

Faculty of

**Engineering**

# Faculty of Engineering

## Departments

Electrical & Computer Engineering  
Civil & Environmental Engineering  
Mechanical Engineering  
Industrial & Management Engineering

## History

The Faculty of Engineering 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. In 1995, the Electrical Engineering Department implemented its new curriculum, which included new and updated courses in electronics - communications, computers, and electric power & control divisions in order to keep up with the fast developments in these fields. Two additional departments were established: The Mechanical Engineering Department in 1996 and the Industrial Engineering & Management Department, established in 2001.

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, economical, 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. About 250 bachelor's degrees and 20 master's and doctoral degrees are awarded annually. The opportunities for study have expanded so that students may choose from more than 206 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 faculty also makes use of about 15 senior professors from abroad 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.

## 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:

- Continually 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 encourage interaction and enriches the educational experience in the faculty

## Undergraduate Programs

The faculty offers a Bachelor of Engineering Degree in the following six specializations:

- Electrical Engineering in Communications and Electronics, Electric Power and Control and Computer Engineering
- Civil and Environmental Engineering
- Mechanical Engineering
- Industrial Management Engineering

## Program Description

The faculty offers a Bachelor of Engineering Degree taken over a minimum of 10 semesters. Students admitted into the program are required to specify their field of specialty upon admittance. All undergraduate degree programs require students to complete at least 150 semester credit hours of coursework, and an approved practical training at senior level of study.

The program coursework comprising of 150 semester credit hours need to be taken as follows:

- A minimum of 16 credit hours taken from a list of General University requirements
- A minimum of 6 credit hours taken from Humanities; among which are: Technical writing, Introduction to engineering, Engineering practice, and Engineering management
- A minimum of 128 credit hours taken from Basic Sciences as well as Engineering core courses as determined by the corresponding department

## Department of Electrical & Computer Engineering

### Bachelor of Communication & Electronics Engineering (150 Cr. Hr.)

#### Curricula

First Semester			Cr.
<b>COMP</b>	111	Computer Programming I	2
<b>HUME</b>	101	Introduction to Engineering	2
<b>EMPH</b>	111	Mathematics	3
<b>EMPH</b>	121	Mechanics I	3
<b>EMPH</b>	131	Physics I	3
<b>EMPH</b>	141	Engineering Drawing & Projection I	3
		Elective (General) <sup>1</sup>	2
			18

## Second Semester Cr.

<b>COMP</b>	102	Elementary Data Structure	2
<b>ELCE</b>	112	Fundamentals of Electric Circuits	3
<b>EMPH</b>	112	Mathematics II	3
<b>EMPH</b>	122	Mechanics II	3
<b>EMPH</b>	132	Physics II	3
<b>IEEM</b>	112	Production Engineering	2
		Elective (General) <sup>1</sup>	1
			17

## Third Semester Cr.

<b>EMPH</b>	207	Chemistry	2
<b>COMP</b>	211	Introductory Web Programming	2
<b>ELCE</b>	221	Electronic Circuits I	3
<b>ELCE</b>	231	Logic Circuit Fundamentals	2
<b>EMPH</b>	211	Differential Equation for Engineers	2
<b>EMPH</b>	209	Applied Engineering Mathematics	2
<b>HUME</b>	201	Technical Writing	1
			14

### Fourth Semester Cr.

<b>ELCE</b>	212	Network Analysis	2
<b>ELCE</b>	212L	Electric Circuits Lab	1
<b>ELCE</b>	222	Electronic Circuits II	3
<b>ELCE</b>	222L	Electronic Circuits Lab	1
<b>ELCE</b>	272	Electromagnetics	2
<b>ELCE</b>	232	Logic Design	3
<b>ELCE</b>	232L	Logic Circuit Lab	1
<b>EMPH</b>	214	Numerical Analysis & Special Functions for Electrical Engineering	2
		Elective (General) <sup>1</sup>	2
			17

### Fifth Semester Cr.

<b>COME</b>	381	Signal & Systems	3
<b>ELCE</b>	311	Electric & Electronic Measurements	3
<b>ELCE</b>	331	Microprocessor Fundamentals	3
<b>ELCE</b>	361	Modern Physics	2
<b>EMPH</b>	311	Probability Theory & Applications for Electrical Engineering	2
<b>PORE</b>	345	Electric Machines & power electronics for Communication Engineer	4
			17

<b>Sixth Semester</b>			<b>Cr.</b>
<b>COME</b>	362	Solid State Electronics	2
<b>COME</b>	372	Propagation & Antennas I	4
<b>COME</b>	382	Analog Communication Theory & Systems	4
<b>COME</b>	384	Digital Signal Processing	3
<b>EMPH</b>	362	Introduction to Matlab	2
			15

<b>Seventh Semester</b>			<b>Cr.</b>
<b>COME</b>	431	Microprocessor Interfacing	2
<b>COME</b>	471	Propagation & Antennas II	2
<b>COME</b>	471L	Propagation & Antennas Lab	1
<b>COME</b>	481	Digital Communication Theory & Systems	2
<b>COME</b>	481L	Communications Lab	1
<b>COMP</b>	401	Principles of Operating Systems	2
<b>PORE</b>	453	Electric Power for Communication Engineer	3
<b>PORE</b>	453L	Electric Power & Machine for Communication Engineer Lab	1
		Elective (General) <sup>1</sup>	2
			16

## Eighth Semester Cr.

<b>COME</b>	472	Microwave Engineering	3
<b>COME</b>	474	Acoustics	2
<b>COME</b>	482	Telephony Systems	3
<b>HUME</b>	103	Engineering Ethics	1
<b>COME</b>	500	Internship	1
		Elective (General) <sup>1</sup>	2
			12

## Ninth Semester Cr.

<b>COME</b>	581	Communication Networks	2
<b>COME</b>	583	Wireless Communication	2
<b>HUME</b>	105	Engineering Management	2
		Elective (Technical) <sup>2</sup>	2
		Elective (Technical Lab) <sup>3</sup>	1
		Elective (General) <sup>1</sup>	3
			12

Tenth Semester			Cr.
COME	502	Senior Project II	6
		Elective (Technical) <sup>4</sup>	2
		Elective (General) <sup>1</sup>	4
			12

<sup>1</sup> A total of 16 credits is required as General University Requirements; 5 credits are selected from the University Mandatory courses list including ARAB 001 (2 Cr.), ENGL 001 (2 Cr.), BLAW 001 (1 Cr.) and another 11 credits are selected from the University Elective courses list.

<sup>2</sup> Selected from 500 levels odd numbered Departmental and Faculty Elective courses.

<sup>3</sup> Selected from COME 531L, COME 561L, and COME 571L, COME581L.

<sup>4</sup> Selected from 500 levels even numbered Departmental and Faculty Elective courses.

## Mandatory Courses

### *HUME 101 - Introduction to Engineering (2 Cr. : 2 Lec : 0 Lab : 0 Tut)*

Early technology: Stone Age, Copper and Bronze Age, Iron Age, Ancient civilizations, Medieval and - Modern technologies: Renaissance, Age of Exploration, Industrial Revolution, 19th century, 20th century, 21st century - History of Engineering: Pre - Industrial Revolution Era (up to early 1800s), from 1800 till today (by specialization alphabetically): Aerospace, chemical, civil, communication, computing, electrical, electromechanical, electronics, energy, environmental, genetic, industrial, manufacturing, marine, materials science, measurement, nuclear, software, sanitary, structural, system, transportation - Major technological and engineering achievements.

### *HUME 103 - Engineering Ethics (1 Cr : 1 Lec : 0 Lab : 0 Tut)*

Personal versus engineering ethics, origin of ethical thought, ethics and the law, introduction of professional codes of ethics, brief history of ethical thought, ethical theories, tools of ethical problem solving, safety and risk, industrial and other accidents, professional responsibility, professional rights, ethics as applied to research and experimentation, and specific codes of ethics of engineering societies.

### *HUME 105 - Engineering Management (2 Cr : 2 Lec : 0 Lab : 0 Tut)*

Engineer versus manager, basic business function and management tools (Planning, organizing, staffing, directing, motivating, leading and controlling), management objectives, introduction to facilities design, introduction to project management, introduction to production and operation management, and introduction to industrial financial, introduction to environmental and safety engineering. (This course is not offered to Industrial Engineering and Management students).

### *HUME 201 - Technical Writing (1 Cr. : 1 Lec : 0 Lab : 0 Tut)*

Technical terms and abbreviations. Formats and methods of writing: Reports, bids, CV, correspondence, formal research proposal, progress report, feasibility study, technical report, Fact sheet etc. . .

### *EMPH 111 - Mathematics I (3 Cr. : 3 Lec : 0 Lab : 1 Tut)*

Partial fractions; Binomial theorem; Roots of polynomial equations; Convergence of series; Matrices: Determinants, rank, Eigen values, eigenvectors, block decomposition, solution of linear system of equations; Introduction to complex analysis; Transfer of axes; Conic sections.

### *EMPH 121 - Mechanics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)*

Force vectors (analytical and graphical methods), equilibrium of a particle, force system resultants (moment of force, couple system); Equilibrium of a rigid body (equilibrium in two - dimensions, equation of equilibrium, free body diagrams); Structure analysis and its applications in truces, frames, mechanisms and simple mechanics); Cable static analysis; Dry friction, slipping, tipping, applications on real systems, experimental application on: Force analysis, friction effect, equilibrium of rigid body.

***EMPH 131 - Physics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Electrostatics: Coulomb's Law, electric dipole, electric field of a continuous charge distribution, Gauss law, electric potential from point and distributed charges, relation between electric field and electric potential, capacitors and dielectrics, series and parallel connections of capacitors, energy stored in capacitors; Electric current: Model for electrical conduction and material resistivity, Kirchhoff's laws; Magnetism: Magnetic forces, magnetic dipole, magnetic flux and Gauss law in magnetism, sources of magnetic fields, Ampere's Law, Biot and Savart law, magnetism of matter; Geometric optics: Images formed by reflection, refraction from spherical surfaces, thin lenses, lens aberrations and defects of images.

***EMPH 141 - Engineering Drawing & Projection I (3 Cr. : 2 Lec : 2 Lab : 2 Tut)***

Drawing instruments and their use; Developing drafting skills; Dimensioning; Geometric construction; Conic sections; Special curves: Involute, cycloid, spiral of Archimedes, helix; Theory of shape: Representing objects by views and applications in machines drawing; Pictorial drawing: Isometric and oblique; Electrical drafting. AutoCad: 2D drawings using the computer software AutoCAD; Projects.

***EMPH 112 - Engineering Mathematics II (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Hyperbolic functions, implicit and logarithmic differentiation, derivatives of higher order, Leibniz theorem, mean value theorem, partial differentiation and applications, curvature, Taylor expansion, methods of integration, improper integrals, multiple integrals.

***EMPH 122 - Mechanics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Introduction to vector analysis, hints about the ordinary differential equations of the second order. Kinematics of the particle in one dimension (rectilinear motion of a particle), two - dimensional kinematical analysis of a particle motion using the cartesian and intrinsic coordinates, engineering applications, kinetics of the particle), two - basic concepts: Newton's Law ( force & acceleration), position integration of Newton's Law (works & energy), time integration of Newton's Law ( impulse & linear momentum). Engineering applications: One dimensional motion in a conservative or dissipative force field, ideal constraints, direct and inclined impact of a particle on a smooth plane, oscillations of a particles, engineering applications.

***EMPH 132 - Physics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Properties of materials: Units, dimensions, circular motion of rigid bodies, moment of inertia, elasticity of materials, stresses and strains, pressure measurements, surface tension, 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, heat measurements, heat transfer by conduction, heat convection, heat radiation, introduction to thermodynamics, first law of thermodynamics, thermodynamic processes for an ideal gas.

***IEEM 112 - Production Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction to production and manufacturing engineering, introduction to material and material properties, iron and steel, metrology, bench work, machining (turning, milling, shaping and planing, drilling, etc...), forging and forming of metals, metal casting (sand casting and permanent mold casting), and cost analysis.

***EMPH 209 - Applied Engineering Mathematics (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Vector analysis: Vector calculus, vector differentiation, curvilinear coordinates; Laplace transforms: Definition and theorems, transform of derivatives, transform of integral, unit step function and shifting theorems, convolution theorem, inverse Laplace transform. Prereq.: EMPH 111 & EMPH 112.

***EMPH 211 - Differential Equations for Engineers (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Differential equations: First order differential equations; Second order differential equations with constant and variable coefficients, simultaneous system of differential equations, series solution; Fourier series: Periodic function, expansion, half period and harmonics; Introduction to partial differential equations. Prereq.: EMPH 111 & EMPH 112.

***EMPH 214 - Numerical Analysis & Special Functions (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Numerical methods: Curve fitting, function approximations, roots of equations, numerical differentiation and integration, numerical solution for ordinary differential equations; Bessel and Legendre special functions. Prereq.: EMPH 211.

***EMPH 311 - Probability Theory & Applications for Electrical Engineer (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Probability space, conditional probability and independence, Bays' theorem; Random variables, and density functions, joint probability; Expectation, variance and covariance, moments and moment generating functions: Discrete and continuous distributions; Binomial, negative binomial, Poisson, geometric, hypergeometric, normal, normal approximation to binomial, gamma, exponential; Applications of probability distributions. Prereq.: EMPH 112.

***EMPH 207 - Chemistry (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction to basic concepts of chemistry, chemical reactions and calculations; Physical states of matter: Gases, liquids and solids; Solutions; Chemical equilibrium, ionic equilibrium; Manufacture and hydration reactions of cements; Practical: Applied experiments related to the above topics.

***EMPH 362 - MATLAB (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

Use of MATLAB software package in specialized engineering areas, applications to linear algebra, and matrix operations, programming elementary operations for engineering computations, plotting and curve fitting and system simulation.

***COMP 101 - Computer Programming I (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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.

***COMP 102 - Elementary Data Structure (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Functions / procedures, call by value / reference, recursion, pointers, user defined data types: Structures and unions, elementary data structures: Stacks, queues and linked lists. Prereq.: COMP111.

***COMP 211 - Introductory Web Programming (2 Cr. : 1 Lec : 2 Lab : 1 Tut)***

Client side programming, XHTML, Java Script and XML. Packages for web - page design. Prereq.: COMP102.

***COMP 401 - Principles of Operating Systems (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction. Types of systems. Processes. Concurrency control. Mutual exclusion. Deadlocks. Processor Scheduling algorithms. Memory management. Disk management. File systems.

***ELCE 112 - Fundamentals of Electric Circuits (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

DC circuit analysis: Reduction methods, mesh current and node voltage analysis methods, transformation methods, DC network theorems, capacitors and inductors, phasors and AC steady state circuit analysis, series and parallel resonance, power in AC circuits, Fourier series technique applied to circuit analysis, balanced three - phase circuits. Prereq.: EMPH131.

***ELCE 201 - Electric & Electronic Circuits (3 Cr. : 3 Lec : 1 Tut)***

DC circuit analysis: Mesh current and node voltage analysis methods, capacitors and inductors. Transient analysis, Laplace transform and its application to circuit analysis. Junction diodes: Construction, I - V characteristics, circuit models. BJT and FET transistors DC models. (Offered for Computer Engineering Students).

***ELCE 212 - Network Analysis (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Transient analysis, laplace transform and its application to circuit analysis, two - port networks, frequency selective passive and active circuits. Prereq.: ELCE 112.

***ELCE 212L - Electric Circuits LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The content of this lab is directly related to the courses ELCE 112 , ELCE 212. Co - req: ELCE 212.

***ELCE 221 - Electronic Circuits I (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Introduction to semiconductor physics, junction diodes: Construction, I - V characteristics, circuit models, applications, special purpose diodes: Zener diodes, light - emitting diodes (LED), photo detectors (PD), Bipolar junction transistors (BJT) and field effect transistors (FET): Types, physical structures, basic configurations, characteristic curves, circuit models, biasing circuits, small - signal amplifiers, computer aided analysis using SPICE. Prereq.: ELCE 112.

***ELCE 222 - Electronic Circuits II (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

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 multivibrators, computer aided analysis and design using SPICE. Prereq.: ELCE 221.

***ELCE 222L - Electronic Circuits LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

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

***ELCE 272 - Electromagnetic Fundamentals (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Electrostatics: Coulomb's law, Gauss's law, divergence theorem, energy and potential, conductors and dielectrics, electric dipole and polarization, capacitances, magnetostatics: Biot - Savart law, Ampere's law, Stoke's theorem, magnetic materials, magnetic dipole and magnetization, inductances, Faraday's law, time varying fields, Maxwell's equations. Prereq.: EMPH 131.

***ELCE 231 - Logic Circuit Fundamentals (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Number systems & coding, Boolean algebra and gate circuits, combinatorial circuits design, function minimization: Tabular method, karnaugh maps, decoder, multiplexer, ROM, arithmetic - logic unit.

***ELCE 232 - Logic Design (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Flip - flops, counters using T or JK flip - flops, state machines, synchronous and asynchronous sequential networks, programmable logic devices: PLA, PAL, CPLD, FPGA, applications in design and implementation of combinational and sequential circuits, sequential circuits for arithmetic operations: Serial address, parallel multipliers, parallel dividers, memory elements, extensive use of VHDL for describing, simulating and implementing digital designs. Prereq.: ELCE 231.

***ELCE 232L - Logic Circuits LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The content of this lab is directly related to the courses ELCE 231, ELCE 232. Co - req:ELCE 232.

***ELCE 311 - Electric & Electronic Measurements (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Introduction to instrumentation and measurements (errors, precision, accuracy, measurement statistics...), analog instrumentation (permanent magnet moving coil PMMC, moving Iron MI, electro-dynamometer, energy meters, electrostatic meters, thermocouples, ...), bridges (AC, DC), potentiometers (AC, DC), oscilloscopes (functions and controls, voltage, time, and frequency measurements), digital measurements (D / A, A / D ...), electrical transducers, signal conditioning, data acquisition and conversion. Prereq.: ELCE 221, ELCE 272.

***ELCE 331 - Microprocessors Fundamentals (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Basic computer organization, data representation, processor organization, ALU's, bus and stack organization, design of a simple hardwired processor, instruction sets and instruction formats, machine and assembly language programming, assembler functions and design, micro - programmed CPU, comparison between RISC and CISC processors, introduction to memory organization. I / O operations. Prereq.: ELCE 232.

***ELCE 361 - Modern Physics (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Special theory of relativity, quantum effects: Particle aspect of electromagnetic radiation, wave aspect of material particles. Atomic physics: Hydrogen atom, quantum numbers, many electrons atoms.

***COME 362 - Solid State Electronics (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Principles of quantum mechanics: State functions and operators, Schrödinger wave equation, application to one dimensional problems, Bloch theorem, band theory, semiconductor characteristics, dielectrics, magnetism, superconductivity. Prereq.: ELCE 361.

***COME 372 - Propagation & Antennas I (4 Cr. : 4 Lec : 0 Lab : 0 Tut)***

Review of Maxwell's equations. Plane wave. Material media. Polarization. Pointing vector. Reflection and transmission. Normal and oblique incidence. Propagation of electromagnetic waves in the atmosphere. High frequency transmission lines. Matching techniques. Smith chart. Rectangular and cylindrical waveguides. Cavity resonators. Antenna parameters. Radiation potentials. Linear antennas: Elementary dipole, short dipole, linear dipole. Antenna arrays. Loop antenna. Other Types of Antennas. Prereq.: ELCE 272.

***COME 381 - Signals & Systems (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Classification of continuous and discrete - time signals and systems. Fourier transform. Linear and time - invariant (LTI) systems: Impulse response, step response, transfer function. Band - pass signals: Hilbert transform, pre - envelope, complex envelope. Convolution and correlation functions. Energy and power spectral densities. Transmission of continuous random signals through LTI systems. Introduction to sampling theorem and reconstruction of signals. Application of tapped delay line filters.

***COME 382 - Analog Communication Theory & Systems (4 Cr. : 4 Lec : 0 Lab : 0 Tut)***

Introduction to communication systems. Linear modulation techniques: AM, DSB, SSB, VSB. AM transmission and super heterodyne receivers. Exponential modulation techniques: FM, NBFM, PM. Analog pulse modulation. Noise effects on linear and exponential modulation techniques. Study of several analog systems which may include: AM and FM radio broadcasting, stereo FM, TV broadcasting, telephony system, frequency - division multiplexing (FDM). Pulse code modulation. Delta modulation. Baseband coding transmission. Optimum detection. Correlation techniques. Matched filters. Probability of error of baseband modulation. Baseband power spectral analysis. Prereq.: COME 381.

***COME 384 - Digital Signal Processing (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Discrete - time signals and systems: Z - transform, DFT, 2 - dimensional versions. Fast Fourier transformer(FFT). Digital system realization using different structures: Parallel, lattice, etc... Digital filter design methods: Windowing, frequency sampling, S - to - Z methods, frequency - transformation methods. Multi - rate sampling. Discrete random signals through systems. Prereq.: COME381.

***COME 431 - Microprocessor Interfacing & Applications (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

Microprocessor chips and LSI technology. Architecture and instruction set of a 16 bit microprocessor. Supporting chips: Buffers, decoders, system clock generator. Interfacing 16 bit microprocessor to memory and I / O devices. Interfacing techniques: Serial, parallel, timers, A / D and D / A converters. Interrupts and interrupt controllers. Direct memory access and DMA controllers. System development and design tools (hardware and software). Prereq.: ELCE 232.

***COME 471 - Propagation & Antennas II (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Micro strip lines. Radar systems. Line of sight radio links. Satellite systems. Special Antennas: Traveling wave antenna. Helical antenna. Yagi antenna. Aperture principles. Microwave antennas: Horn, parabolic, lens and microstrip. Antenna applications in remote sensing. Prereq.: COME 372.

***COME 471L - Propagation & Antenna LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The contents of this lab is directly related to the courses COME 372, COME 471. Co - req.: COME 471.

***COME 472 - Microwave Engineering (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Scattering parameters. Microwave instrumentations: Reflection coefficient, transmission coefficient, S - parameters, powers, dielectric constant, and frequency. Microwave passive components using waveguide technology: T - junction, attenuators, isolators, circulators, couplers. Microstrip components: Power dividers, hybrid couplers. Microwave semiconductor devices: Bipolar transistor, MESFET, GUNN diode, avalanche - transit - time devices. Prereq.: COME 372.

***COME 474 - Acoustics (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Acoustic waves. Analogy with electromagnetic waves. Reflection. Transmission and absorption. Microphones and loudspeakers. Prereq.: ELCE 272.

***COME 481 - Digital Communication Theory & Systems (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Introduction to information theory. Passband power spectral analysis. Time - division multiplexing (TDM). Digital carrier modulation: ASK, PSK, DPSK, FSK, MSK, GMSK, QPSK, M - ray transmission. Bandwidth efficiency. Coherent and noncoherent detection. Noise effects on digital modulation techniques. Probability of error in carrier modulation. Study of several digital systems which may include: TDM system hierarchies and digital FAX. Prereq.: COME 382.

***COME 481L - Communication LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The contents of this lab is directly related to the courses COME 382, COME 481. Co - req.: COME 481.

***COME 482 - Telephony Systems (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Wire - line Telephony: Analog telephone components. Central office connection (local loop). Telephone switches: Space, time, and hybrid switches. Types of communication mediums. Multiplexing. Digital Transport Systems. Digital Access Technologies. Traffic Engineering. Introduction to cellular communications. Prereq.: COME 481.

***COME 483 - Advanced Digital Communication (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Orthogonal Frequency Division Multiplexing (OFDM), OFDMA, Spread Spectrum, (CDMA), Cellular new generations (LTE, WiMAX). (For non electrical engineering students).

***COME 500 - Internship (1 Cr.)***

This is a professional training which should last for at least four weeks in communication or electronics fields. The training is followed by a poster session where the students are supposed to present what they have learned.

***COME 502 - Senior Project (6 Cr. : 6 Lec : 0 Lab : 0 Tut)***

Supervised projects in small groups of students aimed at providing practical experience in some aspects of communications, electronics, computer hardware, and control. This is accomplished through a set of lectures, field visits, and individual design.

***COME 581 - Communication Networks (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Communication networks models, basic concepts. Signal transmission: Channel capacity, signal encoding technique, wired and wireless transmission, multiplexing techniques, error detection and correction. Data link control. Local Area Networks (LANs): Logical link control, medium access control. Fast and Gigabit Ethernet, Internetworking Devices, Unicast Routing Protocols, Wireless LANs. Prereq.: COME 481.

***COME 583 - Wireless Communications (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

RF Spectrum, Spread Spectrum transmission, Wireless Multiplexing and Multiple Access techniques, OFDM, OFDMA, ultra wideband radio, near field communications, infrared communication basics, implementation of Wireless networks (WLAN, WPAN, WMAN, Bluetooth). Prereq.: COME 481.

***PORE 345 - Electric Machines & Power Electronics for Communication Engineer  
(4 Cr. : 4 Lec : 0 Lab : 0 Tut)***

Principles of Energy conversion, single - phase transformer: Construction, theory of operation, equivalent circuit, regulation, and transformer tests. Electromagnetic fields nature, three - phase induction motor: Construction, theory of operation, equivalent circuit, torque - speed characteristics. Single - phase induction motor: Construction, theory of operation and methods of starting. DC machines: Construction, theory of operation, induced voltage, separately excited and shunt excited generators and motors. Power switches: Diode, Thyristor, IGBT, and MOSFET. Single - phase rectifier circuits (uncontrolled and controlled). Single - phase inverters, three - phase inverter 180 conduction and PWM inverter. Prereq.: ELCE 221, ELCE 272.

***PORE 453 - Electric Power for Communication Engineer (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Power system structure, high - voltage transmission systems, DC versus AC transmission, load characteristics, over - head transmission lines (parameters, solutions, and electrical performance), reactive power compensation and Voltage control of transmission lines, underground power cables, power distribution systems, power distribution equipments (circuit breakers, fuses, and switches), three phase symmetrical fault calculations. Prereq.: ELCE 112, ELCE 272.

***PORE 453L - Electric Power & Machine for Communication Engineer LAB  
(1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The contents of this lab is directly related to the courses PORE 345, PORE 453. Prereq: PORE 345, Co - req: PORE 453.

**Elective Courses for Communication Major Students**

***COME 531 - Embedded Systems (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

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. Prereq.: COME 431.

***COME 561 - VLSI Design (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

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. Prereq.: ELCE232.

***COME 563 - Semiconductor Devices (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Carrier transport phenomena in semiconductors. Operation principles and device modeling of p - n junctions, metal - semiconductor contacts, bipolar and MOS transistors, and related devices (Thyristors, MESFETs, and CCDs) - Silicon device fabrication technology: Crystal growth, oxidation, diffusion, lithography, contacts and interconnections. Prereq.: COME 362.

***COME 571 - Optical Communications (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

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. Prereq.: ELCE 272.

***COME 585 - Information Theory & Coding (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Uncertainty, information and entropy. Source coding: E.g. Huffman coding. Mutual information. Channel capacity. Channel coding theorem. Channel capacity theorem. Error control coding techniques: Linear block codes, cyclic codes, convolutional codes. Viterbi decoder. Prereq.: COME 481.

***COME 522 - Radio Frequency Communication Circuits (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

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. Prereq.: ELCE 222, COME 471.

***COME 524 - Digital Integrated Circuits (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Overview of switching characteristics of bipolar and field effect transistors. BJT digital ICs: TTL, Schottky TTL, ECL, IIL. MOS digital ICs: NMOS, CMOS, BiCMOS, dynamic MOS. Timing circuits. MOS memories: SRAM, DRAM, EEPROM, flash memories. A / D and D / A converters. Prereq.: ELCE 221.

***COME 526 - Computer Architecture (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Computer arithmetic, logical operations, floating point number representations. ALU construction, instruction set architecture, addressing modes. CPU Design, data path design, control path design. Hardwired control unit, Micro - programmed control unit. Memory system design, primary memories, secondary memories, virtual memory system, cache memory. Input / Output operations, memory - mapped I / O, interrupt - driven I / O, direct memory access (DMA), and I / O processors. Introduction to advanced computer architecture. Prereq.: ELCE 232.

***COME 531L - Embedded Systems LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The content of this lab is directly related to the course: COME 531. Co - req: COME 531.

***COME 561L - Integrated Circuits LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The content of this lab is directly related to the courses: COME 561 or COME 563. Co - req: COME 561 or COME 563.

***COME 571L - Microwave & Antennas LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The content of this lab is directly related to the course COME 472. Prereq: COME 472.

***COME 581L - Communications Circuits LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The content of this lab is directly related to the course COME 382 and COME 482. Prereq: COME 382, COME 482.

***COME 582 - Cellular Communication (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Components of cellular network. Frequency reuse. Handoff. Cellular traffic engineering. CDMA, GSM, WiMAX, and LTE. Moving towards third generation services. Prereq.: COME 481.

***COMP 501 - Advanced Data Structures (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Trees: Representation, traversals, recursive definition. Binary search trees. Asymptotic notations. Complexity analysis: Worst, and average. Heap and merge sort. Balanced trees: AVL trees, B trees. Hashing. Graphs: Representation, traversals. Graph Algorithms. Prereq.: COMP 102.

***PORE 563 - Control Systems (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Introduction to control systems, control system components, transfer function, block diagram, signal flow graph, time domain analysis of control systems, Routh - Hurwitz, stability criteria, relative stability of feedback, control system, root locus analysis, root locus design, frequency response analysis, Nyquist criterion of stability. MATLAB / SIMULINK is used in class assignment and lab to simulate and analyze feedback control systems. Prereq: EMPH 209.

***COME 584 - Advanced Communication Networks (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Wide Area Networks (WANs): Circuit and packet switching, frame relay, ATM, cellular wireless networks. Internet addressing and subnetting (IPv4 and IPv6), network Security, network timing and congestion control, voice over IP (VOIP) and ADSL systems. Prereq.: COME 581.

## Bachelor of Electric Power & Machines Engineering (150 Cr. Hr.)

### Curricula

First Semester			Cr.
<b>HUME</b>	101	Introduction to Engineering	2
<b>EMPH</b>	111	Engineering Mathematics I	3
<b>EMPH</b>	121	Engineering Mechanics I	3
<b>EMPH</b>	131	Engineering Physics I	3
<b>EMPH</b>	141	Engineering Drawing & Projection	3
<b>COMP</b>	111	Computer Programming I	2
		Elective (General) <sup>1</sup>	2
			18

Second Semester			Cr.
<b>EMPH</b>	112	Engineering Mathematics II	3
<b>EMPH</b>	122	Engineering Mechanics II	3
<b>EMPH</b>	132	Engineering Physics II	3
<b>ELCE</b>	112	Fundamentals of Electric Circuits	3
<b>IEEM</b>	112	Production Engineering	2
<b>COMP</b>	102	Elementary Data Structures	2
		Elective (General) <sup>1</sup>	1
			17

### Third Semester Cr.

<b>EMPH</b>	209	Applied Engineering Math	2
<b>EMPH</b>	211	Differential Equation for Engineers	2
<b>EMPH</b>	207	Chemistry	2
<b>ELCE</b>	231	Logic Circuit Fundamentals	2
<b>ELCE</b>	263	Physics & Material	2
<b>ELCE</b>	221	Electronics Circuits I	3
<b>HUME</b>	201	Technical Writing	1
		Elective (General) <sup>1</sup>	3
			17

### Fourth Semester Cr.

<b>ELCE</b>	222	Electronic Circuits II	3
<b>ELCE</b>	222L	Electronic Circuits Lab	1
<b>ELCE</b>	272	Electromagnetics	2
<b>ELCE</b>	212	Network Analysis	2
<b>ELCE</b>	212L	Fundamentals of Electric Circuits Lab	1
<b>ELCE</b>	232	Logic Design	3
<b>ELCE</b>	232L	Logic Circuits Lab	1
<b>EMPH</b>	214	Numerical Analysis	2
		Elective (General) <sup>1</sup>	2
			17

### Fifth Semester Cr.

<b>ELCE</b>	311	Electrical & Electronic Measurements	3
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<b>ELCE</b>	331	Microprocessor Fundamentals	3
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<b>PORE</b>	341	Electric Machines I	3
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<b>PORE</b>	351	Electric Power I	3
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<b>PORE</b>	361	Control I	3
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<b>EMPH</b>	311	Probability Theory & Applications for Electrical Engineer	2
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### Sixth Semester Cr.

<b>PORE</b>	342	Power Electronics I	3
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<b>PORE</b>	344	Electric Machine II	3
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<b>PORE</b>	352	Electric Power II	3
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<b>COME</b>	386	Communication Engineering	2
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<b>EMPH</b>	362	Introduction to MATLAB	2
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		Elective (General) <sup>1</sup>	2
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**Seventh Semester****Cr.**

<b>PORE</b>	441	Power Electronics II	2
<b>PORE</b>	451	Protection I	2
<b>PORE</b>	461	Control II	2
<b>PORE</b>	471	Instrumentation	2
<b>MECH</b>	407	Fundamentals of Thermo Fluids	2
		Elective (General) <sup>1</sup>	2
			12

**Eighth Semester****Cr.**

<b>PORE</b>	442	Special Machines	2
<b>PORE</b>	452	Protection II	2
<b>PORE</b>	454	Power System Analysis	3
<b>MECH</b>	408	Mechanical Power Stations	2
<b>HUME</b>	103	Engineering Ethics	1
<b>PORE</b>	500	Internship	1
		Elective (Technical) <sup>2</sup>	2
			13

Ninth Semester			Cr.
PORE	541	Electrical Drives	2
PORE	551	High Voltage	2
PORE	571	Power system & Automation Programming	2
HUME	105	Engineering Management	2
		Elective (Technical) <sup>3</sup>	2
		Elective (General) <sup>1</sup>	2
			12

Tenth Semester			Cr.
PORE	502	Senior Project	6
PORE	542	Solid State Drives	2
		Elective (Technical) <sup>4</sup>	2
		Elective (General) <sup>1</sup>	2
			12

<sup>1</sup> A total of 16 credits is required as General University Requirements; 5 credits are selected from the University Mandatory courses list including: ARAB 001 (2 Cr.), ENGL 001 (2 Cr.), BLAW 001 (1 Cr.) and another 11 credits are selected from the University Elective courses list.

<sup>2</sup> Selected from PORE 456, COME 486, and MECH 542.

<sup>3</sup> Selected from PORE 543, PORE 553, and PORE 561.

<sup>4</sup> Selected from PORE 544, PORE 552, and PORE 562.

## Mandatory Courses

### *HUME 101 - Introduction to Engineering (2 Cr. : 2 Lec : 0 Lab : 0 Tut)*

Early technology: Stone age, Copper and Bronze age, Iron age, ancient civilizations, Medieval and Modern technologies: Renaissance, age of exploration, Industrial Revolution, 19th century, 20th century, 21st century - history of Engineering: Pre - industrial revolution Era (up to early 1800s), from 1800 till today (by specialization alphabetically): Aerospace, chemical, civil, communication, computing, electrical, electromechanical, electronics, energy, environmental, genetic, industrial, manufacturing, marine, materials science, measurement, nuclear, software, sanitary, structural, system, transportation - major technological and engineering achievements.

### *HUME 103 - Engineering Ethics (1 Cr. : 1 Lec : 0 Lab : 0 Tut)*

Personal versus engineering ethics, origin of ethical thought, ethics and the law, introduction of professional codes of ethics, brief history of ethical thought, ethical theories, tools of ethical problem solving, safety and risk, industrial and other accidents, professional responsibility, professional rights, ethics as applied to research and experimentation, and specific codes of ethics of engineering societies.

### *HUME 105 - Engineering Management (2 Cr. : 2 Lec : 0 Lab : 0 Tut)*

Engineer versus manager, basic business function and management tools (Planning, organizing, staffing, directing, motivating, leading and controlling), management objectives, introduction to facilities design, introduction to project management, introduction to production and operation management, and introduction to industrial financial, introduction to environmental and safety engineering. (This course is not offered to industrial engineering and management students).

### *HUME 201 - Technical Writing (1 Cr. : 1 Lec : 0 Lab : 0 Tut)*

Technical terms and abbreviations. Formats and methods of writing: Reports, bids, CV, correspondence, formal research proposal, progress report, feasibility study, technical report, fact sheet etc...

### *EMPH 111 - Engineering Mathematics I (3 Cr. : 3 Lec : 0 Lab : 1 Tut)*

Partial fractions; Binomial theorem; Roots of polynomial equations; Convergence of series; Matrices: Determinants, rank, Eigen values, eigenvectors, block decomposition, solution of linear system of equations; Introduction to complex analysis; Transfer of axes; Conic sections.

### *EMPH 121 - Engineering Mechanics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)*

Force vectors (analytical and graphical methods), equilibrium of a particle, force system resultants (moment of force, couple system); Equilibrium of a rigid body (equilibrium in two - dimensions, equation of equilibrium, free body diagrams); Structure analysis and its applications in truces, frames, mechanisms and simple mechanics); Cable static analysis; Dry friction, slipping, tipping, applications on real systems, experimental application on: Force analysis, friction effect, equilibrium of rigid body.

***EMPH 131 - Engineering Physics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Electrostatics: Coulomb's Law, electric dipole, electric field of a continuous charge distribution, Gauss law, electric potential from point and distributed charges, relation between electric field and electric potential, capacitors and dielectrics, series and parallel connections of capacitors, energy stored in capacitors; Electric current: Model for electrical conduction and material resistivity, Kirchhoff's laws; Magnetism: Magnetic forces, magnetic dipole, magnetic flux and Gauss law in magnetism, sources of magnetic fields, Ampere's Law, Biot and Savart law, magnetism of matter; Geometric optics: Images formed by reflection, refraction from spherical surfaces, thin lenses, lens aberrations and defects of images.

***EMPH 141 - Engineering Drawing & Projection (3 Cr. : 2 Lec : 0 Lab : 3 Tut)***

Drawing instruments and their use; Developing drafting skills; Dimensioning; Geometric construction; Conic sections; Special curves: Involute, cycloid, spiral of Archimedes, helix; Theory of shape: Representing objects by views and applications in machines drawing; Pictorial drawing: Isometric and oblique; Electrical drafting. AutoCad: 2D drawings using the computer software AutoCAD; Projects.

***EMPH 112 - Engineering Mathematics II (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Hyperbolic functions, implicit and logarithmic differentiation, derivatives of higher order, Leibniz theorem, mean value theorem, partial differentiation and applications, curvature, Taylor expansion, methods of integration, improper integrals, multiple integrals.

***EMPH 122 - Engineering Mechanics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Introduction to vector analysis, hints about the ordinary differential equations of the second order, kinematics of the particle in one dimension (rectilinear motion of a particle), two - dimensional kinematical analysis of a particle motion using the cartesian and intrinsic coordinates, engineering applications, kinetics of the particle, two - basic concepts: Newton's law(force & acceleration), position integration of Newton's law (works & energy), time integration of Newton's law (impulse & linear momentum). Engineering applications: One dimensional motion in a conservative or dissipative force field, ideal constraints, direct and inclined impact of a particle on a smooth plane, oscillations of a particles, engineering applications.

***EMPH 132 - Engineering Physics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Properties of materials: Units, dimensions, circular motion of rigid bodies, moment of inertia, elasticity of materials, stresses and strains, pressure measurements, surface tension, 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, heat measurements, heat transfer by conduction, heat convection, heat radiation, introduction to thermodynamics, first law of thermodynamics, thermodynamic processes for an ideal gas.

***EMPH 209 - Applied Engineering Mathematics (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Vector analysis: Vector calculus, vector differentiation, curvilinear coordinates; Laplace transforms: Definition and theorems, transform of derivatives, transform of integral, unit step function and shifting theorems, convolution theorem, inverse Laplace transform. Prereq.: EMPH 111 & EMPH 112.

***EMPH 211 - Differential Equations for Engineers Engineering (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Differential equations: First order differential equations; Second order differential equations with constant and variable coefficients, simultaneous system of differential equations, series solution; Fourier series: Periodic function, expansion, half period and harmonics; Introduction to partial differential equations. Prereq.: EMPH 111 & EMPH 112.

***EMPH 207 - Chemistry (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction to basic concepts of chemistry, chemical reactions and calculations; Physical states of matter: Gases, liquids and solids; Solutions; Chemical equilibrium, ionic equilibrium; Manufacture and hydration reactions of cements; Practical: Applied experiments related to the above topics.

***EMPH 214 - Numerical Analysis (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Numerical methods: Curve fitting, function approximations, roots of equations, numerical differentiation and integration, numerical solution for ordinary differential equations; Bessel and Legendre special functions. Prereq.: EMPH 211.

***EMPH 311 - Probability Theory & Applications for Electrical Engineer (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Probability space, conditional probability and independence, Bays' theorem; Random variables, and density functions, joint probability; Expectation, variance and covariance, moments and moment generating functions: Discrete and continuous distributions; Binomial, negative binomial, Poisson, geometric, hypergeometric, normal, normal approximation to binomial, gamma, exponential; Applications of probability distributions. Prereq.: EMPH 112.

***EMPH 362 - MATLAB (2 Cr.:1 Lec : 2 Lab : 0 Tut)***

Use of MATLAB software package in specialized engineering areas, applications to linear algebra, and matrix operations, programming elementary operations for engineering computations, plotting and curve fitting and system simulation.

***COMP 101 - Computer Programming I (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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.

***COMP 102 - Elementary Data Structures (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Functions / procedures, call by value / reference, recursion, pointers, user defined data types: Structures and unions, elementary data structures: Stacks, queues and linked lists. Prereq.: COMP 101.

***IEEM 112 - Production Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction to production and manufacturing engineering, introduction to material and material properties, iron and steel, metrology, bench work, machining (turning, milling, shaping and planning, drilling, etc...), forging and forming of metals, metal casting (sand casting and permanent mold casting), and cost analysis.

***ELCE 112 - Fundamental of Electric Circuits (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

DC circuit analysis: Reduction methods, mesh current and node voltage analysis methods, transformation methods, DC network theorems, capacitors and inductors, phasors and AC steady state circuit analysis, series and parallel resonance, power in AC circuits, Fourier series technique applied to circuit analysis, balanced and unbalanced three - phase circuits. Prereq.: EMPH 131.

***ELCE 221 - Electronic Circuits I (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Introduction to semiconductor physics, junction diodes: Construction, I - V characteristics, circuit models, applications, special purpose diodes: Zener diodes, light - emitting diodes (LED), photo detectors (PD), Bipolar junction transistors (BJT) and field effect transistors (FET): Types, physical structures, basic configurations, characteristic curves, circuit models, biasing circuits, small - signal amplifiers, computer aided analysis using SPICE. Prereq.: ELCE 112.

***ELCE 231 - Logic Circuit Fundamentals (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Number systems & coding, Boolean algebra and gate circuits, combinatorial circuits design, function minimization: Tabular method, Karnaugh maps, MSI and LSI logic design (Decoder, Multiplexer, and ROM), and arithmetic - logic unit. Input / Output devices.

***ELCE 263 - Physics & Material (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Special theory of relativity, semiconductor characteristics, Dielectrics, Magnetism, and super conductors.

***ELCE 212 - Network Analysis (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Transient analysis, Laplace transform and its application to circuit analysis, two - port networks, frequency selective passive and active circuits. Prereq.: ELCE 112.

***ELCE 212L - Fundamental of Electric Circuits LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The content of this lab is directly related to the courses ELCE 112. Prereq.: ELCE 112.

***ELCE 222 - Electronic Circuits II (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

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 multivibrators, computer aided analysis and design using SPICE. Prereq.: ELCE 221.

***ELCE 222L - Electronic Circuits LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The content of this lab is directly related to the courses ELCE 221 and ELCE 222. Co - req.: ELCE 222.

***ELCE 232 - Logic Design (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Flip - flops, counters using T or JK flip - flops, state machines, synchronous and asynchronous sequential networks, programmable logic devices: PLA, PAL, CPLD, FPGA, applications in design and implementation of combinational and sequential circuits, sequential circuits for arithmetic operations: Serial address, parallel multipliers, parallel dividers, memory elements, extensive use of VHDL for describing, simulating and implementing digital designs. Prereq.: ELCE 231.

***ELCE 232L - Logic Circuits LAB (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

The content of this lab is directly related to the courses ELCE 231, ELCE 232. Prereq.: ELCE 231.

***ELCE 272 - Electromagnetic (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Electrostatics: Coulomb's law, Gauss's law, divergence theorem, energy and potential, conductors and dielectrics, electric dipole and polarization, capacitances, magnetostatics: Biot - Savart law, Ampere's law, Stoke's theorem, magnetic materials, magnetic dipole and magnetization, inductances, Faraday's law, time varying fields, Maxwell's equations. Prereq.: EMPH 131 & EMPH 209.

***ELCE 311 - Electric & Electronic Measurements (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Introduction to instrumentation and measurements (Errors, precision, accuracy, measurement statistics...), analog instrumentation (Permanent magnet moving coil PMMC, moving Iron MI, Electrodynamometer, energy meters, Electrostatic meters, Thermocouples, ...), bridges (AC, DC), potentiometers (AC, DC), oscilloscopes (functions and controls, voltage, time, and frequency measurements), digital measurements (D / A, A / D...), electrical transducers, signal conditioning, data acquisition and conversion. Prereq.: ELCE 221& ELCE 272.

***ELCE 331 - Microprocessor Fundamentals (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Basic computer organization, data representation, processor organization, ALU's, bus and stack organization, design of a simple hardwired processor, instruction sets and instruction formats, machine and assembly language programming, assembler functions and design, micro - programmed CPU, comparison between RISC and CISC processors, introduction to memory organization. I / O operations. Prereq.: ELCE 232.

***PORE 341 - Electric Machines I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Principles of energy conversion, concept of energy and co - energy, single phase transformers: Construction, theory of operation, equivalent circuit, power flow, regulation and testing, auto transformer, three phase transformers: Connections, special connections of transformers, DC Machines: Construction, theory of operation, induced voltage and developed torque, armature reaction, commutation, equivalent circuits, generator and motor (types and characteristics). Prereq.: ELCE 112 & ELCE 272.

***PORE 351 - Electric Power I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Power system structure, high - voltage transmission systems, DC versus AC transmission, load characteristics, over - head transmission lines: Parameters, solutions, and electrical performance, reactive power compensation and voltage control of transmission lines, underground power cables. Prereq.: ELCE 112& ELCE 272.

***PORE 361 - Control I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Introduction to control systems, control system components, transfer function, block diagram, signal flow graph, time domain analysis of control systems, Routh - Hurwitz, stability criteria, relative stability of feedback, control system, root locus analysis, root locus design, frequency response analysis, Nyquist criterion of stability. MATLAB / SIMULINK is used in class assignment and lab to simulate and analyze feedback control systems. Prereq.: EMPH 209.

***PORE 342 - Power Electronics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Power Switches: Diodes, Thyristor, Triac, GTO, BJT, MOSFET, IGBT. Rectifying circuits: Single - phase and three - phase, uncontrolled, half controlled and fully controlled rectifiers. Effect of source impedance and overlap angle. AC voltage controllers. Prereq.: ELCE 222.

***PORE 344 - Electric Machines II (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Machine winding, rotating field, Synchronous generator: Construction, theory of operation, windings, induced voltage, equivalent circuit, voltage regulation, electrical and mechanical diagrams, parallel operation, three - phase induction motors: Construction, theory of operation, equivalent circuit, power flow, regulation and testing. Prereq.: PORE 341.

***PORE 352 - Electric Power II (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Physical interpretation of transmission line equations, mechanical analysis and design of overhead transmission lines, line insulators, corona discharge and limiting factors in the design of extra high voltage transmission lines, distribution system design, distribution system equipments, layout of distribution systems, reactive power control in power systems, power factor correction in industrial plants. Prereq.: PORE 351.

***COME 386 - Communication Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction to analogue and digital communication systems, fundamentals of analogue modulation techniques: Fourier transform, AM, FM, pulse modulation techniques, and different detection techniques. Prereq.: ELCE 222.

***PORE 441 - Power Electronics II (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Three phase AC voltage controllers. Cycloconverters: Integral half cycle control, waveform shaping. DC to DC Converters: Modes of operation, single, two and four quadrant operation. Single phase and three phase inverters: VSI and CSI, Voltage control through pulse amplitude and pulse width modulation. Prereq.: PORE 342.

***PORE 451 - Protection I (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Modern analysis of power networks: Simulation of power system elements, network topology and Z bus formulation technique, symmetrical fault analysis, unbalanced fault analysis, instrument transformers for protection purposes, protection fundamentals, relay and switchgear characteristics, line protection: Over - current and differential relays, distance protection: High voltage and extra high voltage line protection, carrier schemes, for high voltage and extra high voltage lines, basics of differential relays. Prereq.: PORE 352.

***PORE 461 - Control II (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Sensitivity and the root locus, design of lag, lead, and lag - lead compensators. PID controllers and design of feedback control systems using frequency response, state variable representation, state - space approach, transition matrix, controllability and absorvability, design of state variable control systems. MATLAB / SIMULINK is used in class assignment and lab to simulate and analyze feedback control systems. Prereq.: PORE 361.

***PORE 471 - Instrumentation (2 Cr. : 2 Lec : 1 Lab : 1 Tut)***

Current transformers, voltage transformers, measurement sensors and transducers, signal conditioning, microcontrollers, embedded control systems, application projects for industrial control. Prereq.: ELCE311 & ELCE 331.

***MECH 407 - Fundamentals of Thermo Fluids (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Properties of fluids; Hydrostatics (pressure in a fluid at rest - forces on immersed surfaces - buoyancy); Thermodynamic definitions; Temperature scales; Flow Kinematics (velocity field - acceleration - flowlines - flow classification); Mass conservation and continuity equation; First law of Thermodynamics; Ideal gases; Applications of closed and open systems; Bernoulli's equation; Laminar and turbulent flows; Friction and energy losses for a flow; Flow in pipes; Second law of Thermodynamics and entropy; Change of phase and Mollier's chart; Steam tables; Steam processes; Psychrometry and Air - Conditioning processes; Principles of AC calculations; Modes of heat transfer; Simple heat exchangers; Cooling of electronic devices. Prereq.: EMPH 132.

***PORE 442 - Special Machines (2 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Single phase induction motor: Construction, theory, methods of starting, equivalent circuit, parameters calculation using open circuit and short circuit tests. Variable reluctance machines: Switched reluctance, Synchronous reluctance, and stepper motor. Hysteresis motor, linear machine: Induction, synchronous reluctance and DC. Permanent magnet motors, servo motors. Prereq.: PORE 344.

***PORE 452 - Protection II (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Protective relaying applications: Generator protection, substation transformer protection, bus - bar protection, line protection, radial network, reactor and shunt capacitor protection and motor protection. Static relays. Introduction to digital protection, relay coordination techniques and applications. Prereq. PORE 451.

***PORE 454 - Power System Analysis (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Power flow analysis and applications, economic operation of power systems, load forecasting, reliability and generation planning, power system security: Assessment and analysis of the effect of disturbing loads connected to the power system, power system stability, voltage stability. Prereq.: PORE 352.

***MECH 408 - Mechanical Power Stations (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Hydraulic power plants: Pelton wheel; Francis Propeller; Kaplan turbines; Centrifugal pumps (theory and principles of operation); Performance curves; Parallel and series operation; Positive displacement pumps; Fire pumps; Hydro - Electric projects in Lebanon. Thermal power plants: Steam generators; Steam and gas turbines; Combined cycles; plant management and economics. Wind turbines: Theory and principles of operation; Emphasis on blade design and pitch angle. Solar energy: Solar physics; Flat - plate collectors; Water systems; Air heaters; Swimming - pool heating, Solar concentrators, Economics of solar heating. Prereq.: MECH 407.

***PORE 500 - Internship (1 Cr.)***

This is a professional training should last for at least four weeks in electrical power engineering fields (electrical machine drives, Industrial electronics, automation, low voltage power system, or medium voltage power system. The course is followed by a poster session where the student supposed to present what he has gained from the training.

***PORE 541 - Electrical Drives (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Definition of electric drives and its components, types of loads, quadrant operation, variable loads, dynamics of motor load combination, steady state stability of electric drives, selection of electric motors, speed control, starting, breaking, thermal considerations, motor insulation, load cycle and motor rating, applications. Prereq.: PORE 344.

***PORE 551 - High Voltage (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Electrical transients in networks with distributed parameters (traveling waves on transmission lines), protection against lightning and insulation coordination, electrical transients in power systems, principles of system grounding and applications to industrial plants, protective grounding systems, breakdown mechanisms in solids, liquids and dielectrics, high voltage generation, measurements and testing techniques. Prereq.: PORE 452 & PORE 454.

***PORE 571 - Power System & Automation Programming (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

Standard software: Simulation and graphics, packages (SPICE, MATLAB, EMT, AUTOCAD). Development of some simple routines to perform the following examples: Load flow, short circuit analysis. Hard wired logic: Components, two and three wire logic, sequential control, ladder diagram, applications. Software logic: PLC history, construction, peripherals, digital and analogue signals, programming techniques: Ladder diagram, instruction list, graph set, Applications. Prereq.: PORE 461 & PORE 454.

***PORE 502 - Senior Project (6 Cr. : 6 Lec : 0 Lab : 0 Tut)***

Supervised projects in small groups of students aimed at providing practical experience in some aspects of machines, drives, industrial electronics, embedded systems, control, and power systems planning and design. This is accomplished through a set of lectures, field visits, and individual design and implementation. Student should earn 130 credits at least.

***PORE 542 - Solid - State Drives (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. MATLAB / SIMULINK is used in class assignment and lab to simulate and analyze electric drive systems. Prereq.: PORE 441 & PORE 541.

**Elective Courses for 8th Semester*****PORE 456 - Electrical Design in Commercial & Industrial Buildings (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: PORE 352.

***COME 486 - Communication Systems (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

ASK, PSK, and FSK, data communication: Data transmission, data encoding, data communication interface, multiplexing, and examples for communication systems. Prereq.: COME 386.

***MECH 542 - Automotive Engineering (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Advanced studies of automotive components, modules & systems (engines - fuel systems - ignition systems - cooling - lubrication - power boosting - transmission - steering - braking - suspension & damping - starting & recharging - emission control), updating of automotive technology. (Student should earn 90 credits at least).

**Elective Courses for 9th Semester*****PORE 543 - Specialized Modes of Machine Operation (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Induction machine modes of operation: Generation, plugging and braking, unbalanced operation. Induction regulator: Single and three phase, selsyns and synchros, single phase induction motors: Construction, theory of operation, types and characteristics, unsymmetrical operation of two phase induction motor, AC tachogenerator. Prereq.: PORE 344.

***PORE 553 - Power System Control & Operation (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Control problems in interconnected power systems, modeling 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 modeling: The SCADA system, system security monitoring and control. Prereq.: PORE 461 & PORE 454.

***PORE 561 - Digital Control (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Digital control system components, difference equations and Z transform, sampling theorem, stability, digital filter design, introduction to state space method in digital systems.

MATLAB / SIMULINK is used in class assignment and lab to simulate and analyze feedback control systems.

**Elective Courses for 10th Semester*****PORE 544 - Advanced Topics in Power Electronics (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Twelve pulse converters, switching mode power supplies, current source inverters, switching and conduction losses in power switches, cooling of switching devices, protection of power switches, induction furnace, harmonic analysis, active power filters, multi - level inverters. Prereq.: PORE 461.

***PORE 552 - Power System Planning (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

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. Prereq.: PORE 551.

***PORE 562 - Mechatronics & Robotics (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Kinematics of machinery and robotics, degrees of freedom, mechanisms, design of machine elements, mechanical power transmission: Power screw, gears and belts. Electrical, mechanical and electromechanical sensing elements and actuators, interfacing and signal conditioning circuits, robot monitoring manipulation and control, applications. Prereq.: PORE 461.

## Offered Courses for other Departments

### *PORE 343 - Conventional Electric Machines (4 Cr. : 4 Lec : 0 Lab : 1 Tut)*

Single - phase and 3 - phase transformers; Power transmission and distribution; DC machines: Construction and theory of operation, generators, motors (separately - and self - excited); Synchronous generators; Poly - Phase Induction Motors; Single - Phase Induction Motors. Prereq.: ELCE 112. (Offered for mechanical engineering students).

### *PORE 346 - Special Electric Machines & Power Electronics (2 Cr. : 2 Lec : 0 Lab : 1 Tut)*

PM motors; Linear motors; Universal motors; Switched - reluctance motors; Stepper motors. Power electronics: Rectifiers; Choppers; Pulse - width modulated inverters; Electric machine drives. Prereq.: PORE 343. (Offered for mechanical engineering students).

## Bachelor of Computer Engineering (150 Cr. Hr.)

### Curricula

First Semester			Cr.
COMP	111	Computer Programming I	2
HUME	101	Introduction to Engineering	2
EMPH	111	Mathematics I	3
EMPH	121	Mechanics I	3
EMPH	131	Physics I	3
EMPH	141	Engineering Drawing & Projection I	3
			16

## Second Semester Cr.

<b>COMP</b>	112	Programming II	4
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<b>EMPH</b>	112	Mathematics II	3
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<b>EMPH</b>	122	Mechanics II	3
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<b>EMPH</b>	132	Physics II	3
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<b>HUME</b>	201	Technical Writing	1
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<b>HUME</b>	103	Engineering Ethics	1
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<b>IEEM</b>	112	Production Engineering	2
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			17
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## Third Semester Cr.

<b>COMP</b>	221	Digital Systems I	3
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<b>COMP</b>	231	Discrete Structures	3
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<b>ELCE</b>	201	Electric & Electronic Circuits	3
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<b>COMP</b>	211	Introductory Web Programming	3
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<b>EMPH</b>	207	Chemistry	2
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		Elective (General) <sup>1</sup>	2
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			16
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**Fourth Semester****Cr.**

<b>COMP</b>	232	Data Structures	4
<b>COMP</b>	252	Transmission & Process Digital Signals	3
<b>EMPH</b>	317	Probability & Statistics	2
<b>COMP</b>	222	Digital Systems II	2
		Elective (General) <sup>1</sup>	3
			14

**Fifth Semester****Cr.**

<b>COMP</b>	311	Object Oriented Programming	3
<b>COMP</b>	361	Control Systems	3
<b>COMP</b>	341	Operating Systems	4
<b>COMP</b>	331	Computer Algorithms	3
<b>EMPH</b>	220	Numerical Computations	3
			16

Sixth Semester			Cr.
COMP	342	Artificial Intelligence	3
COMP	344	Data Base Systems	4
COMP	312	Programming Language Design	3
COMP	322	Microprocessors	3
		Elective (General) <sup>1</sup>	2
			15

Seventh Semester			Cr.
COMP	451	Computer Networks	3
COMP	421	Computer Organization	3
COMP	431	Queuing & Modeling	2
COMP	441	Computer Graphics Theory	3
		Elective (General) <sup>1</sup>	4
			15

### Eighth Semester Cr.

<b>COMP</b>	412	Compilers	3
<b>COME</b>		Elective (Technical) <sup>3</sup>	3
<b>COME</b>		Elective (Technical) <sup>3</sup>	3
<b>COMP</b>		Elective (Technical) <sup>2</sup>	3
		Elective (General) <sup>1</sup>	3
			15

### Ninth Semester Cr.

<b>COME</b>		Elective (Technical) <sup>3</sup>	3
<b>COME</b>		Elective (Technical) <sup>3</sup>	3
<b>COMP</b>		Elective (Technical) <sup>2</sup>	3
<b>COMP COME</b>		Elective (Technical) <sup>4</sup>	3
<b>HUME</b>	105	Engineering Management	2
<b>COMP</b>	500	Internship	1
			15

Tenth Semester			Cr.
COMP COME		Elective (Technical) <sup>4</sup>	3
COMP	502	Senior Project	6
		Elective (General) <sup>1</sup>	2
			11

<sup>1</sup> A total of 16 credits is required as General University Requirements; 5 credits are selected from the University Mandatory courses list including: ARAB 001 (2 Cr.), ENGL 001 (2 Cr.), BLAW 001 (1 Cr.) and another 11 credits are selected from the University Elective courses list.

<sup>2</sup> Selected from: COMP 438, 456, 557, 558, 483, 416, 417, 418, 419, 548, 466, 467, 538, 566, 539.

<sup>3</sup> Selected from: COME 432, 524, 563, 561, 561L.

<sup>4</sup> Selected from: COMP 446, 436, 447, 437, 526, 536, 527, 537, 546, 547. And COME 432, 524, 563, 561, 561L.

## Mandatory Courses

### *HUME 101 - Introduction to Engineering (2 Cr. : 2 Lec : 0 Lab : 0 Tut)*

Early technology: Stone age, Copper and Bronze age, Iron age, ancient civilizations, Medieval and Modern technologies: Renaissance, age of exploration, Industrial Revolution, 19th century, 20th century, 21st century - History of engineering: Pre - industrial revolution Era (up to early 1800s), from 1800 till today (by specialization alphabetically): Aerospace, chemical, civil, communication, computing, electrical, electromechanical, electronics, energy, Environmental, genetic, industrial, manufacturing, marine, materials science, measurement, nuclear, software, sanitary, structural, system, transportation - major technological and engineering achievements.

### *HUME 103 - Engineering Ethics (1 Cr. : 1 Lec : 0 Lab : 0 Tut)*

Personal versus engineering ethics, origin of ethical thought, ethics and the law, introduction of professional codes of ethics, brief history of ethical thought, ethical theories, tools of ethical problem solving, safety and risk, industrial and other accidents, professional responsibility, professional rights, ethics as applied to research and experimentation, and specific codes of ethics of engineering societies.

***HUME 105 - Engineering Management (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Engineer versus manager, basic business function and management tools (Planning, organizing, staffing, directing, motivating, leading and controlling), management objectives, introduction to facilities design, introduction to project management, introduction to production and operation management, and introduction to industrial financial, introduction to environmental and safety engineering. (This course is not offered to Industrial Engineering and Management students).

***HUME 201 - Technical Writing (1 Cr. : 1 Lec : 0 Lab : 0 Tut)***

Technical terms and abbreviations. Formats and methods of writing: Reports, bids, CV, correspondence, formal research proposal, progress report, feasibility study, technical report, fact sheet etc...

***EMPH 111 - Engineering Mathematics I (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Partial fractions; Binomial theorem; Roots of polynomial equations; Convergence of series; Matrices: Determinants, rank, Eigen values, eigenvectors, block decomposition, solution of linear system of equations; Introduction to complex analysis; Transfer of axes; Conic sections.

***EMPH 121 - Engineering Mechanics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Force vectors (analytical and graphical methods), equilibrium of a particle, force system resultants (moment of force, couple system); Equilibrium of a rigid body (equilibrium in two - dimensions, equation of equilibrium, free body diagrams); Structure analysis and its applications in truces, frames, mechanisms and simple mechanics); Cable static analysis; Dry friction, slipping, tipping, applications on real systems, experimental application on: Force analysis, friction effect, equilibrium of rigid body.

***EMPH 131 - Engineering Physics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Electrostatics: Coulomb's law, electric dipole, electric field of a continuous charge distribution, Gauss law, electric potential from point and distributed charges, relation between electric field and electric potential, capacitors and dielectrics, series and parallel connections of capacitors, energy stored in capacitors; Electric current: Model for electrical conduction and material resistivity, Kirchhoff's laws; Magnetism: Magnetic forces, magnetic dipole, magnetic flux and Gauss law in magnetism, sources of magnetic fields, Ampere's Law, Biot and Savart law, magnetism of matter; Geometric optics: Images formed by reflection, refraction from spherical surfaces, thin lenses, lens aberrations and defects of images.

***EMPH 141 - Engineering Drawing & Projection (3 Cr. : 2 Lec : 0 Lab : 3 Tut)***

Drawing instruments and their use; Developing drafting skills; Dimensioning; Geometric construction; Conic sections; Special curves: Involute, cycloid, spiral of Archimedes, helix; Theory of shape: Representing objects by views and applications in machines drawing; Pictorial drawing: Isometric and oblique; Electrical drafting. AutoCad: 2D drawings using the computer software AutoCAD; Projects.

***EMPH 112 - Engineering Mathematics II (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Hyperbolic functions, implicit and logarithmic differentiation, derivatives of higher order, Leibniz theorem, mean value theorem, partial differentiation and applications, curvature, Taylor expansion, methods of integration, improper integrals, multiple integrals.

***EMPH 122 - Engineering Mechanics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Introduction to vector analysis, hints about the ordinary differential equations of the second order kinematics of the particle in one dimension (rectilinear motion of a particle), two - dimensional kinematical analysis of a particle motion using the cartesian and intrinsic coordinates, engineering applications, kinetics of the particle), two - basic concepts: Newton's Law (force & acceleration), position integration of Newton's Law (works & energy), time integration of Newton's Law (impulse & linear momentum). Engineering applications: One dimensional motion in a conservative or dissipative force field, ideal constraints, direct and inclined impact of a particle on a smooth plane, oscillations of a particles, engineering applications.

***EMPH 132 - Engineering Physics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Properties of materials: Units, dimensions, circular motion of rigid bodies, moment of inertia, elasticity of materials, stresses and strains, pressure measurements, surface tension, 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, heat measurements, heat transfer by conduction, heat convection, heat radiation, introduction to thermodynamics, first law of thermodynamics, thermodynamic processes for an ideal gas.

***EMPH 207 - Chemistry (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction to basic concepts of chemistry, chemical reactions and calculations; Physical states of matter: Gases, liquids and solids; Solutions; Chemical equilibrium, ionic equilibrium; Manufacture and hydration reactions of cements; Practical: Applied experiments related to the above topics.

***EMPH 220 - Numerical Computations (3 Cr. : 2 Lec : 1 Lab : 2 Tut)***

Curve fitting Taylor's series, 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), error, stability and convergence, floating point arithmetic, numerical solutions for partial differential equations. Prereq.: EMPH 111, EMPH 112.

***EMPH 317 - Probability & Statistics for Computer Engineering (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Probability space, conditional probability and independence, Bayes' theorem, random variables, and density functions, joint probability; Discrete and continuous distributions: Binomial, poisson, hyper - geometric, normal, approximation to binomial, gamma, exponential; Statistical inference; Probability distribution: T - distribution, F - distribution, chi - distribution; Sampling theory; Theory of estimation, confidence intervals. Prereq: EMPH 112.

***IEEM 112 - Production Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction to production and manufacturing engineering, introduction to material and material properties, iron and steel, metrology, bench work, machining (turning, milling, shaping and planning, drilling, etc...), forging and forming of metals, metal casting (sand casting and permanent mold casting), and cost analysis.

***ELCE 201 - Electric & Electronic Circuits (3 Cr. : 3 Lec : 1 Tut)***

DC circuit analysis: Mesh current and node voltage analysis methods, capacitors and inductors. Transient analysis, Laplace transform and its application to circuit analysis. Junction diodes: Construction, I - V characteristics, circuit models. BJT and FET transistors DC models.

***COMP 102 - Data Structures (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Functions / procedures, call by value / reference, recursion, pointers, user defined data types: Structures and unions, elementary data structures: Stacks, queues and linked lists. Prereq.: COMP 101.

***COMP 201 - Introductory Web Programming (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Client side programming, XHTML, Java Script. Packages for web - page design. Prereq.: COMP 101.

***COMP 401 - Operating Systems (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Introduction. Types of systems. Processes. Concurrency control. Mutual exclusion. Deadlocks. Processor scheduling algorithms. Memory management. Disk management. File systems. Case studies: Windows and solaris. Prereq.: (COMP 102 - for non - majors).

***COMP 501 - Advanced Data Structures (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Trees: Representation, traversals, recursive definition. Binary search trees. Asymptotic notations. Complexity analysis: Worst, and average. Heap and merge sort. Graphs. Prereq.: (COMP 102 - for non - majors).

***COMP 111 - Computer Programming I (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Computer fundamentals. Computer system components: Hardware and software. Problem solving and flowcharts / pseudo - code. High level programming: Data types, structured programming constructs, input and output, expressions and assignments, selection, repetition, arrays.

***COMP 112 - Programming II (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Functions / procedures, call by value / reference, recursion, pointers, user defined data types: Structures and unions, files, searching and sorting. Prereq.: COMP 101.

***COMP 211 - Web Programming (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Client side programming, XHTML, Java Script and XML. Packages for web - page design. Prereq.: COMP 101.

***COMP 221 - Digital Systems I (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Number systems & coding. Boolean algebra and gate circuits. Combinatorial circuits design. Function minimization: Tabular method, Karnaugh maps. MSI and LSI logic design (decoder, multiplexer, ROM). Arithmetic - Logic unit. Flipflops. Synchronous and asynchronous counters using T or JK flipflops. Memory elements. Input / Output devices.

***COMP 231 - Discrete Structures (4 Cr. : 4 Lec : 0 Lab : 0 Tut)***

Logic and predicates. Sets and Power sets. Sequences. Mathematical induction, counting, permutations and combinations. Binomial and multinomial theorems. Functions and relations. Partial and total orders. The pigeon - hole principle. Inclusion / exclusion principle. Recurrence relations. Fibonacci numbers. Groups, rings, fields.

***COMP 232 - Data Structures (4 Cr. : 3 Lec : 2 Lab : 0 Tut)***

Elementary data types. Linked lists. Queues. Stacks. Trees: Representation, traversals, recursive definition. Binary search trees. Binary heaps. Asymptotic notations. Complexity analysis: Worst, average and amortized cases. Searching and sorting techniques. Balanced trees: AVL trees, B trees. Binomial queues. Hashing. Graphs: Representation, traversals. Prereq.: COMP 112.

***COMP 222 - Digital Systems II (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Synchronous sequential systems: Analysis and synthesis. Incompletely specified machine. Asynchronous sequential systems: Design procedures, reduction of states, flow table and race - free state assignment. Control unit. Prereq.: COMP 221.

***COMP 252 - Transmission & Processing of Digital Signals (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Sampling and discrete time signals. The z - transform. Quantization. Histograms. Recursive and non - recursive digital filters. Frequency response and the discrete fourier transform. Processing in 2 - dimensions. Finite precision implementation errors. Encoding digital signals. Modulation. Multiplexing. The physical layer of the OSI model. Synchronous and asynchronous transmission. The RS 232 interface. Modems. Error detection with checksums. Cyclic redundancy checks.

***COMP 311 - Object - Oriented Programming (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Object - oriented design versus structured design. Classes and objects. Inheritance. Polymorphism. Information hiding and abstract data types. UML diagrams. Overloading. Generic functions and classes. Exception handling. Prereq.: COMP 112.

***COMP 361 - Control Systems (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Types of control systems. Advantages and limitations of using digital processors in control systems. Control system components and computer interface. System representation: Transfer function, block diagram, signal - flow - graph. Time domain analysis: Steady state and transient analysis. Frequency domain analysis. Writing programs for solving problems in control systems. Disk - drive read system. Printer - drive system.

***COMP 341 - Operating Systems (4 Cr. : 3 Lec : 2 Lab : 0 Tut)***

Introduction. Types of systems. Processes. Concurrency control. Mutual exclusion. Deadlocks. Scheduling algorithms. Memory management. Disk management. File systems.

***COMP 331 - Analysis of Computer Algorithms (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

The  $P = NP$  question. Time complexity of algorithms. The classes P, NP. Solving recurrences. Divide - and - conquer. Greedy algorithms. Dynamic programming. Graph algorithms. Geometric algorithms. Algorithms on matrices and polynomials. Number theoretic algorithms. Reductions between problems. Theory of NP completeness. Examples of NP complete problems. Some approximation algorithms. Prereq.: COMP 232.

***COMP 312 - Programming Language Design (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Language design issues. Language categories and paradigms. Compilation versus interpretation. Variable attributes and bindings. Memory management. Type checking. Data types in different languages. Expressions and evaluation order. Control statements. Subprograms: Design, parameter - passing methods, calls and implementations. Concurrency and constructs for parallel programming. Prereq.: COMP 311.

***COMP 322 - Microprocessors (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Registers and counters. Fundamentals of microprocessors. Microcomputer Systems. Instruction set. Microprocessor bus. System design. Programming in assembly language. Prereq.: COMP 221.

***COMP 342 - Artificial Intelligence (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Introduction: Definition - History - Goals. AI as representation and search. State space. Search strategy. Blind search techniques. Informed (Heuristic) search techniques. Genetic algorithm (random search). Constraint satisfaction problems. Game trees. Production rule systems (expert systems). First Order Logic: Unification - resolution refutation - Soundness - Completeness. Prereq.: COMP 331.

***COMP 344 - Database Systems (4 Cr. : 3 Lec : 2 Lab : 0 Tut)***

Components of database systems: DBMS functions. Database architecture and data integrity. Data modeling: Conceptual models, object - oriented model, relational data model. Relational databases mapping conceptual schema to a relational schema, relational algebra and relational calculus. Database query languages: SQL. Relational database design: Functional dependency, decomposition, normal forms. Higher normal forms. Transaction processing: Transactions; Failure and recovery systems; Concurrency control. Physical database design: Storage and file structure; Indexed files; Hashed files; Signature files. Query processing. Query optimization.

***COMP 421 - Computer Organization (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Fundamentals of computer design. Instruction format. Instruction set design: RISC & CISC. Assembly level organization. Memory systems. Interfacing and communication. Basic processor implementation techniques. Pipelining. Performance enhancements. Prereq.: COMP 322.

***COMP 431 - Queuing & Modeling (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Random variables. Constructing a model. Discrete event systems. Performance measures. Probability theory. The Poisson and the Exponential distributions. Little's law. Markov processes. Birth / death processes. Solving Markov models. Stochastic Petri nets. GSPN. Queuing models:  $M / M / 1$ ,  $M / M / m$ ,  $M / M / m / m$ ,  $M / M / 1 / K$ ,  $M / G / 1$ . Networks of queues. Burke's theorem. Jackson's theorem. Prereq.: EMPH 317.

***COMP 441 - Computer Graphics Theory (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Introduction to computer graphics, software and hardware and applications. Raster scanning. The graphics pipeline. Transformations. Viewing. Clipping. Anti - aliasing, sampling. Shading and illumination. Curves, surfaces and splines. Hierarchical representations.

***COMP 451 - Computer Networks (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

The OSI Model. Data link layer. Frame format: Character stuffing, bit stuffing. Error control. Automatic - repeat request and sliding - window protocols. Data - link protocols: HDLC, BSC, PPP. The MAC sub - layer. Local area networks: Ethernet, token ring and FDDI, wireless LANs. Circuit switching versus packet switching. Routing algorithms. Prereq.: COMP 252.

***COMP 412 - Compilers (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Virtual machines. 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. Optimization: Machine - independent optimization; Data - flow analysis; Loop optimizations; Machine - dependent optimization. Prereq.: COMP 312.

***COMP 502 - Senior Project (6 Cr. : 6 Lec)*****Elective Courses*****COMP 446 - Digital Image Processing (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Image formation and perception. Image representation. Transformations on digital images. Enhancement and restoration. Segmentation. Encoding and data compression. Prereq.: COMP 252.

***COMP 436 - Theory of Computation (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Regular expressions. Finite automata. Context - free grammars and parsing. Pushdown automata. Closure properties. Turing machines. Computational classes. Complexity theory.

***COMP 447 - Operations Research for Computer Engineers (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

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.

***COMP 437 - Performance Evaluation (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Work load performance indices. Single and multiple job processing models. Scheduling policies. Paging techniques. Network protocols. Routing policies.

***COMP 526 - Microprocessor - Based Systems (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Interfacing microprocessors to memory and I / O devices. Supporting chips: Buffers, decodes, system clock generator. Interfacing techniques: Serial, parallel, timer, ADC, DAC. Interrupts and interrupt controller. Hardware software co - design. Computer applications. Prereq.: COMP 322.

***COMP 536 - Parallel Processing (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Principles in the design and programming of parallel machines. Shared Memory, PRAM, Mesh and Hypercube architectures. Sorting networks. Multithreaded parallelism. Compilers design and optimization for multi - core processors. Parallel algorithms. Prereq.: COMP 421, COMP 331.

***COMP 527 - Neural Networks (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Limitations of the Von - Neumann architecture, Biological vs. Artificial neuron, the McCulloch and Pitts neuron (threshold gate), realizing linearly separable logic functions, solving nonlinear separable problems with Artificial Neural Networks (ANNs), taxonomy of NNs, supervised vs. unsupervised learning, MATLAB neural network models, Rosenblatt's Perceptron training algorithm, Widrow - Hoff LMS learning rule, Backpropagation learning rule (generalized delta learning rule) for multi - layer feed - forward networks, Radial - Basis Function (RBF) neural networks and their learning algorithms. Self - Organizing Maps (SOM) and Learning Vector Quantization (LVQ), recurrent networks and associative learning.

***COMP 537 - Cryptography & Information Security (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Measures of information. Elementary ciphers. Complexity measures. Designing a generic block cipher. Modes of operation. Attacks against block ciphers. Message digests. Cryptographic hash functions. Public key cryptography. Diffie - Hellman key exchange. RSA. Digital signature schemes. Forging digital signatures. Pseudo - random bit generators. Authentication techniques. Applications. Prereq.: COMP 331.

***COMP 546 - AI Programming (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Functional programming (e.g. common Lisp): Functions and data, lists, eval notations, conditionals, variables and side effects, list data structures, applicative programming, recursion. Input / output, assignment, iteration and block structure, structures and the type system, arrays, hash tables and property lists, macros and compilation. Logic programming (prolog): Facts, rules and queries, matching and proof search, recursions, lists, arithmetic, definite clause grammar, terms, cuts and negation, database manipulation and collecting solutions, working with files. Prereq.: COMP 111.

***COMP 547 - Computer Graphics Programming (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Using Open GL to write 2D and 3D graphics applications. Prereq.: COMP 112.

***COMP 438 - Information Theory & Coding (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

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.

***COMP 456 - Computer Networking Laboratory (3 Cr. : 1 Lec : 4 Lab : 0 Tut)***

Covers current technology in computer networking. Topics will vary every year. Prereq.: (Student must take the instructor permission before registering this course).

***COMP 557 - Network Architecture & Protocols (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Engineering and analysis of network protocols and architecture for traditional and high speed networks. Designing heterogeneous networks. Transport protocols. Internet routing foundations and practice. Router design. Congestion control. Prereq.: COMP 451.

***COMP 558 - Network Interconnections (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Bridges. Routers. Brouters. Tunnels. Nodes and links failures. Robust networks. Prereq.: COMP 451.

***COMP 416 - Systems Analysis & Design (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Types of systems, roles of the systems analyst, systems development life cycle, case tools, object oriented systems analysis and design, extreme programming, organizations as systems, feasibility analysis, information requirements analysis, information gathering, prototyping, RAD, data flow diagrams, data dictionaries, systems proposal, decision trees. Prereq.: COMP 311, COMP 344.

***COMP 417 - Software Engineering (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Concepts of software development. Life - cycle of software. Requirements and specification. Data model. Process model. Design and coding. Verification, validation and testing. Management of software projects. Software evolution.

***COMP 418 - Computer Software Laboratory (3 Cr. : 1 Lec : 4 Lab : 0 Tut)***

Covers current technology in computer software. Topics will vary every year. Prereq.: Instructor permission.

***COMP 419 - Advanced Web Programming (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Server side programming: Web servers, Perl, Python, PHP, ASP, JSP, Java Servlets, e - business, e - commerce. Prereq.: COMP 211.

***COMP 548 - Database Systems 2 (3 Cr. : 3 Lec : 0 Lab : 0 Tut)***

Transaction processing: Transactions; Failure and recovery systems; Concurrency control. Physical database design: Storage and file structure; Indexed files; Hashed files; Signature files. Query processing. Query optimization. Distributed databases, parallel databases. Prereq.: COMP 344.

***COMP 466 - Digital Modern Control (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

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. Prereq.: COMP 361.

***COMP 467 - Robotics & Plcs Laboratory (3 Cr. : 1 Lec : 4 Lab : 0 Tut)***

For PLCs topics may include but not limited to: Introduction to PLC hardware and software. Ladder Programming. Training PLCs for some industrial - like applications. For Robotics topics may include but not limited to: Simulation on Matlab for robot manipulators. Simulation of control algorithms to give student feeling of complexity of Robot Systems. Prereq.: Instructor permission

***COMP 538 - Computer Vision (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Image formation, image models. Early vision: One image and multiple images. Mid - level vision, high - level vision. Applications. Prereq.: COMP 446.

***COMP 566 - Game Engine Design (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Euler angles, Hierarchical scene representations, picking, collision detection, animation of characters, geometric level of detail, terrain, spatial sorting, special effects. Prereq.: COMP 441.

***COMP 539 - Advanced AI (3 Cr. : 2 Lec : 2 Lab : 0 Tut)***

Planning, uncertainty, probabilistic reasoning systems. Machine learning: Symbol based (version space, ID3 algorithm, unsupervised learning, reinforcement learning). Machine Learning: Connectionist, machine learning: Social and Emergent. Statistical learning, Decision trees. Prereq.: COMP 342.

## Department of Civil & Environmental Engineering

### Bachelor of Civil Engineering (150 Cr. Hr.)

#### Curricula

#### First Semester Cr.

<b>HUME</b>	101	Introduction to Engineering	2
<b>COMP</b>	111	Computer Programming I	2
<b>EMPH</b>	111	Mathematics I	3
<b>EMPH</b>	121	Mechanics I	3
<b>EMPH</b>	131	Physics I	3
<b>EMPH</b>	141	Engineering Drawing & Projection I	3
			16

#### Second Semester Cr.

<b>CVEE</b>	110	Engineering Surveying I	3
<b>EMPH</b>	112	Mathematics II	3
<b>EMPH</b>	122	Mechanics II	3
<b>EMPH</b>	132	Physics II	3
<b>EMPH</b>	142	Engineering Drawing & Projection II	3
<b>IEEM</b>	112	Production Engineering	2
			17

**Third Semester****Cr.**

<b>HUME</b>	201	Technical Writing	1
<b>EMPH</b>	211	Differential Equations for Engineers	2
<b>CVEE</b>	211	Engineering Surveying II	3
<b>CVEE</b>	213	Transport, Traffic & the Environment	3
<b>CVEE</b>	215	Engineering Geology	2
<b>EMPH</b>	207	Chemistry	2
		Elective (General) <sup>1</sup>	2
			15

**Fourth Semester****Cr.**

<b>ARCH</b>	231	Architectural Planning & Construction	2
<b>CVEE</b>	212	Structural Analysis I	3
<b>CVEE</b>	214	Environmental Science in Civil Engineering	2
<b>CVEE</b>	216	Civil Engineering Drawing	2
<b>ELCE</b>	202	Electric Engineering for Buildings	2
<b>MECH</b>	202	Mechanical Engineering for Buildings	2
		Elective (General) <sup>1</sup>	2
			15

## Fifth Semester Cr.

<b>CVEE</b>	309	Mechanics of Materials	2
<b>CVEE</b>	311	Structural Analysis II	3
<b>CVEE</b>	313	Environmental Engineering Topics	2
<b>CVEE</b>	315	Hydraulics I	3
<b>CVEE</b>	317	Soil Mechanics	3
		Elective (General) <sup>1</sup>	2
			15

## Sixth Semester Cr.

<b>CVEE</b>	312	Structural Analysis III	3
<b>CVEE</b>	314	Reinforced Concrete Design I	3
<b>CVEE</b>	316	Structural Steel Design I	3
<b>CVEE</b>	318	Hydraulics II	3
<b>CVEE</b>	320	Construction Materials	3
		Elective (General) <sup>1</sup>	2
			17

**Seventh Semester****Cr.**

<b>CVEE</b>	411	Reinforced Concrete Design II	3
<b>CVEE</b>	413	Structural Steel Design II	3
<b>CVEE</b>	415	Sanitary Engineering	3
<b>CVEE</b>	417	Hydrology	2
<b>CVEE</b>	419	Geographic Information System (GIS)	2
		Elective (General) <sup>1</sup>	2
			15

**Eighth Semester****Cr.**

<b>CVEE</b>	410	Contracts & Specifications	2
<b>CVEE</b>	412	Foundation Engineering	3
<b>CVEE</b>	414	Highway Engineering	3
<b>CVEE</b>	416	Surveying for Construction	1
<b>CVEE</b>	418	Reinforced Concrete Design III	3
<b>HUME</b>	103	Engineering Ethics	1
		Elective (General) <sup>1</sup>	2
			15

## Ninth Semester Cr.

<b>CVEE</b>	501	Harbor Engineering	3
<b>CVEE</b>	503	Project Management	1
<b>CVEE</b>	505	Internship	1
<b>HUME</b>	105	Engineering Management	2
<b>CVEE</b>		Elective (Technical) <sup>2</sup>	2
<b>CVEE</b>		Elective (Technical) <sup>2</sup>	2
		Elective (General) <sup>1</sup>	2
			13

## Tenth Semester Cr.

<b>CVEE</b>	502	Senior Project	6
<b>CVEE</b>		Elective (Technical) <sup>2</sup>	2
<b>CVEE</b>		Elective (Technical) <sup>2</sup>	2
		Elective (General) <sup>1</sup>	2
			12

<sup>1</sup> A total of 16 credits is required as General University Requirements: 5 credits are selected from the University Mandatory courses list including: ARAB 001 (2 Cr.), ENGL 001 (2 Cr.), BLAW 001 (1 Cr.) and another 11 credits are selected from the University Elective Courses list.

<sup>2</sup> Student have the option to select from the following courses: CVEE 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548.

## Mandatory Courses

### *HUME 101 - Introduction to Engineering (2 Cr. : 2 Lec : 0 Lab : 0 Tut)*

Early technology: Stone age, Copper and Bronze age, Iron age, ancient civilizations, Medieval and Modern technologies: Renaissance, age of exploration, Industrial Revolution, 19th century, 20th century, 21st century - History of engineering: Pre - industrial revolution Era (up to early 1800s), from 1800 till today (by specialization alphabetically): Aerospace, chemical, civil, communication, computing, electrical, electromechanical, electronics, energy, environmental, genetic, industrial, manufacturing, marine, materials science, measurement, nuclear, software, sanitary, structural, system, transportation - major technological and engineering achievements.

### *HUME 103 - Engineering Ethics (1 Cr. : 1 Lec : 0 Lab : 0 Tut)*

Personal versus engineering ethics, origin of ethical thought, ethics and the law, introduction of professional codes of ethics, brief history of ethical thought, ethical theories, tools of ethical problem solving, safety and risk, industrial and other accidents, professional responsibility, professional rights, ethics as applied to research and experimentation, and specific codes of ethics of engineering societies.

### *HUME 105 - Engineering Management (2 Cr. : 2 Lec : 0 Lab : 0 Tut)*

Engineer versus manager, basic business function and management tools (planning, organizing, staffing, directing, motivating, leading and controlling), management objectives, introduction to facilities design, introduction to project management, introduction to production and operation management, and introduction to industrial financial, introduction to environmental and safety engineering. (This course is not offered to Industrial Engineering and management students).

### *HUME 201 - Technical Writing (1 Cr. : 1 Lec : 0 Lab : 0 Tut)*

Technical terms and abbreviations. Formats and methods of writing: Reports, bids, CV, correspondence, formal research proposal, progress report, feasibility study, technical report, fact sheet etc...

### *EMPH 111 - Engineering Mathematics I (3 Cr. : 3 Lec : 0 Lab : 1 Tut)*

Partial fractions; Binomial theorem; Roots of polynomial equations; Convergence of series; Matrices: Determinants, rank, Eigen values, eigenvectors, block decomposition, solution of linear system of equations; Introduction to complex analysis; Transfer of axes; Conic sections.

### *EMPH 121 - Engineering Mechanics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)*

Force vectors (analytical and graphical methods), equilibrium of a particle, force system resultants (moment of force, couple system); Equilibrium of a rigid body (equilibrium in two - dimensions, equation of equilibrium, free body diagrams); Structure analysis and its applications in truces, frames, mechanisms and simple mechanics); Cable static analysis; Dry friction, slipping, tipping, applications on real systems, experimental application on: Force analysis, friction effect, equilibrium of rigid body.

***EMPH 131 - Engineering Physics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Electrostatics: Coulomb's law, electric dipole, electric field of a continuous charge distribution, Gauss law, electric potential from point and distributed charges, relation between electric field and electric potential, capacitors and dielectrics, series and parallel connections of capacitors, energy stored in capacitors; Electric current: Model for electrical conduction and material resistivity, Kirchhoff's laws; Magnetism: Magnetic forces, magnetic dipole, magnetic flux and Gauss law in magnetism, sources of magnetic fields, Ampere's law, Biot and Savart law, magnetism of matter; Geometric optics: Images formed by reflection, refraction from spherical surfaces, thin lenses, lens aberrations and defects of images.

***EMPH 141 - Engineering Drawing & Projection (3 Cr. : 2 Lec : 0 Lab : 3 Tut)***

Drawing instruments and their use; Developing drafting skills; Dimensioning; Geometric construction; Conic sections; Special curves: involutes, cycloid, spiral of Archimedes, helix; Theory of shape: Representing objects by views and applications in machines drawing; Pictorial drawing: Isometric and oblique; Electrical drafting. AutoCad: 2D drawings using the computer software AutoCAD; Projects.

***EMPH 112 - Engineering Mathematics II (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Hyperbolic functions, implicit and logarithmic differentiation, derivatives of higher order, Leibniz theorem, mean value theorem, partial differentiation and applications, curvature, Taylor expansion, methods of integration, improper integrals, multiple integrals.

***EMPH 122 - Engineering Mechanics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Introduction to vector analysis, hints about the ordinary differential equations of the second order. Kinematics of the particle in one dimension (rectilinear motion of a particle), two - dimensional kinematical analysis of a particle motion using the cartesian and intrinsic coordinates, engineering applications, kinetics of the particle), two - basic concepts: Newton's law(force & acceleration), position integration of Newton's Law (works & energy), time integration of Newton's Law (impulse & linear momentum). Engineering applications: One dimensional motion in a conservative or dissipative force field, ideal constraints, direct and inclined impact of a particle on a smooth plane, oscillations of a particles, engineering applications.

***EMPH 132 - Engineering Physics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Properties of materials: Units, dimensions, circular motion of rigid bodies, moment of inertia, elasticity of materials, stresses and strains, pressure measurements, surface tension, 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, heat measurements, heat transfer by conduction, heat convection, heat radiation, introduction to thermodynamics, first law of thermodynamics, thermodynamic processes for an ideal gas.

***EMPH 142 - Engineering Drawing & Projection II (3 Cr. : 2 Lec : 0 Lab : 3 Tut)***

Engineering Drawing & Projection sectional views, intersection of surfaces, structural drawing which includes projection of steel structures and, Monger's descriptive geometry (representation of points, lines and planes), representation of surface (sphere, cone and cylinder) and intersection of surfaces and their development, indexed projection, (representation of points, lines, and planes, and the intersection line of two planes), applications of indexed projection (topographic surfaces and problems of cutting and filling). Prereq.: EMPH 141.

***EMPH 211 - Differential Equations for Engineers (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Differential Equations: First order differential equations; Second order differential equations with constant and variable coefficients, simultaneous system of differential equations, series solution; Fourier series: Periodic function, expansion, half period and harmonics; Introduction to partial differential equations. Prereq.: EMPH 111 & EMPH 112.

***EMPH 207 - Chemistry (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction to basic concepts of chemistry, chemical reactions and calculations; Physical states of matter: Gases, liquids and solids; Solutions; Chemical equilibrium, ionic equilibrium; manufacture and hydration reactions of cements; Practical: Applied experiments related to the above topics.

***IEEM 112 - Production Engineering (2 Cr. : 2 Lec : 1 Lab)***

Introduction to production and manufacturing engineering, introduction to material and material properties, iron and steel, metrology, bench work, machining (turning, milling, shaping and planing, drilling, etc...), forging and forming of metals, metal casting (sand casting and permanent mold casting), and cost analysis.

***COMP 101 - Computer Programming I (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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.

***CVEE 110 - Engineering Surveying I (3 Cr. : 2 Lec : 2 Lab : 1 Tut)***

Basic principles, linear surveying, compass surveying, theodolite surveying: Vernier, optical and digital, traverses: Open, closed, link, and traverse network, engineering and precise leveling, contouring.

***CVEE 211 - Engineering Surveying II (3 Cr. : 2 Lec : 2 Lab : 1 Tut)***

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 haul diagrams, curve ranging simple, compound, reversed, transition, and vertical curves, setting out of constructional schemes. Prereq.: CVEE 110.

***CVEE 212 - Structural Analysis I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Types of loads, structural elements and supports. Analysis of simple, cantilever and overhanging ended beams. Axial, shear, and bending moment diagrams. Compound and inclined beams. Frames and Composite structures. Applications. Prereq.: EMPH 121.

***CVEE 213 - Transport, Traffic & the Environment (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

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.

### ***CVEE 214 - Environmental Science in Civil Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Mass and energy transfer: Materials balance, energy fundamentals. Environmental chemistry. Risk assessment: Hazard identification, human exposure. Water pollution: Water resources and pollutants, water quality in lakes, reservoirs, and groundwater. Air pollution: Criteria pollutants, motor vehicle emissions, indoor air quality. Global atmospheric change: Greenhouse effect, ice melting, ozone depletion, acid rain. Introduction to solid wastes: Types and source reduction, collection and transfer operations, recycling, composting, incineration, landfills.

### ***CVEE 215 - Engineering Geology (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Earth - structure and properties. Structural geology. Earth movements. Geological action and activity of water and wind. Methods of geological surveying (seismic devices). Geology of reservoirs and dam sites. Maps and sections. Geological effect in construction of tunnels.

### ***CVEE 216 - Civil Engineering Drawing (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

Graphical analysis of engineering drawings, computer - aided drafting and work drawing, applications: RC slabs, stairs, retaining walls, footing, bridges, earth slopes, roads, and steel structures, interchanges, and sections. Prereq.: EMPH 142.

### ***CVEE 309 - Mechanics of Materials (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Center of Gravity. Moments of Inertia. Stresses due to axial loads. Stresses due to pure bending. Stresses due to axial forces and biaxial bending. Torsion. Shear stresses. Buckling of columns. Prereq.: CVEE 212.

### ***CVEE311 - Structural Analysis II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Stability and determinacy of structures. Moving loads, influence lines for statically determinate structures, Muller - Breslau's principle, maximum value of internal force function due to moving loads. Elastic deformation (slope and deflection) of beams by double - integration method; Moment - area theorems; and Conjugate Beam Method. Strain energy theorems - Slopes and deflection of beams, frames and trusses utilizing principle of virtual work. Introduction to indeterminate structures. Compatibility conditions and analysis of indeterminate structures by consistent deformation method. Prereq.: CVEE 212.

### ***CVEE312 - Structural Analysis III (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Matrix analysis of structures. Flexibility method for analysis of indeterminate structures (Beams. Trusses and frames). Effect of temperature change and yielding of supports. Three Moment Equations and applications. Concept of Moment distribution methods and applications on continuous beams, moment distribution method in frames with and without sides way. Influence lines of indeterminate structure utilizing concepts of virtual work and moment distribution method, quantitative and qualitative influence lines. Computer applications. Prereq.: CVEE 311.

### ***CVEE 313 - Environmental Engineering Topics (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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.

***CVEE 314 - Reinforced Concrete Design I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 212.

***CVEE 315 - Hydraulics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

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.

***CVEE 316 - Structural Steel Design I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Introduction to steel structures, structural floor framing systems, bracing systems, tension members, compression members, bolted and welded truss connections, laterally supported beams, lateral torsion buckling of beams, beam - column members, detailing. Prereq.: CVEE 212.

***CVEE 317 - Soil Mechanics (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

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.

***CVEE 318 - Hydraulics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

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. Planning of 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. Prereq: CVEE 315.

***CVEE 320 - Construction Materials (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Portland cement: Processing, properties, types & testing, aggregate: Processing, properties and testing, water & admixtures, concrete mix design (mixture proportioning), properties of fresh concrete (workability tests), concrete batching, mixing and placing, hard concrete: Properties and testing, building construction materials: Blocks, tiles, lime, wood.

### ***CVEE 410 - Contracts, Quantities & Specifications (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Areas and methods of measurements used in engineering projects, engineering projects contracts, quantity measurements and schedules, specifications for constructions, project site planning, cost analysis and estimation, law: Engineering contracts, arguments, property, agreements, engineer's responsibility.

### ***CVEE 411 - Reinforced Concrete Design II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

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, applications. Prereq.: CVEE 311, CVEE 314.

### ***CVEE 412 - Foundation Engineering (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 317.

### ***CVEE 413 - Structural Steel Design II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Built - up columns, Eccentrically loaded connections, High tensile bolts, Frame connections, Column bases, Slab - Girder roadway bridges: Non - composite and composite construction, Built - up plate girders, Stability of web plates - Splices, modeling of steel structures, detailing. Prereq.: CVEE 316.

### ***CVEE 414 - Highway Engineering (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

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.

### ***CVEE 415 - Sanitary Engineering (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 318.

### ***CVEE 416 - Surveying for Construction (1 Cr. : 1 Lec : 1 Lab : 0 Tut)***

Route surveying and geometric design, topographic site surveys and mapping, civil engineering and construction surveys, earthwork computation; 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, sight distance on horizontal curves, transition curves, vertical curves, staking a vertical parabolic curve, designing a curve to pass through a fixed point, sight distance. Prereq.: CVEE 211.

***CVEE 417 - Hydrology (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

The hydrologic cycle, precipitation, system flow, evaporation, transpiration, hydrograph analysis, estimating volume runoff, runoff from snow, reservoir routing, and channel routing, groundwater: Occurrence, aquifers, hydraulics of wells, surface and subsurface investigations of groundwater. Prereq.: CVEE 318.

***CVEE 418 - Reinforced Concrete Design III (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 411.

***CVEE 419 - Geographic Information System GIS (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

Digital mapping, Geographic Information System (Definition, GIS historical development), Vector and raster GIS, GIS components (Hardware, Software, Spatial and attributes Database), GIS Implementation, GIS spatial data sources (vector, raster), spatial data processing (conversion, editing, edge matching, data merge).

***CVEE 505 - Internship (1 Cr.)***

This is a professional training which should last for at least four weeks in Civil Engineering fields. The training is followed by a poster session where the students are supposed to present what they have learned.

***CVEE 501 - Harbor Engineering (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

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 rubble 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. Prereq.: CVEE 412.

***CVEE 502 - Senior Project (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Supervised projects in small groups of students aimed at providing practical experience in some aspects of Civil Engineering. This is accomplished through a set of lectures, field visits, and individual design.

***CVEE 503 - Project Management (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Principles of project planning, project identification, time frame, project objectives, project selection techniques, resource planning, activity on arrows, activity on nodes, PERT models, applications, cost control, project funding, equipment cost and depreciation, material management.

***ELCE 202 - Electrical Engineering for Buildings (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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.

***MECH 202 - Mechanical Engineering for Buildings (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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).

***ARCH 231 - Architectural Planning & Construction (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

Classification of structures, building and non - building structures, structural elements and non - structural elements, joints types: Construction, expansion, and settlement, predimensioning and cost estimate of buildings, permanent and temporary shoring systems, optimization of element dimensions, basic architectural requirements: Positioning and orientation of buildings, thermal acoustical and moisture protection, axing, cladding and finishing material.

**Elective Courses*****CVEE 201 - Theory of Structures for Architects (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

Introduction to types of structures, types of loads and supports, stability of structures under applied loads, internal forces or straining actions: Normal forces, shearing forces, and bending moments, calculation of internal forces in simple structures such as cantilevers, simple beams, and overhanging beams, calculation of internal forces in truss members.

***CVEE 202 - Surveying for Architects (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

Introduction to surveying topics and scope, chain surveying verniers and scales, maps plotting, enlargement, reduction and arrangement, compass and compass travers, Theodolite, angle observations, traverse: Adjustment and plotting, closed traverse and open travers, areas: Division of areas, computation areas, and Simons rule, polar planimeter, uses to compute areas of figures, plane - table surveying, leveling and contour maps, volumes: Earth volumes and mass curves, surveying using GPS techniques.

***CVEE 301 - Reinforced Concrete for Architects (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

Basic design of reinforced concrete, types of R.C. structures, methods of design and safety factors, design of R.C. sections subjected to flexure using working stress and ultimate strength methods, columns subjected to axial or combine axial and flexural force, beams subjected to combined action of flexure, as well as shear and axial force, design of one way and two way solid slabs and hollow block slabs, paneled beam, R.C. stairs, R.C. frames, introduction to shells, space framed structures and pre - stressed concrete.

***CVEE 302 - Steel Structure for Architects (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

Introduction to steel structural elements, tension members, compression members, connections, wind bracing, roof trusses, structural space frames, applications on studied topics.

***CVEE 303 - Soil Mechanics & Foundations for Architects (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

Introduction to geotechnical engineering, soil formation and structure, grain size analysis, soil plasticity and classification. Principle of effective stresses. Stress distribution, soil compressibility and theory of consolidation. Failure criteria and shear strength. Shallow foundation: Types, bearing capacity and settlement. Introduction to deep foundations.

***CVEE 511 - Photogrammetry & Geodesy (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 211.

***CVEE 512 - Advanced Surveying (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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.

***CVEE 513 - GPS Surveying (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

GPS different segment, GPS constellation, GPS satellite, the need for GPS positioning, GPS satellite signals, basic concepts of satellite, based positioning. Positioning by Pseudoringing, positioning from carrier phase measurements. Denial of accuracy and access, dilution of precision, mask angle, error sources in GPS, data combination and differences, methods of positioning by GPS: Static, rapid static, reoccupation, stop and go, true Kinematics, differential GPS, RTK GPS. GPS and Photogrammetry.

***CVEE 514 - Advanced Analysis of Structures (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Stability of moment resisting frames and braced frames, imperfect structures, P - delta effect and Euler's load, inelastic analysis and overall response of frames (pushover analysis), frame instability. Stiffness matrix method for analysis of indeterminate beams, and frames. Prereq.: CVEE 312.

***CVEE 515 - Structural Modeling (2 Cr. : 1 Lec : 2 Lab : 0 Tut)***

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...). Prereq.: CVEE 312.

***CVEE 516 - Inelastic Analysis & Dynamics of Structures (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 312.

***CVEE 517 - Earthquake Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 311.

***CVEE 518 - Materials Technology (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Theory of composites: Micro - composite and Macro - composite, engineering applications of fibers, design of composite sections, nonlinear analysis, fracture mechanics: Crack initiation and propagation.

***CVEE 519 - Concrete Technology (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Evaluation of existing structures, field investigation, special types of concrete; (Light and heavy weight concrete, fibers reinforced concrete, precast concrete, self compacted concrete, green concrete...), analysis of fresh concrete, analysis of hard concrete, formwork design and applications. Prereq.: CVEE 320.

***CVEE 520 - Advanced Mechanics of Materials (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

State of stress at a point, principle planes and principle stresses, stress tensor, equation of equilibrium, strain analysis, mohr circle, transverse loading, transformation of stresses and strains, strain rosette, shear stresses, shear flow and shear center, impact loading. Fatigue of Metals. Prereq.: EMPH 301.

***CVEE 521 - Steel Bridges (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Types of steel bridges, standard specifications and loadings of highway and railway bridges, bracing systems, design of slab - beam, highway bridge, design of composite I Girders: Simply supported and continuous, design of flooring systems in railway bridges, design of welded plate girders, design of splices, design of roller and hinged bearings, detailing, design of truss bridges. Prereq.: CVEE 413.

***CVEE 522 - Reinforced Concrete Bridges (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction, types of bridges, and loads, slab type hollow - type bridges, box - type bridges, girder type bridges, bearing pads, code requirements, detailing applications. Prereq.: CVEE 418.

***CVEE 523 - Advanced Reinforced Concrete (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Design of R.C. walls: Walls designed as compression members, empirical design method, alternate design of slender walls, shear walls, pre - cast concrete: Distribution of forces among members, member design, structural integrity, connection and bearing design, strength evaluation of existing structures, reinforced concrete arches. Prereq.: CVEE 418.

***CVEE 524 - Tall Building Structure (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction, types of structural resisting systems, structural walls, cantilever columns, rigid frames, dual systems, code requirements, detailing. Prereq.: CVEE 418.

***CVEE 525 - Pre - Stressed Concrete Structure (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 418.

***CVEE 526 - Design with Geosynthetics (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 317.

***CVEE 527 - Retaining Structures (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 412.

***CVEE 528 - Soil & Site Improvement (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 317.

***CVEE 529 - Feasibility Study & Marketing (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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.

***CVEE 530 - Railway Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Train dynamics (tractive effort, train resistances, ruling gradient, acceleration and deceleration, braking and stopping distances), design of railway track (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).

***CVEE 531 - Urban Railways (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Railway systems in cities (tram, Light Rail Transit LRT, underground, urban metro, suburban rapid rail system), planning requirements for different city railway systems (cross section, track alignment, speed, gradient, super - elevation, stations, signaling and control systems), integration and rationalization of city transport systems, examples for modern railway systems in cities.

***CVEE 532 - Advanced Transportation Planning (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Principles of freight transport and logistics, freight transport systems, road facilities, railway terminals, seaports terminals, container terminals, storage areas, handling equipment, airports terminals, Inland waterways (navigation corridors, storage, wharves, terminals, handling facilities). Multimode transportation. Prereq.: CVEE 213.

***CVEE 533 - Advanced Traffic Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Principles of traffic engineering, driver behavior and information processing, traffic control devices, traffic studies, uninterrupted traffic characteristics, capacity and level of service of uninterrupted facilities, interrupted traffic flow characteristics, intersection control warrants and design issues, traffic characteristics at unsignalized intersections, signal timing and delay, capacity and LOS of signalized intersections, actuated signal control and progression, arterial travel times and LOS. Traffic safety, practical safety work, Intelligent Traffic Systems ITS. Prereq.: CVEE 213.

***CVEE 534 - Advanced Highway Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 414.

***CVEE 535 - Airports Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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). Prereq.: CVEE 414.

***CVEE 536 - Coastal Engineering & Shore Protection (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Waves and currents movements, stability of shore line, erosion and sedimentation in unstable shore line, movement of sediments particles, shore protection structures, groins, retaining walls and blocks, submerged, floating and detached parallel breakwaters, modifying wave properties by changing geological bed properties and slopes, revetments of shore line, theoretical and empirical equations representing sediments movements in marine structure zones, sand nourishment. Prereq.: CVEE 501.

***CVEE 537 - Irrigation & Drainage Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 318.

***CVEE 538 - Hydraulic Structures (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 317, CVEE 318.

***CVEE 539 - Hydraulic & Hydrologic Modeling (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 417.

***CVEE 540 - Hydrology & Floodplain Hydraulics (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Fundamentals of surface - water hydrology, flow in open channels, and flood hazard mitigation. Rainfall - runoff relations. Unit hydrograph method, uniform and non - uniform flow in open channels, measurement and control of river flow. Flood waves in rivers, floodplains, and reservoirs. Design of storage basins, storm channels, and culverts, Lecture, laboratory and computation.

***CVEE 541 - Introduction to Ground Water Hydrology (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Basic principles which govern the flow of water in the subsurface. Development and solution of groundwater flow and contaminant transport equations, in presence and absence of pumping wells, for both confined and phreatic aquifers, measurement and estimation of parameters governing flow and transport, including methods such as pump tests and moment analysis. Remediation of contaminated groundwater.

***CVEE 542 - Water & Wastewater Treatment (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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. Prereq.: CVEE 415.

***CVEE 543 - Water & Wastewater Network (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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 and security of maintenance of collection works, pumping wastewater to treatment and recycle locations. Prereq.: CVEE 415.

***CVEE 544 - Environmental Soil Physics (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Principles of soil physics with emphasis on environmental problems. Topics include characteristics of solid, liquid and gaseous components of soil; Capillarity, air entrapment and the static distribution of water in the unsaturated zone; Infiltration, exfiltration and theredistribution of water. Extension of principles to movement of organic liquids in subsurface.

***CVEE 545 - Environmental Soil Chemistry (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction to the principles of soil chemistry. Topics include chemical composition of soils, chemical structure of minerals and soil organic matter, soil colloidal phenomena, sorption, ion - exchange, surface complexation theory, reactivity of soil constituents with inorganic and organic environmental contaminants. Emphasis on the relationship between chemical structure and reactivity.

***CVEE 546 - Environmental Process Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

An introduction to the analysis, characterization, and modeling of environmental processes; 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.

***CVEE 547 - Design of Environmental Engineering Systems (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Design and theoretical understanding of environmental processes; Biological, physical, and chemical processes, and reactor configurations commonly used for water quality control; Applications to the design of specific water and wastewater treatment operations; Discussion of pollution prevention and green engineering options.

***CVEE 548 - Environmental Systems & Processes (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Concepts of environmental systems and principles of related transport and transformation phenomena and processes; Development of fundamental models for articulation of relevant process dynamics; System and process scaling factors and methods; Extension of process models to ideal and nonideal natural and engineered homogeneous environmental systems.

## Department of Mechanical Engineering

### Bachelor of Mechanical Engineering (150 Cr. Hr.)

#### Curricula

#### First Semester Cr.

<b>HUME</b>	101	Introduction to Engineering	2
<b>COMP</b>	111	Computer Programming I	2
<b>EMPH</b>	111	Engineering Mathematics I	3
<b>EMPH</b>	121	Engineering Mechanics I	3
<b>EMPH</b>	131	Engineering Physics I	3
<b>EMPH</b>	141	Engineering Drawing & Projection I	3
			16

**Second Semester****Cr.**

<b>MECH</b>	102	Fundamentals of Mechanical Engineering	3
<b>EMPH</b>	112	Engineering Mathematics II	3
<b>EMPH</b>	122	Engineering Mechanics II	3
<b>EMPH</b>	132	Physics II	3
<b>EMPH</b>	142	Engineering Drawing & Projection II	3
<b>IEEM</b>	112	Production Engineering	2
			17

**Third Semester****Cr.**

<b>HUME</b>	201	Technical Writing	1
<b>MECH</b>	211	Mechanical Engineering Drawing	2
<b>MECH</b>	213	Mechanics of Machinery I	3
<b>EMPH</b>	211	Differential Equations	2
<b>EMPH</b>	207	Chemistry	2
<b>IEEM</b>	213	Technology & Shaping of Metals	2
		Elective (General) <sup>1</sup>	2
			14

**Fourth Semester****Cr.**

<b>MECH</b>	212	Computer Aided Mechanical Drawing	2
<b>MECH</b>	214	Mechanics of Materials	3
<b>MECH</b>	216	Mechanics of Machinery II	3
<b>ELCE</b>	112	Electric & Electronic Circuits	3
<b>EMPH</b>	212	Applied Engineering Mathematics II	2
<b>COMP</b>	102	Elementary Data Structures	2
		Elective (General) <sup>1</sup>	1
			16

**Fifth Semester****Cr.**

<b>MECH</b>	311	Mechanical Design	3
<b>MECH</b>	313	Mechanical Vibrations	3
<b>MECH</b>	321	Thermodynamics I	3
<b>MECH</b>	331	Fluid Mechanics I	3
<b>PORE</b>	343	Conventional Electric Machines	2
		Elective (General) <sup>1</sup>	2
			16

Sixth Semester			Cr.
MECH	312	Design of Power Transmission Systems	3
MECH	322	Thermodynamics II	3
MECH	332	Fluid Mechanics II	3
MECH	342	Fundamentals of Combustion Engineering	3
PORE	346	Special Electric Machines & Power Electronics	2
		Elective (General) <sup>1</sup>	1
			15

Seventh Semester			Cr.
MECH	401	Mechanical Sensors & Measurements	3
MECH	403	Mechanical Engineering Laboratories	1
MECH	405	Pollution - Control Engineering	2
MECH	421	Heat Transfer	3
MECH	441	Internal Combustion Engines	3
		Elective (General) <sup>1</sup>	3
			15

**Eighth Semester****Cr.**

<b>MECH</b>	412	Dynamic Systems & Feedback I	3
<b>MECH</b>	414	Fundamentals of Mechatronics	3
<b>MECH</b>	422	Refrigeration & Air Conditioning	3
<b>MECH</b>	432	Hydraulic Machinery & Stations	3
<b>MECH</b>	442	Gas Dynamics	3
		Elective (General) <sup>1</sup>	2
			17

**Ninth Semester****Cr.**

<b>MECH</b>	521	Thermal Power Stations	3
<b>MECH</b>	5xx	Elective (Technical) <sup>2</sup>	2
<b>MECH</b>	5xx	Elective (Technical) <sup>2</sup>	2
<b>HUME</b>	105	Engineering Management	2
<b>HUME</b>	103	Engineering Ethics	1
		Elective (General) <sup>1</sup>	2
			12

Tenth Semester			Cr.
MECH	502	Senior Project	6
MECH	5xx	Elective (Technical) <sup>2</sup>	2
MECH	504	Internship	1
		Elective (General) <sup>1</sup>	3
			12

<sup>1</sup> A total of 16 credits is required as General University Requirements; 5 credits are selected from the University Mandatory courses list including: ARAB 001 (2 Cr.), ENGL 001 (2 Cr.), BLAW 001 (1 Cr.) and another 11 credits are selected from the University Elective courses list.

<sup>2</sup> Students have the option of selecting any 6 Credits out of the following list. Course availability and offering is subject to University approval: MECH 512, 513, 514, 516, 522, 523, 524, 525, 526, 531, 532, 533, 541, 542.

## Mandatory Courses

### *HUME 101 - Introduction to Engineering (2 Cr. : 2 Lec : 0 Lab : 0 Tut)*

Early technology: Stone age, Copper and Bronze age, Iron age, ancient civilizations, Medieval and Modern technologies: Renaissance, age of exploration, Industrial Revolution, 19th century, 20th century, 21st century - History of Engineering: Pre - industrial revolution Era (up to early 1800s), from 1800 till today (by specialization alphabetically): Aerospace, chemical, civil, communication, computing, electrical, electromechanical, electronics, energy, environmental, genetic, industrial, manufacturing, marine, materials science, measurement, nuclear, software, sanitary, structural, system, transportation - major technological and engineering achievements.

### *HUME 201 - Technical Writing (1 Cr. : 1 Lec : 0 Lab : 0 Tut)*

Technical terms and abbreviations. Formats and methods of writing: Reports, bids, CV, correspondence, formal research proposal, progress report, feasibility study, technical report, fact sheet etc...

### *HUME 103 - Engineering Ethics (1 Cr. : 1 Lec : 0 Lab : 0 Tut)*

Personal versus engineering ethics, origin of ethical thought, ethics and the law, introduction of professional codes of ethics, brief history of ethical thought, ethical theories, tools of ethical problem solving, safety and risk, industrial and other accidents, professional responsibility, professional rights, ethics as applied to research and experimentation, and specific codes of ethics of engineering societies.

### *HUME 105 - Engineering Management (2 Cr. : 2 Lec : 0 Lab : 0 Tut)*

Engineer versus manager, basic business function and management tools (planning, organizing, staffing, directing, motivating, leading and controlling), management objectives, introduction to facilities design, introduction to project management, introduction to production and operation management, and introduction to industrial financial, introduction to environmental and safety engineering. (This course is not offered to Industrial Engineering and management students).

### *EMPH 111 - Engineering Mathematics I (3 Cr. : 3 Lec : 0 Lab : 1 Tut)*

Partial fractions; Binomial theorem; Roots of polynomial equations; Convergence of series; Matrices: Determinants, rank, Eigen values, eigenvectors, block decomposition, solution of linear system of equations; Introduction to complex analysis; Transfer of axes; Conic sections.

### *EMPH 121 - Engineering Mechanics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)*

Force vectors (analytical and graphical methods), equilibrium of a particle, force system resultants (moment of force, couple system); Equilibrium of a rigid body (equilibrium in two - dimensions, equation of equilibrium, free body diagrams); Structure analysis and its applications in truces, frames, mechanisms and simple mechanics); Cable static analysis; Dry friction, slipping, tipping, applications on real systems, experimental application on: Force analysis, friction effect, equilibrium of rigid body.

***EMPH 131 - Engineering Physics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Electrostatics: Coulomb's law, electric dipole, electric field of a continuous charge distribution, Gauss law, electric potential from point and distributed charges, relation between electric field and electric potential, capacitors and dielectrics, series and parallel connections of capacitors, energy stored in capacitors; Electric current: Model for electrical conduction and material resistivity, Kirchhoff's laws; Magnetism: Magnetic forces, magnetic dipole, magnetic flux and Gauss law in magnetism, sources of magnetic fields, Ampere's Law, Biot and Savart law, magnetism of matter; Geometric optics: Images formed by reflection, refraction from spherical surfaces, thin lenses, lens aberrations and defects of images.

***EMPH 141 - Engineering Drawing & Projection (3 Cr. : 2 Lec : 0 Lab : 3 Tut)***

Drawing instruments and their use; Developing drafting skills; Dimensioning; Geometric construction; Conic sections; Special curves: involutes, cycloid, spiral of Archimedes, helix; Theory of shape: Representing objects by views and applications in machines drawing; Pictorial drawing: Isometric and oblique; Electrical drafting. AutoCad: 2D drawings using the computer software AutoCAD; Projects.

***EMPH 112 - Engineering Mathematics II (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Hyperbolic functions, implicit and logarithmic differentiation, derivatives of higher order, Leibniz theorem, mean value theorem, partial differentiation and applications, curvature, Taylor expansion, methods of integration, improper integrals, multiple integrals.

***EMPH 122 - Engineering Mechanics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Introduction to vector analysis, hints about the ordinary differential equations of the second order kinematics of the particle in one dimension (rectilinear motion of a particle), two - dimensional kinematical analysis of a particle motion using the cartesian and intrinsic coordinates, engineering applications, kinetics of the particle), two - basic concepts: Newton's Law (force & acceleration), position integration of Newton's law (works & energy), time integration of Newton's Law (impulse & linear momentum). Engineering applications: One dimensional motion in a conservative or dissipative force field, ideal constraints, direct and inclined impact of a particle on a smooth plane, oscillations of a particles, engineering applications.

***EMPH 132 - Engineering Physics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Properties of materials: Units, dimensions, circular motion of rigid bodies, moment of inertia, elasticity of materials, stresses and strains, pressure measurements, surface tension, 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, heat measurements, heat transfer by conduction, heat convection, heat radiation, introduction to thermodynamics, first law of thermodynamics, thermodynamic processes for an ideal gas.

***EMPH 142 - Engineering Drawing & Projection II (3 Cr. : 2 Lec : 0 Lab : 3 Tut)***

Engineering drawing & projection sectional views, intersection of surfaces, structural drawing which includes projection of steel structures and, Monger's descriptive geometry (representation of points, lines and planes), representation of surface (sphere, cone and cylinder) and intersection of surfaces and their development, indexed projection, (representation of points, lines, and planes, and the intersection line of two planes), applications of indexed projection (topographic surfaces and problems of cutting and filling). Prereq.: EMPH 141.

***EMPH 207 - Chemistry (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction to basic concepts of chemistry, chemical reactions and calculations; Physical states of matter: Gases, liquids and solids; Solutions; Chemical equilibrium, ionic equilibrium; Manufacture and hydration reactions of cements; Practical: Applied experiments related to the above topics.

***EMPH 211 - Differential Equations for Engineers (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Differential equations: First order differential equations; Second order differential equations with constant and variable coefficients, simultaneous system of differential equations, series solution; Fourier series: Periodic function, expansion, half period and harmonics; Introduction to partial differential equations. Prereq.: EMPH 111 & EMPH 112.

***IEEM 112 - Production Engineering (2 Cr. : 2 Lec : 1 Lab)***

Introduction to production and manufacturing engineering, introduction to material and material properties, iron and steel, metrology, bench work, machining (turning, milling, shaping and planing, drilling, etc.), forging and forming of metals, metal casting (sand casting and permanent mold casting), and cost analysis.

***IEEM 213 - Technology & Shaping of Metals (2 Cr. : 2 Lec : 1 Lab)***

Introduction to manufacturing engineering, micro structure of materials, ferrous materials, non-ferrous materials, polymers and composites, casting and molding, forming processes, material removing processes, conditioning processes, assembling and joining processes including welding technology, Finishing processes, introduction to advanced manufacturing systems (CAD / XCAM - NC - CNC - FMS - CIMS). Prereq.: IEEM 112. (Not offered for Industrial Engineering and Management students).

***ELCE 112 - Fundamentals of Electric Circuits (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

DC circuit analysis: Reduction methods, mesh current and node voltage analysis methods, transformation methods, DC network theorems, capacitors and inductors, phasors and AC steady state circuit analysis, series and parallel resonance, power in AC circuits, fourier series technique applied to circuit analysis, balanced three-phase circuits. Prereq.: EMPH 131.

***EMPH 212 - Applied Engineering Mathematics II (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Vector analysis: Vector calculus, vector differentiation; Complex analysis: Function of complex variables, analytic function and Cauchy - Riemann equations; Laplace transforms: Definition and theorems, transform of derivatives, transform of integral, unit step function and shifting theorems, convolution theorem, inverse laplace transform, applications. Prereq: EMPH 111, EMPH 112.

***COMP 101 - Computer Programming I (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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.

***COMP 102 - Elementary Data Structure (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Functions / procedures, call by value / reference, recursion, pointers, user defined data types: Structures and unions, elementary data structures: Stacks, queues and linked lists. Prereq.: COMP 111.

***MECH 102 - Fundamentals of Mechanical Engineering (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Definition of Mechanical Engineering; Historical background; Scope of applications in real life; Energy conservation; System types; Simple processes and cycles; Principles of power systems; Air conditioning; Automotive engineering; Transmission of mechanical power; Simple mechanisms (4 - bar, slider - crank, etc); Machine parts, materials and stresses.

***MECH 211 - Mechanical Engineering Drawing (2 Cr. : 1 Lec : 0 Lab : 3 Tut)***

Projection and assembly of mechanical elements, mechanical parts, fasteners, springs, gears, valves, welding symbols, machining symbols, fits and tolerances. Prereq.: EMPH 142.

***MECH 212 - Computer - Aided Mechanical Drawing (2 Cr. : 1 Lec : 3 Lab : 0 Tut)***

Detailed and assembly drawing using professional computer softwares, 3D modeling, geometrical analysis, creating managing machine element libraries. Prereq.: MECH 211.

***MECH 213 - Mechanics of Machinery I (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Kinematics of rigid bodies, moments of inertia, Kinetics of rigid bodies, work and energy principles, joints, degrees of freedom, Kinematic chains, velocity and acceleration analysis of mechanisms, static force analysis, dynamic force analysis. Prereq.: EMPH 122.

***MECH 214 - Mechanics of Materials (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Engineering materials, mechanics of polymers and composite materials, basics of mechanical design, design considerations, factor of safety, theories of failure, design for static strength, design for fatigue strength, deflection and rigidity considerations, statically indeterminate members, curved members, column design, pressure vessels. Prereq.: EMPH 132.

***MECH 216 - Mechanics of Machinery II (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Flywheel, specified - motion cams, specified - contour cams, minimum cam size, cam dynamics, gear geometry, gear train, balancing of rotating masses, balancing of reciprocating masses. Prereq.: MECH 213.

***MECH 311 - Mechanical Design (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Design of shafts and couplings, threaded joints, riveted, welded and adhesive joints, power screws, mechanical springs, clutches and brakes, wire ropes. Prereq.: MECH 211, MECH 214.

***MECH 312 - Design of Power Transmission Systems (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Gear drives, belt drives, chain drives, sliding (journal) bearings, anti - friction (rolling element) bearings. Prereq.: MECH 211, MECH 214.

***MECH 313 - Mechanical Vibrations (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Single and multiple degrees of freedom systems, free and forced vibrations, machine insulation, critical speeds, dynamic absorbers, vibration measurements, torsional vibrations, continuous systems. Prereq.: EMPH 122.

***MECH 321 - Thermodynamics I (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Energy equation, second law of thermodynamics, entropy, efficiency, perfect gases, air standard cycles, compressors, steam generation and processes, Carnot and Rankin cycles, real gases. Prereq.: EMPH 132.

***MECH 322 - Thermodynamics II (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Availability and irreversibility, steam and gas turbine cycles, impulse and reaction turbines, flow of steam through nozzles. Prereq.: MECH 321.

***MECH 331 - Fluid Mechanics I (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Forces on immersed surfaces, buoyancy, kinematics of three - dimensional fluid motions, fluid masses moving with acceleration, vortex motion, hydrodynamics, momentum equation, Euler's and Bernoulli's equations, fluid flow in pipelines, PI - theorem. Prereq.: EMPH 132.

***MECH 332 - Fluid Mechanics II (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Unsteady flow through pipes, networks of pipes, dynamics of compressible and incompressible flow, continuity equation, Navier, Stokes equations, boundary layers, lift and drag, fluid film lubrication, turbulent flow, two - phase flow. Prereq.: MECH 331.

***MECH 342 - Fundamentals of Combustion Engineering (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Engine types, combustion systems, fuel systems, ignition systems in reciprocating and rotary engines, fuel properties and ignition quality, types of combustion chambers in reciprocating & rotary engines, combustion thermodynamics, chemical kinetics, flame theories, flammability limits. Prereq.: MECH 321.

***MECH 401 - Mechanical Sensors & Measurements (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Thermocouples, platinum resistance wires, thermistors, Eddy current measurements, ultrasound techniques, laser techniques, fluid flow measurements, viscosity measurements, displacement, velocity, and acceleration measurements, force and pressure measurements, piezo - electric transducers, data - acquisition systems, calibration, error analysis. Prereq.: EMPH 132.

***MECH 403 - Mechanical Engineering Laboratories (1 Cr. : 0 Lec : 2 Lab : 0 Tut)***

Students shall conduct experiments that cover various subfields of Mechanical Engineering. Each student shall submit technical reports on these experiments and their results. Prereq.: EMPH 132.

***MECH 405 - Pollution - Control Engineering (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

The air pollution problem, characteristics of air pollutants, standards, sources, clean air act, atmospheric diffusion models, ambient air quality and emissions monitoring, control of gaseous pollutants, particulate control, cyclone, scrubbers, bag houses, electrostatic precipitators, control of water pollution, control of noise pollution, waste

management, nuclear waste, greenhouse effect and global warming. Prereq.: MECH 321.

***MECH 412 - Dynamic Systems & Feedback I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Mechanical system modeling, open and closed loops, analysis of transient and steady state response to standard inputs, frequency response, root locus, basic control actions, electric, hydraulic and pneumatic controllers, compensation techniques, fluidic logic circuits. Prereq.: EMPH 212.

***MECH 414 - Fundamentals of Mechatronics (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Mechatronics as interdisciplinary system, sensors for displacement, velocity, acceleration, force, temperature flow, level, pressure and tactile, DC and stepper actuators, hydraulic and pneumatic motors, signal processing of analog and digital signals, introduction to digital electronics, A / D and D / A converters, computer interface. Prereq.: ELCE 112.

***MECH 421 - Heat Transfer (3 Cr. : 3 Lec : 1 Lab : 1 Tut)***

Steady state conduction, steady state conduction with heat generation, fins, unsteady state conduction, forced convection, free convection, tube banks, boiling and condensation, heat exchangers, radiation properties of surfaces, radiation shape factors, radiation exchange in enclosures. Prereq.: MECH 321.

***MECH 422 - Refrigeration & Air Conditioning (3 Cr. : 3 Lec ; 1 Lab : 0 Tut)***

Refrigeration methods: Air refrigeration, steam jet, thermoelectric, absorption, vapor compression system, metering devices, compressors, evaporators, condensers, cooling towers, refrigeration cycles, cold stores, psychrometry and human comfort, psychrometric processes and cycles, cooling and heating loads, duct design, air conditioning systems, noise criteria. Prereq.: MECH 421.

***MECH 432 - Hydraulic Machinery & Stations (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Water turbines, pelton wheel, Francis, propeller and Kaplan turbines, construction, design factors, discharge regulation and part load performance, model testing, cavitations and turbine selection, hydropower plants, types, capacity, number of units, pump storage projects, hydro - power plants in Lebanon. Prereq.: MECH 331.

***MECH 441 - Internal Combustion Engines (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Advanced injection systems in both spark - ignited and compression - ignited engines, pressure and flow rate calculations in injection systems, fuel - air cycles and combustion charts, chemical equilibrium and dissociation, emission control, energy balance of engines, testing and performance maps. Prereq.: MECH 342.

***MECH 442 - Gas Dynamics (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

One - dimensional steady motion with area change, flow in ducts with friction, flow with heating and cooling, normal shock and oblique waves, applications and analysis in aero jet engines and components. Prereq.: MECH 321.

***MECH 502 - Senior Project (6 Cr. : 6 Lec : 0 Lab : 0 Tut)***

Supervised projects in small groups of students are aimed at providing practical experience in the areas of Mechanical Engineering. Students should apply engineering principles as well as design considerations. Each group should submit

a written report of the project and make a presentation of the work done. Prereq.: Senior standing.

***MECH 504 - Internship (1 Cr. : 1 Lec : 0 Lab : 0 Tut)***

Students shall present, in public, the experience which they have acquired through industrial training. Prereq.: Senior standing.

***MECH 521 - Thermal Power Stations (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Power plant types and specifications, boilers (components - types - heating surface area), turbines, condensers, evaporators, cooling towers, combined cycles, state of the art in power plant technology, solar power stations. Prereq.: MECH 322 or MECH 421.

**500 - Level Electives**

***MECH 512 - Computer Aided Design & Finite Elements (2 Cr. : 2 Lec : 1 Lab : 1 Tut)***

Geometric and solid modeling, computer applications in mechanics of machinery, machine design and optimization using different software's, finite - element analysis of stresses and deflection in mechanical systems, integrating modeling techniques with 2D and 3D - CAD systems. Prereq.: MECH 213, MECH 311.

***MECH 513 - Robotics (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Components and subsystems of robots, homogeneous transformation, forward kinematics, inverse kinematics, trajectory planning, sensors, measurements, and perception; Actuators. Prereq: Senior standing.

***MECH 514 - Mechatronic Systems (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Discrete state control, I / O modules, microcontrollers, families and architectures, programming, interface with real world, design concepts of mechatronic systems, case studies (Robots, CNC machines, furnaces, automotive, hydraulic systems), experimental implementation of microcontrollers. Prereq.: MECH 414.

***MECH 516 - Dynamic Systems & Feedback II (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Control theory, properties of transient and steady - state response, stability of linear feedback systems, controller design, system performance using MATLAB, modern control analysis. Prereq.: MECH 412.

***MECH 522 - Operation & Management of Thermal Power Stations (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Variable load problem, operation and troubleshooting of boilers, operation and trouble shooting of turbines, maintenance and preventive maintenance. Prereq.: MECH 521.

***MECH 523 - Renewable Energy (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Solar physics, flat plate collectors, solar water systems, air heaters, swimming pool heating, solar concentrators, economics of solar heating. Wind energy. Energy from ocean. Tidal waves. Geothermal energy. Fuel cells. Bio - energy. Prereq.: MECH 321.

***MECH 524 - Energy Management (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Energy consumption, conservation, and resources. Energy audits. Economic analysis. Monitoring and targeting energy consumption of fossil fuels. Analysis of thermofluid systems. Energy conservation in combustion systems. Energy conservation in steam and condensate systems and heat exchangers. Heat recovery and insulation. Energy conservation in industrial systems. Industrial cogeneration. Prereq.: MECH 421.

***MECH 525 - Refrigeration & HVAC Applications (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Cold stores, refrigerators, cryogenic applications, pipe sizing, desiccant system, chilled and hot water systems, chillers, expansion tanks, air handling units, noise control in HVAC systems, computer software. Prereq.: MECH 422.

***MECH 526 - Design of Thermal Equipment (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Shell and tube exchangers types and classifications, TEMA code for heat exchangers, plate type heat exchangers, spiral type heat exchangers, direct contact heat exchangers, inspection and testing of heat exchangers, modeling of thermal systems, computer programs and software. Prereq.: MECH 421.

***MECH 531 - Pipe - Line Engineering (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Pipes in parallel and series, pipe networks, single - and two - phase flow for incompressible flow in pipelines, capsule pipelines, pipes, fittings, valves, accessories, standards, pipeline installation, operation, monitoring and maintenance. Prereq.: MECH 332.

***MECH 532 - Hydraulic Circuits (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Design of basic circuits, elements of hydraulic circuits and design factors, oil pumps as sources of hydraulic power, fluid power actuators, motors, performance of basic hydraulic circuits and applications on practical circuits. Prereq.: MECH 331.

***MECH 533 - Aerodynamics (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Drag and lift, supersonic wave drag, types of trailing - and leading - edge devices, subsonic aerodynamics of airfoils and wings, transonic and supersonic aerodynamics of airfoils and wings. Prereq.: MECH 332.

***MECH 541 - Gas Turbines (2 Cr. : 2 Lec : 0 Lab : 0 Tut)***

Basic types of axial & radial turbines & compressors, fuel systems, combustion chambers, design considerations & effects on performance parameters of turbines, emission control in gas turbines. Prereq.: MECH 442.

***MECH 542 - Automotive Engineering (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Advanced studies of automotive components, modules & systems (engines - fuel systems - ignition systems - cooling - lubrication - power boosting - transmission - steering - braking - suspension & damping - starting & recharging - emission control), updating of automotive technology. (Offered only for mechanical students and power students who have completed 92 Crs.).

## MECH Courses Offered to Non - Mechanical Engineering Students

### ***MECH 202 - Mechanical Engineering for Buildings (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Water supply for buildings; Pumping systems; Heat losses and thermal insulation; Ventilation and air conditioning; Sound insulation; Elevators and escalators; Waste systems; Sump pumps. (Offered for Civil Students).

### ***MECH 301 - HVAC & Sanitation for Architects (2 Cr. : 1 Lec : 3 Lab : 0 Tut)***

Course addressing two technical fields: 1 - 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. 2 - Sanitation: Sanitary engineering issues, building site selection, 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, biological purification of sewerage, solid waste and refuse disposal. (Offered for architect students).

### ***MECH 407 - Fundamentals of Thermofluids (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Properties of fluids; Hydrostatics (pressure in a fluid at rest - forces on immersed surfaces - buoyancy); Thermodynamic definitions; Temperature scales; Flow Kinematics (velocity field - acceleration - flowlines - flow classification); Mass conservation and continuity equation; First law of Thermodynamics; Ideal gases; Applications of closed and open systems; Bernoulli's equation; Laminar and turbulent flows; Friction and energy losses for a flow; Flow in pipes; Second law of Thermodynamics and entropy; Change of phase and Mollier's chart; Steam tables; Steam processes; Psychrometry and Air - Conditioning processes; Principles of AC calculations; Modes of heat transfer; Simple heat exchangers; Cooling of electronic devices. Prereq.: EMPH 132. (Offered for Power Engineering and Machines students).

### ***MECH 408 - Mechanical Power Generation (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Hydraulic power plants: Pelton wheel; Francis Propeller; Kaplan turbines; Centrifugal pumps (theory and principles of operation); Performance curves; Parallel and series operation; Positive displacement pumps; Fire pumps; Hydro - Electric projects in Lebanon.

Thermal power plants: Steam generators; Steam and gas turbines; Combined cycles; Plant management and economics. Wind turbines: Theory and principles of operation; Emphasis on blade design and pitch angle.

Solar energy: Solar physics; Flat - plate collectors; Water systems; Air heaters; Swimming - pool heating, solar concentrators, economics of solar heating. Prereq.: MECH 407. (Offered for Power Engineering and Machines students).

## Department of Industrial & Engineering Management

### Bachelor of Industrial Engineering & Management (150 Cr. Hr.)

#### Curricula

First Semester			Cr.
COMP	111	Computer Programming I	2
EMPH	111	Mathematics I	3
EMPH	121	Mechanics I	3
EMPH	131	Physics I	3
EMPH	141	Engineering Drawing & Projection I	3
HUME	101	Introduction to Engineering	2
			16

Second Semester			Cr.
IEEM	112	Production Engineering	2
HUME	105	Engineering Management	2
EMPH	112	Mathematics II	3
EMPH	122	Mechanics II	3
EMPH	132	Physics II	3
EMPH	142	Engineering Drawing & projection II	3
			16

### Third Semester Cr.

<b>EMPH</b>	211	Differential Equations for Engineers	2
<b>HUME</b>	201	Technical Writing	1
<b>EMPH</b>	207	Chemistry	2
<b>IEEM</b>	201	Engineering Materials & Technology	3
<b>IEEM</b>	211	Metal Shaping	3
<b>IEEM</b>	221	Industrial Economy	3
		Elective (General) <sup>1</sup>	1
			15

### Fourth Semester Cr.

<b>EMPH</b>	216	Probability & Statistics for Industrial Engineers	3
<b>IEEM</b>	202	Manufacturing Processes	3
<b>IEEM</b>	212	Operation Research I	3
<b>IEEM</b>	222	Engineering Design I	3
		Elective (General) <sup>1</sup>	2
		Elective (General) <sup>1</sup>	1
			15

### Fifth Semester Cr.

<b>IEEM</b>	301	Production & Operation Management	3
<b>IEEM</b>	311	Engineering design II	3
<b>IEEM</b>	321	Facility Planning & Design	3
<b>IEEM</b>	341	Environment Systems & Engineering Safety	3
		Elective (General) <sup>1</sup>	2
		Elective (General) <sup>1</sup>	2
			16

### Sixth Semester Cr.

<b>EMPH</b>	314	Numerical Analysis & Techniques for Industrial Engineers	3
<b>IEEM</b>	312	Maintenance Planning Techniques	3
<b>IEEM</b>	322	Management Information Systems	3
<b>IEEM</b>	332	Operations Research II	3
		Elective (Technical) <sup>2</sup>	3
			15

**Seventh Semester****Cr.**

<b>IEEM</b>	401	System Modeling & Simulation	3
<b>IEEM</b>	411	Computer Aided Design & Manufacturing	3
<b>IEEM</b>	421	Reliability	3
<b>IEEM</b>	431	Project Planning & Management	3
		Elective (Technical) <sup>3</sup>	3
			15

**Eighth Semester****Cr.**

<b>IEEM</b>	412	Failure Analysis	3
<b>IEEM</b>	422	Engineering Logistics & Supply Chain	3
<b>IEEM</b>	432	Statistical Quality & Process Control	3
<b>IEEM</b>	442	Ergonomics	2
<b>HUME</b>	103	Engineering Ethics	1
		Elective (General) <sup>1</sup>	2
		Elective (General) <sup>1</sup>	2
			16

Ninth Semester			Cr.
IEEM	500	Internship	1
IEEM	511	Production Systems & Automations	3
IEEM	521	Total Quality Management & Six Sigma	3
		Elective (Technical) <sup>3</sup>	3
		Elective (Technical) <sup>3</sup>	3
			13
Tenth Semester			Cr.
IEEM	502	Senior Project	6
		Elective (Technical) <sup>4</sup>	3
		Elective (General) <sup>1</sup>	2
		Elective (General) <sup>1</sup>	2
			13

<sup>1</sup> A total of 16 credits is required as General University Requirements; 5 credits are selected from the University Mandatory courses list including: ARAB 001 (2 Cr.), ENGL 001 (2 Cr.), BLAW 001 (1 Cr.) and another 11 credits are selected from the University Elective courses list.

<sup>2</sup> Selected from the following courses: IEEM 314 or IEEM 324.

<sup>3</sup> Selected from the following courses: IEEM 433 or IEEM 413.

<sup>4</sup> Selected from the following courses: IEEM 503 or IEEM 513 or IEEM 523.

<sup>5</sup> Selected from the following courses: IEEM 504 or IEEM 514, IEEM 524.

## Mandatory Courses

### *HUME 101 - Introduction to Engineering (2 Cr. : 2 Lec : 0 Lab : 0 Tut)*

Early technology: Stone age, Copper and Bronze age, Iron age, ancient civilizations, Medieval and Modern technologies: Renaissance, age of exploration, Industrial Revolution, 19th century, 20th century, 21st century - History of Engineering: Pre - Industrial Revolution Era (up to early 1800s), from 1800 till today (by specialization alphabetically): Aerospace, chemical, civil, communication, computing, electrical, electromechanical, electronics, energy, environmental, genetic, industrial, manufacturing, marine, materials science, measurement, nuclear, software, sanitary, structural, system, transportation - major technological and engineering achievements.

### *HUME 103 - Engineering Ethics (1 Cr. : 1 Lec : 0 Lab : 0 Tut)*

Personal versus engineering ethics, origin of ethical thought, ethics and the law, introduction of professional codes of ethics, brief history of ethical thought, ethical theories, tools of ethical problem solving, safety and risk, industrial and other accidents, professional responsibility, professional rights, ethics as applied to research and experimentation, and specific codes of ethics of engineering societies.

### *HUME 105 - Engineering Management (2 Cr. : 2 Lec : 0 Lab : 0 Tut)*

Engineer versus manager, basic business function and management tools (planning, organizing, staffing, directing, motivating, leading and controlling), management objectives, introduction to facilities design, introduction to project management, introduction to production and operation management, and introduction to industrial financial, introduction to environmental and safety engineering. (This course is not offered to Industrial Engineering and Management students).

### *HUME 201 - Technical Writing (1 Cr. : 1 Lec : 0 Lab : 0 Tut)*

Technical terms and abbreviations. Formats and methods of writing: Reports, bids, CV, correspondence, formal research proposal, progress report, feasibility study, technical report, fact sheet etc...

### *EMPH 111 - Engineering Mathematics I (3 Cr. : 3 Lec : 0 Lab : 1 Tut)*

Partial fractions; Binomial theorem; Roots of polynomial equations; Convergence of series; Matrices: Determinants, rank, Eigen values, eigenvectors, block decomposition, solution of linear system of equations; Introduction to complex analysis; Transfer of axes; Conic sections.

### *EMPH 121 - Engineering Mechanics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)*

Force vectors (analytical and graphical methods), equilibrium of a particle, force system resultants (moment of force, couple system); Equilibrium of a rigid body (equilibrium in two - dimensions, equation of equilibrium, free body diagrams); Structure analysis and its applications in truces, frames, mechanisms and simple mechanics); Cable static analysis; Dry friction, slipping, tipping, applications on real systems, experimental application on: Force analysis, friction effect, equilibrium of rigid body.

***EMPH 131 - Engineering Physics I (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Electrostatics: Coulomb's law, electric dipole, electric field of a continuous charge distribution, Gauss law, electric potential from point and distributed charges, relation between electric field and electric potential, capacitors and dielectrics, series and parallel connections of capacitors, energy stored in capacitors; Electric current: Model for electrical conduction and material resistivity, Kirchhoff's laws; Magnetism: Magnetic forces, magnetic dipole, magnetic flux and Gauss law in magnetism, sources of magnetic fields, Ampere's law, Biot and Savart law, magnetism of matter; Geometric optics: Images formed by reflection, refraction from spherical surfaces, thin lenses, lens aberrations and defects of images.

***EMPH 141 - Engineering Drawing & Projection (3 Cr. : 2 Lec : 0 Lab : 3 Tut)***

Drawing instruments and their use; Developing drafting skills; Dimensioning; Geometric construction; Conic sections; Special curves: Involute, cycloid, spiral of Archimedes, helix; Theory of shape: Representing objects by views and applications in machines drawing; Pictorial drawing: Isometric and oblique; Electrical drafting. AutoCad: 2D drawings using the computer software AutoCAD; Projects.

***EMPH 112 - Engineering Mathematics II (3 Cr. : 3 Lec : 0 Lab : 1 Tut)***

Hyperbolic functions, implicit and logarithmic differentiation, derivatives of higher order, Leibniz theorem, mean value theorem, partial differentiation and applications, curvature, Taylor expansion, methods of integration, improper integrals, multiple integrals.

***EMPH 122 - Engineering Mechanics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Introduction to vector analysis, hints about the ordinary differential equations of the second order kinematics of the particle in one dimension (rectilinear motion of a particle), two - dimensional kinematical analysis of a particle motion using the cartesian and intrinsic coordinates, engineering applications, kinetics of the particle), two - basic concepts: Newton's Law (force & acceleration), position integration of Newton's Law (works & energy), time integration of Newton's Law (impulse & linear momentum). Engineering applications: One dimensional motion in a conservative or dissipative force field, ideal constraints, direct and inclined impact of a particle on a smooth plane, oscillations of a particles, engineering applications.

***EMPH 132 - Engineering Physics II (3 Cr. : 3 Lec : 1 Lab : 0 Tut)***

Properties of materials: Units, dimensions, circular motion of rigid bodies, moment of inertia, elasticity of materials, stresses and strains, pressure measurements, surface tension, 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, heat measurements, heat transfer by conduction, heat convection, heat radiation, introduction to thermodynamics, first law of thermodynamics, thermodynamic processes for an ideal gas.

***EMPH 142 - Engineering Drawing & Projection II (3 Cr. : 2 Lec : 0 Lab : 3 Tut)***

Engineering drawing & projection sectional views, intersection of surfaces, structural drawing which includes projection of steel structures and, Monger's descriptive geometry (representation of points, lines and planes), representation of surface (sphere, cone and cylinder) and intersection of surfaces and their development, indexed projection, (representation of points, lines, and planes, and the intersection line of two planes), applications of indexed projection (topographic surfaces and problems of cutting and filling). Prereq.: EMPH 141.

***EMPH 207 - Chemistry (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

Introduction to basic concepts of chemistry, chemical reactions and calculations; Physical states of matter: Gases, liquids and solids; Solutions; Chemical equilibrium, ionic equilibrium; Manufacture and hydration reactions of cements; Practical: Applied experiments related to the above topics.

***EMPH 211 - Differential Equations for Engineers (2 Cr. : 2 Lec : 0 Lab : 1 Tut)***

Differential Equations: First order differential equations; Second order differential equations with constant and variable coefficients, simultaneous system of differential equations, series solution; Fourier series: Periodic function, expansion, half period and harmonics; Introduction to partial differential equations. Prereq.: EMPH 111 & EMPH 112.

***EMPH 314 - Numerical Analysis & Techniques for Industrial Engineering (3 Cr. : 2 Lec : 1 Lab : 2 Tut)***

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; Error, stability and convergence; Introduction to finite element method. Prereq.: EMPH 211.

***EMPH 216 - Probability & Statistics for Industrial Engineering (3 Cr. : 2 Lec : 2 Tut : 1 lab)***

Probability theory, random variables and density functions, cumulative distributions; Discrete and continuous probability distributions; Binomial, poisson, hyper - geometric, normal, exponential; Measures of central tendency, measures of dispersion, descriptive statistics using histogram, statistical analysis indices, inferential statistics; Sampling, central limit theory; Confidence intervals; Test of hypotheses; Regression analysis and correlation; Software analysis using packages. Prereq: EMPH 112.

***COMP 101 - Computer Programming I (2 Cr. : 2 Lec : 1 Lab : 0 Tut)***

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.

***IEEM 112 - Production Engineering (2 Cr. : 2 Lec : 1 Lab)***

Introduction to production and manufacturing engineering, introduction to material and material properties, iron and steel, metrology, bench work, machining (turning, milling, shaping and planing, drilling, etc.), forging and forming of metals, metal casting (sand casting and permanent mold casting), and cost analysis.

***IEEM 201 - Engineering Materials Technology (3 Cr. : 2 Lec : 2 Lab)***

Structure of metals, principles of materials properties, theory of elasticity, metal alloys, strengthening by heat treatment, material selection for different engineering applications and introduction to material forming processes, and ferrous metal production. Prereq.: IEEM 112.

***IEEM 211 - Metal Shaping (3 Cr. : 2 Lec : 1 Tut : 1 Lab)***

Introduction to manufacturing engineering, micro structure of materials, ferrous materials, non - ferrous materials, polymers and composites, casting and molding, forming processes, material removing processes, conditioning processes, assembling and joining processes including welding technology, finishing processes, introduction to advanced manufacturing systems (CAD / XCAM - NC - CNC - FMS - CIMS). Prereq.: IEEM 112.

***IEEM 213 - Technology & Shaping of Metals (2 Cr. : 2 Lec : 1 Lab)***

Introduction to manufacturing engineering, micro structure of materials, ferrous materials, non - ferrous materials, polymers and composites, casting and molding, forming processes, material removing processes, conditioning processes, assembling and joining processes including welding technology, finishing processes, introduction to advanced manufacturing systems (CAD / XCAM - NC - CNC - FMS - CIMS). Prereq.: IEEM 112. (Not offered for Industrial Engineering and Management students).

***IEEM 221 - Engineering Economy (3 Cr. : 3 Lec)***

Basics principles and techniques of economics analysis of engineering project, time value of money, present worth, annual worth, internal rate of return, benefit - cost, cost allocation, measures of effectiveness, evaluation of engineering projects and investments, cost estimation, depreciation, inflation, bond and loan financing, after tax cash flow, measures of economic merit, sensitivity and risk analysis, single and multi - attribute decisions. Replacement analysis, selection alternative engineering proposals. Prereq.: HUME 105.

***IEEM 202 - Manufacturing Processes (3 Cr. : 2 Lec : 2 Tut)***

Analysis: Sources of errors in manufacturing, process capability, tolerance analysis in manufacturing and assembly, process planning, parameter selection and comparison of production alternatives, manufacturing technologies - strategies and selection principles and applications of nontraditional machining processes - USM, AJM, WJM, EDM and Wire cut EDM, LBM, EBM, PAM, CHM, ECM. Prereq.: IEEM 201.

***IEEM 212 - Operations Research I (3 Cr. : 2 Lec : 2 Tut)***

Introduction to operations research models, linear programming, (simplex method, duality and sensitivity analysis), goal programming, transportation, assignment, and deterministic dynamic programming. Prereq.: EMPH 112.

***IEEM 222 - Engineering Design I (3 Cr. : 3 Lec)***

Introduction to the concepts, techniques, analysis and application of engineering design, mechanical engineering elements, emphasis on techniques adopting computer - based analysis like AutoCAD, pro - engineer, etc... The role of the design within the production cycle, and integration of design to production. Prereq.: IEEM 112.

***IEEM 301 - Production & Operations Management (3 Cr. : 3 Lec)***

Fundamentals of forecasting, capacity of production systems, supply chain and inventory control (B - Q, s - S), aggregate planning, material requirement planning MRP, enterprise resource - planning ERP, Just in time JIT and lean operation, maintenance, scheduling, decision theory, decision tree. Prereq.: HUME 105, IEEM 212.

***IEEM 311 - Engineering Design II (3 Cr. : 2 Lec : 2 Tut)***

General principle of machine design, engineering materials and their mechanical properties review, factor of safety, and fits and tolerances, basic design principle of machine elements, fasteners, fittings, shaft, couplings, clutches, brakes, bearing selection, fly wheel, belt drive, chain drive, gears, gear train and gear units, non - metallic machine elements, fluid power systems and components, design and drawing of machine systems: power screw, gear units, clutch / brake. Prereq.: IEEM 201, IEEM 222.

***IEEM 321 - Facility Planning & Design (3 Cr. : 2 Lec : 2 Lab)***

Fundamentals of developing efficient layouts of various production / service systems, travel chart, layout procedures, computerized layout planning, single - facility and multifacility location problem, material handling system design for production facilities, and flow analysis techniques. Prereq.: IEEM 212.

***IEEM 341 - Environmental Systems & Engineering Safety (3 Cr. : 3 Lec)***

Sources of environmental pollution: Air, soil, water, natural and man - made methods for environmental protection, construction and manufacturing safety, environmental management systems ISO1 4001, safety management ISO1 4000. Prereq.: HUME 105.

***IEEM 312 - Maintenance Planning & Technology (3 Cr. : 3 Lec : 1 Tut)***

Maintenance strategy, maintenance organization, maintenance systems, condition based maintenance, maintenance awareness in design, auditing maintenance systems, turnaround management, process monitoring, reliability, maintainability and risk, machinery vibration monitoring and analysis, maintenance strategy, maintenance organization, maintenance systems, condition based maintenance. Prereq.: IEEM 202.

***IEEM 322 - Management Information Systems (3 Cr. : 2 Lec : 2 Lab)***

Introduction to the structure, components and design of information systems, different methodologies will be introduced in the context of management decision support that includes determining user needs and demands, establishing system functions, specifying system requirements, analysis of computer internal structure, computer networking and computer process interfacing are presented. Prereq.: IEEM 212.

***IEEM 332 - Operations Research II (3 Cr. : 2 Lec : 2 Tut)***

Queuing theory, stochastic dynamic programming, markov decision process, nonlinear programming, replacement theory, deterministic and probabilistic inventory control, software applications and demonstrations. Prereq.: IEEM 212.

***IEEM 401 - System Modeling & Simulation (3 Cr. : 2 Lec : 2 Lab)***

Systems concepts, modeling, design and analysis of network flows for material and information, principles of simulation and random variables, random number generation, simulation of complex discrete event systems, Monte Carlo simulation with case studies using spread sheet and / or latest available software, modeling of discrete and continuous systems, goodness of distribution data fit tests, advanced system modeling, case studies with verification and validation. Prereq.: IEEM 332.

***IEEM 411 - Computer Aided Design & Manufacturing (3 Cr. : 2 Lec : 2 Lab)***

CAD, geometric / solid modeling, finite element analysis (FEA), design optimization, graphical and computational features of CAD, engineering analysis and design execution, implementation, contemporary design techniques for solving and analyzing applied design problems using FEA. Prereq.: IEEM 311, EMPH 314.

***IEEM 421 - Reliability (3 Cr. : 2 Lec : 2 Tut)***

Reliability, life distribution and their applications in reliability, system reliability models, design by reliability and probabilistic design, reliability and safety analysis through FMECA and FTA, reliability estimation and measurement by testing for binomial, exponential and Weibull distribution. Prereq.: EMPH 216.

***IEEM 431 - Project Planning & Management (3 Cr. : 2 Lec : 2 Tut)***

Principles of project planning, project identification, time frame, project objectives, project selection techniques, resource planning, activity on arrows, activity on nodes, CPM, PERT, applications, cost control, cost estimate and control, project risk management, project quality management, basic types of engineering projects, crashing of schedules, resource leveling and planning, computer - based project management. Prereq.: IEEM 301.

***IEEM 412 - Failure Analysis (3 Cr. : 2 Lec : 2 Tut)***

Brittle fracture, ductile fracture, Griffith's theory and Irwin's theory, crack initiation, crack propagation and spreading, fracture toughness, reasons of failures, procedures of failure analysis, metallurgical failure analysis, creep, case studies. Prereq.: IEEM 311.

***IEEM 422 - Engineering Logistics & Supply Chain (3 Cr. : 3 Lec)***

Introduction to supply chain management, supply chain integration, strategic partnering, decision support systems, information technology, customer value and service, supply chain design, product design for logistics, managing inventory in the supply chain, distribution management, international logistics, supply chain integration, strategic partnering, decision support systems. Prereq.: IEEM 301.

***IEEM 432 - Statistical Quality & Process Control (3 Cr. : 2 Lec : 2 Tut)***

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 ( $\bar{x}$  - bar, R, s, MR, p, np, c, u, and U charts), and acceptance sampling plans by attributes and variables. Prereq.: EMPH 216.

***IEEM 442 - Ergonomics (2 Cr. : 2 Lec)***

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.

***IEEM 500 - Internship (1 Cr.)***

This is a professional training which should last for at least four weeks in Industrial Engineering and Management fields. The training is followed by a poster session where the students are supposed to present what they have learned.

***IEEM511 - Production Systems Automation (3 Cr. : 2 Lec : 2 Tut)***

Types of automation, production systems, mathematical models, automation strategies, cost analysis of automated production line, assembly systems, and introduction to CIM, CNC, FMS, and group technology. Prereq.: IEEM312.

***IEEM 521 - Total Quality Management & Six Sigma (3 Cr. : 3 Lec)***

Analytical and management tools necessary to solve manufacturing quality problems and implement effective quality systems, voice of the customer analysis, customer satisfaction, TQM, the six Sigma problem - solving methodology, Quality system (ISO standards), Taguchi's quality engineering, measurement system analysis (statistical process control and quality function deployment). Prereq.: IEEM 312.

***IEEM 502 - Senior Project (6 Cr.)***

Comprehensive study of any timely or special topic in management engineering and / or technology. Project may be extended for a total of 6 credit. Independent study; Arrange approval prior to enrolling.

**Elective Courses*****IEEM 314 - Industrial Packaging (3 Cr. : 3 Lec)***

Packaging related issues such as materials selection, forming techniques and packaging sealing with a packaging engineer, know how food packaging is manufactured, understand the material properties of various packaging raw materials as well as the final package, understand the principal methods of packaging foods as well as criteria for selecting and testing packaging materials, have familiarity with packaging equipment and methods, have discussed recent advances in food packaging techniques and systems packaging techniques and systems. Prereq.: IEEM 202.

***IEEM 324 - Organizational Design (3 Cr. : 2 Lec : 2 Tut)***

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 greenfield 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. Prereq.: IEEM 301.

***IEEM 413 - Plastics Engineering (3 Cr. : 2 Lec : 2 Tut)***

Plastic materials and their processing, review of the pertinent organic chemistry of polymer materials, classification,

properties, characteristics and applications of plastics; Polyethylene, PVC, ABS, polyesters, phenolics and urethanes, study of processes including injection molding, extrusion, thermoforming and blow molding; Applications, process parameters, quality, economics and tooling considerations. Prereq.: IEEM 201.

### ***IEEM 433 - Industrial Measurements & Inspection (3 Cr. : 2 Lec : 2 Tut)***

Theory of measurements with emphasis on standardization, dimensional and geometrical tolerance on part components, principles of amplification in measurements including mechanical, optical and electronic systems, features of measuring systems including design concepts, automatic gauging and in - process measurements and computer - aided measuring systems. 3-D measurements and surface topology. Prereq.: IEEM 202.

### ***IEEM 503 - Analysis of Variance & Design of Experiments (3 Cr. : 3 Lec)***

Comparing several treatments - one factor experiments, completely randomized design, analysis of fixed effects model, matrix approach to the analysis, analysis of heteroscedastic data, analysis of random effects model, selecting the sample size, randomized block and related designs, randomized complete block experiment, latin square design, efficiency of blocked designs, least squares means, factorial experiments, repeated measures designs, Taguchi philosophy, and design and analysis. Prereq.: EMPH 216.

### ***IEEM 513 - Reverse Engineering & Prototyping (3 Cr. : 2 Lec : 2 Tut)***

Introduction to the concept, techniques ,analysis and applications of engineering design with emphasis on "Learn by Design", fundamentals of design (simplicity, stability, accuracy, reciprocity, the golden rectangle, etc...), functional requirements and design principles, conceptual design, importance of sketching, the use of computer aided drafting, and computer aided design packages, reverse engineering principles, design projects and case studies. Prereq.: IEEM 311.

### ***IEEM 523 - Management of Global Operations (3 Cr. : 3 Lec)***

Introduction to international operations and multi - national enterprises, study of factors affecting operations in a global environment with focus on international economic issues. Prereq.: IEEM 301.

### ***IEEM 504 - Advanced Manufacturing Processes (3 Cr. : 3 Lec)***

Advanced topics in manufacturing materials and processes, including metallic / nonmetallic materials and their fabrication, nonmaterials, powder metallurgy, nontraditional machining, rapid prototyping, and materials' testing.

### ***IEEM 514 - Strategic Manufacturing Planning (3 Cr. : 2 Lec : 2 Tut)***

Formulate a framework for developing and implementing a manufacturing strategy, use manufacturing as a competitive weapon, to 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. Prereq.: IEEM 301.

### ***IEEM 524 - Special Topics in Industrial Engineering (3 Cr.)***

Wide range of topics in engineering of special interest to industrial engineering majors, but not offered on a regular basis.