A. Engineering topics from outside the program	9
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 9 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	
COME 223	Digital Electronics	3	POWE 212
COME 411	Instrumentation	3	COME 221 or COME 223
		9	

Description of the Courses:

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

COME 223 DIGITAL ELECTRONICS (3 Crs.:2 Lec, 2 Lab): Characteristics of bipolar and field effect transistors. Switching mode of operation. BJT digital families: TTL, Schottky TTL, ECL. MOS digital families: NMOS, CMOS. A/D and D/A converters. ***Pre-req.: POWE 212.***

COME 411 INSTRUMENTATION (3 Crs.: 2 lec, 2 lab): 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 or COME 223***

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 215	Programming for Engineers	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 325	Microprocessor Organization and Design	3	Pre: COMP 226
COMP 337	Analysis and Design of Algorithms	3	Pre: COMP 231
COMP 344	Database Systems	3	Pre: COMP 232
COMP 361	Control Systems for Computer Engineers	3	Pre: MATH 283, POWE 212
COMP 364	Introduction to Artificial Intelligence and Machine Learning	3	COMP 215
COMP 423	Computer Architecture	3	Pre: COMP 325 or COMP 326
COMP 428	Digital Systems Design	3	Pre: COMP 325
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 525	Embedded and Microprocessor Systems	3	Pre: COMP 325
COMP 543	Cryptography and Information Security	3	Pre: COMP 337
COMP 543L	Cryptography and Information Security Lab	1	Co: COMP 543
		74	

C. Computer Engineering Tracks

The CE program provides the following track options:

1. Artificial Intelligence and Machine Learning (19 Credits):
    a. Mandatory track base (10 Credits): COMP 215, COMP 364, and COMP 501 and COMP 502 (A Capstone Design Project in Machine Learning and Artificial Intelligence)
    b. Track cap (9 Credits): Select three elective courses rom the following mandatory list: COMP 460, COMP 477, COMP 534, COMP 560, COMP 562, COMP 564, COMP 565, COMP 568.

2. Networks and Cybersecurity (19 Credits):
    a. Mandatory track base (10 Credits): COMP 454, COMP 543, and COMP 501 and COMP 502 (A Capstone Design Project in Networks and Cybersecurity)
    b. Track cap (9 Credits), select three elective courses from the following mandatory list: COMP 431, COMP 455, COMP 477, COMP 510, COMP 512, COMP 529, COMP 554, COMP 555, COMP 556, COMP 559, and COMP 567.

Students not joining a track can freely select their major elective courses.

Description of Core Courses

ENGR 002 INTODUCTION 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.

COMP 210 PROGRAMMING II (3Crs.: 2Lec, 2Lab): Recursion. Arrays, basic 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 215 PROGRAMMING FOR ENGINEERS (3Crs.: 2Lec, 2Lab): Programming in Python for engineers: language, use of external libraries, runtime analysis, applications from data analysis and engineering. ***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 circuit design (HA, FA, and ALU). Combinational functions and circuit design (decoder, encoder, multiplexer and de-multiplexer). Sequential circuits components (Latches, RS-FF, D-FF, JK-FF, T-FF). Introduction to VHDL. Several laboratory experiments will be based on simple logic gates.

COMP 226 DIGITAL SYSTEMS II (3Crs.: 2Lec, 2Lab): Latches and flip-flops. Synchronous and asynchronous sequential systems. Design of sequential circuits using state diagrams. Registers and Counters. Programmable logic devices (PAL and PLA). Control and Datapath units. Cache memory concept. Serial data transfer for multiple registers. Types of RAM and ROM. Cache memory concept. ALU functions and circuits. Binary multipliers. BCD functions and circuits. Several laboratory experiments and projects will be based on course topics. ***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): Elementary data types. Arrays. Study of complexity of algorithms. 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 325 MICROPROCESSOR ORGANIZATION AND DESIGN (3Crs.: 2Lec, 2Lab): This course introduces the organization and gradual design of generic central processing units (CPUs), focusing on the role of a CPU as the core of computer systems. Topics include arithmetic logic unit design; control unit design; registers; and address, data and control buses. Organization of 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. Labels. Flags. Masking. Time Delays. Serial versus parallel I/O. Handshaking. Several laboratory experiments will be based on microcontrollers. ***Pre-req.: COMP 226.***

COMP 337 DESIGN AND ANALYSIS OF ALGORITHMS (3Crs.: 2Lec, 3Lab): Sorting and searching. Algorithm design and analysis; theory of NP completeness; tools for analyzing efficiency; design of algorithms, including recurrence, divide-and-conquer, dynamic programming, greedy algorithms, and graph algorithms. An introduction to geometric algorithms and algorithms on matrices and polynomials. ***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. Practical implementations using modern tools. ***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. Practical implementations using MATLAB. ***Pre-req.: MATH 283, POWE 212***

COMP 364 INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (3Crs.: 3Lec, 0Lab): Rule-based systems and frequent pattern mining, logic programming, machine learning, supervised and unsupervised learning, search and constraint satisfaction. search algorithms. Knowledge representation and reasoning, knowledge representation for diagnosis. Introduction to neural networks. Implementation using various machine learning and data mining tools. ***Pre-req.: COMP 215***

COMP 423 COMPUTER ARCHITECTURE (3Crs.: 2Lec, 2Lab): Design principles associated with modern computer architectures; performance and cost considerations. Architectural features influenced by operating systems, high level languages, etc. Floating point arithmetic. Processor implementation strategies, micro-programming, pipelining, CISC and RISC, vector processors. Modern RISC processors. Memory hierarchy, cache, virtual memory organization for high performance machines. Special purpose components and devices; simple demonstrations provide experience in the designs and operations of different types of computer architecture such as memory architectures, I/O and bus subsystems, special purpose architectures, parallel processing, and distributed systems; explore hardware and software issues and trade-offs in the design, implementation, and simulation of working computer systems. ***Pre-req.: COMP 325 or COMP 326.***

COMP 428 DIGITAL SYSTEMS DESIGN (3Crs.: 2Lec, 2Lab): Introduction: design metrics, design technologies, hardware accelerators, systems-on-a-chip, intellectual property (IP) cores. Advanced Hardware design tools and technologies: hardware-description languages, high-level synthesis tools, FPGA implementation tools. Design of custom single-purpose processors: design, optimization, implementations under VHDL, applications on computationally intensive algorithms. Application-Specific Instruction-Set Processor (ASIP) design. This course has a project component that targets applications from computer, communications, power and biomedical engineering. This course has practical assignments with focus on high-level synthesis tools and FPGAs. ***Pre-req.: COMP 325.***

COMP 442 SOFTWARE ENGINEERING (3Crs.: 3Lec, 0Lab): Concepts of software development. Lifecycle of software. Requirements and specification. Data models. Process models. Design and coding. Verification, validation and testing. Software evolution. ***Pre-req.: COMP 311.***

COMP 443 OPERATING SYSTEMS (3Crs.: 2Lec, 2Lab): Basic operating systems and their components; concurrency, scheduling and dispatch, memory and device management, file systems and performance evaluation, real-time operating systems, operating systems for mobile devices. Practical experience with state-of-the-art Linux/Unix kernels. ***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. Emphasis on automatic compiler generation and compiler-compiler tools. ***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. ***Pre-req.: COMP 231.***

COMP 454 COMPUTER NETWORKS (3Crs.: 3Lec, 0Lab): The OSI Model. The TCP/IP stack. Application Layer protocols. Transport Layer protocols. Network Layer protocols. Data Link Layer protocols. Frame format: character stuffing, bit stuffing. Error control. Automatic-repeat request and sliding-window protocols. Local area networks: Ethernet, token ring and FDDI, wireless LANs. Circuit switching versus packet switching. Routing and forwarding algorithms. Network Address Translation (NAT). SSH Port Forwarding/Tunneling. ***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 & displaying data, writing a research report. Conducting Scientific Research at the faculty of Engineering. ***Pre-req.: ENGL 300***

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.

COMP 525 EMBEDDED AND MICROPROCESSOR SYSTEMS (3Crs.: 2Lec, 2Lab): Microprocessor-based embedded systems, synchronous and asynchronous serial communication, interfacing, interrupt handling, data acquisition, real-time processing. Several laboratory experiments will be based on microprocessors and microcontrollers. ***Pre-req.: COMP 325.***

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. Pseudo-random bit generators. Authentication techniques. Applications. ***Pre-req.: COMP 337.***

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

A. 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 431	Queuing and Modeling	3	Pre: MATH 381
COMP 438	Performance Evaluation	3	Pre: COMP 325 and MATH 283
COMP 444	System Programming	3	Pre: COMP 443
COMP 455	Mobile Computing	3	Pre: COMP 210
COMP 464	Operations Research for Computer Engineering	3	Pre: COMP 231
COMP 477	Emerging Trends in Computer Engineering	3	Pre: COMP 325 or COMP 232
COMP 510	Internet Engineering	3	Pre: COMP 454
COMP 512	Web Programming	3	Pre: COMP 344
COMP 529	Hardware Security	3	Pre: COMP 428
COMP 530	Hardware/Software Co-Design	3	Pre: COMP 428
COMP 532	Information Theory & Coding	3	Pre: COMP 337, MATH 381
COMP 533	Computer Graphics	3	Pre: COMP 311
COMP 534	Pattern Recognition	3	Pre: COMP 231
COMP 535	Digital Image Processing	3	Pre: COMP 453
COMP 541	Software Development	3	Pre: COMP 442
COMP 554	IoT Platform Design and Implementation	3	Pre: COMP 454
COMP 555	Wireless Security	3	Pre: COMP 454
COMP 556	Sensor Networks	3	Pre: COMP 454
COMP 559	Internet Security	3	Pre: COMP 454
COMP 560	Deep Learning	3	Pre: COMP 364
COMP 561	Digital Control	3	Pre: COMP 361
COMP 562	Applied AI and Deep Learning	3	Pre: COMP 364
COMP 564	Natural Language Processing	3	Pre: COMP 364
COMP 565	Computer Vision	3	Pre: COMP 364
COMP 567	Blockchain Network Programming	3	Pre: COMP 454
COMP 568	Soft Computing	3	Pre: COMP 232
ENGR 003	Engineering Project Management	3	Pre: ENGL 300

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:

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 438 PERFORMANCE EVALUATION (3Crs.: 2Lec, 2Lab): Workload performance indices. Single and multiple job processing models. Scheduling policies. Paging techniques. Performance of computing systems: hardware and software implementations. Performance of computer system applications: networks (scheduling, protocols, etc.), signal processing, machine learning, cryptography, etc. Benchmarks. Classification performance metrics: statistical and machine learning models. ***Pre-req.: COMP 325 and MATH 283.***

COMP 444 SYSTEM PROGRAMMING (3Crs.: 2Lec, 2Lab): introduce the student to the process of writing low-level programs that interact directly with a computer's operating system and hardware: Programming under UNIX : File I/O, makefiles, advanced debugging (gdb), Signal handling, and Scripting, Concurrent programming. ***Pre-req.: COMP 443.***

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 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 Model, 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.: COMP 325 or COMP 232***.

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 512 WEB PROGRAMMING (3Crs.: 2Lec, 2Lab): Introduction to HTML, CSS and JavaScript. Server-side programming: Web Servers, Web-Server Scripting language (PHP/ASP/JSP), Website development using Content Management Systems. ***Pre-req.: COMP 344.***

COMP 529 HARDWARE SECURITY (3Crs.: 3Lec, 0Lab): Hardware perspective of security and trust: vulnerabilities in modern digital system design flow, physical attacks, building secure and trusted hardware. Development of hardware security cores (special purpose processors, ASIPs, pipelined, and partitioned implementations) with optimized performance characteristics (area, speed, power consumption, etc.). Provably correct hardware security and formal engineering methods. ***Pre-req.: COMP 428***.

COMP 530 HARDWARE/SOFTWARE CO-DESIGN (3Crs.: 2Lec, 2Lab): Design models: state machines, concurrent process models, dataflow diagrams, communicating sequential processes (CSP) notation, etc. Co-design principles: partitioning, co-synthesis, co-simulation, modern tools. Methodologies: transformational derivation, formal models, testing, verification, correctness, functional programming in hardware design, concurrency frameworks, synthesis of parallel algorithms. Rapid prototyping: hardware compilers, code generators and IDE design. Review of state-of-the-art published research. This course has a project component that targets applications from computer, communication, power, and biomedical engineering. ***Pre-req.: COMP 428.***

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 337, MATH 381***.

COMP 533 COMPUTER GRAPHICS (3Crs.: 2Lec, 2Lab): Open GL, Computer graphics algorithms, 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 534 PATTERN RECOGNITION (3Crs.: 2Lec, 2Lab): Pattern recognition techniques are used to design automated systems that improve their own performance through experience. This course covers the methodologies, technologies, and algorithms of statistical pattern recognition from a variety of perspectives. Topics including feature extraction, Bayesian decision theory, nearest-neighbor rules, clustering, support vector machines, neural networks, classifier combination, and syntactic pattern recognition techniques such as stochastic context-free grammars will be presented. ***Pre-req.: COMP 231.***

COMP 535 DIGITAL IMAGE PROCESSING (3Crs.: 2Lec, 2Lab): Image formation and perception. Image representation. Transformations on digital images. Enhancement and restoration. Segmentation. Encoding and data compression. ***Pre-req.: COMP 453.***

COMP 541 SOFTWARE DEVELOPMENT (3Crs.: 1Lec, 4Lab): Covers current technology in computer software. Software engineering management, cost and quality metrics and estimation. Project team organization and management. Students will work in teams on a substantial programming project. ***Pre-req.: COMP 442***.

COMP 554 IOT PLATFORM DESIGN AND IMPLEMENTATION (3Crs.: 2Lec, 2Lab): Overview of IoT prominent architectures and blueprint designs. Setting up IoT scenarios and workflow models. IoT sensor design with Arduino and Wi-Fi-controlled microchips. IoT and Cloud integration. Developing IoT applications with Raspberry Pi and Android. Python programming in IoT implementations. IoT Protocols: HTTP, CoAP, MQTT, AMQP, 6LoWPAN. Artificial Intelligence and machine learning models in IoT automation. Designing for Quality of Service and security in IoT architectures. ***Pre-req.: COMP 454.***

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.***

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 559 INTERNET SECURITY (3Crs.: 3Lec, 0Lab): This course covers advanced concepts in network security and the different attack models at the 5 TCP/IP network layers. It comprehensively discusses the various security threats, the vulnerabilities in networking protocols and the attacks that exploit such vulnerabilities. The main topics covered in the course include the following: the security of Email and Web applications, the SSL protocol, the IPSec protocol, VPNs, SNMP security, intrusion detection mechanisms, intrusion backtracking, and firewalls. Practical attack generation, defense, and system hardening components will be considered in student projects as well as some Internet security research aspects. ***Pre-req.: COMP 454***.

COMP 560 DEEP LEARNING (3Crs.: 3Lec, 0Lab): Introduction to artificial neural networks. Data convolutional neural network architectures, invariance learning, deep unsupervised learning and non-convex optimization. Mathematical, statistical and computational challenges of building stable representations for high-dimensional data, such as images, text. Practical implementations under Practical implementations under MATLAB and Python. ***Pre-req.: COMP 364***.

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 562 APPLIED AI AND DEEP LEARNING (3Crs.: 2Lec, 2Lab): Introduction to Deep Learning models used by experts. Overview on the practical aspects of Neural Networks and Deep Learning with applications using most popular Frameworks like Keras, TensorFlow, Apache System/ML and Deep Learning 4J. Applications include Anomaly Detection, Time Series Forecasting, Image Recognition and Natural Language Processing using Keras and TensorFLow. Models created include real life examples of IoT, Financial, medical, and other datasets. Scale those models using Kubernetes, Apache Spark and GPUs. ***Pre-req.: COMP 364.***

COMP 564 NATURAL LANGUAGE PROCESSING (3Crs.: 3Lec, 0Lab): Language modeling, part-of-speech tagging, speech recognition, speech synthesis, prosodic analysis, conversational dialogue, context-free grammars, syntactic parsing, coreference, text classification, sentiment analysis, and machine translation. Applications on Arabic, English and other languages. Programming in Python. ***Pre-req.: COMP 364***.

COMP 565 COMPUTER VISION (3Crs.: 3Lec, 0Lab): Computer vision fundamentals: image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, image classification, scene understanding, and deep learning with neural networks. Methods for applications: finding known models in images, depth recovery from stereo, camera calibration, image stabilization, automated alignment, tracking, boundary detection, and recognition. Practical implementations using tools, such as MATLAB and Python. ***Pre-req.: COMP 364***.

COMP 567 BLOCKCHAIN NETWORK PROGRAMMING (3Crs.: 2Lec, 2Lab): The course presents a general overview of Blockchain, from applications and administration to programming and infrastructure. Its main emphasis is on programming techniques for Blockchain decentralized distributed systems. The topics include overview of Blockchain, decentralized apps and smart contracts, Ethereum, IBM Hyperledger, Blockchain storage systems, Digital Currency systems. ***Pre-req.: COMP 454***.

COMP 568 SOFT COMPUTING (3Crs.: 3Lec, 0Lab): Soft computing techniques. Fuzzy sets, membership functions, fuzzy logic, fuzzy rules, fuzzy reasoning, fuzzification and defuzzification. Probabilistic reasoning, Bayesian network, evolutionary computation, genetic algorithms, simulated annealing, swarm intelligence, continuous optimization, combinatorial optimization, real-world problems. Practical implementations under MATLAB and Python. ***Pre-req.: COMP 232***.

Study Plan
Bachelor of Engineering in Computer Engineering (150 Credits)

First Semester (16 Credits)		**Crs.**	**Pre/Co-requisites**
MATH 281	Linear Algebra	**3**	MATH112
MATH 282	Calculus	**3**	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 215	Programming for Engineers	**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 and Algorithms	**3**	Pre: COMP 231
COMP 311	Object Oriented Programming	**3**	Pre: COMP 210
COMP 325	Microprocessor Organization and 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 337	Analysis and Design of Algorithms	**3**	Pre: COMP 231
COME 411	Instrumentation	**3**	COME 221 or COME 223
COMP 361	Control Systems for Computer Engineers	**3**	Pre: MATH 283, POWE 212
COMP 453	Transmission and Processing of Digital Signals	**3**	Pre: COMP 231
COMP 423	Computer Architecture	**3**	Pre: COMP 226 or COMP 326
	Technical Elective 1	**3**	

Sixth Semester (17 Credits)		**Crs.**	**Pre/Co-requisites**
COMP 364	Introduction to Artificial Intelligence and Machine Learning	**3**	Pre: COMP 215
COMP 428	Digital Systems Design	**3**	Pre: COMP 325
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
COMP 344	Database Systems	**3**	Pre: COMP 232
	General Elective	**1**	

Seventh Semester (14 Credits)		**Crs.**	**Pre/Co-requisites**
COMP 499	Internship (Approved Experience / Independent Study)	**1**	Pre: COMP 500
COMP 500	Research Methodology	**2**	Pre: ENGL 300
COMP 501	Final Year Project I	**1**	Pre/Co: COMP 500
COMP 543	Cryptography and Information Security	**3**	Pre: COMP 337
COMP 543L	Cryptography and Information Security Lab	**1**	Co: COMP 543
	Technical Elective 2	**3**	
	Technical Elective 3	**3**	

Eighth Semester (15 Credits)		**Crs.**	**Pre/Co-requisites**
COMP 452	Compilers	**3**	Pre: COMP 311
COMP 502	Final Year Project II	**3**	Pre: COMP 500
COMP 525	Embedded and Microprocessor Systems	**3**	Pre: COMP 325
COMP 443	Operating Systems	**3**	Pre: COMP 423
	Technical Elective 4	**3**	

Courses offered for other programs

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, basic 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 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 circuit design (HA, FA, and ALU). Combinational functions and circuit design (decoder, encoder, multiplexer and de-multiplexer). Sequential circuits components (Latches, RS-FF, D-FF, JK-FF, T-FF). Introduction to VHDL. 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. Design of sequential circuits using state diagrams. Registers and Counters. Programmable logic devices (PAL and PLA). Control and Datapath units. Cache memory concept. Serial data transfer for multiple registers. Types of RAM and ROM. Cache memory concept. ALU functions and circuits. Binary multipliers. BCD functions and circuits. Several laboratory experiments and projects will be based on course topics. ***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 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 & 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 325.***

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 005 INTRODUCTION TO HEALTH INFORMATICS (2Crs.: 2Lec, 0Lab): Introduction to health informatics and its fields: biomedical informatics, public health informatics, consumer and informatics. Infrastructure and basic technological tools. Application of health informatics tools in public health. Emerging technologies.

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 BIOMEDICAL ENGINEERING

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 communityneeds 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 GAIN:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Biomedical Engineering consists of 150 credit-hours of course work + IC003, where the standard duration of study is 8 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	Credits
General Education Requirements	20
Basic Sciences and Mathematics	26
General Engineering topics	9
II. BME Program-Specific Requirements	**Credits**
A. Engineering topics from outside the major	2
B. Basic Electrical, Computer and Communications Engineering	35
C. BME Core	41
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	

Descriptions of this group of courses are given below:

ENGR 002 INTODUCTION 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.

B. Basic Electrical, Computer and Communication Engineering

This part of the BME curriculum includes 35-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
POWE 342	Control Systems I	3	Pre: MATH 283, COME 214
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

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***

POWE 342 CONTROL SYSTEMS I (3 Crs.: 3 Lec): 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 283, COME 214.***

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***.

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 & Physiology	3	
HESC 202	Health Care Profession & Bio Ethics	1	
BIOL 231	Biology I	3	
PHYS 352	Biophysics	3	
BIOL 334	Cell and Molecular Biology	3	Pre: BIOL 231
BIME 310	Biomedical Instrumentation I	3	
BIME 336	Machine Learning for Medical Applications	3	
BIME 411	Biomedical Instrumentation II	3	Pre: BIME 310
BIME 413	Biomedical Image Processing	3	Pre: COME 381
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.

BIOL 334 CELL AND MOLECULAR BIOLOGY (3Cr.:3Lec): This course provides an introduction to cell biology emphasizing on cell division, cell cycle, structure and function of cellular organelles and the functional interaction of the cells with their microenvironment, an overview on DNA replication, transcription and

translation, regulation of gene expression in prokaryotes and eukaryotes and protein synthesis. This course also covers molecular biology techniques including isolation and purification of nucleic acids, enzymes used in molecular biology such as restriction endonucleases and ligases, genomic library, PCR, Southern, northern and western blotting, sequencing, and cloning. ***Pre-requisite: BIOL 231***

BIME 336 MACHINE LEARNING FOR MEDICAL APPLICATIONS (3Crs.:3Lec): Basics of machine learning, supervised and unsupervised learning, machine learning techniques including neural networks, support vector machines, regression models, Bayesian models, and classification trees. introduction to deep learning. Examples of artificial intelligence for computational medicine (oncology, pathology, physiology, anatomy of diseases) and discussion of the interpretability and ethics of machine learning for medical applications.

BIME 413 BIOMEDICAL IMAGE PROCESSING (3Crs.:3Lec): Basics of imaging including the differences between pixels and voxels, spatial resolution, orientation, and data type. Medical imaging file formats (DICOM, Nifti, Minc). Basics of image processing for biomedical applications: statistical characterization, filtering, enhancement, registration, edge detection, spectral representation, transformations. Applications to medical images including x-rays, computed tomography (CT), MRI and functional MRI, SPECT and PET. ***Pre-requisite: COME 381***

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 & 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 theacademic 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 310
BIME 541	Telemedicine	3	Pre: BIOL 231
BIME 532	Introduction to Neuroscience for Engineers	3	Pre: BIOL 231
BIOL 451	Bioinformatics	3	Pre: BIOL 334
ENGR 003	Engineering Project Management	3	Pre: ENGL 300

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 310***

BIME 532 INTRODUCTION TO NEUROSCIENCE FOR ENGINEERS (3Crs.:3Lec,0Lab): I*ntroduction 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 231.***

BIOL 451 BIOINFORMATICS (3Crs.:2Lec,2Lab): This course covers basic principles of bioinformatics. Topics include biological databases, sequence homology searching, sequence alignment, genome browsers, motif finding, protein structure analysis and modeling and gene expression analysis. This course also includes practical application of bioinformatics tools. ***Pre-requisite: BIOL 334***

ENGR 003 ENGINEERING PROJECT MANAGEMENT (3 Crs.: 3 Lec): The course covers the characteristics, techniques and challenges associated with initiating, planning, executing, controlling and closure of projects. Project management skills are discussed as they apply to projects, with special focus on leadership, teaming, and coordinating individual and group efforts. MS Project is introduced to provide hands-on practical skills with building a project plan, scheduling tasks, assigning resources, managing dependencies, monitoring progress and costs, keeping projects on track, and communicating project data through Gantt charts. ***Pre-requisite: ENGL 300.***

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	
ENGL001	English Language	2	

Summer I (9 Credits)		**Crs.**	**Pre/Co-requisites**
CHEM 241	Principles of Chemistry	3	
ENGL 211	Advanced Writing	2	Pre: 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	Pre: CHEM 241
ENGR001	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 & Physiology	3	
BIOL 334	Cell and Molecular Biology	3	Pre: BIOL 231
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 & Bio Ethics	1	
PHYS 352	Biophysics	3	
POWE 342	Control Systems I	3	Pre: MATH 283, COME 214
BIME 310	Biomedical Instrumentation I	3	
BIME 336	Machine Learning for Medical Applications	3	
COME 384	Digital Signal Processing	3	Pre: COME 381

Seventh Semester (17 Credits)		**Crs.**	**Pre/Co-requisites**
BIME 413	Biomedical Image Processing	3	Pre: COME 381
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
BIME432	Biological Materials	3	Pre: BIOL 231
BIME 502	Final Year Project II	3	Pre: BIME 501
	Technical Elective	3	
	Technical Elective	3	

DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

Chairperson	Adnan Masri,
Professors	Adel El Kordi, Yehia Temsah, Oussama Baalbaki, Jamal Khatib
Associate Professors	Youssef Attallah
Assistant Professors	Hassan Ghanem, Ayman Trad, Hussein Kassem, Wael Sleika, Diala Tabbal, Mohamad Dandachy, Lina Jaber, Mohamad Barakat, Mohamad Soliman
Full-time Instructors	Sandy Chaaban, Nour Wehbi, Ruba Joumblat

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

- Be competent to handle complex engineering tasks and provide innovative solutions through the integration of best practices.
- Be recognized for their ability to pursue graduate studies in Civil Engineering and related interdisciplinary areas as well as aptitude for lifelong learning.
- Demonstrate leadership in their fields of expertise and service to local and international communities.

Learning Outcomes

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

1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. Be able to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. Gain skills to communicate effectively with a range of audiences.
4. Be able to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. Be able to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. Gain ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Civil Engineering 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. Also, contracting firms and construction management offices have job opportunities for civil engineers.

Program Overview

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

I. Common Requirements (60 credits)	**Credits**
General University Requirements	20 (12 Comp & 8 Elect)
Basic Sciences and Mathematics	26
General Engineering Courses	14
II. CE Program-Specific Requirements (90 credits)	**Credits**
A. Civil Engineering Core Courses	73
B. Civil Engineering Technical Electives	12
C. Internship (Approved Experience / Independent Study)	1
D. 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. However, the general engineering component includes 14 credits 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	
ENGR002	Introduction to Engineering	2	

II. CE Program-Specific Requirements

A. Civil Engineering Core Courses

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

Course	Title	Credits	Pre-/Co-requisites
CVLE 208*	Environmental Biology	2	
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 & CHEM 241
CVLE 231	Engineering Geology	2	
CVLE 260	Engineering Surveying I	2	Pre: MATH281
CVLE 261	Engineering Surveying II	2	Pre: CVLE 260
CVLE 270	Civil Engineering Drawings & Detailing	2	Pre: MCHE 201
CVLE 323	RC Structures I	3	Pre: CVLE 213& MATH 381
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 & CVLE 231
CVLE 341	Hydraulics I	3	Pre: PHYS282
CVLE 342	Hydraulics II	3	Pre: CVLE 341
CVLE 354	Environmental Engineering	2	Pre: CVLE 208
CVLE 371	Structural Modeling	2	Pre: CVLE 213 & COMP 208
CVLE 425	Steel I	3	Pre: CVLE 213
CVLE 426	Steel II	3	Pre: CVLE 425
CVLE 427	Building Information & 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 463	Transportation & Traffic Engineering	3	Pre: MATH281
CVLE 464	Highway Engineering	3	Pre: CVLE463 & CVLE 333
CVLE 466	Construction Project Management	3	Pre: CVLE323
CVLE 467	Construction Planning & Scheduling	3	Pre: CVLE466
CVLE 500	Research Methodology	2	Pre: ENGL300

* Basic Sciences Course

** General Engineering Course

A.1 Description of the CE Core Courses

ENGR 002 INTODUCTION 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.

CVLE 208-ENVIRONMENTAL BIOLOGY (2Crs.: 2Lec)
Molecular biology and genetics, microbial cell structure and function, microbial metabolism, microbial growth, and water and soil microbiology. In addition, the course will introduce topics related to the use of biotechnologies for renewable energy, production of alternative fuels, and enhancement of various aspects related to the ecosystem.

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 & 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& CHEM241***

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 & 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. ***Pre-req: MATH281***

CVLE 261-ENGINEERING SURVEYING II (2Crs: 1Lec & 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 270-CIVIL ENGINEERING DRAWING AND DETAILING (2Crs:1Lec & 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, MATH 381***

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 & 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 & 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 & CVLE 231***

CVLE 341-HYDRAULICS I (3Crs: 2Lec & 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. ***Pre-req: PHYS282***

CVLE 342-HYDRAULICS II (3Crs: 2Lec & 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: CVLE208***

CVLE 371-STRUCTURAL MODELING (2Crs:1Lec & 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, COMP208***

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

CVLE 427-BUILDING INFORMATION & 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 & 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 463-TRANSPORTATION & 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. ***Pre-req: MATH281***

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 463 & CVLE 333***

CVLE 466-CONSTRUCTION PROJECT MANAGEMENT (3Crs.:3Lec)
Organization and administration: construction company and project, construction project identification and objectives, construction project's lifecycle, project delivery methods, cost estimating and bidding, staffing for construction, milestones' planning, and quality control. ***Pre-req: CVLE 323***

CVLE 467-CONSTRUCTION PLANNING & SCHEDULING (3Crs.:3Lec)
Principles of project planning, Gantt chart, networks (activity on arrows and activity on nodes), critical path method, precedence diagraming, schedule control, codes, collaborative planning, resource management (leveling and allocation), project control (earned value analysis), schedule reduction, PERT, line of balance scheduling, Primavera P6, and Microsoft Project. ***Pre-req: CVLE 466***

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 & 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.

B. 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 482	Contracts, Quantities & Specifications	3	Pre: CVLE 324
CVLE 510	Non-Destructive Concrete Testing	3	Pre: CVLE 222
CVLE 511	Photogrammetry and Geodesy	3	Pre: CVLE 261
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 519	Concrete Technology	3	Pre: CVLE 222
CVLE 520	Structural Modeling of Buildings	3	Pre: CVLE 371
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	Pre: CVLE 482
CVLE 530	Railway Engineering	3	Pre: CVLE 463
CVLE 531	Harbor Engineering	3	Pre: CVLE 333
CVLE 532	Road Traffic Safety	3	Pre. CVLE 463
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 463
CVLE 541	Water Treatment and Water Desalination	3	Pre. CVLE 453
CVLE 542	Water and Wastewater Treatment	3	Pre: CVLE 342 & CVLE 453
CVLE 543	Water and Wastewater NetworkS	3	Pre: CVLE 342
CVLE 546	Environmental Process Engineering	3	Pre: CVLE 354
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 566	Introduction to Finite Elements	3	Pre. CVLE 214
CVLE 567	Advanced RC Structures	3	Pre. CVLE 324
CVLE 581	Mechanical Eng. for Civil Engineers	3	
CVLE 582	Electrical Eng. for Civil Engineers	3	
CVLE 586	Construction Business Management	3	Pre. CVLE 466
CVLE 587	Simulation of Construction Operations	3	Pre. CVLE 466
CVLE 588	Temporary Support Structures	3	Pre. CVLE 466

CVLE 591	Urban Infrastructure Management	3	Pre. CVLE 466
CVLE 593	Sustainable Concepts & Materials	3	Pre. CVLE 325

B.1 Description of the CE Technical Elective Courses

B.1.1 Structural Eng. Sequence Courses

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 519-CONCRETE TECHNOLOGY (3Crs.:3Lec,0Lab): Evaluation of Existing Structures, 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 structures defects, concrete epoxy injection, ready-mixed concrete. ***Pre-req: CVLE222***.

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 371.***

CVLE 521-STEEL BRIDGES (3Crs.:3Lec)
Types of Steel Bridges – Loads – Bracing Systems – Multi-Span Roadway & 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 324.***

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 592 SUSTAINABLE CONCEPTS & MATERIALS, (3Cr.: 3Lec)
Sustainability concepts and practices. Development of a sustainable built environment. Sustainable design practice, sustainability metrics, life-cycle analysis and the implications of the use of energy, water and other natural resource use in civil engineering projects. Green building that include energy, water, sustainable sites, materials and resources, and indoor environmental quality.
Prerequisite: ***Pre-req: CVLE 325.***

B.1.2 **Geotechnical Eng. Sequence Courses**

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. 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.***

B.1.3 Environmental Eng. & Water Resources Sequence Courses

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***

CVLE 591- Urban Infrastructure Management (3Crs.:3Lec)
Basics of the management of urban infrastructures: Socioeconomic, demographic, technological, environmental, and financial challenges and reflection on infrastructure services and management practices. Various infrastructure management concepts and application in the context of urban energy, urban transportation, water and wastewater infrastructure, solid wastes infrastructure, and communication infrastructure. Environmental characteristics of infrastructure: Efficiency, sustainability, and resilience. ***Pre-req: CVLE 466***

B.1.4 Transportation Eng. Sequence Courses

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.***

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 463.***

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 333.***

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 463.***

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 534-ADVANCED HIGHWAY ENGINEERING (3Crs.:3Lec,0Lab): Highway and Airports pavement design (flexible and rigid pavements), Stress Analysis in flexible and rigid pavements, pavement response under traffic load, failure of flexible and rigid pavements, highways pavement maintenance and rehabilitation (methods, programs, management), types and design, Hot mix Asphalt Concrete: Materials, Design Methods and Testing. ***Pre-req: CVLE 464.***

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 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 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 463.***

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.***

B.1.5 Construction Management Sequence Courses

CVLE 482- CONTRACTS, QUANTITIES & SPECIFICATIONS (3Crs.:3Lec)
Structure of the construction documents and their inter-relationships, building requirements, general and particular contract conditions. Areas and methods of measurements used in engineering projects. Quality measurements and schedules, specifications of contracts. Cost analysis and estimation. ***Pre-req: CVLE 324.***

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. ***Pre-req: CVLE 482.***

CVLE 586- CONSTRUCTION BUSINESS MANAGEMENT (3Crs.:3Lec)
Theoretical principles and practical skills required to manage a firm operating in the construction industry, including financial management, accounting systems and transactions, depreciation, costs and profits management, and cash flows management. ***Pre-req: CVLE 466.***

CVLE 587- SIMULATION OF CONSTRUCTION OPERATIONS (3Crs.:3Lec)
Planning of construction operations, design of efficient processes, construction supply chain management, simulation paradigms: discrete-event simulation, agent-based modeling and system dynamics, simulation of construction operations. ***Pre-req: CVLE 466.***

CVLE 588- TEMPORARY SUPPORT STRUCTURES (3Crs.:3Lec)
Design and construction of temporary support structures used in the construction industry, including concrete formwork, scaffolding, jumping formwork, cofferdams, and caissons. ***Pre-req: CVLE 466.***

B.1.6 Other Engineering Courses

CVLE 581 MECHANICAL ENG. FOR CIVIL ENGINEERS, (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 ENG. FOR CIVIL ENGINEERS, (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.

C. 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.

D. 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 (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	
CHEM 241	Principles of Chemistry	3	Pre: CHEM110
ENGR 002	Introduction 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	Pre : MATH281
CVLE 270	Civil Engineering Drawing and Detailing	2	Pre: MCHE 201
CVLE 208	Environmental Biology	2	
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 341	Hydraulics I	3	Pre: PHYS282
MATH 381	Probability and Statistics	3	Pre: MATH 282
MATH 283	Differential Equations	3	Pre: MATH 281 & 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& CHEM 241
CVLE 342	Hydraulics II	3	Pre: CVLE 341
INME 221	Engineering Economy	3	
MATH 284	Numerical Analysis	3	Pre: MATH 283
ENGL 300	Speech Communications	2	Pre: ENGL 211

Summer II (8 Credits)		**Crs.**	**Pre/Co-requisites**
MGMT 002	Entrepreneurship I	2	
GENE xxx	General Electives	4	

		Crs.	Pre/Co-requisites
Fifth Semester (17 Credits)			
CVLE 325	Construction Materials II	3	Pre: CVLE 222
CVLE 323	RC Structures I	3	Pre: CVLE 213,MATH381
CVLE 333	Soil Mechanics	3	Pre: CVLE 211 & CVLE 231
CVLE 425	Steel I	3	Pre: CVLE 213
CVLE 463	Transportation & Traffic Engineering	3	Pre: MATH281
CVLE 441	Hydrology	2	Pre: CVLE 342

Sixth Semester (18 Credits)		**Crs.**	**Pre/Co-requisites**
CVLE 324	RC Structures II	3	Pre: CVLE 323
CVLE 426	Steel II	3	Pre: CVLE 425
CVLE 464	Highway Engineering	3	Pre: CVLE 463 & CVLE 333
CVLE 466	Construction Project Management	3	Pre: CVLE 323
CVLE 500	Research Methodology	2	Pre: ENGL 300
CVLE 354	Environmental Engineering	2	Pre: CVLE 208
CVLE 371	Structural Modeling	2	Pre: CVLE 213 , COMP208

Summer III (0 Credits)		**Crs.**	**Pre/Co-requisites**
	Practical Training		

Seventh Semester (15 Credits)		**Crs.**	**Pre/Co-requisites**
CVLE 501	Final Year Project I	1	Pre: ENGL 300
CVLE 427	Building Information & Modeling	3	Pre: CVLE 324
ENGR 001	Engineering Ethics	1	(Completed 90 crds)
CVLE xxx	Technical Electives	3	
CVLE 467	Construction Planning & Scheduling	3	Pre: CVLE 466
CVLE 453	Sanitary Engineering	3	Pre: CVLE 354
CVLE 499	Internship (Approved Experience / Independent Study)	1	

Eighth Semester (15 Credits)		**Crs.**	**Pre/Co-requisites**
CVLE 502	Final Year Project II	3	Pre: CVLE 500 & CVLE 501
CVLE 432	Foundation Engineering	3	Pre: CVLE 323 & CVLE 333
CVLE xxx	Technical Electives	9	

[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.

III. Courses Offered to Other Majors

The Civil & 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 & FOUNDATIONS, AND TESTING & 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 MECHANICAL ENGINEERING

Chairperson	Ali Hammoud.
Associate Professors	Amr Ibrahim, Yasser El Samadony, Semaan Amine, Mohamad Kanaan, , Hassan Assoum
Assistant Professors	Mohamad Darwiche, , Amine Abou Moughlbay, Mohamad Ali, Mohamed El-Gohary, Eddie Hanna, Ahmad Salem.

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MECHANICAL ENGINEERING (ME) PROGRAM

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.

Program Educational 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. have demonstrated competency in providing professional solutions in Mechanical Engineering through integration of analytical, experimental, and computer knowledge.
2. have demonstrated ability to pursue graduate studies in mechanical engineering and related multidisciplinary areas.
3. have demonstrated professional leadership in their fields of expertise and service to local and international communities

Student Outcomes

Upon completion of the program, graduates shall have developed:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

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 IC3 (Internet and Computing Core Certification), 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. ME Program-Specific Requirements	**Credits**
A. Engineering topics from outside the major	8
B. Mechanical Engineering Major	64
C. Mechanical Engineering Technical Electives	12
D. Final Year Project	4
E. Internship	1

I. Common Requirements

The list of the Common Requirements courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog.
The general engineering component includes 15 credits distributed as follows:

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

These two general engineering courses offered by the ME department are described below.

MCHE 201 ENGINEERING DRAWING AND GRAPHICS (3Crs.: 2Lec, 2Lab): 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) 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. 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 8-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
POWE 211	Electric Circuits (for Mechanical Engineering students)	3	Pre: PHYS 281
POWE 335	Electric Drives (for Mechanical Engineering students)	2	Pre: MCHE 214

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.***

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. Passive and 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.***

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 311	Mechanics of Materials	3	Pre: CVLE 210, Co: INME 211
MCHE 312	Machine Design I	3	Pre: MCHE 201 and MCHE 311
MCHE 315	Instrumentation and Measurement	2	Pre: MATH 381 and MCHE 214; Co: MCHE 315L
MCHE 315L	Instrumentation and Measurement Lab	1	Co: MCHE 315
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 410	Mechanical Vibrations	3	Co: MCHE 418
MCHE 411	Machine Design II	3	Pre: MCHE 312, MCHE 317
MCHE 416	Mechatronics System Design	2	Pre: COMP 208, MCHE 315; Co: MCHE 416L, POWE 335
MCHE 416L	Mechatronics System Design Lab	1	Co: MCHE 416
MCHE 418	Dynamic Systems	3	Pre: MATH 283 and MCHE 317
MCHE 421	Heat Transfer	3	Pre: MATH 284, MCHE 321
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 515	Control Systems	2	Pre: MCHE 418; Co: MCHE 515L
MCHE 515L	Control Systems Lab	1	Co: MCHE 515
MCHE 521	Thermal Power Stations	3	Pre: MCHE 321
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 Mechatronics; Basic electronic components; semiconductor PN junction; Diodes and applications; Bipolar junction transistors; Field-Effect Transistors (FETs); FET amplifiers and switching circuits; Thyristors; Oscillators; Basic programming concepts. ***Pre-req.: POWE 211, Co-req.: MCHE 214L***.

MCHE 214L FUNDAMENTALS OF MECHATRONICS LAB (1Cr.:0Lec,2Lab): Laboratory instruments; Basic electrical circuits; Thevenin and Norton equivalent circuits; Voltage divider and resistance bridge circuits; passive and active filters; Applications on diodes, bipolar transistors, and FET switching circuits; Applications on operational amplifiers and oscillators. ***Co-req.: MCHE 214.***

MCHE 216 DYNAMICS OF MACHINERY I (3Crs.: 3Lec, 0Lab): Machines and mechanisms. Principles of motion generation and introduction to the concepts of mobility, degrees of freedom and kinematic chains. Graphical linkage synthesis, path and function generation. Position, velocity and analysis of mechanisms. Kinetostatic analysis of rigid mechanisms. Computer-aided solutions. Project. ***Pre-req.: MCHE 213.***

MCHE 311 MECHANICS OF MATERIALS (3Crs.: 3Lec, 0Lab): Introduction to the mechanics of deformable bodies considering linear material response. Concepts of stress and strain. Tension/compression of rods, 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. ***Pre-req.: MCHE 201 and MCHE 311.***

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.: MATH 381 and 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 317 DYNAMICS OF MACHINERY II (3Crs.: 3Lec, 0Lab): Types of gears, gear tooth terminology and relations for spur, helical, bevel and worm gearing. Kinematic analysis and synthesis of ordinary and planetary gear trains. Types and synthesis of cam-follower mechanisms for specified follower motion. Balancing of mechanisms and rotating machinery. Flywheel design. Computer-aided solutions. Project. ***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. Entropy production and Exergy. Gas power cycles. Vapor refrigeration cycles. Introduction to psychometry. ***Pre-req.: PHYS 282.***

MCHE 322 THERMODYNAMICS II (3Crs.: 3Lec, 0Lab): Simple and real Rankine cycle, Rankine cycle parameters impact, Reheat and regenerative steam power generation plants. Co-generation cycle concept. Steam flow through nozzles and forces exerted on different types of turbine blades. Gas turbine (Regeneration, inter-cooling, and reheat cycles) and ideal cycles for reciprocating engines. Exergy analyses of power plants. Research by topics. ***Pre-req.: MCHE 321.***

MCHE 331 FLUID MECHANICS I (3Crs.: 3Lec, 0Lab): Introduction to Fluid Mechanics, Fluid properties, Fluid static, Forces on immersed surfaces, buoyancy and stability of floating bodies, fluid masses subjected to acceleration, vortex motion. Basic fluid dynamic equation, Continuity equation, Bernoulli's equation, Bernoulli's equation application. Fluid flow in pipelines, pipe losses, major and minor losses calculation, series and parallel pipes. ***Pre-req.: PHYS 282.***

MCHE 332 FLUID MECHANICS II (3Crs.: 3Lec, 0Lab): Dimension analysis using PI-Theorem. Fluid flow kinematics for three- dimensional fluid motions, velocity potential, Basic and combined flow field applications, Continuity equation. Lift and Drag forces. Navier-Stokes equations, Applications on Navier-Stokes equations. ***Pre-req.: MCHE 331.***

MCHE 410 MECHANICAL VIBRATIONS (3Crs.: 3Lec, 0Lab): Introduction to vibration. Equivalent systems. Harmonic motion. Free and forced vibrations of single degree of freedom systems, rotating unbalance and base excitation. Two degree of freedom systems. Lagrange's equations. Vibration of multi degree of freedom (MDOF) systems through the calculation of eigenvalues and mode shapes (Modal analysis). Vibration measurements. Practical applications. ***Co-req.: MCHE 418.***

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. Team project to formulate and design a mechanical system for a useful purpose. ***Pre-req.: MCHE 312 and MCHE 317.***

MCHE 416 MECHATRONICS SYSTEM DESIGN (2Crs.: 2Lec, 0Lab): Structure of mechatronic systems; Architecture of microcontrollers; A/D and D/A conversion; Interfacing analog and digital sensors; Controlling actuators using power interface; Servo and stepper motors control; Digital control systems; Logic gates; Karnaugh Maps and flip-flops; Case studies on mechatronic systems design. ***Pre-req.: COMP 208 and MCHE 315, Co-req.: POWE 335 and MCHE 416L.***

MCHE 416L MECHATRONICS SYSTEM DESIGN LAB (1Cr.: 0Lec, 2Lab): Arduino board architecture; Arduino programming language; Analog and digital I/O; Data acquisition from analog and digital sensors; Serial connection; Servo and stepper motors interfacing and control; Data display; Team project to develop a mechatronic system. ***Co-req.: MCHE 416.***

MCHE 418 DYNAMIC SYSTEMS (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 and MCHE 317.***

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. ***Pre-req.: MATH 284 and MCHE 321.***

MCHE 422 REFRIGERATION AND AIR CONDITIONING (3Crs.: 3Lec, 0Lab): Refrigeration introduction and fundamentals, Basic refrigeration cycles (vapor compression cycle, vapor absorption cycle, vapor adsorption cycle, steam-jet refrigeration, air refrigeration cycle, and heat pump), different types of central/unitary air conditioning systems (DX-unit, chillers, and VRV systems). Different types of central heating plants (selection and design). Psychometric air properties, air-conditioning processes, air conditioning cycles analysis. Fundamentals of HVAC system design, cooling/heating load estimation, analysis of applied psychometrics charts, schematic design of HVAC system, equipment selection, air duct design. Fan types and selection. Fan affinity laws. Noise criteria and analysis. Computer software**.** ***Pre-req.: MCHE 421.***

MCHE 429 THERMO-FLUIDS LAB (2Crs.: 0Lec, 4Lab): Experiments relevant to thermodynamics, heat transfer, fluid systems and hydraulic machines. Measurement of temperature, thermal conductivity, convective heat transfer coefficients, and heat radiation. In addition to experiments on air conditioning unit, Francis and Pelton turbines, pressure measurement device, process trainer, and diesel engine. ***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 & displaying data, writing a research report. ***Pre-req.: ENGL 300.***

MCHE 515 CONTROL SYSTEMS (2Crs.: 2Lec, 0Lab): Transfer function for various dynamic systems. Block reduction techniques. Performance of first-, second-, and higher-order systems. Steady-state error. Stability analysis and Routh-Hurwitz criterion. Root-locus techniques. Design of controllers and compensators. Frequency response and Bode plots. ***Pre-req.: MCHE 418, Co-req.: MCHE 515L.***

MCHE 515L CONTROL SYSTEMS LAB (1Cr.: 0Lec, 2Lab): Analysis of various control systems in Matlab and Simulink. Design of PID controllers using the control toolbox. Control experiments that includes: DC Motor and inverted pendulum. Team project. ***Co-req.: MCHE 515.***

MCHE 521 THERMAL POWER STATIONS (3Crs.: 3Lec, 0Lab): Introduction to thermal power station. Types of thermal power station .Demonstration of simple Rankine cycle, impact of key parameters variation on cycle performance, review of modified Rankine cycles (reheat cycle, regenerative cycle, and co-generation cycle).

Thermal analysis and design of the various components of the steam power plants (steam generator – steam condenser – cooling tower – feed water heaters) are given in details. Water treatment procedure for boiler makeup water. Steam turbines types and construction. Gas-turbine cycle and combined cycle. Overview of solar power plants. Concentrating solar collector analysis and design. Nuclear power plant types and constructions. ***Pre-req.: MCHE 321.***

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 fans, compressors, and blowers. Design, operation and fans selection for ventilation systems. Fire pump specifications and safety codes based on NFPA 20. Mechanical specification codes and standards used in the mechanical services in building. Pump stations design. Pipe network systems. Water hammer protection cause effect & solution. Application of fluid thermal (space air heating application) such as radiator systems including pipe sizing and selection of boiler, pump, and radiators. High-rise building water distribution riser diagram. Chiller piping system applications (constant primary, constant primary-variable secondary, variable primary). Two course Projects in the implementing of fluid thermal systems design and plumbing. ***Pre-req.: MCHE 531.***

C. Mechanical Engineering Technical Electives

The ME 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.

Course	Title	Credits	Pre-/Co-requisites
MCHE 513	Finite Element Analysis – Theory and Applications	3	Pre: MCHE 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 528	Aircraft Engines	3	Pre: MCHE 322
MCHE 530	Pipeline Engineering	3	Pre: MCHE 331 or MCHE 339
MCHE 533	Hydraulic Machinery and Stations	3	Pre: MCHE 331
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 539	Gas Dynamics	3	Pre: MCHE 321 and MCHE 331
MCHE 560	Mobile Robotics	3	Co: MCHE 416
MCHE 562	Sensors and Actuators	3	Pre: MCHE 315
MCHE 563	Applied Engineering Optimization	3	Pre: MATH 284 and MCHE 312
MCHE 564	Automotive Engineering	3	
MCHE 565	Technology Ventures	3	Pre: MGMT 002 and INME 221
MCHE 566	Automotive Control	3	Pre: MCHE 564
MCHE 567	Fundamentals of Robotics	3	Pre: MCHE 317 or COMP 328
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 315 and MCHE 422
MCHE 575	REVIT MEP For Mechanical Engineers	3	Pre: MCHE 422
MCHE 581	Computational Fluid Dynamics	3	Pre: MCHE 321 and MCHE 331

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.: MCHE 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): Overview of the main renewable energy sources including solar energy, wind energy, geothermal energy, hydro-energy, biofuel and biomass, and ocean energy. Solar angles, estimation of hourly and daily solar radiation, selected heat transfer topics, energy storage, flat-plate solar collector, solar building-heating active and passive, concentrating collector, wind energy, introduction to alternative energy technologies such as hydro, geothermal, and ocean thermal energy conversion. Engineering economy and environmental impact of utilization of renewable energy systems will be also discussed. ***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; lighting efficiency technique, use of waste thermal energy systems for domestic and industrial applications, and electrical energy conservation are highlighted. ***Pre-req.: MCHE 321.***

MCHE 528 AIRCRAFT ENGINES (3Crs.: 3Lec, 0Lab): Introduction to air propulsion engine. History of aircraft engine. Air propulsion principles. Performance of turbojet, turbofan, and turbo-propeller engines. Design of main components of aircraft engines including air intake, compressor, turbine, and nozzle. Gas turbine cycle for aircraft applications. Estimating engine thrust, engine fuel consumption and efficiencies. Comparing types of combustion chambers. Description of engine lubrication, cooling, start-up and ignition systems. Principles of thrust reversal. Methods for providing vertical aircraft take-off and landing. Strategies used for ice protection. ***Pre-req.: MCHE 322.***

MCHE 530 PIPELINE ENGINEERING (3Crs.: 3Lec, 0Lab): Introduction to Pipeline engineering, Specification, selection of pipes and material, Piping system analysis, Unsteady flow in pipe systems. Piping Codes and standards, Instrumentation and measurements. Corrosion in Pipelines, Pipeline protection, and coating. Introduction to installation, operation, backfilling, cleaning, monitoring and maintenance. Welding techniques, operation, control, maintenance, repair, metering, storage and inspection. Pipeline testing, Piping supports, General requirements of pipes used in Oil and Gas industries, Transportation of oil using centrifugal pumps. Gas pipelines. ***Pre-req.: MCHE 331 or MCHE 339.***

MCHE 533 HYDRAULIC MACHINERY AND STATIONS (3Crs.: 3Lec, 0Lab): Introduction to water turbines. Types of Hydraulic turbines, Pelton wheel, Francis, propeller and Kaplan turbines, construction, design factors, discharge regulation and part load performance, velocity diagram, power, efficiency ,model testing, cavitations and turbine selection, hydropower plants capacity, number of units, pump storage projects, mini-water turbines, Turgo, Gorllov ,cross flow turbines. Hydro-power plants in Lebanon. ***Pre-req.: MCHE 331.***

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 & 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): An overview of compressed air systems, Compressor types, Air treatment devices: dryers, filters. 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 539 GAS DYNAMICS (3Crs.: 3Lec, 0Lab): Introduction to compressible flow. Speed of sound in gases and liquids. Stagnation state for ideal gas model. Isentropic flow in convergent and convergent-divergent nozzles. Variation of fluid properties with Mach number for subsonic and supersonic flows. Governing equations and analysis of normal and oblique shock waves in supersonic flow. Analysis of adiabatic flow in ducts with friction (Fanno model). Describing frictionless flow in ducts with heat transfer (Raylieh model). Applications of gas dynamics in jet engines. ***Pre-req.: MCHE 321 and MCHE 331.***

MCHE 560 MOBILE ROBOTICS (3Crs.: 3Lec, 0Lab): Key issues for locomotion: legged and wheeled mobile robots; Mobile robot kinematics: mobility, steerability, maneuverability; Sensors for mobile robots' perception and localization; Introduction to autonomous mobile robots: path planning, obstacle avoidance and navigation. ***Co-req.: MCHE 416.***

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.: MATH 281 and MCHE 312.***

MCHE 564 AUTOMOTIVE ENGINEERING (3Crs.: 3Lec, 0Lab): Engine parts and construction. Engine classifications. Estimation of engine power, fuel consumption and efficiencies. Engine combustion and emissions. Carburetor and electronic fuel injection systems. Mechanical and electronic ignition systems. Engine cooling and lubrication systems. Automotive disc and drum brakes. Power brakes. Anti-lock brake system (ABS). Automotive manual and power steering systems. Conventional, air, and active suspension systems. Four wheel steering. Components of power train including Clutches, transmission, and differential.

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 566 AUTOMOTIVE CONTROL (3Crs.: 3Lec, 0Lab): Concepts of automotive control, Electro-mechanical systems that are controlled by electronic control modules via an appropriate algorithm such as fuel injection timing control, emission control, transmission clutch control, anti-lock brake control, traction control, stability control, etc. ***Pre-req.: MCHE 564.***

MCHE 567 FUNDAMENTALS OF ROBOTICS (3Crs.: 3Lec, 0Lab): Robot architecture, subsystems, and applications; mechanisms and drives; forward and inverse kinematics. Trajectory planning; dynamics and control. Metrics of robot performance. Serial and parallel-drive manipulators. Static force and torque analysis. Computer-aided analysis. ***Pre-req.: MCHE 317 or COMP 328.***

MCHE 571 REFRIGERATION AND HVAC APPLICATIONS (3Crs.: 2Lec, 2Lab): Refrigeration cycles, Multi-stage compression cycles, compressor types and selection, metering device selection, evaporator selection and design, condenser selection and design. Basic cycle performance, suction accumulator. Liquid receiver, oil separator, multi evaporators design, and different defrost methods. Refrigerant piping design, chilled and hot water piping design, cold stores planning, cooling load calculations for cold store, cold store insulation. Refrigeration equipment selection and installation. Air conditioning systems selection. Air duct design. Course project. Computer software. ***Pre-req.: MCHE 422.***

MCHE 572 WATER DESALINATION TECHNOLOGIES (3Crs.: 3Lec, 0Lab): The course provides theoretical and practical aspects of seawater/brackish water desalination technologies. The main topics include basic concepts of water chemistry; detailed evaluation and technology description of thermal-based (SSE, MEV, MSF, MED, and VC) and membrane-based (RO) desalination processes; conventional and innovative intake and pre-treatment systems; process design and system performance; fouling, scaling (including bio-fouling) and cleaning; product water quality and post-treatment. Other related topics such as innovative desalination technologies (Forward Osmosis (FO), Membrane Distillation (MD), Absorption/adsorption Desalination; energy consumption; environmental impact; economics; hybrid systems; desalination using renewable energy; trends of desalination market; full scale plants and case studies, will also be covered in this course depending on time availability. ***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. Boiler operation and control, boiler testing and maintenance, water treatment procedure, condenser operation and troubleshooting, steam turbine construction, steam turbine governing systems types and operation, gas turbine operation and control, 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; Sound Propagation and Decibel Scale, Sound Power Level, The Ear and Assessment of Loudness, Quantifying Loudness. Community Reaction to Noise; Noise Annoyance, Noise Standards and Legal Aspects, Controlling Level Outsides Buildings. Behaviour of Sound Inside Buildings; Calculation of Room Noise Levels, Sound Transmission Through Partitions. Noise in Ductwork Systems; Fan Noise, Ductwork Attenuation, Ductwork Acoustic Calculations. Computer software applications. ***Pre-req.: MCHE 315 and MCHE 422.***

MCHE 575 REVIT MEP FOR MECHANICAL ENGINEERS (3Crs.:0Lect, 6 Lab): The aim of this course is to effectively communicate building information using Autodesk Revit software for mechanical and plumbing systems of building structures. Principles and applications of MEP modeling and documentation. Revit project setup for engineering purposes. Work sharing concepts, methods, tools and commands with Revit for building design, construction documentation and presentation purposes. Topics include working with interrelated architectural files where students learn how to add mechanical equipment to a project, create HVAC zones, add insulation, piping systems, fire protection systems and more**.** ***Pre-req.: 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 321 and MCHE 331.***

D. Final Year Project

MCHE 501 FINAL YEAR PROJECT I (1Cr) / MCHE 502 FINAL YEAR PROJECT II (3Crs) After completing 114 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.

E. Internship

MCHE 499 INTERNSHIP (1Cr): 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.

Study Plan
Bachelor of Engineering in Mechanical Engineering (150 Credits)

First Semester (16 credit hours)		**Crs.**	**Pre/Co-requisites**
BLAW 001	Human Rights	1	
CHEM 241	Principles of Chemistry	3	Pre: CHEM 110
MATH 281	Linear Algebra	3	Pre: MATH 112
MCHE 201	Engineering Drawing and Graphics	3	
MCHE 213	Dynamics	3	
PHYS 282	Material Properties and Heat	3	

Second Semester (18 credit hours)		**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	Pre: MATH 111
MCHE 216	Dynamics of Machinery I	3	Pre: MCHE 213
PHYS 281	Electricity and Magnetism	3	Pre: PHYS 112

Summer 1 (8 credit hours)		**Crs.**	**Pre/Co-requisites**
ARAB 001	Arabic Language	2	
ENGL 001	General English	2	
	General Electives[1]	4	

Third Semester (18 credit hours)		**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 credit hours)		**Crs.**	**Pre/Co-requisites**
MATH 284	Numerical Analysis	3	Pre: MATH 283
MATH 381	Probability and Statistics	3	Pre: MATH 282
MCHE 214	Fundamentals of Mechatronics	2	Pre: POWE 211, Co: MCHE 214L
MCHE 214L	Fundamentals of Mechatronics Lab	1	Co: MCHE 214
MCHE 312	Machine Design I	3	Pre: MCHE 201 and MCHE 311
MCHE 322	Thermodynamics II	3	Pre: MCHE 321
MCHE 332	Fluid Mechanics II	3	Pre: MCHE 331

Summer 2 (8 credit hours)		**Crs.**	**Pre/Co-requisites**
ENGL 211	Advanced Writing	2	Pre: ENGL 001
MGMT 002	Entrepreneurship I	2	
	General Electives[1]	4	

Fifth Semester (18 credit hours)		Crs.	Pre/Co-requisites
ENGL 300	Speech Communications	2	Pre: ENGL 211
CHEM 405	Solid State Chemistry	2	Pre: CHEM 241
INME 221	Engineering Economy	3	
MCHE 315	Instrumentation and Measurement	2	Pre: MATH 381 and 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
MCHE 429	Thermo-fluids Lab	2	Pre: MCHE 332, Co: MCHE 421

Sixth Semester (17 credit hours)		Crs.	Pre/Co-requisites
MCHE 410	Mechanical Vibrations	3	Co: MCHE 418
MCHE 416	Mechatronics System Design	2	Pre: COMP 208, MCHE 315, Co: MCHE 416L, POWE 335
MCHE 416L	Mechatronics System Design Lab	1	Co: MCHE 416
MCHE 418	Dynamic Systems	3	Pre: MATH 283, MCHE 317
MCHE 422	Refrigeration and Air Conditioning	3	Pre: MCHE 421
POWE 335	Electric Drives (for Mechanical Engineering)	2	Pre: MCHE 214
	Technical Elective[2]	3	

Seventh Semester (16 credit hours)		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 515	Control Systems	2	Pre: MCHE 418, Co: MCHE 515L
MCHE 515L	Control Systems Lab	1	Co: MCHE 515
MCHE 521	Thermal Power Stations	3	Pre: MCHE 321
MCHE 531	Pump Technology	3	Pre: MCHE 332
	Technical Elective[2]	3	

Eighth Semester (13 credit hours)		Crs.	Pre/Co-requisites
ENGR 001	Engineering Ethics	1	
MCHE 502	Final Year Project II	3	Pre: MCHE 501
MCHE 534	Fluid Thermal System Design	3	Pre: MCHE 531
	Technical Electives[2]	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; plumbing; waste systems; sump pumps; heat losses and thermal insulation; ventilation and air conditioning; sound insulation; elevators and escalators, and firefighting.

MCHE 225 THERMODYNAMICS FOR CHEMICAL ENGINEERS (3Crs.: 3Lec, 0Lab): Heat and work, first law of thermodynamics, properties of steam and gases, steam tables and charts, entropy, second law, air standard cycle, compressors, reversibility, availability and second law efficiency, real gases. ***Pre-req.: PHYS 282*.**

MCHE 226 APPLIED THERMODYNAMICS FOR CHEMICAL ENGINEERS (3Crs.: 3Lec, 0Lab): Power and refrigeration cycles, vapor cycles, Carnot, Rankine, reheated, regenerative, gas power cycle, gas turbine, reciprocating engine cycles. Refrigeration and heat pump cycles, vapor compression cycle, absorption refrigeration cycle, thermodynamic tables. ***Pre-req.: MCHE 225*.**

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 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.: CVLE 210*.**

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.: PHYS 282*.**

MCHE 338 PUMPS AND PIPING SYSTEMS (3Crs.: 3Lec, 0Lab): Pipeline and piping system, Pump types and operation, Centrifugal pumps operation, pump selection, pump in parallel and series, viscosity effect on centrifugal pumps, pump problem (Cavitation), priming of centrifugal pumps. ***Pre-req.: MCHE 331*** **and CHME 202.**

MCHE 339 FLUID MECHANICS for PE (3Crs.: 3Lec, 0Lab): Fluid static, Forces on immersed surfaces, buoyancy and stability of floating bodies, fluid masses subjected to acceleration, vortex motion, hydrodynamics, Bernoulli's equation application, fluid flow in pipelines, introduction to pumps. ***Pre-req.: PHYS 282*.**

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; thermodynamic principles including Rankine cycle, Brayton cycle, and combined cycles; steam generations and boiler systems; steam turbines systems; condensers and cooling technologies. Energy conservation, continuity; introduction to fluid mechanics and hydraulic machines: pumps, turbines.

DEPARTMENT OF INDUSTRIAL ENGINEERING AND ENGINEERING MANAGEMENT

Chairperson: Adel El Kordi
Associate Professors Akram Tannir
Assistant Professors Ramzi Fayad, Hisham Abou Ibrahim
Full- time Instructors Zeidoun Zeidan, 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.

Program Educational Objectives
The Bachelor of Engineering in Industrial Engineering (IE) is the only undergraduate degree awarded by the Industrial Engineering & Engineering Management Department at BAU. The Industrial Engineering (IE) program educational objectives were set and approved by the IE program's constituencies, i.e. Faculty, Alumni, Advisory Board, and Employers. The program has as its objectives that within a few years our graduates must:

1. be competent 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. be competent 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. assume leadership roles with strong communication skills and will be able to work competently and ethically alone and as team members.

Learning Outcomes
The IEEM department has adopted the ABET Students learning Outcomes (SLOs) "1 to 7" to ensure the quality of the Industrial Engineering Program Educational Objectives. Upon completion of the program graduates must attain:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Degree Requirements
The undergraduate curriculum for the degree of Bachelor of Engineering in Industrial Engineering consists of 150 credit-hours of course work + IC3 + 30 credits transferred from the Lebanese Baccalaureate or its equivalents.

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. IE 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 General Education Requirements and Basic Sciences and Mathematics courses and their descriptions are presented in the introductory pages of the Faculty of Engineering section in this catalog. The courses required as General Engineering topics for the INME program are:

Course	Title	Credits
INME206	Production Engineering	3
INME221	Engineering Economy	3
CVLE 210	Statics	3
MCHE 201	Engineering Drawing and Graphics	3
COMP 208	Programming I	3

II. IE Program-Specific Requirements

A. Industrial Engineering Core Courses

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

Course	Title	Crs	Pre-requisites
INME204	Introduction to Industrial Engineering	2	
INME206	Production Engineering	3	
INME211	Engineering Materials and Technology	3	PHYS282
INME212	Metal Shaping	3	INME211
INME214	Manufacturing Processes	3	INME211
INME221	Engineering Economy	3	
INME222	Operations Research	3	MATH281
INME312	Computer Aided Design and Manufacturing	3	MCHE201
INME321	Management Information Systems	3	INME204
INME321L	Management Information Systems Lab	1	INME204 and Co: INME321
INME322	Organization Design	3	INME204
INME324	Production and Operation Management	3	INME222
INME325	Stochastic Operations Research	3	MATH381
INME326	Industrial Process Design	2	INME321
INME332	Industrial Measurements and Inspection	3	MATH284
INME333	Facility Planning and Design	3	INME204
INME335	Quantitative Methods for Decision Making	2	MATH381
INME341	Engineering Safety	2	INME212 and INME214
INME422	Engineering Logistics and Supply Chain	3	INME325
INME423	Project Planning and Management	3	INME324
INME431	System Modeling and Simulation	3	COMP208 and INME326
INME431L	System Modeling and Simulation Lab	1	COMP208, INME326, Co: INME431
INME433	Maintenance Planning and Technology	3	INME332 Co: INME332L
INME434	Statistical Quality and Process Control	3	MATH381

INME442	Ergonomics	2	CVLE210
INME500	Research Methodology	2	Co: ENGL300
INME521	Total Quality Management & Six Sigma	3	INME434
INME522	Management of Global Operations	3	INME422
INME531	Production Systems and Automations	3	INME333
INME535	Advanced Engineering Statistics	3	INME335

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 and the various aspects of Industrial Engineering. Introduction to selected topics in Industrial Engineering, including: facilities design, project management, production and operation management.

INME206 PRODUCTION ENGINEERING (3Crs.:3Lec,0Lab): Introduction to production and manufacturing engineering, Production of iron and steel, metrology, bench work, hand forging, and production cost analysis.

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 and INME206.***

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 LAB (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. ***Pre-req.: INME204 and 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.***

INME326 INDUSTRIAL PROCESS DESIGN (2Crs.:2Lec,0Lab): Topics include business process diagnosis, design, and development, process simplification and optimization, performance improvement. ***Pre-req.: INME321.***

INME 332 INDUSTRIAL MEASUREMENTS 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 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 335 QUANTITATIVE METHODS FOR DECISION MAKING (2Crs.:2Lec,0Lab): Topics include decision theory, decision trees decision making techniques, decision statistical methods, game theory, and utility questions. ***Pre-req.: MATH381***

INME 341 ENGINEERING SAFETY (2Crs.:2Lec,0Lab): Engineering principles to control hazards, maintaining optimally safe systems, types of Hazards, Personal Protective Equipment, construction and manufacturing safety. ***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.: INME325.***

INME 423 PROJECT PLANNING AND MANAGEMENT (3Crs.:3Lec,0Lab): Principles of project planning, 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. ***Pre-req.: INME324***

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 and INME326.***

INME 431L SYSTEM MODELING AND SIMULATION Lab (1Crs.: Lec,2Lab): The content of this lab is directly related to the courses INME431. ***Pre-req.: COMP208, INME326 and 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.: INME332 and INME332L.***

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 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-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 essentials for business process design, performance measures, tools for process design, from as-is towards to-be and activity value analysis, process flow management, modeling and simulation business processes, input and output analysis, optimizing process performance, and process benchmarking. ***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, 2^k 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.***

C. Final Year Project

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 & displaying data, writing a research report. ***Co-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

D. INTERNSHIP

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.
Refer to the department policy for further details.

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	MATH 112
PHYS 281	Electricity and Magnetism	3	
CHEM241	Principle of Chemistry	3	
COMP 208	Programming I	3	
BLAW 001	Human Rights	1	

Second Semester (17 Credits)		**Crs.**	**Pre/Co-requisites**
MATH 282	Calculus	3	MATH 111
INME 206	Production Engineering	3	
PHYS 282	Materials properties and Heat	3	
INME 204	Introduction to Industrial Engineering	2	
INME 221	Engineering Economy	3	
CVLE 210	Statics	3	

Summer Semester (8 Credits)		**Crs.**	**Pre/Co-requisites**
ARAB001	Arabic Language	2	
ENGL001	English Language	2	
	Elective (General)	2	
	Elective (General)	2	

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 322	Organization Design	3	Pre: INME 204
ENGL 211	Advanced Writing	2	Pre: ENGL001

Fourth Semester (17 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 211and INME 206
INME 214	Manufacturing Processes	3	Pre: INME 211
INME 326	Industrial Process Design	2	Pre: INME 321

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

Fifth Semester (18 Credits)		Crs.	Pre/Co-requisites
INME325	Stochastic Operations Research	3	Pre: MATH 381
INME 335	Quantitative Methods for Decision Making	2	Pre: MATH 381
INME 324	Production and Operation Management	3	Pre: INME 222
INME 341	Engineering Safety	2	Pre: INME 212 and INME 321
INME 333	Facility Planning and Design	3	Pre: INME 204
	Technical Elective	3	
INME 500	Research Methodology	2	Co: ENGL 300

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 423	Project Planning and Management	3	Pre: INME 324
INME 442	Ergonomics	2	Pre: CVLE 210
	Technical Elective	3	

Seventh Semester (15 Credits)		Crs.	Pre/Co-requisites
INME 535	Advanced Engineering Statistics	3	Pre: INME 335
ENGR 001	Engineering Ethics	1	
INME 433	Maintenance Planning and Technology	3	Pre: INME 332
INME 531	Production Systems and Automations	3	Pre: INME 333
INME 431	System Modeling and Simulation	3	Pre: COMP 208 and INME326
INME 431L	System Modeling and Simulation Lab	1	Pre: COMP 208, INME326, Co INME 431
INME 501	FYP 1	1	Pre: INME 500

Eighth Semester (16 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	3	
	Technical Elective	3	
INME 499	Internship	1	
INME 502	FYP 2	3	Pre: INME 501

DEPARTMENT OF PETROLEUM ENGINEERING AND CHEMICAL ENGINEERING

Acting Chairperson:	Rami Harkous
Assistant Professors	Kamel Bou Hamdan, Jean Al Achkar
Full- time Instructors	Shereef Mostafa, Hussein El Gharib

1- 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:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

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. PE 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-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.:PTRE*****202*****, 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.: PTRE*****301**

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, Introduction to drilling simulation using DrillSim20. ***Pre-req.: PTRE*206**

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, MCHE*329**.

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.
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 & 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.:PTRE*301**.

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.: PHYS*282**

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.: PHYS*282.**

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- requisites**
PTRE413	Natural Gas Engineering	3	PTRE308
PTRE415	Fire Control Engineering	3	PTRE412
PTRE416	Hydraulic Fracturing in Unconventional Rerservoirs	3	PTRE308
PTRE417	Hydrocarbon Phase Behavior	3	MCHE329
PTRE418	Petroleum Law	3	BLAW001, PTRE 201
PTRE419	Petroleum Economy, Risk & 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 & 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 & 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 416 – HYDRAULIC FRACTURING IN UNCONVENTIONAL RESERVOIRS
(3Crs.: 3Lec,0Lab):
The course presents the physical principles and engineering methods involved in hydraulic fracturing. It covers an introduction to unconventional reservoirs, hydraulic fracturing operation and execution, shale reservoir stimulation, fluid systems, proppant design, chemical selection and design, fracture treatment and perforation design, horizontal multistage completions techniques, rock mechanical properties and in situ stresses.
Pre-req.: PTRE308

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 418 PETROELUM LAW (3Crs.:3Lec,0Lab): The course provides the legal aspects of petroleum exploration and exploitation both internationally and in Lebanon. The focus of the course is on regulation of upstream petroleum activities, i.e. exploration and production, and the general legal premises that apply in this regard, both under national and international law. ***Pre-req.: BLAW 001, PTRE 201.***

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**
COMP208	Programming I	3	
MATH281	Linear Algebra	3	
CVLE210	Statics	3	
PHYS282	Material Properties and Heat	3	
MCHE210	Engineering Drawing and Graphics	3	

Second Semester (15 Credits)		**Crs.**	**Pre/Co-requisites**
MATH282	Calculus	3	Pre: MATH111
MCHE213	Dynamics	3	
PHYS281	Electricity & Magnetism	3	
PTRE201	Introduction to Petroleum Engineering	3	
CHEM281	Principles of Chemistry I	3	Pre: CHEM110

Summer I Semester (9 Credits)		**Crs.**	**Pre/Co-requisites**
ARAB001	Arabic Language	2	
ENGL001	English Language	2	
BLAW001	Human Rights	1	
	Elective (General)	4	

Third Semester (18 Credits)		**Crs.**	**Pre/Co-requisites**
MATH283	Differential Equations	3	Pre:MATH281 + MATH282
MCHE339	Fluid Mechanics for PE	3	Pre:PHYS282
CHEM331	Organic Chemistry	3	Pre:CHEM281
PTRE202	Reservoir Rock Properties	3	Pre:PTRE201
CHEM282	Principles of Chemistry II	3	Pre:CHEM281
GEOL201	Physical Geology	3	

Fourth Semester (17 Credits)		**Crs.**	**Pre/Co-requisites**
MATH284	Numerical Analysis and Techniques	3	Pre:MATH283
PTRE206	Petroleum Drilling Systems	3	Pre:PTRE201
PTRE301	Reservoir Fluids	3	Pre:PTRE202 + MCHE339
GEOL206	Principles of Petroleum Geology	3	Pre:GEOL201 + MCHE201
MCHE319	Mechanics of Materials for PE	3	Pre:CVLE210
ENGL211	Advanced Writing	2	Pre:ENGL001

Summer II Semester (8 Credits)		**Crs.**	**Pre/Co-requisites**
ENGL300	Speech Communication	2	Pre:ENGL211
MGMT002	Entrepreneurship	2	
	Elective (General)	4	

Fifth Semester (18 Credits)		Crs.	Pre/Co-requisites
PTRE405	Well Testing	3	Pre:PTRE301
MCHE329	Thermodynamics for PE	3	Pre:PHYS282
PTRE409	Reservoir Simulation	3	Pre:PTRE301 + MATH284 + COMP208
PTRE306	Petroleum Geomechanics	3	Pre:MCHE319
PTRE303	Well Logging	3	Pre:GEOL206
	Technical Elective	3	

Sixth Semester (17 Credits)		Crs.	Pre/Co-requisites
PTRE308	Petroleum Production Technology	3	Pre:PTRE206
PTRE410	Reservoir Characterization	3	Pre:PTRE202 + PTRE303
PTRE412	Drilling Technology	3	Pre:PTRE206
MATH381	Probability & Statistics	3	Pre:MATH282
GEOL205	Geophysical Techniques	3	Pre:PHYS281
PTRE500	Research Methodology	2	Pre:ENGL300

Seventh Semester (17 Credits)		Crs.	Pre/Co-requisites
PTRE513	Reservoir Engineering	3	Pre:PTRE301
PTRE501	Final Year Project 1	1	Pre:PTRE500
PTRE511	Petroleum Refining Operations	3	Pre:CHEM331
PTRE499	Internship (Approved Experience / Independent Study)	1	
GEOL401	Geology of Lebanon and Levantine Region	3	Pre:GEOL206
INME221	Engineering Economy	3	
	Technical Elective	3	

Eighth Semester (16 Credits)		Crs.	Pre/Co-requisites
PTRE502	Final Year Project 2	3	Pre:PTRE501
PTRE512	Environment & Safety	3	Pre:PTRE306
PTRE414	Gas Production Engineering	3	Pre:MCHE329 + PTRE308
ENGR001	Engineering Ethics	1	
	Technical Elective	3	
	Technical Elective	3	

DEPARTMENT OF CHEMICAL ENGINEERING

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:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

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	36
General Engineering topics	15
IV. ChE Program-Specific Requirements	**Credits**
F. Chemical Engineering Core	47
G. Engineering topics from outside the major	15
H. Chemical Engineering Technical Electives	12
I. Final Year Project	4
J. Internship	1

III. 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.

IV. CHME Program-Specific Requirements

A. Chemical Engineering Core Courses

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

Course	Title	Credits	Pre-requisites
CHME202	Introduction to Chemical Engineering	3	
CHME204	Mass transfer Operations	3	CHME 202
CHME301	Separation Processes	3	CHME204
CHME302	Chemical Engineering Reaction	3	MCHE322
CHME302L	Chemical Engineering Reaction Lab	1	Co-req: CHME302
CHME304	Membrane Science	3	CHME301
CHME305	Catalysis and Catalytic Processes	3	CHEM345
CHME402	Unit Operation	3	CHME302
CHME402L	Unit Operation Lab	1	Co-req: CHME402
CHME403	Process Control	3	CHME301
CHME403L	Process Control Lab	1	Co-req: CHME403
CHME404	Transportation of Hydrocarbons	3	MCHE338
CHME405	Reactor Design	3	CHME302
CHME406	Colloids and Interfaces	3	CHEM248
CHME408	Chemical Process Design	3	CHME305
CHME499	Internship	1	
CHME500	Research Methodology	2	ENGL300
CHME501	Final Year Project I	1	CHEM500
CHME502	Final Year Project II	3	CHEM501
CHME507	Process Optimization	3	CHME403
CHME511	Polymer Engineering	3	CHEM248

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. Introduction to chemical engineering calculations

CHME 204 MASS TRANSFER OPERATIONS (3Crs:3Lec,0Lab): Diffusional and convective mass transfer and its application to continuous contact operation. Introduction to the operating principles and the selection criteria of separation processes (Gas-liquid absorption, liquid-liquid extraction, distillation and humidification) **Pre-req.: CHME 202**

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.:*** CHME204

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

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 305 CATALYSIS AND CATALYTIC PROCESSES (3 Crs: 3 Lec, 0 Lab): Introduction to catalysis, fundamentals of catalytic science; catalyst properties, preparation and characterization, application to industrial catalytic processes: Hydrogen Production and Synthesis Gas Reactions (Fischer-Tropsch Process), Hydrogenation and dehydrogenation of organic compounds, Oxidation of organic and inorganic compounds. Catalytic reactor design and catalyst deactivation. ***Pre-req.: CHEM 345***

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. Mechanical unit operations ***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.:*** MCHE338

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 COLLOIDS AND INTERFACES (3Crs.3Lec,0Lab): Fundamentals of surface and colloid chemistry, mixed colloids and aggregation stability , interfacial phenomena, dynamic surface tension and interaction of surfactant, properties of gels, surface energetics, adhesion, emulsion, foams and aerosol, principles of corrosion and their prevention control. ***Pre-req.: CHEM248, CHEM345***

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.:*** CHME305

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.

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 & 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 flow schemes. 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 248***

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.

MCHE 225	Thermodynamics for Chemical Eng.	3	PHYS 282
MCHE 226	Applied Thermodynamics for Chem. Eng.	3	MCHE225
MCHE 331	Fluid Mechanics I	3	PHYS282
MCHE 338	Pumps and Piping Systems	3	MCHE331 + CHME 202
MCHE 421	Heat Transfer	3	MATH284 + MCHE321

Descriptions of this group of courses are given below.

MCHE 225 THERMODYNAMICS FOR CHEMICAL ENG. (3Crs.:3Lec,0Lab): Heat and work, first law of thermodynamics, properties of steam and gases, steam tables and charts, entropy, second law, air standard cycle, compressors, reversibility, availability and second law efficiency, real gases. ***Pre-req.: PHYS*282**

MCHE 322 APPLIED THERMODYNAMICS FOR CHEMICAL ENG. (3Crs.:3Lec,0Lab): Power and refrigeration cycles, vapor cycles, Carnot, Rankine, reheated, regenerative, gas power cycle, gas turbine, reciprocating engine cycles. Refrigeration and heat pump cycles, vapor compression cycle, absorption refrigeration cycle, thermodynamic tables. ***Pre-req.: MCHE 225.***

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 338 PUMPS AND PIPING SYSTEMS (3Crs.: 3Lec, 0Lab): Pipeline and piping system, Pump types and operation, Centrifugal pumps operation, pump selection, pump in parallel and series, viscosity effect on centrifugal pumps, pump problem (Cavitation), priming of centrifugal pumps. *Pre-req.: MCHE 331 and CHME 202*

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 and MCHE 321.

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- requisites**
PTRE511	Petroleum Refining Operations	3	CHEM331
PTRE419	Petroleum Economics and Management	3	MATH381
PTRE503	Crude Oil Processing	3	CHEM331
CHEM355	Petro-chemistry	3	
CHME503	Biomass Engineering	3	CHME403 + CHME408
CHME512	Chemical Product design	3	CHME403
CHME513	Water and Waste Management	3	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.

Chemical Engineering Program
Study Plan (150 Credits)

First Semester (15 Credits)		**Crs.**	**Pre-requisites**
COMP208	Programming I	3	
MATH281	Linear Algebra	3	MATH112
CVLE210	Statics	3	
PHYS281	Electricity & Magnetism	3	PHYS120
MCHE210	Engineering Drawing and Graphics	3	

Second Semester (15 Credits)		**Crs.**	**Pre-requisites**
MATH282	Calculus	3	MATH111
MCHE213	Dynamics	3	
PHYS282	Material Properties and Heat	3	
CHME202	Introduction to Chemical Engineering	3	
CHEM281	Principles of Chemistry I	3	CHEM110

Summer I Semester (9 Credits)		**Crs.**	**Pre/Co-requisites**
ARAB001	Arabic Language	2	
ENGL001	English Language	2	
BLAW001	Human Rights	1	
	Elective (General)	4	

Third Semester (17 Credits)		**Crs.**	**Pre-requisites**
MATH283	Differential Equations	3	MATH281 + MATH282
MCHE331	Fluid Mechanics I	3	PHYS282
MCHE225	Thermodynamics For Chemical Eng. I	3	PHYS282
CHEM331	Organic Chemistry	3	CHEM281
CHEM282	Principles of Chemistry II	3	CHEM281
ENGL211	Advanced Writing	2	ENGL001

Fourth Semester (18 Credits)		**Crs.**	**Pre-requisites**
MATH284	Numerical Analysis and Techniques	3	MATH283
MCHE 338	Pumps and Piping Systems	3	MCHE331 + CHME 202
MCHE 226	Applied Thermodynamics for Chemical Eng.	3	MCHE321
CHEM345	In-organic Chemistry I	3	CHEM282
CHEM248	Physical Chemistry I	3	CHEM282
CHME204	Mass transfer Operations	3	CHME 202

Summer II Semester (8 Credits)		**Crs.**	**Pre/Co-requisites**
ENGL300	Speech Communication	2	ENGL211
MGMT002	Entrepreneurship	2	
	Elective (General)	4	

Fifth Semester (19 Credits)		Crs.	Pre-requisites
MATH381	Probability & Statistics	3	MATH282
CHME305	Catalysis and Catalytic Processes	3	CHEM345
CHME301	Separation Processes	3	CHME204
CHME302	Chemical Engineering Reaction	3	MCHE322
CHME302L	Chemical Engineering Reaction Lab	1	Co-req: CHME302
MCHE 421	Heat Transfer	3	MATH284 + MCHE321
	Technical Elective	3	

Sixth Semester (18 Credits)		Crs.	Pre-requisites
INME221	Engineering Economy	3	
CHME403	Process Control	3	CHME301
CHME403L	Process Control Lab	1	Co-req: CHME403
CHME304	Membrane Science	3	CHME301
CHME405	Reactor Design	3	CHME302
	Technical Elective	3	
CHME500	Research Methodology	2	ENGL300

Seventh Semester (15 Credits)		Crs.	Pre-requisites
CHME404	Transportation of Hydrocarbons	3	MCHE338
CHME408	Chemical Process Design	3	CHME305
CHME406	Colloids and Interfaces	3	CHEM248 + CHEM345
ENGR001	Engineering Ethics	1	
CHME501	Final Year Project 1	1	CHME500
CHME499	Internship (Approved Experience / Independent Study)	1	
	Technical Elective	3	

Eighth Semester (16 Credits)		Crs.	Pre-requisites
CHME502	Final Year Project 2	3	CHME501
CHME507	Process Optimization	3	CHME403
CHME511	Polymer Engineering	3	CHEM248
CHME402	Unit Operation + lab	3	CHME302
CHME402L	Unit Operation Lab	1	Co-req: CHME402
	Technical Elective	3	