The School of Engineering
The School of Engineering

MISSION
To educate students, to provide them with abilities for success in their lives as engineers and as responsible citizens, and to graduate them with distinctive skills that are sought after in the professional world and by graduate schools.

SCHOOL VISION
To advance a distinctive and innovative environment for engineering education.

SCHOOL CORE VALUES

Integrity: To deal honestly and fairly with the public and one another, and to be transparent in our dealing with the public and one another.

Commitment: To be committed to our students and to our school, and to conscientiously strive for excellence in our work.

Responsibility: To be accountable for our actions toward ourselves, others and the community, and to be accountable for our performance and committed to shared governance.

Respect: To value one’s self and others and to respect the rights and dignity of others.

Courage: To face difficult situations with confidence and determination, and to promote intellectual freedom and stand up for one’s convictions.

DEAN
George E. Nasr, Ph.D.

ASSISTANT DEAN
Mazen Tabbara, Ph.D.

CHAIRS
Jean Chatila, Ph.D.
Samer Saab, Ph.D.
Pierrette Zouein, Ph.D.

FACULTY
Grace Abou Jaoude, Ph.D.
Chadi Abou-Rjeily, Ph.D.
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Rita Awwad, PhD.
Elie Badr, Ph.D.
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The School of Engineering

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Iyad Ouaiss, Ph.D.
Samer Saab, Ph.D.
Abdallah Sfeir, Ph.D.
Mazen Tabbara, Ph.D.
Pierrette Zouein, Ph.D.

UNDERGRADUATE PROGRAMS
The School of Engineering offers Bachelor of Engineering (B.E.) degrees in:

Civil Engineering
Computer Engineering
Electrical Engineering
Industrial Engineering
Mechanical Engineering

With Minors in:
Packaging
Environmental Sciences

GRADUATE PROGRAMS
The School of Engineering offers Master of Science (M.S.) degrees in:

Civil and Environmental Engineering
Computer Engineering
Industrial Engineering and Engineering Management

INSTITUTES

INSTITUTE FOR WATER RESOURCES & ENVIRONMENTAL TECHNOLOGIES (IWRET)
This institute aims to promote usable technology in areas of water resources, environmental protection, and agriculture in the Middle East. It seeks to initiate new ideas and venues for applied research.

CISCO INSTITUTE
This institute offers Cisco courses in computer networking, and trains Cisco instructors for the Middle East and North Africa (MENA) region. It also performs quality visits to regional and local Cisco academies in the MENA region. The visits are meant to ensure these academies are offering high-standard Cisco courses, and have the proper manpower and equipment resources to perform the work.
ENGINNEERING FACILITIES

CIVIL ENGINEERING LABORATORIES

The Department of Civil Engineering at the School of Engineering is committed to providing hands-on measurements, and experimentation, as a viable component of the educational program. The Civil Engineering Laboratories provide undergraduate students with the state-of-the-art equipment for experimentation and demonstration of the basic concepts covered in class. The Laboratories also serve for research purposes for the Faculty, and for the students’ final year projects. The Civil Engineering Laboratories play a leading role in serving as testing facilities, and technical consultation, for several engineering firms, and private entities, following the internationally accepted standards and testing procedures. The Civil Engineering Laboratories house the following sub-specialty laboratories:

The Construction Materials Laboratory is equipped with a 400-ton Forney Hydraulic Testing Rig, a high precision, displacement controlled, Instron Testing Frame, equipment for standard testing of aggregates and concrete, in both fresh and hardened stages, equipment for non-destructive testing of different elements of existing structures, such as ultrasonic device, Schmidt Hammer, Windsor Probe, Rebar Scan, and Core Drills. Most standard tests can be performed on almost all the building and construction materials, including concrete, aggregates, asphalt, various metals, and related constituents.

The Environmental and Water Quality Laboratory is equipped with sampling devices and quality analysis of water/wastewater, jar tests, stream gauging, top of the line point and depth sediment samplers, bed load samplers, fluorometers, UV-visible spectrophotometers, colorimeters, peristaltic pumps, gas meters, centrifuges, incubators, and furnaces, in addition to mobile environmental monitoring stations for air pollution field measurements. This Laboratory has a full range of standard equipment for performing routine environmental analyses of unit processes and operations in water and wastewater treatment, water quality parameters, investigations in fresh and marine water quality, solid waste characterization and properties, evaluation of treatment processes, digestion and co-digestion, reactor performance, solid waste management, environmental impact monitoring, and environmental site investigations.

The GPS/GIS and Surveying Laboratory is equipped with mobile stations, and the only continuous monitoring GPS station in Lebanon, namely the LAUG station, which is part of the UNAVCO consortium in the United States, and the International GPS Service (IGS). This Laboratory helps and enables students to understand the basic principles of surveying by conducting numerous field exercises. Most of the field exercises are conducted outside the laboratory room to gather field data. Reduction and calculation of field data for final result is done in the laboratory room. In addition, activities include: collecting and modifying topographic maps, preparing digitized and GIS referenced maps with related features, DGPS measurements, presenting a general overview of geography, population, climate, water resources, water flows, dams, wastewater, water withdrawals, irrigation and drainage, on maps, survey and collect various data, and analyzing that data.

The Soil and Geotechnical Laboratory is equipped with an automated direct shear boxes, triaxial cells, permeability cells, and a full SHARP asphalt concrete testing laboratory, in addition to a reflected light high precision microscope facility. Standard laboratory and field identification tests of soils, and their properties in the disturbed and undisturbed forms, may be performed on soils.

The Water Resources Laboratory features modern instruments and apparatuses for testing of various fluids and water resources. Tests may be performed to measure fluid properties and behavior, flow measurements, pipes/systems, pumps and their characteristics, flow conditions, open channels, turbines, suspended sediments and bed load analysis, river flows and characteristics, flow measuring devices calibration and standardization, fluid friction, calibration of weirs, orifices, hydraulic jumps, forces on gates, hydraulic banches, flow regimes identification, flow velocities, dispersion studies, water depths and discharges, build the corresponding hydrographs, offer technical consultations on hydraulic, and hydrologic, flow problems.

ELECTRICAL AND COMPUTER ENGINEERING LABORATORIES

The Advanced Networking Laboratory features the latest networking devices from Cisco Systems. It places students in direct contact with advanced LAN and WAN devices, performing various real-life
operations, including simulated router traffic, problem troubleshooting, and company-wide configurations.

The Advanced Technology Laboratory features different technologies, such as: Microwave and various types of antennas with design and testing package for test reception, radiation pattern, and various other parameters on the airwaves, a high-end GPS station with differential base station (DGPS), used for various field experiments, a 6 DOF Robot manipulator section, used in various automated applications, and a 6 DOF Inertial Measurement Unit, used in aerospace applications. In addition, this Lab features a variety of state-of-the-art software to be used for the analysis, and design, of telecommunication systems.

The Communication Systems Laboratory introduces students to the different analog, and digital, communication systems using educational modulation and demodulation boards. The data acquisition for the associated experiments is done using MATLAB/SIMULINK, which provide a display of various signals in time and frequency domain.

The Control Systems Laboratory introduces students to the implementation of PID-controllers, and two-step controllers, to first order delay, as well as third order delay, systems using educational PID boards and DC servo boards. Experimentations and analysis use industrial standard oscilloscopes, and data-acquisition boards interfaced via SIMULINK/MATLAB.

The Digital Design Laboratory is the home of all the microprocessor design and reconfigurable computing courses. Students who take microprocessor-programming courses come in with real life, step-by-step, processor programming. They learn to program, at the assembly level, all the types of devices and appliances such as a small video game, or a digital clock and stopwatch, etc. In addition, FPGA-based hardware boards are used for rapid prototyping. Students use hardware languages such as VHDL to design more complex digital circuits, such as pipelined simple processors, VGA controllers, and neural networks, and execute them on the FPGA platforms.

The Electromechanics and Power Laboratory features test benches for testing three phase circuits, single, and three phase transformers, AC machines both synchronous and induction, and DC machines. A model of a transmission line is also available for simulating power line capability and compensation. A power electronics test bench can simulate AC/DC DC/AC DC/DC conversions using thyristors, GTOs and MOSFETs.

The Instrumentation and Electronics Laboratory features the practical and technical aspects of electric, and electronic, circuitry. The student learns how to design, and analyze, basic and advanced circuits, through the usage of state-of-the art digital equipment such as oscilloscopes, function generators, and multimeters.

The Linux Programming Laboratory is targeted towards the Linux Operating System environment. Linux and UNIX have always been the best platforms in terms of reliability, and many reputable companies use UNIX servers for their core network services. Courses such as Operating Systems, Networks, and other advanced topics, use this Lab extensively.

The Micro-Computer Laboratory is a general engineering area where students, from all the Engineering majors, gather to work on their assignments and projects, or simply browse the internet. It is composed of high-end workstations, dual booting Microsoft Windows, and Red Hat Linux operating systems. Most of the general engineering applications, as well as office productivity software, are centralized in this area. The Lab opens at 8 a.m. and closes at 8 p.m. During rush periods, the Lab is open late, and sometimes overnight.

INDUSTRIAL AND MECHANICAL ENGINEERING LABORATORIES

The Fluid Mechanics Laboratory is equipped with adequate facilities, and equipment, to allow students to understand the behavior of fluids. It includes several means for measuring different fluid properties, fluid flow, fluid friction, calibration of weirs, orifices, pumps, turbines, hydraulic jumps, forces on gates, hydraulic benches, flow regimes identification, in addition to a five meter-long open channel with proper controls and mechanisms. It also includes Particle Image Velocimetry equipment that allows students to visualize fluid structures. Location: Flex 102.

The Heat Transfer Laboratory features a series of equipment on which various experiments can be performed to demonstrate the three basic modes of heat transfer which include: conduction (linear and radial), convection (steady and unsteady state), and radiation heat transfer. The Lab also includes
a heat exchanger unit where several types of heat exchangers, such as shell and tube, concentric tube, plate and jacketed vessel heat exchangers, can be studied. Instrumentation is provided to allow the evaluation of the processes occurring in each heat exchanger. Location: Flex103.

The HVAC Laboratory consists of an air conditioning laboratory unit, which allows the processes governing air conditioning to be demonstrated. It also allows students to investigate the measurement and calculation of all the thermodynamic processes involved in the heating, cooling, humidification, and dehumidification of air, as well as the mixing of two air streams. Location: Flex 103.

The Internal Combustion Engines Laboratory features a petrol engine, and a diesel engine. Both engines can be connected to a dynamometer and control unit. The engines and control unit are equipped with the instrumentation required to allow students to monitor, and measure, the different parameters required to analyze the operation of the engine, such as RPM, torque, inlet and exhaust temperatures, inlet air flow rate, and fuel flow rate. In addition, the Lab includes a sectioned, electrically operated, four-cylinder engine, which allows students to observe the operation of the engine’s internal parts. Location: Flex 103.

The Machine Dynamics Laboratory has a range of equipment, designed to meet the needs of students who are required to understand the basic principles of machines. The Lab includes a whirling of shafts apparatus, a cam analysis machine, a balancing of reciprocating masses apparatus, in addition to a vibration apparatus, where experiments can be performed on pendulums, springs and rotors, covering free and forced vibration, damping, and torsional oscillations. Location: ARC 205.

The Manufacturing Laboratory features a four axis CNC vertical milling machine, and a CNC lathe. The lab is equipped with twenty computers networked to the machines in a classroom environment. This setup allows the students to build, analyze, and then manufacture, a modelled part. Location: ENG 604.

The Materials Testing Laboratory features a servo-hydraulic testing system, where a wide variety of tests can be performed ranging from simple tension/compression tests, to fracture mechanics, mechanical fatigue, and high rate testing. The system includes a console with controlling software, which allows the tests to be programmed and controlled, and the data to be acquired and processed. This Lab also includes a Brinell test machine to measure the hardness of metals. Location: ARC 205.

The Instrumentation Laboratory is an environment that helps students become familiar with instrumentation and measurement techniques. It features data acquisition modules connected to the computers and to which several types of sensors can be connected. Acquired data can be collected, analyzed processed and stored using LabVIEW software. This system also allows the students to develop their own virtual instruments. Location: ENG 609A.

The Industrial Computing Laboratory is a general purpose computing lab equipped with 20 computers. It features state of the art engineering software such as Arena for simulation, Catia for ergonomics and manufacturing, JMP for quality control, Ansys and Comsol for thermofluids simulations, Fluent, AutoCad, etc. Location: ENG 605.

The Ergonomics Laboratory features equipment and software required for ergonomic design and analysis, such as an anthropometric kit, a thermo-anemometer, a sound level meter, a light meter, a psychometer with IR thermometer, a body composition monitor, a distance meter, and a baseline hydraulic dynamometer. In addition, the lab features workstations equipped with DELMIA software enabling the students to perform digital human measurement, human building, human task analysis, human posture analysis and human activity analysis. Location: ARC 602.

The Packaging Laboratory features an incline impact tester, a paper bursting machine, a cardboard bursting machine and a universal testing machine. The equipment allows students to analyze and perform tests on various packages and packaging materials. Location: Flex 101.

The Machine Shop includes a metal working area and a wood working area. It provides the students with hands-on experience in the use of tools and equipment used in manufacturing processes, such as lathes, saws, drilling machines, welding equipment, grooving machines, etc. Location: ARC 102.
DEPARTMENT OF CIVIL ENGINEERING

The Department of Civil Engineering offers the following degree programs:

• Bachelor of Engineering (B.E.) in Civil Engineering
• Master of Science (M.S.) in Civil and Environmental Engineering

UNDERGRADUATE PROGRAM:
B.E. IN CIVIL ENGINEERING

The Department of Civil Engineering at LAU provides a well-rounded quality and challenging engineering education that graduates dynamic and creative engineers. The program draws upon the broad resources of the comprehensive university that aspires to be among the top universities in the country and the region.

The Department of Civil Engineering is committed to providing students with a solid theoretical background, training in the latest design methods and proficiency in technological applications. Our graduates go on to pursue varied careers in design, construction, management and research.

The Department of Civil Engineering currently offers courses in the fields of:

• Construction Engineering
• Environmental Engineering
• Geotechnical Engineering
• Surveying
• Structural Engineering
• Transportation Engineering
• Water Resources Engineering

We prepare our graduates to be technically competent, talented, creative, and ethically responsible engineers who are effective professionals in today's work environment. We keep them abreast of the latest technical software. This enables them to enrich their lives and make valuable contributions to their communities.

The total number of credits required for graduation is 150. This includes six technical elective courses, and seven courses with a separate industry standard software laboratory. Elective courses allow students to choose the emphasis, depending on their own interests and current market needs. Software courses enhance the learning experience and improve the marketability of our graduates. A typical schedule over a four-year period, including summer modules, is listed below. Students may elect to take these courses over a longer period of time.

MISSION

The mission of the Department of Civil Engineering at LAU is to provide students with a quality and challenging education, through innovative teaching, professional practice and community service, enabling the students to enrich their lives and make valuable contributions to their communities.

PROGRAM EDUCATIONAL OBJECTIVES

Within a few years of graduation, the graduates of the Civil Engineering program will:

1. Achieve success in their chosen career path be it professional practice or graduate studies.
2. Adapt to meet the changing requirements of the job market.
3. Be responsible citizen engineers.

PROGRAM OUTCOMES

The students will acquire in their matriculation through the program, the following skills, knowledge, and behaviors:

a. An ability to apply knowledge of mathematics, science, and engineering.
b. An ability to design and conduct experiments, as well as to analyze and interpret data.
c. An ability to design a system, component, or process, to meet the desired needs, within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
d. An ability to function on multidisciplinary teams.
e. An ability to identify, to formulate, and to solve engineering problems.
f. An understanding of one's professional and ethical responsibility.
g. An ability to communicate effectively.
h. A broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and social context.
i. A Recognition of the need and the ability to engage in lifelong learning.
j. A Knowledge of contemporary issues.
k. An ability to use the techniques, the skills, and the modern engineering tools that are necessary for the engineering practice.
# Major Requirements

## First Year

### Fall Semester (17 credits)

- **MTH 201** Calculus III 3
- **CHM 201** Chemical Principles 3
- **CIE 200** Statics 3
- **COE 212** Engineering Programming 3
- **COE 201** Computer Proficiency 1
- **MEE 211** Engineering Graphics 1
- **ENG 202** Sophomore Rhetoric 3

### Spring Semester (17 credits)

- **ARA 2--/3--** Arabic Language/Literature 3
- **HLT 201** Basic Health 1
- **CIE 202** Mechanics of Materials 3
- **MTH 206** Calculus IV 3
- **BIO200 or BIO203** 3
- **ETH 201** Moral Reasoning 1
- **ENG 203** Fundamental of Oral Communication 3

### Summer Module I (3 credits)

- --- Liberal Arts Curriculum Elective 3

### Summer Module II (3 credits)

- --- Liberal Arts Curriculum Elective 3

## Second Year

### Fall Semester (15 credits)

- **CIE 308** Construction Materials 3
- **CIE 309** Construction Materials–LAB 1
- **CIE 302** Structural Analysis I 3
- **CIE 303** Structural Analysis - SOFT 1
- **CIE 330** Fluid Mechanics 3
- **CIE 331** Fluid Mechanics–LAB 1
- **MTH 304** Differential Equations 3

### Spring Semester (15 credits)

- **CIE 306** Concrete Structures I 3
- **CIE 307** Concrete Structures I–SOFT 1
- **CIE 322** Hydraulics 3
- **CIE 323** Hydraulics–SOFT 1
- **CIE 304** Stress Analysis 3
- **CIE 305** Stress Analysis–LAB 1
- **CIE 360** Surveying 3

### Summer Module I (6 credits)

- **GNE 331** Probability and Statistics 3
- **GNE 301** Professional Communication 2
- **PED 2--** Physical Education 1

### Summer Module II (6 credits)

- **INE 320** Probability and Statistics 3
- **INE 305** Professional Communication 2
- **PED 2--** Physical Education 1

## Third Year

### Fall Semester (16 credits)

- **CIE 444** Soil Mechanics 3
- **CIE 445** Soil Mechanics – LAB 1
- **CIE 424** Water Distribution & Treatment 3
- **CIE 425** Environmental Engineering – LAB 1
- **CIE 460** Highway Engineering 3
- **CIE 461** Transportation Engineering – SOFT 1
- **CIE 480** Civil Eng. Management Fundamentals 3
- **GNE305** Professional Ethics 1

### Spring Semester (15 credits)

- **CIE 426** Wastewater Collection & Treatment 3
- **CIE 427** Environmental Engineering – SOFT 1
- **CIE 446** Foundation Engineering 3
- **CIE 447** Geotechnical Engineering – SOFT 1
- **CIE 465** Transportation Systems Engineering 3
- **CIE 485** Construction Management 3
- **CIE 486** Construction Management – SOFT 1

### Fourth Year

### Fall Semester (16 credits)

- **CIE 601** Project I 3
- **CIE 436** Detailing for Civil Engineers 2
- **CIE 434** The Civil Engineering Profession 2
- **CIE ---** Technical Elective 3
- **CIE ---** Technical Elective 3
- **CIE ---** Technical Elective 3
- **CIE ---** Technical Elective 3
- **CIE ---** Technical Elective 3

### Spring Semester (15 credits)

- **CIE 400** Steel Structures 3
- **CIE ---** Technical Elective 3
- **CIE ---** Technical Elective 3
- **CIE ---** Technical Elective 3
- **CIE ---** Technical Elective 3
- **--- Liberal Arts Curriculum Elective 3**

### Technical Electives

- **CIE510** Finite Element Method I 3
- **CIE512** Concrete Structures II 3
- **CIE520** Solid Waste Management 3
- **CIE521** Hydrology 3
- **CIE522** Environmental impact Assessment 3
- **CIE525** Environmental Policy and Management 3
- **CIE526** Environmental Remediation 3
- **CIE563** Transportation Planning and Land Use 3
- **CIE564** Mass Transit Systems 3
- **CIE582** Infrastructure Management 3
- **CIE584** Quality Management Systems 3
- **CIE585** Risk and Natural Hazard Management 3
- **CIE 517** Earthquake Analysis of Structures 3
- **CIE 540** Advanced Geotechnical Engineering 3
COURSE DESCRIPTIONS

[Lecture hours-Lab hours, No. of Credits]

CIE201 Statics [3-0, 3 cr.]
Review of vector algebra; force system resultants; equilibrium of a particle and rigid body; internal forces and applications to beams, trusses and frames; shear and moment diagrams for beams; centroid and moment of inertia.
Pre-requisite: MTH102 and PHY111

CIE202 Mechanics of Materials [3-0, 3 cr.]
Review of equilibrium principles; types of stress and linear stress-strain relationships; axial, shear, torsion, and bending deformations; shear force and bending moment diagrams; and deflection of beams by integration.
Pre-requisite: CIE201 Statics.

CIE302 Structural Analysis I [3-0, 3 cr.]
Classification of statically determinate/indeterminate structures; deflections using the principle of virtual work; introduction to matrix algebra, analysis of statically indeterminate structures using Flexibility Method and Stiffness Method;

*CIE303 Structural Analysis I – SOFT [0-2, 1 cr.]
Structural analysis using commercial software; computational model for trusses and frames: load cases, supports, linear static analysis. Results visualizations and assessment: axial force, shear force and bending moment diagrams; deformed shapes.
Co-requisite: CIE302 Structural Analysis I.

CIE304 Stress Analysis [3-0, 3 cr.]
Stress-strain formulations in 1-D, 2-D, and 3-D; introduction to constitutive theories of materials and failure criteria for engineering materials; design and analysis of pressure vessels; elastic stability and simple buckling problems of columns, plates and shells; introduction to linear elastic fracture mechanics (LEFM) concepts and integrated design.

*CIE305 Stress Analysis – LAB [0-3, 1 cr.]
Laboratory demonstration of stress analysis concepts including: stress and strain measurements, failure of materials, elastic stability, and fracture mechanics.
Co-requisite: CIE304 Stress Analysis.
*Course is a co-requisite to the corresponding course.

CIE306 Concrete Structures I [3-0, 3 cr.]
Analysis and design of reinforced concrete members according to ACI code including: beams, solid and ribbed one-way slabs, T-beams, doubly reinforced beams, short columns, including development length and splicing of reinforcing steel bars.
Pre-requisite: CIE302 Structural Analysis I and CIE308 Construction Materials.

*CIE307 Concrete Structures I – SOFT [0-2, 1 cr.]
Concrete design using commercial software according to established codes. Results visualization and assessment for beams, slabs, columns and footings: concrete section, reinforcement, development length, reinforcement layout.
Co-requisite: CIE306 Concrete Structures I.

CIE308 Construction Materials [3-0, 3 cr.]
Introduction to the geological origins of construction materials and the effects of geological processes. General considerations on the use of materials in construction, required properties, selection, testing, design, and quality control of civil engineering materials. Design and testing of ordinary Portland cement concrete, asphaltic concrete, masonry, steel, and wood construction; overview of composites and other materials in civil engineering.

*CIE309 Construction Materials – LAB [0-3, 1 cr.]
Laboratory demonstration of materials testing and evaluation methods with emphasis on aggregate, concrete, and steel reinforcement testing as per national and international standard methods and specifications.
Co-requisite: CIE308 Construction Materials.

CIE320 Fluid Mechanics [3-0, 3 cr.]
Properties of fluids; hydrostatics and kinematics; basic equations and conservation laws; mass, energy and momentum; Reynolds Transport Theorem; steady laminar and turbulent pipe flow; dimensional analysis and similarity, flow measurements.

Pre-requisite: CIE200 Statics.

*CIE321 Fluid Mechanics – LAB [0-3, 1 cr.]
Laboratory applications in fluid mechanics including fluid measurements and properties; flow in pipes; Reynolds number; forces on gates; orifices; weirs; open channel flow; and pumps.

Co-requisite: CIE320 Fluid Mechanics.

CIE322 Hydraulics [3-0, 3 cr.]
Review of governing equations, design of municipal water supply and distribution systems, flow in pipes and flow regimes; methods of flow measurements; open channel flow with gradually varied flow computations; hydraulic machinery. Introduction to spillways, reservoir routing, well hydraulics and drawdown.

Pre-requisite: CIE320 Fluid Mechanics.

*CIE323 Hydraulics – SOFT [0-2, 1 cr.]
Analysis and design using commercially available software: municipal water distribution systems including pipes, reservoir, pumps and losses. Results visualizations and assessment: pressure, velocity, head losses.

Co-requisite: CIE322 Hydraulics.

CIE360 Surveying [2-3, 3 cr.]
Types of surveys and maps, theory of measurements and errors, survey equipment and field notes; horizontal distance measurements and slope computations; leveling-theory, equipment, and measurements; angles, bearings, azimuths, and compass; and length, area, volumes and mass diagrams; topography-maps, surveys, and contours; horizontal and vertical curves; photogrammetry- aerial cameras, maps and scales; public land surveys; GPS and GIS.

Pre-requisite: MEE211 Engineering Graphics

CIE400 Steel Structures [3-0, 3 cr.]
Introduction to the AISC-LRFD design philosophy; discussion of the behavior, analysis and design of steel structures; design of tension members, simple bolted connections, introduction to welded connections, compression members, laterally supported beams, beams under torsion, and lateral torsional loading.

Pre-requisite: CIE302 Structural Analysis I and CIE304 Stress Analysis.

CIE424 Water Distribution and Treatment [3-0, 3cr.]
Physical, chemical and biological water quality parameters and standards; water quantity, population estimation and use factors; methods of distribution and design criteria and periods; stresses in pipes and pipe materials, distribution system related appurtenances; water treatment techniques: purpose, sedimentation, thickening, coagulation/flocculation processes and basin design, filtration, disinfection.

Pre-requisite: CIE322 Hydraulics.

CIE425 Environmental Engineering – LAB [0-3, 1 cr.]
Fundamental quantities, titration, standards, physical, chemical and biological water and wastewater characteristics and parameter determination using standard methods, data reduction, analysis and interpretation.

Pre-requisite: CHM201 Chemical Principles and co-requisite: CIE424 Water Distribution and Treatment.

CIE426 Wastewater Collection and Treatment [3-0, 3 cr.]
Design of sanitary and storm sewers and related appurtenances, mass balances and hydraulic flow regimes; reaction order and rates, analysis of experimental data, attached and suspended growth biological wastewater treatment systems including: activated sludge and its variations, aerated lagoons, SBR, trickling filters, RBC; basic nitrification-denitrification processes; oxygen requirements; introduction to sludge treatment and disposal.

Pre-requisite: CIE 424 Water Distribution and Treatment.

CIE427 Environmental Engineering – SOFT [0-2, 1 cr.]
Analysis and design of wastewater treatment plants using commercially available software:
sizing of tanks; and effluent concentration. Results visualizations and assessment.

Co-requisite: CIE426 Wastewater Collection and Treatment.

CIE434 The Civil Engineering Profession [2-0, 2 cr.]
Introduction to the history and heritage of civil engineering; specialized sub disciplines; professionalism and professional registration and societies; continuing education; impact of historical and contemporary issues on the identification, formulation, and solution of engineering problems, impact of engineering solutions on the economy, environment, political landscape, and society. The course involves teamwork researching topics related to the impact of contemporary engineering solutions.

Pre-requisite: fourth year standing

CIE436 Detailing for Civil Engineers [0-2, 2 cr.]
An introduction to computer-aided drafting techniques and design drawings using a CAD program and sketching to generate two and three dimensional drawings based on the conventions of engineering graphical communication, applications to different Civil Engineering areas of specialty. A required team effort project introduces the preparation of working design drawings and consideration of production methods.

Pre-requisite MEE 211 Engineering Graphics.

CIE444 Soil Mechanics [3-0, 3 cr.]
Formation and types of soils, field testing and soil classification, permeability and seepage analysis in saturated soils, stresses in a soil mass, total and effective stress analysis, stress-strain relationships and strength properties of soils, failure criteria, and theory of consolidation.

Pre-requisite: CIE308 Construction Materials.

*CIE445 Soil Mechanics – LAB [0-3, 1 cr.]
Laboratory testing for properties and characteristics of soils including: classification tests, soil compaction and relative density, hydraulic conductivity, shear strength tests, and consolidation test.

Co-requisite: CIE444 Soil Mechanics.

CIE446 Foundation Engineering [3-0, 3 cr.]
Analysis, design and construction aspects of foundations including: subsurface exploration and soil characterization; design of shallow foundations based on bearing capacity and settlement calculations; earth pressure theories and design of typical retaining structures; introduction to deep foundations design.

Pre-requisite: CIE444 Soil Mechanics.

*CIE447 Geotechnical Engineering – SOFT [0-2, 1 cr.]
Geotechnical analysis and design using commercial software including design of foundations and lateral earth retaining systems. Results visualizations and assessment.

Co-requisite: CIE446 Foundation Engineering.

CIE460 Highway Engineering [3-0, 3 cr.]
Planning, design, and operation of transportation systems. Theory and practice of the geometric design of streets and highways including horizontal and vertical curves, traffic flow modeling, analysis, control, and safety. Introduction to the design of intersections, and interchanges. Introduction to pavement design principles.

Pre-requisite: CIE360 Surveying.

*CIE461 Transportation Engineering – SOFT [0-2, 1 cr.]
Highway design using commercial software integrating planning, geometric design, traffic modeling and GIS systems. Results visualizations and assessment.

Co-requisite: CIE460 Highway Engineering.

CIE465 Transportation Systems Engineering [3-0, 3 cr.]
Road vehicle performance, analysis and design of infrastructure systems, components of highway systems; planning and design of freeway interchanges, highway capacity and quality of service using High Capacity Manual methodologies, fundamentals of traffic flow theory and queuing analysis, traffic control and analysis of intersections, travel demand and forecasting.

Pre-requisite: CIE460 Highway Engineering.
CIE480 Civil Engineering Management Fundamentals [3-0, 3 cr.]
Organization and management theory, understanding of business fundamentals as applied in the private, government and non-profit sectors; public policy; public administration fundamentals, with applications. Principles of leadership, government regulations and responsibilities of the different parties involved in public construction, bonds and insurance requirements, funding mechanisms, dispute resolution processes, professional ethics.
Pre-requisite: INE 320 Engineering Economy and Co-requisite GNE305 Professional Ethics.

CIE485 Construction Management [3-0, 3 cr.]
Construction contracting processes, development of the different phases of a construction project, quantity take-off and price estimating, proposal preparation; scheduling methods and networks, application of construction control tools such as: CPM, PERT, repetitive scheduling method; resource allocation and leveling, time-cost tradeoff; budgeting and cost control, and quality control.
Pre-requisite: CIE480 Civil Engineering Management Fundamentals.

*CIE486 Construction Management – SOFT [0-2, 1 cr.]
Use of commercial software for the operations, scheduling, planning, resource allocation, budgeting and control of construction projects.
Co-requisite: CIE485 Construction Management.

CIE498 Professional Experience [0-6, 6 cr.]
Professional experience through training in the execution of real-life engineering projects.

CIE510 Finite Element Method I [3-0, 3 cr.]

CIE512 Concrete Structures II [3-0, 3 cr.]
Design of: deep beams reinforced for shear and torsion; stair cases, slender columns, two-way column-supported slabs, footings, foundation and retaining walls.

CIE517 Earthquake Analysis of Structures [3-0, 3 cr.]
Introduction to earthquake engineering including plate tectonics with emphasis on seismicity of Lebanon; introduction to structural dynamics and natural modes of vibrations, determination of earthquake loading on structures; computer analysis of structural response.
Pre-requisites: CIE302 Structural Analysis I and CIE303 Structural Analysis I-Soft.

CIE520 Solid Waste Management [3-0, 3 cr.]
Quantity and quality of municipal and industrial solid wastes, collection, transfer, disposal, treatment and recovery of solid wastes, hazardous and non hazardous residues, solid waste management principles and processes, environmental impact assessment, environmental legislation and risk, and pollution control management.
Pre-requisite: 4th year standing

CIE521 Hydrology [3-0, 3 cr.]
Occurrence of water, precipitation, interception, depression storage, infiltration, evaporation, transpiration, snow melt, well hydraulics, stream flow, data sources, instrumentation, runoff and hydrographs, hydrograph routing, probability in hydrologic design and frequency analysis, and introduction to hydrologic modeling.
Pre-requisite: 4th year standing.

CIE522 Environmental Impact Assessment [3-0, 3 cr.]
This course is the study and evaluation of the impacts of large scale projects on the quality of the physical, biological, and socio-economic environment taking into account environmental laws and regulations and EIA guidelines, identification of impacts, quantification methods, mitigation measures, and monitoring plans. Case study involving the preparation of an EIA report.
Pre-requisite: consent of instructor or senior standing.
CIE525 Environmental Policy and Management [3-0, 3 cr.]
This course explores human made problems in the environment parallel with concepts in environmental ethics, management and policies so as solutions are provided concerning preservation of the environment. Topics covered are toxic and solid wastes, pollution of air, water, food and soil, international and national environmental ethics, management and policies.
Pre-requisite: senior standing

CIE526 Environmental Remediation [3-0, 3 cr.]
This course deals with processes employing microorganisms, fungi, plants or their enzymes to return contaminated environments, such as polluted waters and soils, to their natural conditions. The control, optimization and monitoring of bioremediation is discussed as well as the environmental factors and microbial populations involved. In-situ, ex-situ applications and genetic engineering approaches are emphasized.
Pre-requisite: senior standing

CIE540 Advanced Geotechnical Engineering [3-0, 3 cr.]
Advanced topics in geotechnical engineering including: Load and Resistance Factor Design (LRFD); design of deep foundations for axial and lateral loading; two-dimensional limiting equilibrium methods of slope stability analysis; design methods for slope stabilization; design of shoring systems such as diaphragm walls, sheet-pile walls, anchored walls, and braced excavations.
Pre-requisite: CIE 446 Foundation Engineering

CIE563 Transportation Planning and Land Use [3-0, 3 cr.]
Interaction between transportation and land use variables, including modeling requirements, impacts, and data needs within the context of good community planning and economic development; transportation management; administration, finance, system evaluation, implementation, and integration.
Pre-requisites CIE465 Transportation Systems Engineering and GNE 331 Probability and Statistics

CIE564 Mass Transit Systems [3-0, 3 cr.]
An overview of mass transit systems; transit system planning including demand and cost analysis and evaluation; transit system design including route design, scheduling, and fare policy; transit networks and marketing; para-transit systems; future trends in mass transit.
Pre-requisites INE320 Engineering Economy and CIE465 Transportation Systems Engineering.

CIE582 Infrastructure Management [3-0, 3 cr.]
General methods of engineering systems management and the different types of infrastructure. Application of different methods for the planning and analysis of complex infrastructure projects considering possible financing alternatives, engineering solutions, and overall management issues during the life cycle of the project. Review of selected case studies from the Arab Gulf countries.
Pre-requisite: CIE 485 Construction Management

CIE584 Quality Management Systems [3-0, 3 cr.]
Introduction to quality management systems, ISO 9000, 14000, Total Quality Management, and the applications of QMS to engineering and management of large projects, systems, and organizations.
Pre-requisite: 4th year standing

CIE585 Risk and Natural Hazard Management [3-0, 3 cr.]
Types, frequency, effects of natural hazards, calculation of return period, planning and designing engineering systems to survive natural events, mitigation of damage.
Pre-requisite: GNE331 Probability and Statistics.

CIE586 Construction Decisions under Uncertainty [3-0, 3 cr.]
Application of decision analysis theory to construction project and organization decisions under uncertainty; decision trees and sensitivity analysis, utility assessment, multi-attribute utility theory, multiple sampling and decision strategies; bidding theory and use of probabilistic modeling and Monte-Carlo simulation to determine optimal bidding strategies.
Pre-requisites CIE480 Civil Engineering Management Fundamentals and GNE 331 Probability and Statistics.
CIE587 Construction Cost Engineering [3-0, 3 cr.]
Cost engineering for construction organizations, projects, and operations. Construction financial accounting, project monitoring and cost controlling; construction financing, break even analysis, profit, earned value, balance sheets, and cash flow analyses; Cost indices, parametric estimates, unit price proposals, quantity take-off, cost estimation and bid preparation.
Pre-requisite: CIE485 Construction Management

CIE600 Topics in Civil Engineering [3-0, 3 cr.]
Special topic relevant to civil engineering. Course title and content are announced prior to registration time.
Pre-requisite: To be announced prior to registration time.

CIE601 Project I [3-0, 3 cr.]
This course provides students with a design experience that is as close as possible to real life design projects; students will work on multidisciplinary teams according to a team work plan and under the supervision of fulltime faculty; each team meets separately with their advisors as needed to complete the work on the project but not less than three times during the semester; students choose from a set of predefined projects that have been approved by the department.
Co-requisite: CIE498 Professional Practice.

CIE602 Project II [3-0, 3 cr.]
Independent work performed by student with emphasis on research. Selection of topic and progress of work are supervised by a faculty advisor. Formal technical report and presentation are required.
Pre-requisite: CIE601 Project I and Consent of instructor.

MINOR IN ENVIRONMENTAL SCIENCE

The minor in Environmental Science is an interdisciplinary program, which gives students the opportunity to examine environmental issues from a variety of perspectives. The knowledge of environmental science major issues is central to theories and research in chemistry, biology, civil engineering, as well as social science, business, and public policy. The purpose of this program is to provide students with the broad conceptual framework of environmental issues and to offer a new global vision of this interesting discipline. A Minor in Environmental Science aims at providing quality education to interested students and enriching their knowledge in existing global environmental issues and problems. It is expected to expose them to important issues related to environmental problems and their causes, including but not limited to ecosystems and how they work, deforestation, loss of biodiversity, species extinction, air pollution, global warming, ozone depletion, solid waste disposal, and renewable energy. Concepts in environmental ethics, management and policies concerning preservation of the environment will also be provided. Additionally it covers topics related to the study of natural and non-natural chemical and microbiological substances in the environment and their transformations, ending with remediation to most of environmental pollution issues.

EDUCATIONAL OBJECTIVES

1. Provide students with an understanding of the social, economic, political and legal framework of environmental issues
2. Provide students with enough background to be able to collect, analyze and formulate possible solutions to environmental problems.
3. Provide students with understanding of the intertwining effects and impacts of human activities on the world vital natural resources.
4. Better prepare students for the job market.

STUDENT OUTCOMES

a. Understand the underlying concepts and principles associated with environmental science.
b. Identify sources of water, soil and air pollutants.
c. Demonstrate familiarity with the practical/field dimensions of a range of environmental problems and issues.
d. Understand the interrelationships between society, economy and environment.
e. Ability to critically review environmental impact assessment reports.
f. Discuss remediation strategies of a variety of environmental contaminants.
g. Recognize potential harmful role of human being in shaping the environment.

MINOR REQUIREMENTS
Minor in Environmental Science students must complete a minimum of 18 credits (9 core credits, 9 elective credits)

Core Courses (9 Cr)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENV200</td>
<td>Introduction to Environmental Science</td>
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</tr>
<tr>
<td>ENV 402 /</td>
<td>Environmental Policy and Management</td>
<td>3</td>
</tr>
<tr>
<td>CIE525</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENV422 /</td>
<td>Environmental Impact Assessment</td>
<td>3</td>
</tr>
<tr>
<td>CIE522</td>
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Elective Courses (9 Cr)

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<thead>
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<th>Course</th>
<th>Title</th>
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<tr>
<td>CHM340</td>
<td>Environmental chemistry</td>
<td>3</td>
</tr>
<tr>
<td>*BIO203</td>
<td>Introduction to Ecology</td>
<td>3</td>
</tr>
<tr>
<td>ENV423</td>
<td>Environmental Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>CIE424</td>
<td>Water Distribution and Treatment</td>
<td>3</td>
</tr>
<tr>
<td>CIE 520</td>
<td>Solid Waste Management</td>
<td>3</td>
</tr>
<tr>
<td>CIE 585</td>
<td>Risk and Natural Hazard Management</td>
<td>3</td>
</tr>
<tr>
<td>ENV426 /</td>
<td>Environmental Remediation</td>
<td>3</td>
</tr>
<tr>
<td>CIE526</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENV427</td>
<td>Environmental Physics</td>
<td>3</td>
</tr>
</tbody>
</table>

*May replace ENV200 for engineering students only. Also, it can be substituted with BIO 331 (Ecology) for biology students. CIE course are considered as CIE technical electives for civil engineering students.

COURSE DESCRIPTIONS

BIO203 Introduction to Ecology [3-0, 3 cr.]
This course introduces the organization of individual organisms into populations, communities, and ecosystems. It focuses on the interactions between living organisms and their physical environment. Concepts such as diversity, competition, natural selection, adaptation, climate changes, migration, extinction and deforestation are covered. Additionally the course tackles concepts of environmental microbiology in relation to pollution, remediation and recycling of liquid and solid wastes.

CHM340 Environmental Chemistry [3-0, 3 cr.]
This course is a study of natural and non-natural chemical substances in the environment and their chemical transformations. It involves chemistry of energy resources, atmosphere, hydrosphere, biosphere, and, lithosphere (natural and in polluted environment). Principles of chemical reactions, chemical equilibrium and reaction kinetics are applied in this course. Other covered topic is waste treatment and chemical processes. Parallel with these is learning the methods of environmental chemical analysis.

ENV200 Introduction to Environmental Science [3-0, 3 cr.]
This is an introduction to the environmental problems and challenges facing mankind. Global problems will be directly related to issues facing the regional, and local environment. The course covers environmental problems and their causes, ecosystems and how they work, deforestation, loss of biodiversity, species extinction, air pollution, global warming, ozone depletion, solid waste disposal, renewable energy technologies, and applications to alleviate environmental problems. Case studies will be presented, and potential solutions will be attempted. The course includes field trips.

ENV423 Environmental Microbiology [2-3, 3 cr.]
This ecologically based course discusses the relationship of microorganisms with one another and with their environment. It stresses the three major domains of life – Eucaryota, Archaea and Bacteria and studies their diversity, interactions and physiology in their natural environments. Biodegradation of organic matter, bio-geo-cycling of minerals and waste bio-treatment are emphasized. The course also deals with metagenomic, metaproteomic techniques and applications as well as the use of microarrays in Microbial Ecology.

ENV427 Environmental Physics [3-0, 3 cr.]
The course comprises aspects of atmospheric physics, soil physics and many aspects of applied physics. It introduces the essentials in environmental physics, and describes the basics in environmental spectroscopy e.g. black body radiation and the solar UV and Life. It also addresses the global climate, energy balance, energy available for human use, transport of pollutants, and noise pollution. The course also discusses risk estimations, energy saving and nature and future thinking in the context of the global society.

CIE course descriptions are included in relevant sections of this academic catalogue.
Graduate Program

MASTERS OF SCIENCE (M.S.) IN CIVIL AND ENVIRONMENTAL ENGINEERING

The Department of Civil Engineering at LAU offers a comprehensive program leading to the degree of Master of Science (M.S.) in Civil and Environmental Engineering (CEE) with one of three emphases: (i) Infrastructure and Construction Management; (ii) Environmental Science, Engineering and Management; or (iii) Engineering Mechanics. The CEE Program aims at attracting qualified students to pursue graduate studies. The program provides graduate students with a sound professional and academic training in civil engineering, giving them access to a variety of courses in their area of study, as well as the opportunity to conduct research, thus combining the theoretical and the applied aspects of civil engineering.

The program is designed to stimulate independent thinking and the acquisition of knowledge, as well as the application of acquired knowledge and skills to the solution of practical engineering problems. The program provides an in-depth experience with one or more particular fields of Civil Engineering, while simultaneously exposing the student to cross-disciplinary issues and topics that affect the engineering and management of systems.

Flexibility is a key benefit of this program as it allows students to plan their degree in line with their long-term career goals, and to be consistent with any professional experience and prior training they may have. The M.S. – CEE Degree may be completed with or without a thesis.

MISSION

The mission of the graduate program in Civil and Environmental Engineering at LAU is to provide students with a well-rounded set of career skills that empowers them to address a wide range of problems through exposure to an advanced body of knowledge and scholarly endeavours.

PROGRAM EDUCATIONAL OBJECTIVES

The purpose of the Graduate Program in Civil and Environmental Engineering is to:

1. Train students to develop the methodology and necessary skills to explore emerging issues in engineering and science.
2. Provide students with an advanced background and a focused body of knowledge required for the present day professional practice in their chosen field of study, and to prepare them to adapt to a changing profession.
3. Train the students in an active research environment, to equip them with the latest tools of research, and to prepare them for further study toward the Doctoral Degree.

STUDENT LEARNING OUTCOMES

Graduates of the M.S. – CEE Programs will be able to:

a. Reinforce skills developed in the undergraduate program.
b. Use advanced analytical, computational, and/or experimental aspects of civil engineering.
c. Make critical judgments based on a sound knowledge base.
d. Conduct research and appreciate its importance in the evolution of civil engineering.

EMPHASIS AREAS

The course work for the M.S. - CEE can be grouped into the following three concentrations or emphasis areas:

1. INFRASTRUCTURE AND CONSTRUCTION MANAGEMENT:
   This is designed to prepare the graduates to meet the challenges of planning, financing, designing, building and managing public and private infrastructure under growing technical, financial, social and environmental constraints.

2. ENVIRONMENTAL SCIENCE, ENGINEERING AND MANAGEMENT:
   This is designed to prepare graduates to meet the challenges of sustainable development and natural resources management while protecting the environment.

3. ENGINEERING MECHANICS:
   This is designed to prepare graduates to meet the challenges of designing technically efficient, cost-effective, and state-of-the-art facilities that are responsive to natural hazards and economic constraints.
ADMISSION REQUIREMENTS

Applicants for admissions to this program must have a Bachelor of Science in Engineering, or a Bachelor of Engineering Degree, from a recognized university, with a minimum general Grade Point Average (GPA) equivalent to 2.75, on a 4-point scale, or 2.75 in the Major. If the Bachelor’s Degree is not in the field to be pursued, and/or if the GPA is less than 2.75, the applicant may be admitted as “special,” as described in the Academic Rules and Regulations for Graduate Programs.

The GRE general exam is required of all applicants (GRE subject exams are not required). All applicants must submit scores for the GRE general exam (includes verbal reasoning, quantitative reasoning, and analytical writing scores). Your GRE test scores are an important part of your application. GRE test scores that are more than 5 years old will not be accepted.

The admissions committee considers several factors when making admission decisions: your academic performance at prior institutions (grades, rankings, and GPAs) and your GRE test score. The rate of graduate assistantship (GA), when requested, is directly related to your GPA and GRE scores. Letters of recommendation are optional; however, three letters are recommended, two of which to be completed by faculty who are familiar with your academic performance.

M.S. – CEE Requirements

Students are required to complete 30 credits for graduation. A student in the program can choose to pursue either a thesis or a non-thesis option. Students who take the thesis option are required to complete a six-credit thesis. The remaining credits can be completed according to the course requirements in each concentration or emphasis area, as specified below. The breadth requirements consist of six courses (18 credit hours) for all of the emphasis areas. The student should take at least the equivalent of 18 credits in engineering courses.

Students with a Bachelor of Engineering (B.E.) degree who are pursuing a M.S. degree may transfer up to six credits from their B.E. degree, provided that the transferred credits correspond to courses labelled graduate courses and the student has scored, at least, a grade of “B” on each of these courses. The transfer of credits is governed by the Rules and Regulations for Graduate Programs.

In order to satisfy the requirements for the M.S. - CEE with a specific concentration or emphasis, the student is required to complete either one of the following options:

1. Infrastructure and Construction Management
2. Environmental Science, Engineering and Management
3. Engineering Mechanics

Infrastructure and Construction Management

The student is required to complete at least four courses from Infrastructure and Construction Management, one course from Optimization (please refer to the Industrial and Mechanical Engineering Department for courses in Optimization), and any course offered by the School of Engineering.

Environmental Science, Engineering and Management

The student is required to complete at least four courses from Environmental Science, Engineering and Management, and any two courses offered by the School of Engineering.

Engineering Mechanics

The student is required to complete, at least, four courses from Engineering Mechanics, and any two courses offered by the School of Engineering.

Remaining courses may be taken from any graduate program of the School of Engineering, or any approved graduate course in the university, including Business, International Affairs, Biology, Toxicology, Chemistry, and Computer Science.

It is recommended that the remaining courses in each program/emphasis area are chosen in the thesis area, if a thesis option is selected, and is done in consultation with the student’s advisor. It is important to note that offering courses in a specific concentration area is contingent on adequate enrolment in that specific course/area.
## COURSE LISTINGS

### Infrastructure and Construction Management

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIE760</td>
<td>Transportation Engineering II</td>
<td>3</td>
</tr>
<tr>
<td>CIE761</td>
<td>Traffic Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CIE782</td>
<td>Infrastructure Management</td>
<td>3</td>
</tr>
<tr>
<td>CIE784</td>
<td>Quality Management Systems</td>
<td>3</td>
</tr>
<tr>
<td>CIE785</td>
<td>Risk and Natural Hazard Management</td>
<td>3</td>
</tr>
<tr>
<td>CIE786</td>
<td>Highway Design and Management</td>
<td>3</td>
</tr>
<tr>
<td>CIE787</td>
<td>Concrete and Steel Construction</td>
<td>3</td>
</tr>
<tr>
<td>CIE788</td>
<td>GIS and Remote Sensing</td>
<td>3</td>
</tr>
<tr>
<td>CIE789</td>
<td>Cost Engineering and Control</td>
<td>3</td>
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<tr>
<td>CIE790</td>
<td>Construction Methods</td>
<td>3</td>
</tr>
<tr>
<td>CIE791</td>
<td>Project Scheduling</td>
<td>3</td>
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<tr>
<td>CIE792</td>
<td>Project Contracting</td>
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### Environmental Science, Engineering and Management

<table>
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<tr>
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<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CIE720</td>
<td>Solid Waste Management</td>
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<tr>
<td>CIE721</td>
<td>Hydrology</td>
<td>3</td>
</tr>
<tr>
<td>CIE722</td>
<td>Environmental Impact Assessment</td>
<td>3</td>
</tr>
<tr>
<td>CIE723</td>
<td>Water Resources: Planning and Management</td>
<td>3</td>
</tr>
<tr>
<td>CIE724</td>
<td>Air Quality Management</td>
<td>3</td>
</tr>
<tr>
<td>CIE725</td>
<td>Geo-environmental Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CIE726</td>
<td>Unit Operations of Water Treatment Systems</td>
<td>3</td>
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<tr>
<td>CIE727</td>
<td>Unit Operations of Wastewater Treatment Systems</td>
<td>3</td>
</tr>
<tr>
<td>CIE728</td>
<td>Fate &amp; Transport of Pollutants in the Environment</td>
<td>3</td>
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<tr>
<td>CIE729</td>
<td>Hydrogeology</td>
<td>3</td>
</tr>
<tr>
<td>CIE730</td>
<td>Irrigation and Drainage</td>
<td>3</td>
</tr>
<tr>
<td>CIE731</td>
<td>Urban Water Resources</td>
<td>3</td>
</tr>
<tr>
<td>CIE732</td>
<td>Advanced Environmental Engineering</td>
<td>3</td>
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<tr>
<td>CIE733</td>
<td>Groundwater Engineering</td>
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### Engineering Mechanics

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<tbody>
<tr>
<td>CIE700</td>
<td>Steel Structures</td>
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<tr>
<td>CIE701</td>
<td>Finite Element Methods</td>
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</tr>
<tr>
<td>CIE704</td>
<td>Case Histories in Structural &amp; Geotechnical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CIE705</td>
<td>Computational Hydraulics</td>
<td>3</td>
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<tr>
<td>CIE706</td>
<td>Structural Dynamics</td>
<td>3</td>
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<tr>
<td>CIE707</td>
<td>Earthquake Engineering</td>
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<td>CIE708</td>
<td>Applied Elasticity</td>
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<tr>
<td>CIE709</td>
<td>Advanced Concrete Design</td>
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<td>CIE710</td>
<td>Pre-stressed Concrete Design</td>
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<td>CIE711</td>
<td>Pavement Design</td>
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</tr>
<tr>
<td>CIE712</td>
<td>Design of Hydraulic Structures</td>
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</tr>
<tr>
<td>CIE742</td>
<td>Foundations Engineering</td>
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### Other Courses (12 credits)

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<tr>
<td>CIE799</td>
<td>Special Topics Course</td>
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<tr>
<td>CIE891</td>
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<td>3</td>
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<tr>
<td>CIE899</td>
<td>Thesis</td>
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</table>

## COURSE DESCRIPTIONS

### CIE700 Steel Structures [3-0, 3 cr.]

This course is an introduction to the LRFD philosophy. It covers the behaviour and design of steel structures, design of tension members, simple connections, compression members, laterally supported beams, beams under torsion and beams under lateral torsional loading.

Pre-requisites: CIE302 Structural Analysis I and CIE304 Stress Analysis.

### CIE701 Finite Element Methods [3-0, 3 cr.]

This course covers stress analysis of solids which include: shape function, displacement interpolation, linear constitutive relations, element stiffness-matrix, direct stiffness method, assessment of model adequacy and error estimation. It also covers stress analysis using commercial software.


### CIE704 Case Histories in Structural and Geotechnical Engineering [3-0, 3 cr.]

This course is a selection of case histories in structural and geotechnical engineering, exposing the failures and limitations of the current practice and exploring state of the art solutions. The course involves site visits and visiting lecturers.


### CIE705 Computational Hydraulics [3-0, 3 cr.]

This course covers the formulation of ordinary and partial differential equations related to flow and transport problems such as flood waves, tidal propagation, shallow waves and transport of pollutants. The course also covers the numerical solutions using finite difference (explicit and implicit) schemes, finite element techniques and boundary integral methods. Also, the course comprises the measuring techniques in flow problems, data acquisition and online analysis.

Pre-requisite: CIE322 Hydraulics.

### CIE706 Structural Dynamics [3-0, 3 cr.]

The course covers the dynamics effects of wind, earthquake, impact and blast loading, vibration of structural components and the damping effects.

Pre-requisite: CIE302 Structural Analysis I.
CIE707 Earthquake Engineering [3-0, 3 cr.]
This course is an introduction to earthquakes, seismological and faulting mechanisms, design of constructed facilities and infrastructural systems under earthquake loads, risk assessment and strengthening and case studies.
Pre-requisites: CIE302 Structure Analysis I and GNE331 Probability and Statistics.

CIE708 Applied Elasticity [3-0, 3 cr.]
This course covers tensor notation, analysis of stress, two-dimensional elasticity, bending of beams, torsion of prismatic bars, asymmetrically loaded members, beams on elastic foundations and elastic stability.

CIE709 Advanced Concrete Design [3-0, 3 cr.]
This course covers advanced topics in concrete design that include: Combined Footings, Retaining Walls, Mat Foundations, Pile Caps, Torsion, Walls, Shell Structures, Computer Aided Design of Concrete, in addition to other topics of interest.
Pre-requisites: CIE306 Concrete Structures I and CIE446 Foundation Engineering.

CIE710 Pre-stressed Concrete Design [3-0, 3 cr.]
This course covers the design of pre-stressed concrete structures, with an emphasis on flexural design of beams and slabs.
Pre-requisite: CIE306 Concrete Structures I.

CIE711 Pavement Design [3-0, 3 cr.]
This course covers the beam on elastic foundation, rigid and flexible pavements, highway and airport pavements, pavement performance and pavement systems management and maintenance.
Pre-requisites: CIE460 Highway Engineering I and CIE444 Soil Mechanics.

CIE712 Design of Hydraulics Structures [3-0, 3 cr.]
This course covers the history and background, function, planning process, types, analysis and design of culverts and bridge openings, dam appurtenances, intakes, aprons, chute blocks, spillways and drop structures. It also covers dam safety, stability and protection against scour.
Pre-requisites: CIE322 Hydraulics and CIE306 Concrete Structures I.

CIE720 Solid Waste Management [3-0, 3 cr.]
This course covers the quantity and quality of municipal and industrial solid wastes; the collection, transfer, disposal, treatment and recovery of solid wastes; hazardous and non-hazardous residues, solid waste management processes, environmental impact assessment, environmental legislation and risk, and pollution control management.
Pre-requisite: Consent of the instructor.

CIE721 Hydrology [3-0, 3 cr.]
This course covers the occurrence of water, precipitation, interception, depression storage, infiltration, evaporation, transpiration, snow melt, well hydraulics, stream flow, data sources, instrumentation, runoff and hydrographs, urban hydrology, hydrograph routing, probability in hydrologic design and the introduction to hydrologic modeling.
Pre-requisite: CIE322 Hydraulics.

CIE722 Environmental Impact Assessment [3-0, 3 cr.]
This course covers the study and evaluation of the impacts of large-scale projects on the quality of the physical, biological and socio-economical environment, taking into account environmental laws and regulations as well as environmental impact assessment guidelines. The course covers the identification of impacts, quantification methods, mitigation measures, and monitoring plans. The course deals with a case study involving the preparation of an environmental impact assessment report.
Pre-requisite: Consent of the instructor.

CIE723 Water Resources Planning and Management [3-0, 3 cr.]
This course covers the major issues in the planning and management of water resource systems, and the techniques — such as linear programming, dynamic programming and nonlinear programming — that are used to solve them. Practical problems in water resource systems such as water allocation, water quality management, reservoir operations, flood control, water resources management, basin modelling and flood and drought forecasting demonstrated are discussed with system analysis methods.
Pre-requisite: CIE721 Hydrology.
CIE724 Air Quality Management [3-0, 3 cr.]
This course covers the analysis of air pollution sources and methods for controlling emissions, with a focus on transportation-related air pollution. The course also encompasses a summary of fundamental chemical and physical processes governing pollutant behavior, and a quantitative overview of the characterization and control of air pollution problems. The analysis of key elements of the air pollution system such as the sources and control techniques, atmospheric transformations, atmospheric transport and modelling are discussed.
Pre-requisites: CIE320 Fluid Mechanics and CHM201 Chemical Principles.

CIE725 Geo-environmental Engineering [3-0, 3 cr.]
This course covers the geotechnical practice in environmental protection and restoration. The characterization of contaminated sites, preliminary site assessment, site investigation techniques and site cleanup and remediation technologies, as well as the monitoring requirements, are discussed. The course also covers the methods of soil and site characterization for siting of waste repositories, the design of waste containment systems, including landfills, slurry walls and soil stabilization, as well as the applicability and use of geosynthetics.
Pre-requisite: CIE444 Soil Mechanics.

CIE726 Unit Operations of Water Treatment Systems [3-0, 3 cr.]
This course covers the theory of aquatic chemistry and the principles of conventional and advanced unit operations, such as sedimentation, filtration, aeration, ion exchange, reverse osmosis for the treatment of drinking water and decontamination of groundwater, stability and conditioning, in addition to a detailed design of inlets, outlets and operational parts of the treatment plant.
Pre-requisite: CIE424 Water Distribution and Treatment

CIE727 Unit Operations of Wastewater Treatment Systems [3-0, 3 cr.]
This course covers wastewater characteristics and laboratory analysis, population kinetics and micro-organisms and their role in the various waste treatment processes, as well as process selection, oxidation kinetics, process modelling and control, sludge treatment and disposal, and unit operations and processes of wastewater treatment.
Pre-requisite: CIE426 Wastewater Collection and Treatment.

CIE728 Fate and Transport of Pollutants in the Environment [3-0, 3 cr.]
This course emphasizes man-made chemicals, their movement through surface and groundwater, air, soil, and their eventual fate. The course covers the physical transport, as well as chemical and biological sources and sinks, and the linkages to health effects, sources and control and policy aspects.
Pre-requisites: CHM201 Chemical Principles and CIE322 Hydraulics.

CIE729 Hydrogeology [3-0, 3 cr.]
This course covers the natural parameters, distribution of water, hydro-geological structures, movement and storage of water; methods of investigation, collection of samples, observation of water levels, measurement of aquifer properties, speed and direction of ground water flow, and hydro-geological models.
Pre-requisite: CIE721 Hydrology.

CIE730 Irrigation and Drainage [3-0, 3 cr.]
This course covers the irrigation practices application systems, soil-plant-water relationships, irrigation system types, scheduling, effluent reuse, case studies, quantity and quality of stream flow generated in a drainage basin, and surface, and subsurface, drainage systems.
Pre-requisite: CIE322 Hydraulics.

CIE731 Urban Water Resources [3-0, 3 cr.]
This course covers the urban climate, urban development effects on catchments responses, design of storm water drainage systems, master plans, management for water pollution, sedimentation, and erosion control, use of models for planning and operation, flood control, reservoir design and operation (linear and dynamic programming, and case studies.
Pre-requisite: CIE721 Hydrology.

CIE732 Advanced Environmental Engineering [3-0, 3 cr.]
This course covers reaction kinetics, classes and types of reactions, rates and orders, analysis of experimental data, applications,
setup of mass balances, flow analysis of CM and PF regimes, detention time in vessels, flow and quality equalization, system material balances, sludge production in activated sludge systems, nitrogen and phosphorus removal, treatment in ponds and wetlands as well as natural systems, fate and transport of pollutants in natural waters, loading equations for streams, dissolved oxygen variation in a stream.

Pre-requisite: CIE426 Wastewater Collection and Treatment.

CIE733 Groundwater Engineering [3-0, 3 cr.] This course covers the flow of incompressible fluids through porous media, groundwater movement, Darcy’s law, groundwater production, recharge, quality, saltwater intrusion, aquifer management, differential equations governing the flows, laboratory and field methods of hydraulic conductivity measurements, confined and unconfined flow, and graphical flow nets and the use of analogs, as well as seepage control in earth structures, soil stabilization, drainage, geo-textiles, and construction denaturing.

Pre-requisite: CIE721 Hydrology.

CIE742 Foundations Engineering [3-0, 3 cr.] This course is an introduction to the elastic and plastic theories of foundations, behavior and design of shallow foundations, behavior and design of lateral earth retaining structures, and an introduction to deep foundations design, and case studies.

Pre-requisite: CIE444 Soil Mechanics.

CIE760 Transportation Engineering II [3-0, 3 cr.] This course covers the analysis and design of infrastructure systems, components of highway systems, interchanges, intersections, execution methods and practices, and the basic design of major transportation facilities.

Pre-requisite: CIE460 Highway Engineering.

CIE761 Traffic Engineering [3-0, 3 cr.] This course covers the human and vehicular characteristics, as they affect highway traffic flow, traffic regulations, accident cause and prevention, improving the flow on existing facilities, planning traffic systems, and terminal problems.

CIE782 Infrastructure Management [3-0, 3 cr.] This course covers the general methods of engineering systems management, and the different types of infrastructure. The course analyzes the possible financing and engineering solutions, and alternatives, as well as the overall management during the life cycle of the project.

Pre-requisite: CIE485 Construction Management.

CIE784 Quality Management Systems [3-0, 3 cr.] This course is an introduction to quality management systems, ISO 9000, 14000, Total Quality Management, and the applications of QMS to engineering and management of large projects, systems, and organizations.

Pre-requisite: Consent of the instructor.

CIE785 Risk and Natural Hazard Management [3-0, 3 cr.] This course covers the types, frequency, and the effects of natural hazards, the calculation of the return period, and the planning and designing of engineering systems to survive natural events, as well as the mitigation of damage.

Pre-requisite: GNE331 Probability and Statistics.

CIE786 Highway Design and Management [3-0, 3 cr.] This course is an introduction to highway networks, their engineering and management characteristics, and their maintenance and performance issues, financing and cost recovery methods, and integrated solutions and information technology tools (use of HDM tools by the World Road Association PIARC).

Pre-requisites: CIE460 Highway Engineering I and INE320 Engineering Economy.

CIE787 Concrete and Steel Construction [3-0, 3 cr.] This course covers the selection and planning of construction methods for modern concrete and steel structures, including bridges, high-rise buildings, sea structures, structural steel erection, and the heavy industrial plants including special forming and heavy erection and false-work.

Pre-requisites: CIE306 Concrete Structures I, CIE400 Steel Structures, and CIE485 Construction Management.
CIE788 GIS and Remote Sensing [3-0, 3 cr.]
This course covers the fundamentals of sensing earth resources, data acquisition and sis, aircraft and satellite images, digital image processing, pattern recognition, feature extraction, and the geographic information systems in various applications, using GIS software including ARC-INFO and ARC-VIEW.

Pre-requisite: CIE360 Surveying.

CIE789 Cost Engineering and Control [3-0, 3 cr.]
This course covers cost engineering for construction organizations, projects, and operations. It encompasses construction financing, break-even, profit, and cash flow analyses, and capital budgeting, as well as the equipment cost and procurement decisions. Construction financial accounting, cost accounting, cost control systems, and databases are discussed, as well as cost indices, parametric estimates, and unit price proposals, measuring work and settling claims.

Pre-requisite: CIE485 Construction Management.

CIE790 Construction Methods [3-0, 3 cr.]
This course is an advancement study of the application and analysis of construction equipment and methods. Topics include drilling, blasting, tunneling, dewatering foundations, and rigging studies.

Pre-requisites: CIE308 Construction Materials and CIE306 Concrete Structures I.

CIE791 Project Scheduling [3-0, 3 cr.]
This course covers the basic critical path planning, and scheduling, with arrow and precedence networks. The course is an introduction to resource leveling, and least cost scheduling, including time-cost tradeoff analysis, and schedule control.

Pre-requisite: Consent of the instructor.

CIE792 Project Contracting [3-0, 3 cr.]
This course covers construction and contracting for contractors, owners and engineers, industry structure, the types of contracts and delivery systems of construction, and the planning, estimating, quantity takeoff and pricing, labor and equipment estimate, as well as the proposal preparation. Students use contract documents to prepare detailed estimates.

Pre-requisite: Consent of the instructor.

CIE799 Special Topic Course [3-0, 3 cr.]
This course is a special topic course which can be offered in any of the concentration areas. When offered, it is counted towards the Degree requirements as a regular course.

Pre-requisite: To be announced prior to registration time.

CIE891 Project Course [3-0, 3 cr.]
This course is a project course in any of the concentration areas. It can be taken by the Graduate student seeking a non-thesis Master’s degree. It is contingent upon the Advisor’s approval. The student is limited to one project course per degree.

Pre-requisite: Consent of the instructor.

CIE899 Thesis [6-0, 6 cr.]
This course is an independent work performed by students with emphasis on research, and leading to original contribution to knowledge. The selection of the topic and the progress of the work are supervised by a Faculty Advisor. The student is limited to one thesis course per degree.

Pre-requisite: Consent of the instructor.
The Department of Electrical and Computer Engineering offers the following degree programs:

**UNDERGRADUATE PROGRAMS**

1. Bachelor of Engineering (B.E.) in Computer Engineering
2. Bachelor of Engineering (B.E.) in Electrical Engineering

**GRADUATE PROGRAM**

Master of Science (M.S.) in Computer Engineering

**UNDERGRADUATE PROGRAMS**

**BACHELOR OF ENGINEERING IN COMPUTER ENGINEERING**

Students in the computer engineering program develop an in-depth knowledge of digital systems, computers, software, networks, and communications systems. In addition to the core topics in electrical and computer engineering, students are exposed to subjects including microprocessors, operating systems, computer architecture, database systems, networks, electronics, control systems, software engineering, reconfigurable computing, communications systems, and telecommunications. This provides for a balanced coverage and an integration of hardware, software, and communications engineering. As part of the academic program, six credits of professional experience are also included in the last summer prior to graduation, to give students an opportunity to integrate classroom instruction with practical work experience.

The broad scope of the program enables the students to pursue different career paths in the design and use of computing and communication systems. Graduates of the program are prepared for employment in the computer and communication industries, and may also select to pursue graduate studies.

The computer engineering program is credit-based and requires the completion of 150 semester hours. A typical schedule is listed below and extends over a four-year period including summer modules; students may select to take these courses over a longer period of time.

**MISSION**

The Mission of the Computer Engineering Program is to educate each student to become a responsible and productive computer engineer who can effectively manage future challenges.

**PROGRAM EDUCATIONAL OBJECTIVES**

Within a few years of graduation, the graduates of the Computer Engineering program will:

1. Demonstrate technical aptitude in Computer Engineering careers and/or graduate studies
2. Establish themselves in diverse fields of Computer Engineering
3. Conduct themselves as effective professionals

**PROGRAM OUTCOMES**

The students will acquire in their matriculation through the program, the following skills, knowledge, and behaviors:

a. An ability to apply knowledge of mathematics, science, and engineering.
b. An ability to design and conduct experiments, as well as to analyze and interpret data.
c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
d. An ability to function on multidisciplinary teams.
e. An ability to identify, to formulate, and to solve engineering problems.
f. An understanding of one’s professional and ethical responsibility.
g. An ability to communicate effectively.
h. A broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
i. A recognition of the need and the ability to engage in lifelong learning.
j. A knowledge of contemporary issues.
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
## MAJOR REQUIREMENTS

### First Year

**Fall Semester (17 credits)**

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<td>MTH201</td>
<td>Calculus III</td>
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<tr>
<td>COE212</td>
<td>Engineering Programming</td>
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<td>GNE212</td>
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<tr>
<td>COE201</td>
<td>Computer Proficiency</td>
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**Spring Semester (16 credits)**

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<td>MTH207</td>
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<td>ETH201</td>
<td>Moral Reasoning</td>
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<td>MTH206</td>
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<td>MTH304</td>
<td>Differential Equations</td>
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</tr>
<tr>
<td>ELE201</td>
<td>Electrical Circuits I</td>
<td>3</td>
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</tbody>
</table>

**Summer Module I (6 credits)**

- Liberal Arts Curriculum Elective (3)
- Liberal Arts Curriculum Elective (3)

**Summer Module II (3 credits)**

- ARA2-3 Arabic Language/Literature (3)

### Second Year

**Fall Semester (15 credits)**

<table>
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<td>ENG203</td>
<td>Fundamentals of Oral Communication</td>
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<tr>
<td>ELE202</td>
<td>Electrical Circuits II</td>
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<tr>
<td>COE312</td>
<td>Data Structures</td>
<td>3</td>
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<tr>
<td>COE321</td>
<td>Logic Design</td>
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<tr>
<td>COE322</td>
<td>Logic Design Lab</td>
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</table>

**Spring Semester (17 credits)**

- Engineering Elective (3)
- ELE401 Electronics I (3)
- ELE402 Electronics I Lab (1)
- ELE430 Signals and Systems (3)
- COE323 Microprocessors (3)
- COE324 Microprocessors Lab (1)
- Liberal Arts Curriculum Elective (3)

**Summer Module I (2 credits)**

- GNE301 Professional Communication (2)

**Summer Module II (4 credits)**

- PED Physical Education (1)
- GNE331 Probability and Statistics (3)

### Third Year

**Fall Semester (16 credits)**

<table>
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<th>Course Code</th>
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<td>ELE442</td>
<td>Control Systems</td>
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<td>ELE443</td>
<td>Control Systems Lab</td>
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<td>ELE537</td>
<td>Communication Systems</td>
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<tr>
<td>COE423</td>
<td>Computer Architecture</td>
<td>3</td>
</tr>
<tr>
<td>COE493</td>
<td>Professionalism</td>
<td>3</td>
</tr>
</tbody>
</table>

**Spring Semester (18 credits)**

- ECE Track X1 (3)
- COE424 Digital Systems (3)
- COE425 Digital Systems Lab (1)
- ECE Elective (3)
- ECE Elective (3)
- ECE Track U1 (3)
- COE492 Fundamentals in ECE (1)
- ELE540 Communications System Lab (1)

**Summer Module I (6 credits)**

- COE498 Professional Experience (6)

### Fourth Year

**Fall Semester (15 credits)**

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>COE418</td>
<td>Database Systems</td>
<td>3</td>
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<tr>
<td>COE414</td>
<td>Operating Systems</td>
<td>3</td>
</tr>
<tr>
<td>COE 591</td>
<td>Capstone Design Project</td>
<td>3</td>
</tr>
</tbody>
</table>
- ECE Track X2 (3)
- Free Elective (3)

**Spring Semester (15 credits)**

- COE416 Software Engineering Systems (3)
- COE431 Computer Networks (3)
- Engineering Elective (3)
- COE592 COE application (3)
- ECE Track U2 (3)

**Technical Electives:**

- ECE technical electives for both COE and ELE programs are grouped into four different tracks. The four tracks and courses within each track are:

1. **Communication & Networks:**
   - ELE599 Information & Coding Theory
   - ELE599 Optical Fiber Communication
   - ELE538 Noise in Communications
   - ELE539 Telecommunications
   - COE431 Computer Networks (for ELE)
   - COE599 Optical Networks

2. **Computer Hardware & Systems:**
   - COE599 VLSI Design
   - COE599 Embedded Systems

   Technical Electives: ECE technical electives for both COE and ELE programs are grouped into four different tracks. The four tracks and courses within each track are:
3. Engineering Systems:
- ELE599 Linear Systems
- ELE599 Reliability
- ELE420 Electro-mechanics (for COE)
- ELE 422 Power (for COE)
- ELE 599 Faulted Power Systems

4. Theory & Algorithms:
- COE418 Database Systems (for ELE)
- COE414 Operating Systems (for ELE)
- COE599 Queuing Theory
- ELE599 Information & Coding Theory

Engineering Electives: engineering electives can be any of the following courses:
- Any ECE Technical Elective
- INE307 Deterministic OR models
- INE308 Stochastic OR models
- INE428 Project Management
- INE529 Project Contracting
- INE527 Project Scheduling
- INE320 Engineering Economy
- INE350 Simulation
- INE402 Optimization
- INE440 Advanced Statistics
- INE506 Decision Analysis
- MEE401 Energy systems (2 credits)
- MEE590 Energy Audit (2 credits)
- MEE599 Introduction to Mechatronics
- CIE520 Solid Waste Management
- CIE521 Hydrology
- CIE522 Environmental Impact Assessment
- CIE525 Environmental Policy and Management
- CIE526 Environmental Remediation
- CIE584 Quality Management Systems
- CIE585 Risk and Natural Hazard Management
- CIE723 Water Resources Planning and Management
- CIE733 Groundwater Engineering
- CIE788 GIS and Remote Sensing

2. Allowed only for Electrical Engineering students
3. Allowed only for Computer Engineering students

COURSE DESCRIPTIONS

COE201 Computer Proficiency [0-2, 1 cr.]
This course covers word processing, spreadsheet, presentation software, internet, e-mail, database and web design.

COE211 Computer Programming [3-2, 4 cr.]
This course covers a one-language syntax, structured programming, basic constructs (arrays, etc.), object-oriented programming and projects.

Pre-requisite: COE201 Computer Proficiency.

COE212 Engineering Programming [3-0, 3 cr.]
This course covers a high-level programming language syntax, structured programming, basic constructs, arrays, object programming, case studies, and projects tailored towards solving engineering and mathematically-oriented problems.

Concurrent with COE 201 Computer Proficiency (Except for INE and MEE Students)

COE312 Data Structures [3-0, 3 cr.]
This course covers the programming principles, stacks and recursion, queues, lists, searching, and sorting algorithms, binary trees and the introduction to object-oriented programming concepts.

Pre-requisite: COE212 Engineering Programming.

COE321 Logic Design [3-0, 3 cr.]
This course provides an introduction to digital logic circuits and covers binary number representations, combinational logic design, Boolean algebra, arithmetic circuits, regular logic, programmable logic devices, flip flops, registers, counters, sequential state machines, and asynchronous and synchronous logic.

Pre-requisites: COE201. Computer Proficiency, COE 212 Engineering Programming, MTH 207 Discrete Structures I.

COE322 Logic Design Lab [0-3, 1 cr.]
This laboratory course provides hands-on experience implementing digital logic design systems using modern computer-aided design tools, discrete components, breadboards, and digital probes.

Concurrent with COE321 Logic Design.

1. Except for ELE305, ELE391 and COE312, any COE/ELE course can be considered as a technical elective as long as it is not a required course. COE599/ELE599 could be taken more than once for credit when topics differ.
COE323 Microprocessors [3-0, 3 cr.]
This course covers the internals of the microprocessor and assembly language, storing, manipulating, moving data, basics of control flow, interfacing to other devices, basics of writing good assembly code using the stacks and position independent codes.
Pre-requisite: COE321 Logical Design.

COE324 Microprocessor Lab [0-3, 1 cr.]
This is a lab course with experiments in microprocessors.
Concurrent with COE323 Microprocessors.

COE414 Operating Systems [3-0, 3 cr.]
This course provides an overview of operating systems and provide the basic structure and architecture of some operating systems in the market.
This course covers the process creation, management, synchronization, communications, and scheduling. Memory management and protection.
Pre-requisite: COE 312 Data Structures, COE323 Microprocessors

COE416 Software Engineering [3-0, 3 cr.]
This course covers the analysis, development, design and documentation of software.
Pre-requisite: COE312 Data Structures.

COE418 Database Systems [3-0, 3 cr.]
This course covers the data modeling, relational database, SQL, query languages, object oriented databases and client-server databases.
Pre-requisite: COE 212 Engineering Programming

COE423 Computer Architecture [3-0, 3 cr.]
This course introduces computer components and systems. Topics include evolution of computer systems, bus interconnections, I/O mechanisms, memory management and hierarchy, instruction set design, and basic pipelined techniques.
Pre-requisites: COE323 Microprocessors.

COE424 Digital Systems [3-0, 3 cr.]
This course is an introduction to digital systems design and covers timing concepts, area-delay tradeoffs, pipelining, and synthesis. Register transfer notation and VHDL are introduced to model, simulate, and verify designs. Topics include field-programmable gate arrays, technology mapping, layout synthesis, and routing.
Pre-requisite: COE323 Microprocessors.

COE425 Digital Systems Lab [0-3, 1 cr.]
This laboratory course provides hands-on experience implementing complex digital systems using modern computer-aided design tools, FPGA-based boards, and various I/O devices.
Concurrent with COE424 Digital Systems

COE431 Computer Networks* [3-0, 3 cr.]
This course covers the topologies, installation and configuration, testing, modeling and simulation of networks. In addition to: protocols, standards, TCP/IP, and socket programming.
Fourth year standing required

COE 492 FUNDAMENTALS IN ECE [0-3, 1 cr.]
This course consolidates the concepts covered in the first two years of the program in mathematics, computers, and engineering with emphasis on their practical applications in ECE. It also provides an accurate and comprehensive assessment for these concepts by exposing the students to professional engineering and FE-style examinations.
Pre-requisite: GNE 331 Probability & Statistics, ELE 430 Signals & Systems, ELE 401 Electronics I, COE 323 Microprocessors

COE 493 PROFESSIONALISM IN ENGINEERING [3-0, 3 cr.]
Overview of the nature and scope of engineering profession. Working on a multidisciplinary team environment; professional and ethical responsibility; the impact of engineering solutions in a global and societal context; contemporary issues; and life-long learning.
Pre-requisite: Third year standing required.

COE498 Professional Experience [0-6, 6 cr.]
This course entails professional experience through training in the execution of real-life engineering projects.
Pre-requisite: Fifth year standing and the consent of the instructor.

COE533 Advanced Computer Networks [3-0, 3 cr.]
This course covers advanced networks, remote procedure calls (RPC’s), layering and ISO.
Pre-requisite: COE431 Computer Networks.
MISSION
The mission of the Electrical Engineering Program is to educate each student to become a responsible and productive electrical engineer capable of effectively managing future challenges.

PROGRAM EDUCATIONAL OBJECTIVES
Within a few years of graduation, the graduates of the Electrical Engineering program will:

1. Demonstrate technical aptitude in Electrical Engineering careers and/or graduate studies
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PROGRAM OUTCOMES
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## MAJOR REQUIREMENTS

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<td>COE212</td>
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<td>ETH201</td>
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<td>MTH304</td>
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**Summer Module I (6 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Liberal Arts Curriculum Elective</td>
<td>3</td>
</tr>
<tr>
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**Summer Module II (3 credits)**

<table>
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<tbody>
<tr>
<td>ARA2-/-3-</td>
<td>Arabic Language/Literature</td>
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### Second Year

**Fall Semester (15 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>ENG203</td>
<td>Fund. of Oral Communication</td>
<td>3</td>
</tr>
<tr>
<td>COE321</td>
<td>Logic Design</td>
<td>3</td>
</tr>
<tr>
<td>COE322</td>
<td>Logic Design Lab</td>
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</tr>
<tr>
<td>ELE391</td>
<td>Mathematical Methods in Elec. Eng.</td>
<td>3</td>
</tr>
<tr>
<td>ELE302</td>
<td>Electrical Circuits II</td>
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<tr>
<td>ELE303</td>
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<tr>
<td>HLT201</td>
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**Spring Semester (17 credits)**

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<tbody>
<tr>
<td>ELE401</td>
<td>Electronics I</td>
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<tr>
<td>COE323</td>
<td>Electronics Lab</td>
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<tr>
<td>COE323</td>
<td>Microprocessors</td>
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<tr>
<td>COE324</td>
<td>Microprocessors Lab</td>
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<tr>
<td>ELE411</td>
<td>Electromagnetic Fields</td>
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</tr>
<tr>
<td>ELE430</td>
<td>Signals and Systems</td>
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**Summer Module I (2 credits)**

<table>
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<tr>
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<th>Credits</th>
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<tbody>
<tr>
<td>GNE301</td>
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**Summer Module II (4 credits)**

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<tbody>
<tr>
<td>PED –</td>
<td>Physical Education</td>
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</tr>
<tr>
<td>GNE331</td>
<td>Probability and Statistics</td>
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### Third Year

**Fall Semester (18 credits)**

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>ELE493</td>
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### Fourth Year

**Fall Semester (13 credits)**

<table>
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<tr>
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<th>Course Title</th>
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<tbody>
<tr>
<td>ELE413</td>
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<td>3</td>
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<tr>
<td>ELE591</td>
<td>Capstone Design Project</td>
<td>3</td>
</tr>
<tr>
<td>MEE220</td>
<td>Engineering Graphics</td>
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<tr>
<td>ELE422</td>
<td>Power Systems</td>
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<tr>
<td></td>
<td>ECE Track U1</td>
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**Spring Semester (16 credits)**

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<tbody>
<tr>
<td>ELE592</td>
<td>ELE Application</td>
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<tr>
<td>ELE423</td>
<td>Power Systems Lab</td>
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<td></td>
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<tr>
<td></td>
<td>ELE Elective</td>
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<tr>
<td></td>
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<td>3</td>
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<tr>
<td></td>
<td>Semiconductor Technologies</td>
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**Summer Module I (2 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNE301</td>
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</table>

**Summer Module II (4 credits)**

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>PED –</td>
<td>Physical Education</td>
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</tr>
<tr>
<td>GNE331</td>
<td>Probability and Statistics</td>
<td>3</td>
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</tbody>
</table>

Technical Electives: ECE technical electives for both COE and ELE programs are grouped into four different tracks. The four tracks and courses within each track are:

### 1. Communication & Networks:
- ELE599 Information & Coding Theory
- ELE599 Optical Fiber Communication
- ELE538 Noise in Communications
- ELE539 Telecommunications
- COE431 Computer Networks (for ELE)
- COE599 Optical Networks

### 2. Computer Hardware & Systems:
- COE599 VLSI Design
- COE599 Embedded Systems
- COE599 High-Perf. Computer Architecture
- COE423 Computer Architecture (for ELE)
3. Engineering Systems:

- ELE599 Linear Systems
- ELE599 Reliability
- ELE420 Electro-mechanics (for COE)
- ELE 422 Power (for COE)
- ELE 599 Faulted Power Systems

4. Theory & Algorithms:

- COE418 Database Systems (for ELE)
- COE414 Operating Systems (for ELE)
- COE599 Queuing Theory
- ELE599 Information & Coding Theory

**Engineering Electives:** engineering electives can be any of the following courses:

- Any ECE Technical Elective
- INE307 Deterministic OR models
- INE308 Stochastic OR models
- INE428 Project Management
- INE529 Project Contracting
- INE527 Project Scheduling
- INE320 Engineering Economy
- INE350 Simulation
- INE402 Optimization
- INE440 Advanced Statistics
- INE506 Decision Analysis
- MEE401 Energy systems (2 credits)
- MEE590 Energy Audit (2 credits)
- MEE599 Introduction to Mechatronics
- CIE520 Solid Waste Management
- CIE521 Hydrology
- CIE522 Environmental Impact Assessment
- CIE525 Environmental Policy and Management
- CIE526 Environmental Remediation
- CIE584 Quality Management Systems
- CIE585 Risk and Natural Hazard Management
- CIE723 Water Resources Planning and Management
- CIE788 GIS and Remote Sensing

1. Except for ELE305, ELE391 and COE312, any COE/ELE course can be considered as a technical elective as long as it is not a required course. COE599/ELE599 could be taken more than once for credit when topics differ.

2. Allowed only for Electrical Engineering students
Pre-requisite: MTH 304 Differential Equations.

**ELE401 Electronics I [3-0, 3 cr.]**
This course covers Microelectronics devices and their applications using latest semiconductors technologies. These devices range from Normal Diodes, ZENER Diodes, LEDs, Photodiodes, BJTs, to MOSFETS. Their applications include the design of regulators, rectifiers, clamping, operational amplifiers and digital integrated circuitry.

Pre-requisite: GNE 331 Probability and Statistics, ELE302 Electrical Circuits II

**ELE402 Electronics I Lab [0-3, 1 cr.]**
The laboratory experiments are hands-on implementation of the devices and circuitry presented in the course as well as circuit simulation using the SPICE software.

Concurrent with ELE401 Electronics I

**ELE411 Electromagnetic Fields [3-0, 3 cr.]**
Fundamental concepts of the electromagnetic model, vector analysis, static electric fields, static magnetic fields, steady electric currents, Maxwell’s equations, Coulomb’s law, Gauss’s law, Biot-Savart law, Faraday’s law, Poisson’s and Laplace’s equations, Joule’s law, capacitance calculations, inductance calculations, resistance calculations.

Pre-requisite: ELE 201 Electrical Circuits I, ELE 391 Mathematical Methods in Electrical Engineering, COE 321 Logic Design

**ELE413 Electromagnetic Waves [3-0, 3 cr.]**
Fundamental concepts of electromagnetic waves, Maxwell’s equations, propagation of plane electromagnetic waves, theory and application of transmission lines, waveguides, antennas.

Pre-requisites: ELE302 Electrical Circuits II and ELE411 Electromagnetic Fields.

**ELE420 Electromechanics [3-0, 3 cr.]**
This course covers three-phase circuit concepts; magnetic circuits; energy storage and conversion; force and emf production; forces and torques of electric origin in electromagnetic systems; power transformers and autotransformers; principles of electric ac machines; synchronous generators; three-phase and single-phase induction motors.

Pre-requisites: ELE411 Electromagnetic Fields.

**ELE422 Power Systems [3-0, 3 cr.]**
This course provides students with a working knowledge of power system problems and computer techniques to solve some of these problems. Topics include: review of three-phase analysis, complex power, per-unit system, synchronous machines, transformers, autotransformers, and regulating transformers; calculation of transmission line parameters, evaluation of steady state operation of transmission lines; reactive power compensation; line capability; power flow analysis using Gauss-Seidel and Newton-Raphson methods.

Pre-requisite: ELE420 Electromechanics

**ELE423 Power Systems Lab [0-3, 1 cr.]**
This course covers the following experiments to study various aspects of electric machines and power systems: fundamentals of electrical power technology; alternating currents; power and impedance in ac circuits; three-phase circuits; single-phase and three-phase transformers; fundamentals of rotating machines; dc motors and generators; ac induction motors; three-phase synchronous generators and motors.

Concurrent with ELE422 Power Systems

**ELE430 Signals and Systems [3-0, 3 cr.]**
Signal and system modeling concepts; system modeling and analysis in time domain; the Fourier series; the Fourier transform and its applications; the Laplace transformation and its applications; discrete-time signals and systems; z-transform; analysis and design of digital filters; DFT and FFT.

Pre-requisite: ELE302 Electrical Circuits II

**ELE442 Control Systems [3-0, 3 cr.]**
This course covers modeling and dynamical systems, transient-response analysis, response of control systems, root locus analysis, and modern control (state space).

Pre-requisite: ELE430 Signals and Systems.

**ELE443 Control Systems Lab [0-3, 1 cr.]**
This course covers laboratory experiments in control systems.

Concurrent with ELE442 Control Systems.

**ELE 492 FUNDAMENTALS IN ECE [0-3, 1 cr.]**
This course consolidates the concepts
covered in the first two years of the program in mathematics, computers, and engineering with emphasis on their practical applications in ECE. It also provides an accurate and comprehensive assessment for these concepts by exposing the students to professional engineering and FE-style examinations.

Pre-requisite: ELE 430 Signals and Systems, GNE 331 Probability and Statistics, COE 323 Microprocessors

**ELE 493 PROFESSIONALISM IN ENGINEERING [3-0, 3 credits]**
Overview of the nature and scope of engineering profession. Working on a multidisciplinary team environment; professional and ethical responsibility; the impact of engineering solutions in a global and societal context; contemporary issues; and life-long learning.

Pre-requisite: Third year standing required.

**ELE498 Professional Experience [0-6, 6 cr.]**
This course entails a professional experience through training in the execution of real life engineering projects.

Pre-requisite: Fifth-year standing and the consent of the instructor.

**ELE525 Faulted Power System* [3-0, 3 cr.]**
This course provides students with advanced knowledge of power system evaluation techniques. Topics include: economic load dispatch with generation limits and line losses; impedance model; three-phase symmetrical faults; symmetrical components; and unsymmetrical faults analysis.

Pre-requisite: ELE422 Power Systems.

**ELE528 Electrification of Plants [3-0, 3 cr.]**
Electrical Design, software and calculation notes complete including Lighting, Power and Low current systems design.

Pre-requisite: ELE422 Power Systems.

**ELE537 Communication Systems [3-0, 3 cr.]**
Basic principles of point-to-point communication link design and analysis, introduction to the theory and principles of modern communication systems, overview of the currently used analog and digital communication techniques and their relative advantages and disadvantages, analog modulation and demodulation, component parts used in analog and digital transceivers.

Pre-requisite: ELE430 Signals and Systems, GNE 331 Probability and Statistics.

**ELE538 Noise in Communication Systems [3-0, 3 cr.]**
This course covers physical noise sources, noise calculations in communication systems, stochastic processes, and communication systems performance in the presence of noise.

Pre-requisite: ELE537 Communication Systems.

**ELE539 Telecommunication Systems [3-0, 3 cr.]**
This course covers spread spectrum and data communications, microwave and satellite links, optical fiber, mobile radio systems, the evolution of mobile radio communications including 2G, 2.5G and 3G, cellular concept, and mobile radio propagation including large-scale path loss.

Pre-requisite: ELE537 Communication Systems.

**ELE540 Communication Systems Lab [0-3, 1 cr.]**
This is a lab course with experiments in communication systems.

Concurrent with ELE538 Noise in Communication Systems.

**ELE591 Capstone Design Project I [3-0, 3 cr.]**
The course is devoted to the solution of open-ended engineering design projects with functional specifications and realistic constraints. This project provides a culminating major design experience that is concluded by a written report and an oral presentation.

Course Pre-requisites: Fifth year standing.

**ELE592 Project II [3-0, 3 cr.]**
This course is an advanced engineering project using acquired technical knowledge, formal report, and presentation.

Pre-requisites: Fifth year standing and the consent of the instructor.

**ELE599 Topics in Electrical Engineering [1-3, 3 cr.]**
This course covers the treatment of new development in various areas of Electrical Engineering.

Pre-requisites: Final-year standing and the consent of the instructor.
Graduate Program

MASTER OF SCIENCE IN COMPUTER ENGINEERING

The Graduate Computer Engineering (COE) and the Computer and Communication Engineering (CCE) programs strive to prepare students for further graduate studies, as well as for a possible career in the industry. Two important objectives are addressed:

1. A sufficient level of breadth that guarantees general knowledge in the main areas of COE/CCE. These areas were chosen carefully to span four major areas: Hardware and Systems, Software and Theory, Communication Systems, and Systems Engineering.

2. A sufficient level of depth that will allow students some degree of specialization. Therefore, students will have the requisite background needed to pursue a higher graduate education and perform research. In addition, the curriculum provides a good practical experience by allowing students to choose from a variety of practical and implementation-oriented courses.

MISSION

The Mission of the Graduate Program in Computer Engineering is to train graduate students in an active research environment, and to equip them with the latest tools of research.

EDUCATIONAL OBJECTIVES

The purpose of the Graduate Program in Computer Engineering is to:

1. Aid students in creatively using their background in basic sciences and mathematics, as well as their expertise in certain areas of computer engineering.

2. Assist students in innovatively applying the design process to complex engineering problems, and innovatively using computers as a tool for simulation, analysis, design and computing.

3. Provide a creative, critical and model-based thinking and problem-solving approach.

4. Offer students the opportunity to do research on important scientific and technical problems, to disseminate knowledge, and to publish research findings.

STUDENT OUTCOMES

Graduates of the Graduate Program in Computer Engineering will acquire the following skills:

a. The ability to demonstrate a mastery of the methodology and the techniques specific to the field of study.

b. The ability to communicate both orally and in writing at a high level of proficiency in the field of study.

c. The ability to conduct research or to develop other forms of creative project work.

d. The ability to function as a professional in the discipline.

EMPHASIS AREAS

The course work for the master’s program in Computer Engineering can be grouped into the following two emphasis areas:

1. Computer Engineering
2. Computer and Communication Engineering

Computer Engineering (COE) focuses on the design, analysis and application of computers, and on their applications as components of systems.

Computer and Communication Engineering (CCE) focuses on the design, analysis and application of communication and telecommunication systems, as well as systems in computer engineering.

ADMISSION REQUIREMENTS

Applicants for admission to this program must have a Bachelor of Science in Engineering, or a Bachelor of Engineering Degree from a recognized college or university, with a minimum general Grade Point Average (GPA) equivalent to 2.75, on a 4-point scale, or 2.75 in the major. If the bachelor’s degree is not in the field to be pursued, and/or if the GPA is less than 2.75, the applicant may be admitted as “special,” as described in the Academic Rules and Regulations for Graduate Programs.

The GRE general exam is required of all applicants (GRE subject exams are not required). All applicants must submit scores for the GRE general exam (includes verbal reasoning, quantitative reasoning, and analytical writing scores). Your GRE test scores are an important part of your application. GRE test scores that are more than 5 years old will not be accepted.
The admissions committee considers several factors when making admission decisions: your academic performance at prior institutions (grades, rankings, and GPAs) and your GRE test score. The rate of graduate assistantship (GA), when requested, is directly related to your GPA and GRE scores. Letters of recommendation are optional; however, three letters are recommended, two of which to be completed by faculty who are familiar with your academic performance.

CREDIT REQUIREMENTS

The Graduate Program in COE, with emphasis in COE or CCE, consists of 30 credit hours, and leads to a Master of Science in Computer Engineering, with emphasis in COE or CCE.

Students with a Bachelor of Engineering Degree, and who are pursuing a Master of Science Degree, may transfer up to six credits from their Bachelor of Engineering Degree, provided that the transferred credits correspond to courses labeled graduate courses, and the student has scored at least a “B” on each of these courses.

GRADUATE COURSE REQUIREMENTS

The graduate courses have been grouped into the following four concentration areas:

1. Hardware and Systems
2. Software and Theory
3. Communication Systems
4. Systems Engineering

The proposed graduate curricula for each of the two programs are based on the breadth and depth requirements. The breadth requirements consist of six courses (18 credit hours) for both programs.

In order to satisfy the requirements for the MSE in Computer Engineering with emphasis on:

Computer Engineering, the student is required to complete at least

• Four courses from Hardware & Systems,
• One course from Software and Theory, and
• One course from either Communication Systems or Systems Engineering.

Computer and Communications Engineering, the student is required to complete at least

• Two courses from Hardware & Systems,
• One course from Software & Theory

• Two courses from Communication Systems, and
• One course from Systems Engineering

The remaining courses may be chosen, without restriction, from any of the four concentration areas, and counted toward the depth requirement. It is recommended that these courses be chosen in the thesis area, in consultation with the student’s advisor.

COURSE LISTINGS

The following is a list of selected courses (three credits each) in the four concentration areas:

Other topic courses might be offered in these areas:

Hardware & Systems

<table>
<thead>
<tr>
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<th>Course Name</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>COE725</td>
<td>VLSI Design</td>
<td>3</td>
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<tr>
<td>COE722</td>
<td>Rapid Prototyping</td>
<td>3</td>
</tr>
<tr>
<td>COE726</td>
<td>VLSI Design Automation</td>
<td>3</td>
</tr>
<tr>
<td>COE728</td>
<td>ULSI Testing</td>
<td>3</td>
</tr>
<tr>
<td>COE761</td>
<td>Embedded Systems</td>
<td>3</td>
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Systems

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<tr>
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<th>Course Name</th>
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<tbody>
<tr>
<td>COE533</td>
<td>Advanced Computer Networks</td>
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</tr>
<tr>
<td>COE711</td>
<td>Transactions Processing Systems</td>
<td>3</td>
</tr>
<tr>
<td>COE712</td>
<td>Distributed Systems</td>
<td>3</td>
</tr>
<tr>
<td>COE723</td>
<td>High Performance Computer Architecture</td>
<td>3</td>
</tr>
<tr>
<td>COE732</td>
<td>Networks Security</td>
<td>3</td>
</tr>
<tr>
<td>COE733</td>
<td>Optical Networks</td>
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Software & Theory

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<tr>
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<th>Course Name</th>
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<tbody>
<tr>
<td>COE714</td>
<td>Advanced Software Engineering</td>
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<tr>
<td>COE715</td>
<td>Object-Oriented Software Engineering</td>
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</tr>
<tr>
<td>COE716</td>
<td>Knowledge-Based Systems</td>
<td>3</td>
</tr>
<tr>
<td>COE717</td>
<td>Parallel Programming and Cluster Workstations</td>
<td>3</td>
</tr>
<tr>
<td>COE718</td>
<td>Computer Graphics</td>
<td>3</td>
</tr>
<tr>
<td>COE741</td>
<td>Artificial Intelligence</td>
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Theory and Algorithms

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<th>Course Name</th>
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<tr>
<td>COE742</td>
<td>Neural Networks</td>
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<td>COE752</td>
<td>Design &amp; Analysis of Algorithms</td>
<td>3</td>
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<tr>
<td>COE753</td>
<td>Heuristic Optimization</td>
<td>3</td>
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<tr>
<td>COE754</td>
<td>Automata Theory &amp; Formal Languages</td>
<td>3</td>
</tr>
<tr>
<td>COE755</td>
<td>Queuing Theory</td>
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Communication Systems

<table>
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<th>Course Name</th>
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<tbody>
<tr>
<td>ELE731</td>
<td>Optical Fiber Communications</td>
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</tr>
<tr>
<td>ELE732</td>
<td>Wireless Communication Systems</td>
<td>3</td>
</tr>
<tr>
<td>ELE733</td>
<td>Mobile Communication Systems</td>
<td>3</td>
</tr>
<tr>
<td>ELE735</td>
<td>Information and Coding Theory</td>
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</table>

Students with a Bachelor of Engineering Degree, and who are pursuing a Master of Science Degree, may transfer the following
This course is an introduction to distributed systems, distributed system models, network architecture and protocols, interprocess communication, client-server models, group communication, TCP sockets, remote procedure calls, distributed objects and remote invocation, distributed file systems, file service architecture, name services, directory and discovery services, distributed synchronization and coordination, and distributed multimedia systems.

COE714 Advanced Software Engineering [3-0, 3 cr.]
This course covers the techniques for the construction of reliable and cost-effective large-scale software. Topics include process models, requirements analysis and specification, design methods and principles, testing methodologies, software maintenance, software metrics, and software management and quality. Students will explore, in depth, current research work on a topic of their choice.

COE715 Object-Oriented Software Engineering [3-0, 3 cr.]
This course introduces key concepts in object-oriented programming and software engineering. Topics covered include data abstraction and encapsulation, polymorphism, object-oriented analysis and design methods, object-oriented programming, templates, design patterns, an introduction to UML, documentation, debugging, metrics, formal specification, user-interfaces, concurrent and distributed objects, process and project management issues.

Pre-requisite: COE312 Data Structures and Algorithms.

COE716 Knowledge-Based Systems [3-0, 3 cr.]
This course covers the knowledge representation, search techniques, logical reasoning, and language understanding. The course is an introduction to the methodology of design and the implementation of expert systems. The course emphasizes the techniques for representing and organizing domain and control knowledge, as opposed to the theory and implementation of inference engines.

Pre-requisite: COE312 Data Structures and Algorithms.

COE717 Parallel Programming and Cluster Workstations [3-0, 3 cr.]
This course covers a parallel computing, using groups of computers to solve problems at a greater computational speed. Topics
include parallel computing techniques and algorithms, including divide and conquer, pipelined computations, genetic algorithms and simulated annealing. Topics also include synchronous and asynchronous computations, load balancing, shared memory, distributed memory, and distributed shared memory. Use of the message-passing method of parallel computing, and use the standard parallel computing tools such as PVM and MPI.

Pre-requisite: COE312 Data Structures and Algorithms.

COE718 Computer Graphics [3-0, 3 cr.]
This course is an introduction to computer graphics algorithms, programming methods and applications, with a focus on the fundamentals of two and three dimensional raster graphics, scan-conversion, clipping, geometric transformations, computational geometry, computer-human interfaces, animation, and visual realism.

Pre-requisite: CSC312 Data Structures and Algorithms.

COE721 Embedded Systems [3-0, 3 cr.]
This course explores the embedded system hardware and firmware design, embedded processor selection, hardware/firmware partitioning, glue logic, circuit design, circuit layout, circuit debugging, development tools, firmware architecture, firmware design, and firmware debugging, analysis of the architecture and instruction set of a popular microcontroller, and the relationship between hardware and high-level languages.

Pre-requisites: COE323 Microprocessors and COE321 Logical Design.

COE722 Rapid Prototyping [3-0, 3 cr.]
This course covers the principles and techniques for rapid prototyping of electronic systems, top-down design methodology, techniques, technologies, and tradeoffs (design time–cost–speed–power–area) as applied to the entire digital electronic system design hierarchy (system–module–chip–circuit), high-level system specification, and simulation techniques, synthesis and schematic capture alternatives to hardware realization.

Pre-requisite: COE312 Reconfigurable Computing.

COE723 High Performance Computer Architecture [3-0, 3 cr.]
This course covers the concepts and examples of advanced computer systems, especially scalable parallel computers. Topics include memory-system design, advanced processor design techniques, pipelined, vector, shared-memory, and distributed-memory computer systems, parallel algorithms, and software and architectural issues for efficient parallel processing.

Pre-requisite: COE725 VLSI Design [3-0, 3 cr.]
This course covers the VLSI design, circuits’ layout, timing, delay, power estimation, use of layout editors and circuit simulation tools, synthesis, and an introduction to electronic design automation.

Pre-requisite: COE321 Logical Design.

COE725 VLSI Design Automation [3-0, 3 cr.]
This course covers the algorithms and methodologies for the synthesis, analysis and verification of digital systems, silicon compilation, high-level synthesis, logic synthesis, and layout synthesis, hardware description languages and their use in the synthesis process, fault simulation and coverage analysis, and the extensive use of electronic design automation tools.

Pre-requisite: COE321 Logical Design.

COE728 ULSI Testing [3-0, 3 cr.]
This course covers the problems of testing of Ultra Large Scale Integrated Circuits (ULSI), the design of circuits for testability, the design of built-in self-testing circuits, and the use of the IEEE Boundary Scan Standards. Topics include introduction to the testing process, fault modeling and detection, logic and fault simulation, testability measures, test generation for combinational circuits, test generation for sequential circuits, design for testability, built-in self-test, delay testing, current testing, ATPG-based logic synthesis, system test, and core-based design, and testing a system-on-a-chip (SOC).

Pre-requisite: COE321 Logical Design.

COE732 Networks Security [3-0, 3 cr.]
This course is an introduction to network security, including developing an understanding of security engineering, cryptography, mechanisms to protect private communication over public network, and techniques to protect networked computer systems. This course considers the technical, operational and managerial issues of computer systems and network security in an operational environment. The course will address the threats to computer security, including schemes for breaking security, and techniques for detecting and preventing security
violations. Emphasis will be on instituting safeguards, examining the different types of security systems, and applying the appropriate level of security for the perceived risk.

Pre-requisite: COE431 Computer Networks.

COE 733 Optical Networks [3-0, 3 cr.]
This course covers the fundamentals of optical networking. In particular, it touches on the following topics: the building blocks of optical wavelength division multiplexed networks, wavelength division multiplexing (WDM) and its enabling technologies, WDM-based access and metro optical network architectures, wavelength-routed optical wavelength division multiplexed networks used for wide area coverage, optical burst switched networks, and optical packet switched networks.

Pre-requisite: Consent of instructor.

COE741 Artificial Intelligence [3-0, 3 cr.]
This course is an introduction to artificial intelligence concepts, heuristic search, clause form logic, knowledge representation, reasoning and inference, an overview of the computer vision, planning, natural language, Lisp, and Prolog. Subjects covered may include unification and resolution in first order logic, graph search algorithms, planning, game playing, heuristic classifiers, knowledge engineering, and uncertainty management.

Pre-requisite: COE312 Data Structures and Algorithms.

COE742 Neural Networks [3-0, 3 cr.]
This course covers the construction and function of neurons, synaptic transmission and plasticity, the functional organization of the neural system, modeling and simulation of real neural networks, the most well-known ANN-architectures and algorithms for learning, methods for unsupervised learning, principles for neural network representation, hardware architectures for neural computations (neural chips and neural computers), examples of technical applications of ANN in areas like pattern recognition, combinatorial optimizations, diagnosis, and robotics.

Pre-requisite: The consent of the instructor.

COE752 Design and Analysis of Algorithms [3-0, 3 cr.]
This course covers the time and space complexity of algorithms. It looks at the models of computation, the techniques for efficient algorithm design, and the effect of data structure choice on the efficiency of an algorithm, as well as the divide and conquer techniques, greedy methods, dynamic programming, amortized analysis, graph and network algorithms, NP-completeness, and selected advanced algorithms.

Pre-requisite: The consent of the instructor.

COE753 Heuristic Optimization [3-0, 3 cr.]
This course covers the basic heuristic optimization techniques in computing. This course describes a variety of heuristic search methods including serial simulated annealing, Tabu search, genetic algorithms, ant algorithms, derandomized evolution strategy, and random walk. Algorithms will be described in serial as well as in parallel fashion. Students can select application projects from a range of application areas. The advantages and disadvantages of heuristic search methods, for both serial and parallel computation, are discussed in comparison to other optimization algorithms.

Pre-requisite: The consent of the instructor.

COE754 Automata Theory and Formal Languages [3-0, 3 cr.]
This course covers the Finite Automata and regular expressions, context-free grammars, pushdown Automata, properties of context-free languages, Turing machines, undecidability, computational complexity, and P and NP problems.

Pre-requisite: The consent of the instructor.

COE 755 Queuing Theory [3-0, 3 cr.]
This course introduces two modeling techniques, namely simulation and queuing modeling techniques. The following topics are discussed in this regard: single queue Markovian systems, semi-Markovian queueing systems, open queueing networks, closed queueing networks, pseudo-random number generation, estimation techniques for analyzing endogenously created data, and validation of a simulation design.

Pre-requisite: Consent of instructor.

COE 761 Embedded Systems [3-0, 3 cr.]
This course provides an introduction to the design of embedded systems including both their hardware and software. Topics ranging from simple circuit design to computer architecture will be discussed. Different types of processors will be presented along with interfacing to memories, I/O devices, and other processors. The 68HC12 will be used as an example processor for assignments and the course project. Pre-requisite: Consent of instructor.

COE898 Project [3-0, 3 cr.]
This design course integrates various areas of electrical and computer engineering into a real design project. Design reviews, and a final oral presentation with a written report, are required.

Pre-requisites: 15 graduate credits, and the consent of the instructor.

COE899 Thesis [6-0, 6 cr.]
This is a master’s thesis research course under the direction of a faculty member.

ELE544 Feedback Control [3-0, 3 cr.]
This course covers the frequency-response analysis, control systems design by frequency response, PID controls, and an introduction to robust control.

Pre-requisite: ELE442 Control Systems.

ELE 724 Faulted Power System [3-0, 3cr.]
This course covers the techniques and mathematical tools needed to analyze faulted power systems. Topics include impedance model, analysis of three-phase symmetrical faults, symmetrical components, unsymmetrical faults, and power systems stability. Students will be challenged to draw upon a background of knowledge from earlier studies to explore these topics in a comprehensive manner. Pre-requisite: ELE 422 Power Systems and Consent of instructor.

ELE731 Optical Fiber Communications [3-0, 3 cr.]
This course covers the waveguiding in optical fibers, fiber losses including attenuation, dispersion and nonlinearities, noise, receiver and transmitter design, link analysis, introduction to erbium-doped amplifiers, and time- and wavelength-division-multiplexed networks.

Pre-requisite: The consent of the instructor.

ELE732 Wireless Communication Systems [3-0, 3 cr.]
This course covers the evolution of the mobile radio communications including 2G, 2.5G and 3G, cellular concept, and the mobile radio propagation, including large-scale path loss, and small-scale fading and multipath.

Pre-requisite: ELE537 Communication Systems.

ELE733 Mobile Communication Systems [3-0, 3 cr.]
This course covers the modulation techniques for mobile radio, equalization, diversity, and channel coding, speech coding, multiple access techniques for wireless communications, wireless networking, and wireless systems and standards.


ELE 734: Optical Fiber Communications [3-0, 3 cr.]
Basic principles of point-to-point optical fiber communications, waveguiding and signal degradation in optical fibers, optical sources, photodetectors, WDM components, dimensioning of fiber links for analog and digital transmissions, performance of digital optical communication systems in the presence of noise. Pre-requisite: Consent of instructor.

ELE 735: Information and Coding Theory [3-0, 3 cr.]
Information theory applied to communication systems. It covers digital signals and streams, information measures, data compression, error-correcting codes, block codes, convolutional codes, Viterbi algorithm, noise, maximum-entropy, Markov chains, channel capacity formalism and Shannon’s theorem.

Pre-requisite: Consent of instructor.

ELE742 Linear Systems [3-0, 3 cr.]
This course covers the canonical realization of transfer functions, state observability and controllability, state feedback and asymptotic observers, reduced order observers, and regulator design.

Pre-requisite: ELE442 Control Systems.

ELE753 Reliability Evaluation of Engineering Systems [3-0, 3 cr.]
This course covers the basic reliability concepts, elements of probability and statistical theory, application of important distributions, reliability in series, parallel and complex systems, application of Markov chains in the evaluation of repairable system reliability, application of Markov processes for reliability evaluation of complex systems, and the utilization of Monte Carlo simulation in basic system reliability evaluation.

Pre-requisite: GNE331 Probability and Statistics.

Special topics [3-0, 3 cr.]
This course covers topics of current interest selected by the faculty.

Pre-requisite: The consent of the instructor.
Department Of Industrial & Mechanical Engineering

The Department of Industrial and Mechanical Engineering offers the following degree programs:

UNDERGRADUATE PROGRAMS
1. Bachelor of Engineering (B.E.) in Industrial Engineering
2. Bachelor of Engineering (B.E.) in Mechanical Engineering
With a minor in Packaging

GRADUATE PROGRAM
Master of Science (M.S.) in Industrial Engineering and Engineering Management.

Undergraduate Programs

BACHELOR OF ENGINEERING IN INDUSTRIAL ENGINEERING

Industrial growth has created unusual opportunities for industrial engineers in Lebanon and the region. Automation, and the emphasis on increased productivity, coupled with higher complexity in systems’ engineering, are resulting in a greater demand for engineering graduates with a broad interdisciplinary background. This program prepares students for industrial practice in such areas as: product design, process design, plant operation, production control, quality control, facilities planning, work system analysis and evaluation, and economic analysis of operational systems.

Students are trained to apply engineering principles in solving problems encountered in environments and situations, where a quantitative basis for decision-making is needed. Six credits of professional experience are also included in the summer of the third year, to give students an opportunity to integrate classroom instruction with practical work experience as a part of their academic program.

The Industrial Engineering Program requires the completion of 150 semester hours. While the program is credit-based, a typical schedule over a four-year period, including summer modules, is listed below. Students may select to take these courses over a longer period of time.

MISSION
The Industrial Engineering Program strives to support the mission of the school by providing students with a solid and contemporary industrial engineering curriculum and a broad education that prepares them for successful careers as industrial engineers in a globalized world as well as graduate studies.

PROGRAM EDUCATIONAL OBJECTIVES
Within a few years of graduation, the graduates of the industrial engineering program will:

1. Lead successful careers in a wide range of Industrial Engineering areas or succeed in graduate studies.
2. Be agents of change in dynamic environments.
3. Establish themselves as responsible professionals and work successfully as members of a multi-disciplinary team.

PROGRAM OUTCOMES
The students will acquire in their matriculation through the program, the following skills, knowledge, and behaviors:

a. An ability to apply knowledge of mathematics, science and engineering.
b. An ability to design and conduct experiments, as well as to analyze and interpret data.
c. An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
d. An ability to function on multidisciplinary teams.
e. An ability to identify, formulate and solve engineering problems.
f. An understanding of one’s professional and ethical responsibility.
g. An Ability to communicate effectively.
h. A broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
i. A recognition of the need and the ability to engage in lifelong learning.
j. A Knowledge of contemporary issues.
k. An Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
### MAJOR REQUIREMENTS

#### First Year

**Fall Semester (16 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>COE 212</td>
<td>Engineering Programming</td>
<td>3</td>
</tr>
<tr>
<td>ENG 202</td>
<td>Sophomore Rhetoric</td>
<td>3</td>
</tr>
<tr>
<td>GNE 212</td>
<td>Engineering Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>MEE 211</td>
<td>Engineering Graphics</td>
<td>1</td>
</tr>
<tr>
<td>MTH 201</td>
<td>Calculus III</td>
<td>3</td>
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#### Spring Semester (16 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ARA 201</td>
<td>Appreciation of Arabic Lit.</td>
<td>3</td>
</tr>
<tr>
<td>ELE 305</td>
<td>Introduction to Electrical Eng.</td>
<td>3</td>
</tr>
<tr>
<td>ETH 201</td>
<td>Moral Reasoning</td>
<td>1</td>
</tr>
<tr>
<td>MTH 304</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>MTH 206</td>
<td>Calculus IV</td>
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#### Summer Module I (6 credits)

<table>
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<tr>
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<tbody>
<tr>
<td>GNE333</td>
<td>Engineering Analysis I</td>
<td>3</td>
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#### Summer Module II (4 credits)

<table>
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<tbody>
<tr>
<td>GNE331</td>
<td>Probability and Statistics</td>
<td>3</td>
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<tr>
<td>PED 2-</td>
<td>Physical Education</td>
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#### Second Year

**Fall Semester (15 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>INE 307</td>
<td>Intro. To Deterministic OR Models</td>
<td>3</td>
</tr>
<tr>
<td>INE 350</td>
<td>Simulation</td>
<td>3</td>
</tr>
<tr>
<td>INE 351</td>
<td>Simulation Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>MEE 212</td>
<td>Computer Applications in IME</td>
<td>2</td>
</tr>
<tr>
<td>MEE 321</td>
<td>Material Properties &amp; Processes</td>
<td>3</td>
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<tr>
<td>xxx</td>
<td>Engineering Elective (1/3)</td>
<td>3</td>
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#### Spring Semester (16 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>INE 308</td>
<td>Intro. To Stochastic OR models</td>
<td>3</td>
</tr>
<tr>
<td>INE 320</td>
<td>Engineering Economy I</td>
<td>3</td>
</tr>
<tr>
<td>INE 346</td>
<td>Production Systems I</td>
<td>3</td>
</tr>
<tr>
<td>INE 362</td>
<td>Production Processes &amp; Mach.</td>
<td>3</td>
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<tr>
<td>INE 363</td>
<td>Production Processes Lab.</td>
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<td>Engineering Elective (2/3)</td>
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#### Summer Module I (5 credits)

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<th>Course Code</th>
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<tbody>
<tr>
<td>ENG203</td>
<td>Fundamentals of Oral Communication</td>
<td>3</td>
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<tr>
<td>GNE301</td>
<td>Professional Communication</td>
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#### Summer Module II (4 credits)

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Liberal Arts Curriculum Elective</td>
<td>3</td>
</tr>
<tr>
<td>HLT201</td>
<td>Basic Health</td>
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#### Third Year

**Fall Semester (15 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>GNE 305</td>
<td>Professional Ethics</td>
<td>1</td>
</tr>
<tr>
<td>INE 416</td>
<td>Ergonomics</td>
<td>4</td>
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<tr>
<td>INE 417</td>
<td>Ergonomics Lab</td>
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</tr>
<tr>
<td>INE 442</td>
<td>Quality Control</td>
<td>3</td>
</tr>
<tr>
<td>INE 446</td>
<td>Production Systems II</td>
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</tbody>
</table>

#### Spring Semester (17 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>INE 428</td>
<td>Project Management</td>
<td>3</td>
</tr>
<tr>
<td>INE 438</td>
<td>Facilities Planning and Logistics</td>
<td>3</td>
</tr>
<tr>
<td>INE xxx</td>
<td>Technical Elective (1/10) [Area 1]</td>
<td>3</td>
</tr>
<tr>
<td>INE xxx</td>
<td>Technical Elective (2/10) [Area 2]</td>
<td>3</td>
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<tr>
<td>INE xxx</td>
<td>Technical Elective (3/10) [Area 3]</td>
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#### Summer Module I (6 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>COE498</td>
<td>Professional Experience</td>
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#### Fourth Year

**Fall Semester (16 credits)**

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<th>Course Code</th>
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<th>Credits</th>
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<tbody>
<tr>
<td>INE 591</td>
<td>Project 1</td>
<td>3</td>
</tr>
<tr>
<td>INE 593</td>
<td>Capstone Engineering Design</td>
<td>1</td>
</tr>
<tr>
<td>INE 440</td>
<td>Advanced Statistics</td>
<td>3</td>
</tr>
<tr>
<td>INE xxx</td>
<td>Technical Elective (4/10) [Area 4]</td>
<td>3</td>
</tr>
<tr>
<td>INE xxx</td>
<td>Technical Elective (5/10) [Free]</td>
<td>3</td>
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<tr>
<td>INE xxx</td>
<td>Technical Elective (6/10) [Free]</td>
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#### Spring Semester (14 credits)

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<tbody>
<tr>
<td>INE 491</td>
<td>Seminar on Contemporary Issues</td>
<td>2</td>
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<tr>
<td>INE xxx</td>
<td>Technical Elective (7/10) [Free]</td>
<td>3</td>
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<tr>
<td>INE xxx</td>
<td>Technical Elective (8/10) [Free]</td>
<td>3</td>
</tr>
<tr>
<td>INE xxx</td>
<td>Technical Elective (9/10) [Free]</td>
<td>3</td>
</tr>
<tr>
<td>INE xxx</td>
<td>Technical Elective (10/10) [Free]</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Engineering Elective Courses

The following table clarifies the “INE Engineering Elective” requirement:

- The first column lists the approved courses’ Subjects
- The second column lists the excluded courses that DO NOT count as INE Engineering elective towards graduation.
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Department Of Industrial & Mechanical Engineering

<table>
<thead>
<tr>
<th>Category</th>
<th>Exclusions from category</th>
</tr>
</thead>
<tbody>
<tr>
<td>courses with MEE prefix</td>
<td>MEE220, MEE241, MEE498, MEE591, MEE92, MEE99 and all Lab courses (1-credit courses).</td>
</tr>
<tr>
<td></td>
<td>Lab Courses are: MEE305, MEE312, MEE333, MEE406, MEE408, MEE433, MEE443, MEE404, MEE516.</td>
</tr>
<tr>
<td>courses with COE prefix</td>
<td>COE201, COE211, COE498, COE591, COE592, COE599 and all Lab courses (1-credit courses).</td>
</tr>
<tr>
<td></td>
<td>Lab Courses are: COE303, COE322, COE324, COE411, COE425, COE515, COE516.</td>
</tr>
<tr>
<td>courses with ELE prefix</td>
<td>ELE201, ELE591, ELE498, ELE592, ELE599, and all lab courses (1 credit courses).</td>
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<tr>
<td></td>
<td>Lab Courses are: ELE303, ELE402, ELE403, ELE416, ELE423, ELE443, ELE523, ELE540, ELE546.</td>
</tr>
<tr>
<td>courses with CIE prefix</td>
<td>CIE200, CIE360, CIE498, CIE580, CIE584, CIE585, CIE600, CIE601, CIE602, and all Lab and SOFT Courses.</td>
</tr>
<tr>
<td>courses with ACC, FIN, ECO, MIS prefixes</td>
<td>ACC430, ACC499, ACC521, FIN401, FIN499, EC0330, EC0331, EC0402, EC0410, EC0499, EC0511, MIS350, MIS488, MIS499.</td>
</tr>
<tr>
<td>Courses with CSC, and MTH prefix</td>
<td>CSC201, CSC241, CSC242, CSC243, CSC398, CSC480, CSC490, CSC498, CSC599, MTH101, MTH102, MTH111, MTH200, MTH201, MTH206, MTH301, MTH304, MTH320 to MTH406, MTH497, MTH498, MTH499, MTH321, MTH401, MTH402, MTH406.</td>
</tr>
</tbody>
</table>

3. Manufacturing
- INE563 [3-0, 3 cr.] CAD/CAM
- INE564 [3-0, 3 cr.] Reliability Evaluation of Engineering Systems
- INE565 [3-0, 3 cr.] Analysis of Automated Manufacturing Systems
- INE566 [3-0, 3 cr.] Advanced Information Technology for Industrial & Manufacturing Engineering
- INE567 [3-0, 3 cr.] Time Series Control & Process Adjustment

4. Industrial Management & Economics
- INE506 [3-0, 3 cr.] Decision Analysis
- INE521 [3-0, 3 cr.] Engineering Economy II
- INE522 [3-0, 3 cr.] Cost Engineering and Control
- INE523 [3-0, 3 cr.] Financial Engineering
- INE524 [3-0, 3 cr.] Advanced Financial Engineering
- INE527 [3-0, 3 cr.] Project Scheduling
- INE529 [3-0, 3 cr.] Project Contracting

Special Topics
- INE599 [1-3, 3 cr.] Topics in Industrial Engineering

Technical Elective Courses by Concentration Areas

1. Optimization
- INE407 [3-0, 3 cr.] Network Flow
- INE501 [3-0, 3 cr.] Linear Programming
- INE502 [3-0, 3 cr.] Integer Programming
- INE503 [3-0, 3 cr.] Nonlinear Optimization
- INE504 [3-0, 3 cr.] Stochastic Processes
- INE505 [3-0, 3 cr.] Dynamic Programming
- INE507 [3-0, 3 cr.] Advanced Stochastic Processes
- INE551 [3-0, 3 cr.] Advanced Simulation

2. Production Systems
- INE436 [3-0, 3 cr.] Materials Handling
- INE541 [3-0, 3 cr.] Quality Management Systems
- INE542 [3-0, 3 cr.] Supply Chain Management
- INE544 [3-0, 3 cr.] Inventory Analysis
- INE548 [3-0, 3 cr.] Machine Scheduling
COURSE DESCRIPTIONS

INE302 Linear Programming [3-0, 3 cr.]
This course covers the formulation of linear programming problems, simplex method, duality, and sensitivity analysis.
Pre-requisite: GNE333 Engineering Analysis I.

INE307 Deterministic OR models [3-0, 3 cr.]
Introduction to deterministic OR modeling. Optimization modeling: decision variables, objective functions, and constraints. Models include linear programs, integer programs, transportation and assignment problems, simple network problems. Methods include simplex method, transportation simplex, shortest path, minimum cost flow, and maximum flow problems.
Pre-requisites: GNE333 Engineering Analysis I, COE 212 Engineering Programming.

INE308 Stochastic OR models [3-0, 3 cr.]
Introduction to discrete Markov chains and continuous Markov Processes, including transient and limiting behavior. The Poisson/Exponential process. Conditional probabilities and conditional expectations. Applications to reliability, maintenance, inventory, production, simple queues and other engineering problems. Introduction to decision theory, risk, utility and decision trees.
Pre-requisites: GNE331 Probability and Statistics, INE 307 Deterministic OR models.

INE320 Engineering Economy I [3-0, 3 cr.]
This course covers equivalence and interest formulae, real-world transactions, present worth analysis, annual equivalent worth, rate of return analysis, depreciation, inflation, and cost/benefit ratio.
Pre-requisite: Third year standing.

INE345 Production Control [4-0, 4 cr.]
This course covers forecasting, capacity planning, aggregate planning, line balancing, and financial analysis.
Pre-requisite: INE302 Linear Programming, COE221 Computer Programming, and GNE331 Probability and Statistics.

INE346 Production Systems I [3-0, 3 cr.]
Course is an introduction to subjects that span the industrial engineering curriculum and that are covered in greater detail in more advanced courses. Subjects covered are Forecasting, EOQ, safety stock, Process design, Aggregate Planning, facilities planning and logistics, quality control, human factors, ergonomics and work design, principles of Industrial Management and Project management.
Pre-requisites: GNE331 Probability and Statistics, INE 307 Deterministic OR models.

INE350 Simulation [3-0, 3 cr.]
This course covers random number generation, random variety generation, components of discrete event simulation, learning simulation software, and the simulation of simple systems: queuing, inventory, manufacturing, QC, transportation, layout.

INE351 Simulation Lab [0-2, 1 cr.]
Lab course complements the course INE350 simulation. This lab provides students with hands-on experience in the use of state of the art simulation tools and programs such as ARENA.
Pre-requisites: INE 350 Simulation.

INE362 Production Processes and Machinery [3-0, 3 cr.]
This course covers metal machining, cutting tools technology, and thermal cutting processes, machining operations and machine tools, abrasive processes, and joining and assembly processes.
Pre-requisite: MEE321 Material Properties and Processes.

INE363 Production Processes and Machinery Lab [0-3, 1 cr.]
This course entails laboratory experiments in production processes and machinery.
Concurrent with INE362 Production Processes and Machinery.

INE402 Optimization [3-0, 3 cr.]
This course covers queuing theory and models, linear programming, integer programming, transportation/allocation, assignment, inventory, annealing, networks, dynamic programming, forecasting, and simulation techniques.
Pre-requisite: GNE333 Engineering Analysis I.
INE407 Network Flow [3-0, 3 cr.]
This course covers networks, shortest/longest path, decision trees, and network flow.

Pre-requisites: INE307 Deterministic OR models or Consent of instructor.

INE410 Work Design and Measurement [3-0, 3 cr.]
This course covers methods engineering, operation analysis, worker and machine relationships, productivity measures, time study, time standards, allowances, work sampling, predetermined time systems, learning curves, wage payment, safety and risk factor identification.

Pre-requisites: Fourth year standing

INE414 Human Factors in Engineering [3-0, 3 cr.]
This course covers information input and processing, auditory and visual and tactual displays, motor skills, human factors in systems design, physical work and MMH, hand tools and devices, work place design, illumination, and climate and noise considerations.

Pre-requisite: Fourth-year standing.

INE415 Occupational Safety [2-0, 2 cr.]
This course covers eliminating and controlling hazards, system safety, expert systems, and accident reconstruction methodologies.

Pre-requisites: INE410 Motion and Time Study, and INE414 Human Factors in Engineering.

INE416 Ergonomics [4-0, 4 cr.]
Course covers the biomechanics of the musculoskeletal system; anthropometry; manual work design; lifting; motion study; workstation, tools, and tasks design; displays & controls design; machine user interfaces; environmental stress assessment (noise, heat, illumination); toxicology; cognitive work design; operations analysis; worker and machine relationships; productivity measures; time standards; allowances; work sampling; predetermined time systems; learning curves; wage payment; safety and risk factor identification; worker motivation; job evaluation; job compensation.

Pre-requisites: Fourth year standing.

INE417 Ergonomics Lab [0 -3, 1 cr.]
Course provides students with hands-on experience in the use of the state of the art ergonomics equipment and software for virtual human modeling such as DELMIA.

Pre-requisites: INE416 Ergonomics.

INE428 Project Management [3-0, 3 cr.]
Course covers topics on organization structures, project manager-line manager interface, manager’s role as planning agent, skill requirements for project manager, management functions, team building as an ongoing process, concurrent engineering as a PM approach, TQM as a PM approach, effective team communication and communication traps, project communication, effective time management, managing conflicts and conflict resolution, ethics obligation matrix and ethics for project managers, project planning, project time management, activity planning, CPM scheduling, and resource allocation. Course includes a team project to plan and schedule the implementation of a selected project.

Pre-requisites: GNE305 Professional Ethics.

INE434 Facilities Planning and Layout [4-0, 4 cr.]
This course covers process, product, and schedule design, determining activity relationships and space requirements, mathematical layout models, and computerized layout algorithms, location and assignment models, storage spaces and warehouse design, design of non-manufacturing facilities, airport design, and evaluation of alternative design.

Pre-requisites: INE446 Production Systems II.

INE436 Materials Handling [3-0, 3 cr.]
This course covers materials handling equipment, the selection and design of material handling systems, simulation, and interface with facilities layout.

Pre-requisites: INE446 Production Systems II or Consent of instructor.

INE438 Facilities Planning & Logistics [3-0, 3 cr.]
Course covers topics in flow measurements and analysis, flow planning, activity planning and relationships, layout planning, single facility location models minimax and minimum facility location, multiple facility location, process capacity analysis, materials handling capacity analysis, facilities planning in the context of supply chain design and supply chain excellence.

Pre-requisites: INE446 Production Systems II.
INE440 Advanced Statistics [3-0, 3 cr.]
This course covers single factor experiments, randomized blocks, Latin squares, introduction to factorial designs, 2k factorial blocking and confounding, and forecasting.

Pre-requisite: GNE331 Probability and Statistics.

INE442 Quality Control [3-0, 3 cr.]
This course covers the modeling process quality, inferences about process quality, statistical process control, types of control charts, acceptance sampling, and process capability analysis.

Pre-requisites: INE 346 Production Systems I.

INE443 Quality Control II [1-2, 2 cr.]
This course covers application of SPC tools to control process quality in a real manufacturing setting, and the introduction to TQM/ISO standards.

Pre-requisites: INE440 Advanced Statistics and INE442 Quality Control I.

INE446 Production Systems II[3-0, 3 cr.]
Course covers topics on Inventory analysis, Forecasting, Machine Scheduling, sequencing, cycle time, material control, Manufacturing systems, e.g., cellular, group technology, flexible, lean, JIT, MRP, and ERP. Concurrent engineering and design for manufacturing.

Pre-requisites: INE 346 Production Systems I.

INE491 Seminar on Contemporary issues in INE [2-0, 2 cr.]
This is a seminar course covering contemporary issues in Industrial Engineering. Students are asked to research contemporary subjects in the field and present findings to the class.

Pre-requisites: Fourth year standing.

INE498 Professional Experience [0-6, 6 cr.]
This course covers professional experience, through training in the execution of real-life engineering projects.

Pre-requisites: Fifth-year standing and the consent of the instructor.

INE501 Linear Programming [3-0, 3 cr.]
Formulation of linear programming problems; Simplex method; Duality and sensitivity analysis.

Pre-requisites: GNE333 Engineering Analysis I and consent of instructor.

INE502 Integer Programming [3-0, 3 cr.]
This course covers integer programming and general search techniques.

Pre-requisites: INE307 Deterministic OR models or Consent of instructor.

INE503 Nonlinear Optimization [3-0, 3 cr.]
This course covers nonlinear/continuous optimization methods.

Pre-requisites: INE307 Deterministic OR models or Consent of instructor.

INE504 Stochastic Processes [3-0, 3 cr.]
Introduction to non-measure theoretic stochastic processes. Poisson processes, renewal processes, and discrete time Markov chains. Applications in queuing systems, reliability, stochastic scheduling, and inventory control.

Pre-requisites: GNE331 Probability and Statistics and consent of instructor.

INE505 Dynamic Programming [3-0, 3 cr.]
This is a course on the theory and practice of dynamic programming. Topics covered in Deterministic DP: Shortest path algorithms including label setting and correcting, A*, and solution horizon approaches, with applications in resource allocation, knapsack problem, capacity expansion, equipment replacement, and traffic routing; Infinite decision trees and dynamic programming networks with cycles. Topics covered in Stochastic DP are stochastic shortest path problem and Markov decision processes. Applications include asset divesture, capital budgeting, portfolio selection, inventory control, systems reliability, and maximization of expected utility with constant risk posture.

Pre-requisites: INE307 Deterministic OR models, and consent of instructor.

INE506 Decision Analysis [3-0, 3 cr.]
This course covers decision analysis, game theory, Bayesian decision theory, and the utility theory.

Pre-requisite: GNE331 Probability and Statistics, and consent of instructor.
INE507 Advanced Stochastic Processes [3-0, 3 cr.]
Pre-requisites: INE 504 Stochastic processes and consent of instructor.

INE521 Engineering Economy II [3-0, 3 cr.]
This course deals with the uncertainty, break-even analysis, sensitivity analysis, probabilistic risk analysis, and accounting principles.
Pre-requisites: INE320 Engineering Economy I.

INE522 Cost Engineering and Control [3-0, 3 cr.]
Pre-requisites: consent of instructor.

INE523 Financial Engineering [3-0, 3 cr.]
Pre-requisites: INE504 Stochastic Processes and consent of instructor.

INE524 Advanced Financial Engineering [3-0, 3 cr.]
Pre-requisites: INE507 Advanced Stochastic Processes and INE 523 Financial Engineering

INE527 Project Scheduling [3-0, 3 cr.]
This course covers the basic critical path planning and scheduling, with arrow and precedence networks, introduction to resource levelling, and least cost scheduling, including time-cost trade-off analysis, and schedule control.
Pre-requisites: consent of instructor or Fourth-year standing.

INE529 Project Contracting [3-0, 3 cr.]
This course covers construction contracting for contractors, owners, and engineers. (1) Industry structure, (2) Types of contracts and delivery systems of construction, (3) Planning, estimating, quantity takeoff and pricing, labor and equipment estimate, (4) Proposal preparation, and students use of contract documents to prepare detailed estimates.
Pre-requisites: consent of instructor or Fourth-year standing.

INE541 Quality Management Systems [3-0, 3 cr.]
Course covers Total Quality Management theories and application, Design for Six Sigma (DFSS) and six sigma approaches, DMAIC, Auditing, ISO standards and ISO certification.
Pre-requisites: Consent of instructor and Fourth year standing.

INE542 Supply Chain Management [3-0, 3 cr.]
Special topics of current interest; Treatment of new developments in various areas of industrial engineering as warranted; Network Design in a Supply Chain; Demand Forecasting and Aggregate Planning; Transportation Networks; Sourcing. Pre-requisites: Consent of instructor and Fourth year standing.

INE544 Inventory Analysis [3-0, 3 cr.]
This course covers continuous/periodic/deterministic/stochastic inventory models, materials requirements planning(MRP), just-in-time production systems, assembly systems, and flexible manufacturing distribution systems.
Pre-requisites: INE446 Production Systems II or Consent of instructor.
INE548 Machine Scheduling [3-0, 3 cr.]
This course covers basic single machine problem (BSMP), flow shop scheduling with setup cost (TSP), and vehicle routing.
Pre-requisites: INE446 Production Systems II or Consent of instructor.

INE551 Advanced Simulation [3-0, 3 cr.]
This course covers the analysis of simulation data, input and output, validation and verification of system design, comparing alternative system configuration, simulation of complex systems, and case studies.
Pre-requisites: INE350 Simulation, INE346 Production Systems I, Fourth year standing.

INE563 CAD/CAM [3-0, 3 cr.]
This course covers the use of computer-aided design software packages, including systems for computer-aided drafting; solid modeling, finite element analysis, and computer-aided manufacturing, and design projects including: fabrication of physical prototypes generated with numerically controlled machines.
Pre-requisite: INE362 Production Processes and Machinery or Consent of instructor, and Fourth year standing.

INE567 Time Series Control & Process Adjustment [3-0, 3 cr.]
Statistical analysis and design of process adjustment methods for quality improvement purposes. Topics include ARIMA time series models, autocorrelation and SPC, integration of SPC schemes and feedback control, identification and estimation of transfer function models, design and analysis of optimal stochastic controllers, PID and EWMA controllers, self-tuning and multivariate control.

INE591 Project I [3-0, 3 cr.]
This course covers selected engineering project, using acquired technical knowledge, formal report, and presentation.
Pre-requisites: Fifth year standing and INE362 Production Processes and Machinery, INE350 Simulation , INE446 Production Systems II, INE434 Facilities Planning and Layout, INE428 Project Management, GNE305 Professional Ethics.

INE592 Project II [3-0, 3 cr.]
This course covers advanced engineering project, using acquired technical knowledge, formal report, and presentation.
Pre-requisites: consent of the instructor and Fifth year standing.

INE593 Capstone Engineering Design [1-0, 1 cr.]
The course will reinforce and integrates topics covered in other courses in the curriculum and used in engineering design. Topics covered include need identification and problem definition, managing the design process, team behavior and group dynamics, design research and information gathering, concept generation and evaluation, risk, reliability, and safety, legal and ethical issues in design, communicating the design.
Pre-requisites: course to be given Concurrent with INE591 Project I.

INE599 Topics in Industrial Engineering [1-3, 3 cr.]
This course covers the treatment of new development, in various areas of industrial engineering.
Pre-requisites: consent of the instructor and Fourth year standing.
The Mechanical Engineering Program offers a broad base for preparing students for a variety of careers in the design and construction of mechanical systems. The production, transformation, transmission and control of thermal and mechanical energy constitute one of the main tracks, which rely on thermodynamics, fluid mechanics and heat transfer. This track leads to applications in internal combustion engines, steam and gas power plants, and HVAC. Solid mechanics, kinematics, and dynamics of machinery lead to applications in vibrations control and machine design. The general area of manufacturing, which is closely linked to industrial engineering, is also covered in the course of study. The program emphasizes the broad spectrum of applications of mechanical engineering, as well as the interaction with other engineering disciplines. Laboratory experimentation and computer simulation are used to train students on the understanding, design and testing of thermal and mechanical systems. Six credits of professional experience are also included in the summer of the third year, to give students an opportunity to integrate classroom instruction with practical work experience, as a part of their academic program.

The Mechanical Engineering Program requires the completion of 150 semester hours. While the program is credit-based, a typical schedule over a four-year period, including summer modules, is listed below. Students may select to take these courses over a longer period of time.

**MISSION**

The Mechanical Engineering Program strives to support the mission of the school by providing students with a solid and contemporary mechanical engineering curriculum and a broad education that prepares them for successful careers as mechanical engineers in a globalized and diverse world as well as graduate studies.

**PROGRAM EDUCATIONAL OBJECTIVES**

Within a few years of graduation, the graduates of the Mechanical Engineering program will:

1. Establish themselves as practicing mechanical engineers or be engaged in advanced studies in the areas of thermal/fluid systems, mechanical systems and design or materials and manufacturing

2. Demonstrate leadership and function effectively as responsible members of professional teams.

3. Demonstrate ability to undertake engineering projects that address environment, society and economy requirements.

**PROGRAM OUTCOMES**

The students will acquire in their matriculation through the program, the following skills, knowledge, and behaviors:

a. An ability to apply knowledge of mathematics, science and engineering.

b. An ability to design and conduct experiments, as well as to analyze and interpret data.

c. An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

d. An ability to function on multidisciplinary teams.

e. An ability to identify, formulate and solve engineering problems.

f. An understanding of professional and ethical responsibility.

g. An ability to communicate effectively.

h. A broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.

i. A recognition of the need and the ability to engage in lifelong learning.

j. A knowledge of contemporary issues.

k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
### MAJOR REQUIREMENTS

#### First Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Courses</th>
<th>Credits</th>
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<tbody>
<tr>
<td><strong>Fall Semester (16 credits)</strong></td>
<td>COE 212 Engineering Programming</td>
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<td>ENG 202 Sophomore Rhetoric</td>
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<td>CIE 200 Statics</td>
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<td>MEE 211 Engineering Graphics</td>
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<tr>
<td></td>
<td>MTH 201 Calculus III</td>
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<td>--- Liberal Arts Curriculum Elective</td>
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<tr>
<td><strong>Spring Semester (16 credits)</strong></td>
<td>ELE 305 Introduction to Electrical Eng.</td>
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<td>ETH 201 Moral Reasoning</td>
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<td>ARA 20 Appreciation of Arabic Literature</td>
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<td>MTH 304 Differential Equations</td>
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<td>MTH 208 Calculus IV</td>
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<td></td>
<td>MEE 241 Dynamics</td>
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<tr>
<td><strong>Summer Module I (6 credits)</strong></td>
<td>GNE 333 Engineering Analysis I</td>
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<tr>
<td><strong>Summer Module II (4 credits)</strong></td>
<td>GNE 331 Probability and Statistics</td>
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<td>PED 2 Physical Education</td>
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#### Second Year

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<td><strong>Fall Semester (15 credits)</strong></td>
<td>MEE 311 Fluid Mechanics</td>
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<td>MEE 312 Fluid Mechanics Lab</td>
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<td></td>
<td>MEE 301 Thermodynamics</td>
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<td>MEE 351 Computer Aided Engineering</td>
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<td>MEE 321 Material Properties and Processes</td>
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<td></td>
<td>MEE 212 Computer Applications in IME</td>
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<tr>
<td><strong>Spring Semester (17 credits)</strong></td>
<td>MEE 403 Heat Transfer</td>
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<td>MEE 404 Heat Transfer - Lab</td>
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<td>MEE 391 Instrumentation and Measurements</td>
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<td>MEE 320 Strength of Material</td>
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<tr>
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<td>MEE 341 Kinematics and Dynamics of Linkages</td>
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<td></td>
<td>MEE 332 Production Processes and Machinery</td>
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<td>MEE 333 Production Processes and Machinery Lab</td>
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<tr>
<td><strong>Summer Module I (5 credits)</strong></td>
<td>ENGR 203 Fundamentals of Oral Communication</td>
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<td>GNE 301 Professional Communication</td>
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<td><strong>Summer Module II (4 credits)</strong></td>
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<td>HLT 201 Basic Health</td>
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#### Third Year

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<tr>
<td><strong>Fall Semester (15 credits)</strong></td>
<td>GNE 305 Professional Ethics</td>
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<td>MEE 442 Machine Dynamics</td>
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<td>MEE 445 Control Systems</td>
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<td>MEE 446 Control Systems Lab</td>
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<td></td>
<td>MEE 414 Thermal Systems Design</td>
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<tr>
<td><strong>Spring Semester (17 credits)</strong></td>
<td>INE 428 Project Management</td>
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<td>INE 491 Seminar on Contemporary Issues</td>
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<td>MEE 302 Energy Conversion</td>
<td>3</td>
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<td>MEE 422 Mechanical Engineering Design</td>
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<td>--- Technical Elective (2/6)</td>
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<tr>
<td><strong>Summer Module II (6 credits)</strong></td>
<td>MEE 498 Professional Experience</td>
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#### Fourth Year

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<td><strong>Fall Semester (14 credits)</strong></td>
<td>MEE 593 Capstone Engineering Design</td>
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<td>MEE 591 Project I</td>
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<td>INE 402 Optimization</td>
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<td>MEE 515 Refrigeration and Air Conditioning</td>
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<td>MEE 516 Refrigeration and Air Conditioning Lab</td>
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<td>INE 320 Engineering Economy I</td>
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#### Technical Electives

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<td>GNE 334</td>
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<td>MEE 407</td>
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<td>MEE 421</td>
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<td>MEE 590</td>
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<td>MEE 592</td>
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<td>MEE 599</td>
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<tr>
<td>Or any other approved technical elective course by the department.</td>
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Science Electives
The Science elective must be taken from the following courses

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>CHM 201</td>
<td>Chemical Principles</td>
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<tr>
<td>BIO 201</td>
<td>General Biology</td>
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</tr>
<tr>
<td>PHY 201</td>
<td>Electricity and Magnetism</td>
<td>4</td>
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</tbody>
</table>

COURSE DESCRIPTIONS

MEE211 Engineering Graphics [0-2, 1 cr.]
An introduction in the basics of 2D drafting, sketching and pictorial views, orthographic multiviews, auxiliary and section views, dimensions, drawing layouts and presentations. Basic use of a computer aided drafting software (such as AutoCAD).

MEE212 Computer Applications in IME [1-2, 2 cr.]
This course is designed to introduce students to powerful computational software such as MATLAB and MATHEMATICA and to database systems. Students will learn how to write MATLAB and MATHEMATICA programs for Industrial and Mechanical engineering applications. Array definitions and manipulations, user-defined functions, solution of differential equations, plotting, and several built in functions will be covered.

Pre-requisite: COE212 Engineering Programming.

MEE220 Engineering Graphics [2-4, 4 cr.]
This course covers basic engineering drawing, CAD proficiency, sketching, and schematics.

MEE241 Dynamics [3-0, 3 cr.]
This course covers kinematics, and kinetics of particles, systems of particles, and kinetics of rigid bodies.

Pre-requisites: MTH201 Calculus III and CIE200 Statics.

MEE301 Thermodynamics [3-0, 3 cr.]
This course covers the basic concepts of work and heat, systems and control volumes, pure substances, equation of state, first law for systems, steady flow energy equation, second law for systems and control volume, and entropy.

Pre-requisite: Sophomore standing.

MEE302 Energy Conversion [3-0, 3 cr.]
This course covers the performance and design considerations of energy conversion systems, the design and performance problems involving steam, gas turbine, and combined cycle power plants, and the reciprocating and rotary engines.

Pre-requisite: MEE301 Thermodynamics.

MEE311 Fluid Mechanics [3-0, 3 cr.]
This course covers fluid statics, analysis of fluid motion using the continuity, momentum, and energy, relationship, and the introduction to viscous flow.

Pre-requisite: MEE241 Dynamics.

MEE312 Fluid Mechanics Lab [0-3, 1 cr.]
This course entails laboratory experiments in fluid mechanics.

Concurrent with MEE311 Fluid Mechanics.

MEE320 Strength of Materials [3-0, 3 cr.]
This course covers mechanical properties and behavior of stressed materials, stress analysis of beams, columns and shafts, statically indeterminate structures, plane stress and strain, and principal stresses.

Pre-requisite: CIE200 Statics.

MEE332 Production Processes and Machinery [3-0, 3 cr.]
This course covers metal machining, cutting tools technology, and thermal cutting processes, machining operations, and machine tools, abrasive processes, and joining and assembly processes.

Pre-requisite: MEE321 Material Properties and Processes.

MEE333 Production Processes and Machinery Lab [0-3, 1 cr.]
This course entails laboratory experiments in...
production, processes and machinery.

Concurrent with MEE332 Production Processes and Machinery.

MEE341 Kinematics and Dynamics of Linkages [3-0, 3 cr.]
This course covers kinematics of mechanical devices, displacement, velocity and acceleration of linkages, cams and gear trains, and an introduction to synthesis, design, and computer problems.

Pre-requisites: MEE241 Dynamics and COE211 Computer Programming.
Concurrent with MEE332 Production Processes and Machinery.

MEE351 Computer Aided Engineering [2-2, 3 cr.]
This course covers the numerical design chain encompassing conceptual design techniques & methodologies, design specifications, mechanical components design, mechanical assembly, product assembly & mechanisms, basic design analysis, knowledge management, and reverse engineering. Students are required to use advanced CAD/CAM software such as CATIA V5.

Pre-requisites: MEE241 Dynamics

MEE390 Instrumentation and Measurements [1-3, 2 cr.]
This course covers data acquisition, design of experiments, and laboratory safety, selection of instruments for experiments, informal and formal report writing, statistics of large samples applied to fixed and dynamic response of instruments, and the use of instrumentation software.

Pre-requisite: ELE305 Introduction to Electrical Engineering, GNE331 Probability and Statistics.

MEE391 Instrumentation and Measurements [2-3, 3 cr.]
Data acquisition; design of experiments and laboratory safety; selection of instruments for experiments; informal and formal report writing; statistics of large samples applied to fixed and dynamic response of instruments; use of instrumentation software.

Pre-requisites: ELE 305 Introduction to electrical engineering; GNE 331 Probability and Statistics

MEE401 Energy Systems [2-0, 2 cr.]
This course covers the energy and its transformation, balance, and open/closed systems.

MEE403 Heat Transfer [3-0, 3 cr.]
This course covers the transfer of heat by conduction, radiation and convection, and the analysis of steady state, and simple transient heat processes, and the evaporation, boiling, and condensing, heat transfer.

Pre-requisites: MTH304 Differential Equations, MEE311 Fluid Mechanics.

MEE404 Heat Transfer Lab [0-3, 1 cr.]
This course entails laboratory experiments in heat transfer.

Pre-requisites: GNE 331 Probability and Statistics; Concurrent with MEE403 Heat Transfer.

MEE407 Internal Combustion Engines [3-0, 3 cr.]
This course covers the principles, practice, and characteristics, of internal combustion engines, with laboratory demonstrations in engine testing and performance. The laboratory entails experiments in internal combustion engines.

Pre-requisite: MEE302 Energy Conversion.

MEE408 Internal Combustion Engines Lab [0-3, 1 cr.]
This course entails laboratory experiments in internal combustion engines.

Concurrent with MEE407 Internal Combustion Engines.

MEE 414 Thermal Systems Design [3-0, 3 cr.]
This course covers the analysis and design of thermal systems using the principles developed in thermodynamics, fluid mechanics, and heat transfer. Students develop computer programs to solve open-ended thermal design problem.

Pre-requisites: MEE403 Heat Transfer.

MEE 421 Finite Element Methods [3-0, 3 cr.]
This course introduces a numerical technique used in the solution of PDE governed problems. Applications cover solid mechanics, fluid dynamics and heat transfer problems in 1D. The course provides an insight on the extension to 2D and 3D problems. Bar, truss,

MEE422 Mechanical Engineering Design [3-0, 3 cr.]
This course covers statics, and forces analysis of machine and elements, balancing, critical speed, flywheel design, and dynamic measurement, and design and engineering problems.

Pre-requisites: MEE341 Kinematics and Dynamics of Linkages, and MTH304 Differential Equations.

MEE443 Machine Dynamics Lab [0-3, 1 cr.]
This course entails laboratory experiments in machine dynamics.

Pre-requisites: GNE 331 Probability and Statistics; Concurrent with MEE442 Machine Dynamics.

MEE445 Control Systems [3-0, 3 cr.]
This course covers control system design of mechanical systems, emphasis on thermal, fluid, and motion, systems under feedback control, and classical control topics, including Laplace transforms, system modeling, stability theory, and practical applications to professional practice.

Pre-requisites: GNE333 Engineering Analysis I; Concurrent with MEE442 Machine Dynamics.

MEE 446 Control Systems Lab [0-3, 1cr]
The Control Systems lab provides experiential training of the methods used in modeling, analysis, simulation, and control of engineering systems. Students will design and implement controllers using modern instruments and software.

Concurrent with MEE445 Control Systems.

MEE 491 Seminar on Contemporary issues in MEE [2-0, 2 cr.]
This is a seminar course covering contemporary issues in Mechanical Engineering. Students are asked to research contemporary subjects in the field and present findings to the class.

Pre-requisites: Third year standing.

MEE498 Professional Experience [0-6, 6 cr.]
This course covers professional experience through training in the execution of real-life engineering projects.

Pre-requisites: Fifth-year standing and the consent of the instructor.

MEE503 Power Plant Engineering [3-0, 3 cr.]
This course covers steam and gas turbine power cycles, modern power plants, combined power plants, energy and availability analysis, economics of power generation, and design problems and field trips.

Pre-requisites: MEE302 Energy Conversion and MEE512 Thermo-fluids.

MEE505 Solar Systems [3-0, 3 cr.]
This course covers the solar energy resources, collector models, active DHW, and space heating systems, passive heating, utilization, and design-chart method, and photovoltaic and wind systems.

Pre-requisite: MEE403 Heat Transfer.

MEE512 Thermofluids [3-0, 3 cr.]
This course covers the analysis of the mechanics, and thermodynamics, of flowing compressible fluids, and the design of incompressible fluid flow and machinery.

Pre-requisite: MEE403 Heat Transfer.

MEE513 Gas Turbines [3-0, 3 cr.]
This course covers the design and performance of stationary and propulsion gas turbines.

Pre-requisite: MEE302 Energy Conversion.

MEE515 Refrigeration and Air-Conditioning [3-0, 3 cr.]
This course covers principles of vapor compression and absorption refrigeration, heat pumps, psychometrics, principles of thermal comfort, and environmental aspects, determination of heating and cooling loads, and air conditioning system design and analysis.

Pre-requisite: MEE403 Heat Transfer.

MEE516 Refrigeration and Air-Conditioning Lab [0- 3, 1 cr.]
This course entails laboratory experiments in refrigeration and air-conditioning.
Concurrent with MEE515 Refrigeration and Air-Conditioning.

MEE533 CAD/CAM [3-0, 3 cr.]
This course covers the use of computer-aided design software packages, including systems for computer-aided drafting, solid modeling, and finite element analysis, and computer-aided manufacturing design projects, including fabrication of physical prototypes generated with numerically controlled machines.

Pre-requisite: MEE332 Production Processes and Machinery.

MEE543 Acoustics and Vibration Control [3-0, 3 cr.]
This course covers the acoustic momentum, energy and intensity, propagation, reflection and absorption, effects of the physical properties, transmission of sound in real media, forced and free vibration systems, with one or more degrees of freedom, vibration isolation, and transmission applied to problems of rotating, and reciprocating, machinery, and design problems on vibration isolation systems, and absorbers.

Pre-requisite: MEE442 Machine Dynamics.

MEE590 Energy Audit [3-0, 3 cr.]
This course covers the survey of energy sources, cost analysis, alternatives, environmental issue, audit techniques, and technical reporting.

Pre-requisite: Fourth-year standing.

MEE591 Project I [3-0, 3 cr.]
This course covers selected engineering project using acquired technical knowledge, formal report, and presentation.


MEE592 Project II [3-0, 3 cr.]
This course covers advanced engineering project, using acquired technical knowledge, formal report, and presentation.

Pre-requisites: Final-year standing and the consent of the instructor.

MEE 593 Capstone Engineering Design [1-0, 1 cr.]

Course reinforces and integrates topics covered in other courses in the curriculum and used in engineering design. Topics covered include need identification and problem definition, managing the design process, team behavior and group dynamics, design research and information gathering, concept generation and evaluation, risk, reliability, and safety, legal and ethical issues in design, communicating the design.

Co-requisites: Project I

MEE599 Topics in Mechanical Engineering [1-3, 3 cr.]
This course covers the treatment of new development in various areas of mechanical engineering.

Pre-requisites: Fifth-year standing and the consent of the instructor.

PACKAGING MINOR (PM)

The Packaging Minor at LAU is an interdisciplinary field in which scientific and design principles are applied to analyze, develop and produce packages that inform, communicate, advertise, contain, protect, preserve and transport a product. The Packaging Minor includes the study of products, package materials, materials behavior, structures, methods, machinery and most common types of processes used for package design, production, and transportation.

The program is designed to capitalize on the theories and skills learned in other disciplines, thereby uniquely preparing students for success as packaging professionals, in positions ranging from technical research and development to design, production and sales.

In order to maximize the comprehension of this study field by the student, the minor includes laboratory and studio courses to provide the student with hands-on experience.

EDUCATIONAL OBJECTIVES

The objective of the Packaging Minor is to capitalize on theories and skills learned in other disciplines, to prepare students for success as packaging professionals in positions ranging from technical research and development to design, production and sales.
STUDENT OUTCOMES

a. The ability to apply scientific and design principles to analyze, develop and produce packages that protect, preserve and transport a product.

b. The ability to apply design principles to inform, to communicate, and to advertise a product.

c. Knowledge of materials, and materials’ behavior, structures, methods, machinery, and the most common types of processes used for package design, production, and transportation.

d. Hands-on experience in testing, analyzing and designing packages.

MAJOR REQUIREMENTS

The Packaging Minor requires the completion of 18 credits of packaging courses, consisting of 12 required core credits, and six elective credits.

Required Core Courses (12 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PKG/INE570</td>
<td>Introduction to Packaging</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE572</td>
<td>Packaging Dynamics and Permeation</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE573</td>
<td>Packaging Types and Processes</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE580</td>
<td>Packaging Design</td>
<td>3</td>
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Elective Courses (6 credits)

Design Electives

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>PKG/INE582</td>
<td>Structural Packaging</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE584</td>
<td>Package Branding</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE586</td>
<td>Computer Graphics for Packaging</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE588</td>
<td>Packaging Applications</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE589</td>
<td>Special Topic Course in Packaging Design</td>
<td>3</td>
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</table>

Engineering Electives

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tr>
<td>PKG/INE574</td>
<td>Paper and Paperboard Packaging</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE575</td>
<td>Corrugated Packaging</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE576</td>
<td>Rigid Plastic Packaging</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE577</td>
<td>Packaging for Food, Drug and Cosmetics</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE578</td>
<td>Food Preservation Packaging</td>
<td>3</td>
</tr>
<tr>
<td>PKG/INE579</td>
<td>Special Topic Course in Packaging Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: Students with Engineering or Design emphasis are advised to take the two electives in the respective area of emphasis.

COURSE DESCRIPTIONS

PKG/INE570 Introduction to Packaging [3-0, 3 cr.]

This course will present an overview of the history of packaging, its functions, materials, and development, and an overview of packaging design, processing systems, and testing. The historical, social, technological, and environmental impact, as well as the legal aspects of packaging will also be discussed. Examples will include product/package combinations, and the impact these choices make on the market success of a product, and the important role of proper packaging design in the reduction of solid waste, and sustainable development.

Pre-requisite: Second-year standing.

PKG/INE572 Packaging Dynamics and Permeation [2-3, 3 cr.]

This course is an introduction to the mechanics, stresses and strains, shock, vibration, compression, temperature, humidity, friction and pressure, as factors affecting the design of packaging, including the design of packages to protect against these hazards. Damage boundary, product fragility, barrier properties against permeation will be explored from the point of view of the packaging industry.

Pre-requisite: PHY211 Statics or ARC311 Building Systems.

PKG/INE573 Packaging Types and Processes* [3-0, 3 cr.]

This course is a study of the operation and performance of modern packaging systems (e.g. die cutting, blister packaging, blow molding, injection molding, etc.). Topics include equipment selection and specification, design and implementation of packaging lines in production, assessing and improving operating performance, process control and instrumentation, as well as overall environmental friendliness of the process, its sustainability and amenability to reuse, recycling, and total waste reduction.

Pre-requisite: PKG/INE570 Introduction to Packaging.

PKG/INE580 Packaging Design [1-4, 3 cr.]

This course covers the application of graphic skills on 3-D representations, and investigation of new materials and methods in designing product containers. Projects include designing a line of products under the same brand name, constructing die cut boxes, labels, and creating experimental packages.

Pre-requisite: Second-year standing.
This course is a study of the sources of cellulose fiber, methods of extraction, the effect of different fibers on the finished product, additives, conversion to paper and paperboard, identify paper types, surface finishes, and the design features and performance of basic paper characterization tests.

Pre-requisite: PKG/INE570 Introduction to Packaging.

PKG/INE576 Rigid Plastic Packaging* [3-0, 3 cr.] This course is a study of the different methods of forming polymers into usable shapes, and the advantages and limitations of each, with case studies of plastic bottle designs, thermoform design practice, with performance of standard container tests and evaluations.

Pre-requisite: PKG/INE570 Introduction to Packaging.

PKG/INE577 Packaging for Food, Drug, and Cosmetics* [3-0, 3 cr.] This course covers the physical and chemical properties of packaging materials including metals, glass, paper and polymers, in relation to their use in food, drugs, and cosmetics packaging applications. The major technical, safety, and legislative, areas critical to the successful application of packaging technologies will be reviewed, including a brief exploration of the historical aspects of food, drug, and cosmetics packaging in order to provide a perspective on modern packaging industries and their associated regulatory measures.

Pre-requisite: PKG/INE570 Introduction to Packaging.

PKG/INE578 Food Preservation Packaging [3-0, 3 cr.] This course covers the study of the process of food deterioration, and the packaging methods that are used to control these processes, in order to extend useful shelf life of certain products.

Pre-requisite: PKG/INE570 Introduction to Packaging.

PKG/INE579 Special Topic Course in Packaging Engineering [3-0, 3 cr.] This course will address the current issues in packaging engineering, and the trends in the market, with lectures by invited guests from the field.

Pre-requisite: The consent of the instructor.

PKG/INE582 Structural Packaging* [1-4, 3 cr.] This course will revolve around the creation and manipulation of basic shapes, in order to generate new structures for package designs. Issues of structures’ functional relevance and appropriateness, will be investigated, in addition to the emphasis on the notion of the package as a work of art.

Pre-requisite: PKG/INE570 Introduction to Packaging.

PKG/INE584 Package Branding* [1-4, 3 cr.] This course will examine packaging in relation to the brand identity of a product. Students will be encouraged to explore new methods, and to bring fresh ideas to the concept of surface treatment and structure in the elaboration of the visual identity of a product.

Pre-requisite: PKG/INE570 Introduction to Packaging.

PKG/INE586 Computer Graphics for Packaging* [2-2, 3 cr.] This course covers the major software tools used by professionals in the packaging industry. Students will design and develop a relational database. Commercial label design software will be used to create product labels, including bar codes. Spreadsheets and programming environment will be used to solve packaging/business related problems. 2D/3D design software will be used to develop packaging concepts, and generate working drawings.

PKG/INE588 Packaging Applications* [1-4, 3 cr.]
This course provides the students the opportunity to apply the knowledge gained through actual projects, with a follow up on the production of packages in the factory. Assignments will address the functionality of packaging from product identification to its entire appeal, stacking, display and protection.

Pre-requisites: PKG/INE573 Packaging Types and Processes, and PKG/INE572 Packaging Dynamics and Permeation, or PKG/INE580 Packaging Design.

PKG/INE589 Special Topic Course in Packaging Design* [3-0, 3 cr.]
This course will address the current issues in packaging design, and the trends in the market, with lectures by invited guests from the field.

Pre-requisite: Consent of the instructor.

MISSION
The Mission of the Graduate Program in Industrial Engineering and Engineering Management is to capitalize on the skills and theories learned in disciplines other than Industrial Engineering, to uniquely prepare students for successful engineering management careers.

EDUCATIONAL OBJECTIVES
The objectives of the Graduate Program in Industrial Engineering and Engineering Management are to:

1. Provide engineers, coming from other engineering disciplines, with a significant opportunity to specialize in the management and optimization, of engineering systems.
2. Introduce engineers to the state of the art tools and methods used in the design, management, or improvement, of integrated systems of people, materials, facilities, information, and technology.
3. Provide students with a unique, non-traditional, interdisciplinary education that is tailored to the student’s professional needs and interests.

STUDENT OUTCOMES
The students will acquire in their matriculation through the program, the following skills, knowledge, and behaviors:

a. The ability to use the knowledge of math and science to model, and to improve, complex integrated systems of people, materials, facilities or technology.

b. The broad knowledge that encompasses the fields of production systems and manufacturing, construction engineering and management, and finance and economics.

c. The ability to use data analysis, and optimization, for decision making.

d. The ability to provide support for systems engineering and project management.

e. The ability to function as a professional in the discipline.

f. The ability to grow through a lifelong acquisition of knowledge.

g. Advanced proficiency in the student-selected topics in optimization, production systems and manufacturing, infrastructure and construction, and management, or finance and economics.
ADMISSIONS REQUIREMENTS
The program is open to applicants with B.E. or B.S. degrees in the Engineering disciplines, other than in Industrial Engineering. Admission is granted, only, on a selective basis to students meeting the following minimum requirements. Applicants must have a Bachelor of Science in Engineering, or a Bachelor of Engineering, Degree from an accredited college or university, with a minimum general Grade Point Average (GPA) equivalent to 2.75, on a 4-point scale, or 2.75 in the Major.

The GRE general exam is required of all applicants (GRE subject exams are not required). All applicants must submit scores for the GRE general exam (includes verbal reasoning, quantitative reasoning, and analytical writing scores). Your GRE test scores are an important part of your application. GRE test scores that are more than 5 years old will not be accepted.

The admissions committee considers several factors when making admission decisions: your academic performance at prior institutions (grades, rankings, and GPAs) and your GRE test score. The rate of graduate assistantship (GA), when requested, is directly related to your GPA and GRE scores. Letters of recommendation are optional; however, three letters are recommended, two of which to be completed by faculty who are familiar with your academic performance.

If the GPA is less than 2.75, the applicant may be admitted as “special,” as described in the Academic Rules and Regulations for Graduate Programs.

DEGREE REQUIREMENTS
The Graduate Program in Industrial Engineering and Engineering Management, with Emphasis in Engineering Management, consists of 30 credit hours, and leads to a Master of Science in Industrial Engineering and Engineering Management (Emphasis in Engineering Management).

In particular the degree requirements are:
- 30 hours of Graduate level courses.
- At least 18 hours in Engineering courses.
- No more than six credit hours in project-based courses, or Thesis work.
- At least six hours in Optimization.
- At least nine hours from Production Systems and Manufacturing, or Infrastructure and Construction Management.
- At least 3 hours from Finance and Economics.

The remaining courses may be taken from any of the following concentration areas:
- CA_1 Optimization
- CA_2 Production Systems and Manufacturing
- CA_3 Infrastructure and Construction Management
- CA_4 Finance and Economics
- CA_5 Software

TRANSFER OF CREDITS
B.E. holders can transfer up to six credits from their B.E. degree, provided that the student has scored at least a grade of “B” on each of these courses. Transfer of credits is governed by the Graduate Program Rules and Regulations.

COURSE LISTING BY CONCENTRATION AREAS
Courses eligible for Graduate credit under this Program are grouped into five concentration areas:

**CA_1: Optimization**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>INE700</td>
<td>Advanced Statistics</td>
<td>3</td>
</tr>
<tr>
<td>INE701</td>
<td>Linear Programming</td>
<td>3</td>
</tr>
<tr>
<td>INE702</td>
<td>Integer Programming</td>
<td>3</td>
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<tr>
<td>INE703</td>
<td>Dynamic Programming</td>
<td>3</td>
</tr>
<tr>
<td>INE704</td>
<td>Stochastic Processes</td>
<td>3</td>
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<tr>
<td>INE705</td>
<td>Non-linear Programming</td>
<td>3</td>
</tr>
<tr>
<td>INE706</td>
<td>Decision Analysis</td>
<td>3</td>
</tr>
<tr>
<td>INE707</td>
<td>Network Flow</td>
<td>3</td>
</tr>
<tr>
<td>INE708</td>
<td>Queuing Theory and Applications</td>
<td>3</td>
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<tr>
<td>INE709</td>
<td>Advanced Stochastic Processes</td>
<td>3</td>
</tr>
<tr>
<td>INE711</td>
<td>Advanced Simulation</td>
<td>3</td>
</tr>
<tr>
<td>INE810</td>
<td>Special Topics in Optimization</td>
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**CA_2: Production Systems and Manufacturing**

<table>
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<tr>
<td>INE742</td>
<td>Industrial Quality Control</td>
<td>3</td>
</tr>
<tr>
<td>INE743</td>
<td>Reliability Evaluation of Engineering Systems</td>
<td>3</td>
</tr>
<tr>
<td>INE744</td>
<td>Inventory Analysis</td>
<td>3</td>
</tr>
<tr>
<td>INE745</td>
<td>Facilities Planning and Layout</td>
<td>3</td>
</tr>
<tr>
<td>INE746</td>
<td>Materials Handling</td>
<td>3</td>
</tr>
<tr>
<td>INE748</td>
<td>Machine Scheduling</td>
<td>3</td>
</tr>
<tr>
<td>INE749</td>
<td>Transportation and Supply Chain Systems</td>
<td>3</td>
</tr>
<tr>
<td>INE761</td>
<td>Computer Aided Design/ Computer Aided Manufacturing</td>
<td>3</td>
</tr>
<tr>
<td>INE762</td>
<td>Analysis of Automated Manufacturing Systems</td>
<td>3</td>
</tr>
<tr>
<td>INE763</td>
<td>Advanced Information Technology for Industrial &amp; Manufacturing Engineering</td>
<td>3</td>
</tr>
<tr>
<td>INE764</td>
<td>Time Series Control &amp; Process Adjustment</td>
<td>3</td>
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<tr>
<td>INE840</td>
<td>Special Topics in Production Systems &amp; Manufacturing</td>
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# CA_3: Infrastructure and Construction Management

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<tr>
<td>CIE761</td>
<td>Traffic Engineering</td>
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<tr>
<td>CIE762</td>
<td>Transportation Engineering II</td>
<td>3</td>
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<tr>
<td>CIE785</td>
<td>Risk and Natural Hazard Management</td>
<td>3</td>
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<tr>
<td>CIE786</td>
<td>Highway Design and Management</td>
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<tr>
<td>CIE787</td>
<td>Concrete and Steel Construction</td>
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<tr>
<td>CIE788</td>
<td>GIS and Remote Sensing</td>
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<tr>
<td>CIE790</td>
<td>Construction Methods</td>
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<td>INE721/</td>
<td>Cost Engineering and Control</td>
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<td>CIE789</td>
<td>Infrastructure Management</td>
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<td>INE724/</td>
<td>Quality Management Systems</td>
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<td>CIE784</td>
<td>Project Scheduling</td>
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<td>INE729</td>
<td>Project Contracting</td>
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<tr>
<td>INE820</td>
<td>Special Topics in Infrastructure &amp; Construction Management</td>
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# CA_4: Finance and Economics

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<tr>
<td>BUS821</td>
<td>Financial Accounting</td>
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<tr>
<td>BUS836</td>
<td>Modern Portfolio Management</td>
<td>3</td>
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<tr>
<td>BUS837</td>
<td>International Business</td>
<td>3</td>
</tr>
<tr>
<td>BUS861</td>
<td>Financial Management</td>
<td>3</td>
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<tr>
<td>INA831</td>
<td>International Political Economy</td>
<td>3</td>
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<tr>
<td>INE771</td>
<td>Financial Engineering</td>
<td>3</td>
</tr>
<tr>
<td>INE772</td>
<td>Advanced Financial Engineering</td>
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</tr>
<tr>
<td>INE781</td>
<td>Engineering Economy II</td>
<td>3</td>
</tr>
<tr>
<td>INE870</td>
<td>Special Topics in Finance &amp; Economics</td>
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# CA_5: Software

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<tbody>
<tr>
<td>COE716/CSC723</td>
<td>Knowledge-Based Systems</td>
<td>3</td>
</tr>
<tr>
<td>COE717</td>
<td>Parallel Programming and Cluster Workstations</td>
<td>3</td>
</tr>
<tr>
<td>COE718/CSC450</td>
<td>Computer Graphics</td>
<td>3</td>
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<tr>
<td>COE741/CSC460</td>
<td>Artificial Intelligence</td>
<td>3</td>
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<tr>
<td>COE742</td>
<td>Neural Networks</td>
<td>3</td>
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<tr>
<td>COE752/CSC711</td>
<td>Design and Analysis of Algorithms</td>
<td>3</td>
</tr>
<tr>
<td>COE753/CSC714</td>
<td>Heuristic Optimization</td>
<td>3</td>
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<tr>
<td>CSC475</td>
<td>Advanced Topics in Databases</td>
<td>3</td>
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Other Courses

- INE800: Project Course (3 credits)
- INE801: Special Topic Courses (3 credits)
- INE899: Thesis (6 credits)

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# COURSE DESCRIPTIONS

**INE700 Advanced Statistics [3-0, 3 cr.]**
This course covers single factor experiments, randomized blocks, Latin squares, introduction to factorial designs, 2k factorial blocking and confounding, and forecasting.

**INE701 Linear Programming [3-0, 3 cr.]**
This course covers the formulation of linear programming problems, simplex method, and duality and sensitivity analysis.

**INE702 Integer Programming [3-0, 3 cr.]**
This course covers integer programming, and general search techniques.

**INE703 Dynamic Programming [3-0, 3 cr.]**
This is a course on the theory and practice of dynamic programming. Topics covered in Deterministic DP: Shortest path algorithms including label setting and correcting, $A^*$, and solution horizon approaches, with applications in resource allocation, knapsack problem, capacity expansion, equipment replacement, and traffic routing; infinite decision trees and dynamic programming networks with cycles. Topics covered in Stochastic DP are stochastic shortest path problem and Markov decision processes. Applications include asset divesture, capital budgeting, portfolio selection, inventory control, systems reliability, and maximization of expected utility with constant risk posture.

Pre-requisite: INE701 Linear Programming.

**INE704 Stochastic Processes [3-0, 3 cr.]**
This course covers Markov decision processes, and chains stochastic processes.

**INE705 Non-linear Programming [3-0, 3 cr.]**
This course covers nonlinear/continuous optimization methods.

**INE706 Decision Analysis [3-0, 3 cr.]**
This course covers decision analysis, game theory, Bayesian decision theory, and utility theory.

**INE707 Network Flow [3-0, 3 cr.]**
This course covers networks, shortest/longest path, decision trees, and network flow.

**INE708 Queuing Theory and Applications [3-0, 3 cr.]**
This course is an introduction to congestion and related stochastic models. Topics include birth and death models, measures of performance, Little’s Law, conservation law,
PASTA, work in system, service disciplines and priorities, regenerative processes, stability and stationary distributions, approximations and bounds. Examples from telecommunications, production, inventory, and computer science, are covered.

INE709 Advanced Stochastic Processes [3-0, 3 cr.]
This course is an introduction to martingales in continuous time. Brownian motion: construction, basic properties, sample paths. Stochastic integration, Ito’s rule, and applications, are discussed. The course is an introduction to stochastic differential equations and diffusion processes. Applications to financial economics: option pricing, and consumption/investment problems, are also covered.

Pre-requisite: INE704 Stochastic Processes.

INE711 Advanced Simulation [3-0, 3 cr.]
This course covers an analysis of simulation data: input and output, validation and verification of system design, comparing alternative system configuration, simulation of complex systems, and case studies.

INE721 Cost Engineering and Control [3-0, 3 cr.]
This course covers cost engineering for construction organizations, projects, and operations, it also covers construction financing, break-even, profit, and cash flow analyses, capital budgeting, equipment cost, and procurement decisions. Construction, financial accounting, cost accounting, cost control systems, and databases, as well as cost indices, parametric estimates, unit price proposals, measuring work, and settling claims are also covered.

Pre-requisite: INE729 Project Contracting.

INE722 Infrastructure Management [3-0, 3 cr.]
This course covers the general methods of engineering systems management, and the different types of infrastructure. The course analyzes possible financing, and engineering, solutions and alternatives, and the overall management during the life cycle of the project.

INE724 Quality Management Systems [3-0, 3 cr.]
This course is an introduction to quality management systems, ISO 9000, 14000, Total Quality Management, and the applications of QMS to the engineering, and management, of large projects, systems, and organizations.

Pre-requisite: Consent of the instructor.

INE727 Project Scheduling [3-0, 3 cr.]
This course covers the basic critical path planning, and scheduling with arrow and precedence networks, introduction to resource leveling, and least cost scheduling, including time-cost tradeoff analysis and schedule control.

INE729 Project Contracting [3-0, 3 cr.]
This course covers the construction contracting for contractors, owners and engineers. The course also covers industry structure, the types of contracts and delivery systems of construction, planning, estimating, quantity takeoff and pricing, labor and equipment estimate, and the proposal preparation. Students use contract documents to prepare detailed estimates.

INE742 Quality Control I [3-0, 3 cr.]
This course covers the modeling process quality, inferences about process quality, statistical process control, types of control charts, acceptance sampling, and process capability analysis.

INE743 Reliability Evaluation of Engineering Systems [3-0, 3 cr.]
This course covers the concepts and basic background for evaluating the reliability of engineering systems. It covers network modeling and evaluation of simple and complex systems, cut-set method, tie-set method, multi-failure modes. Probability distributions in reliability evaluation and system reliability evaluation using probability distributions are discussed. Also, discrete and continuous Markov chains (reliability evaluation in repairable systems), frequency and duration techniques (concepts, applications to multi-state problems, frequency balance approach) and the Monte Carlo simulation, are covered.

INE744 Inventory Analysis [3-0, 3 cr.]
This course covers the continuous/periodic/deterministic/stochastic inventory models, Materials Requirements Planning (MRP), just-in-time production systems, assembly systems, and flexible manufacturing distribution systems.

INE745 Facilities Planning and Layout [3-0, 3 cr.]
This course covers the process product and schedule design, determining activity relationships and space requirements,
mathematical layout models and computerized layout algorithms, location and assignment models, storage spaces and warehouse design, design of non-manufacturing facilities, airport design and the evaluation of alternative design.

INE746 Materials Handling [3-0, 3 cr.]
This course covers the materials handling equipment; selection and design of material handling systems, simulation, and interface with facilities layout.

INE748 Machine Scheduling [3-0, 3 cr.]
This course covers the Basic Single Machine Problem (BSMP); flow shop scheduling with setup cost (TSP); vehicle routing.

Pre-requisite: INE302 Linear Programming.

INE749 Transportation and Supply Chain Systems [3-0, 3 cr.]
This course covers the topics of supply chain characterization, site location, mode selection, distribution planning, vehicle routing, demand management, replenishment management, geographic information systems, and real-time control issues.

Pre-requisite: Consent of the instructor.

INE761 CAD/CAM [3-0, 3 cr.]
This course covers the use of computer-aided design software packages, including systems for computer-aided drafting, solid modeling, finite element analysis, and computer-aided manufacturing, and design projects including the fabrication of physical prototypes generated with numerically controlled machines.

INE762 Analysis of Automated Manufacturing Systems [3-0, 3 cr.]
This course covers the development of analytical stochastic models as the basis for understanding the performance, and the design/planning aspects of automated manufacturing systems. The course focuses on flow lines, job shops, and flexible manufacturing systems.

INE763 Advanced Information Technology for Industrial & Manufacturing Engineering [3-0, 3 cr.]
This course covers advanced information technology concepts, tools, and techniques, for designing, and implementing, manufacturing systems.

INE764 Time Series Control & Process Adjustment [3-0, 3 cr.]
This course covers the statistical analysis and design of process adjustment methods for quality improvement purposes. Topics include ARIMA time series models, autocorrelation and SPC, integration of SPC schemes and feedback control, identification and estimation of transfer function models, design and analysis of optimal stochastic controllers, PID and EWMA controllers, self-tuning and multivariate control.

INE771 Financial Engineering [3-0, 3 cr.]
This course is an introduction to financial models: mean-variance analysis, portfolio selection, separation theorems, capital asset pricing, arbitrage pricing, derivative security pricing, bond management, modeling, analysis, and computation of derivative securities. Applications of stochastic calculus and stochastic differential equations are covered, as well as numerical techniques: finite-difference, binomial method, and Monte Carlo simulation.

Pre-requisite: INE704 Stochastic Processes.

INE772 Advanced Financial Engineering [3-0, 3 cr.]
This course is a review of basic mathematics, including renewal theory and stochastic calculus, Martingale approach to Black-Scholes formula, optimal stopping and American options, pricing of continuous and discrete exotic options, term structure models and pricing of bond options, jump diffusion models, and applications, including pricing of real and electricity options, and hedging of real options.

Pre-requisite: INE709 Advanced Stochastic Processes.

INE781 Engineering Economy II [3-0, 3 cr.]
This course covers the principles of investing, including investment strategies, investment in stocks and bonds. Project risk and uncertainty with focus on break-even analysis, decision trees, and sequential investment decisions, are discussed. Capital budgeting, including the choice of minimum attractive rate of return under capital rationing, evaluation of multiple investment alternatives and capital budgeting with limited budgets are covered, as well as the Monte Carlo Simulation.

INE800 Project Course [3-0, 3 cr.]
This course is an applied design course. Design reviews and a final oral presentation with a written report are required.

Pre-requisite: Consent of the instructor.
INE810 Special Topics in Optimization [3-0, 3 cr.]
This course covers topics of current interest in optimization, selected by instructor.
Pre-requisite: Consent of the instructor.

INE820 Special Topics in Infrastructure & Construction Management [3-0, 3 cr.]
This course covers topics of current interest in infrastructure, and construction management, selected by instructor.
Pre-requisite: Consent of the instructor.

INE840 Special Topics in Production Systems & Manufacturing [3-0, 3 cr.]
This course covers topics of current interest in production systems and manufacturing, selected by instructor.
Pre-requisite: Consent of the instructor.

INE870 Special Topics in Finance & Economics [3-0, 3 cr.]
This course covers topics of current interest in finance, and economics, selected by the Instructor.
Pre-requisite: Consent of the instructor.

INE899 Thesis [6-0, 6 cr]
This course is an independent directed study, design, research in the field of interest of the student or Instructor.

GNE305 Professional Ethics [1-0, 1 cr.]
Introduce the fundamental canon of ethics in engineering practices and the associated professional liabilities. Reinforce the importance of safety as it relates to engineering design and implementation. The course involves teamwork researching a situation related to professional and ethical responsibilities.
Pre-requisites: Third year standing.

GNE331 Probability and Statistics [3-0, 3 cr.]
This course covers set theory, probability axioms, random variables (RV), continuous and discrete probability density functions, distributions, operations on RV’s, sampling distributions, confidence intervals (single variable), hypothesis testing (single variable), linear regression (single variable), and nonlinear regression.
Pre-requisite: MTH206 Calculus IV.

GNE333 Engineering Analysis I [3-0, 3 cr.]
This course covers vector spaces, matrix algebra, solution of linear systems with numerical applications, eigenvalues and eigenvectors and applications, nonlinear equations and systems with numerical solutions and numerical integration.
Pre-requisite: MTH204 Differential Equations and GNE333 Engineering Analysis I.