

Faculty of

Engineering

Faculty of Engineering

Departments

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

History

The Faculty of Engineering at Beirut Arab University was established in recognition of the national and regional need for engineering education in 1975. The Faculty initially offered two degree programs providing opportunities for formal course of study in Electrical and Civil Engineering. The Electrical Engineering Department granted its first bachelor of Engineering degree to its pioneer - graduates in June 1980, followed by the Civil Engineering Department in June 1981. In 1995, the Electrical Engineering Department implemented its new curriculum, which included new and updated courses in electronics - communications, computers, and electric power & control divisions in order to keep up with the fast developments in these fields. Two additional departments were established: The Mechanical Engineering Department in 1996 and the Industrial Engineering & Management Department, established in 2001.

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

In a collaborating effort to provide students with the opportunity to participate in practical projects that exhibit and demonstrate their skills and knowledge, the faculty established mutual incorporation and contacts with various industrial stakeholders. One aspect of this mutual interaction was the instigation of the Engineering Day in 1997. This event involved all faculty, staff and students to display the students respective work projects. The Engineering Day became an annual event to celebrate the faculty's mission of teamwork and creativity. In 2002, the faculty expanded its postgraduate programs further by incorporating a PhD program in all of its four major fields of specialization.

Today, the faculty of Engineering at Beirut Arab University is consistently ranked among the top leading engineering schools in Lebanon and the region. About 250 bachelor's degrees and 20 master's and doctoral degrees are awarded annually. The opportunities for study have expanded so that students may choose from more than 206 engineering courses. There are 30 full - time faculty members graduated from top ranked universities in USA and Europe, with diverse research background and experience. The faculty also makes use of about 15 senior professors from abroad on a part - time basis. The faculty has an up - to - date electronic library that includes over 5800 book titles and 230 scientific journal titles, as well as over 15 research laboratories.

Vision

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

Mission

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

- Continually improve the standard of our graduates through having high caliber faculty members together with quality educational programs and facilities in - line with the rapid technological advancements
- Provide a balanced regime of quality education that incorporates theoretical and practical education, innovation and creativity as well as freedom of thought and research with emphasis on professionalism and ethical behavior
- Promote and support research activities over a broad range of academic interests among students and staff
- Encourage research and technical seminars that contribute to the growth of individual knowledge and prepares for continuous learning
- Provide an excellent environment for our students that encourage interaction and enriches the educational experience in the faculty

Postgraduate Programs

Offered Degrees

The Postgraduate program offered at the Faculty of Engineering includes Master and Doctor of Philosophy (PhD) degrees in the following fields:

Electrical & Computer Engineering (3 specialities)

- Communication & Electronics
- Electric Power & Machines
- Computer Engineering

Civil & Environmental Engineering (4 specialities)

- Structural & Geotechnical Engineering
- Public works Engineering
- Water Resources & Environmental Engineering
- Surveying Engineering

Mechanical Engineering (4 specialities)

- Design & Dynamic Systems
- Thermal Engineering
- Fluids Engineering
- Combustion & Automotive Engineering

Industrial & Management Engineering (4 specialities)

- Project Management
- Engineering Management
- Management Planning
- Production & Service Systems

Program Description

MA Degrees

The duration of study to receive a Master Degree is 4 semesters (minimum) and the program involves both taught courses and a thesis and requires a total of 36 credit hours taken as follows:

Mandatory Courses - 15 Cr.

Departmental Elective Courses - 15 Cr.

Thesis - 6 Cr.

PhD Degrees

The duration of study to receive a PhD Degree is 6 semesters (minimum). The program involves both taught courses and a thesis adding up to total of 40 credit hours taken as follows:

Departmental Elective Courses - 18 Cr.

Thesis - 22 Cr.

The PhD program requirements also include the publication of one international journal paper or two international conference papers on topics related to the PhD thesis.

Department of Electrical & Computer Engineering

MA & PhD Degrees Curricula

MA Degree in Electrical & Computer Engineering (36 credit hours) - Communication & Electronics -

				Cr.
COME	601	Advanced Communication Theory		3
COME	602	Propagation of Electromagnetic Waves in Different Media		3
COME	603	Advanced Electronic Circuits		3
COME	604	Microprocessor - Based Systems		3
COME	699	Thesis		6
EMPH	XXX	Mathematics		3
				21

*The remaining 15 credits should be taken as elective courses.

PhD Degree in Electrical & Computer Engineering (40 credit hours) - Communication & Electronics -

				Cr.
COME	799	Thesis		22
				22

*The remaining 18 credits should be taken as elective courses.

MA Degree in Electrical & Computer Engineering (36 credit hours)
- Electric Power & Machines -

			Cr.
PORE	601	Advanced Power System Analysis	3
PORE	602	Advanced Power Electronics	3
PORE	603	Introduction to Robust Control	3
PORE	604	DSP Microprocessors	3
PORE	699	Thesis	6
EMPH	XXX	Mathematics	3
			21

*The remaining 15 credits should be taken as elective courses.

PhD Degree in Electrical & Computer Engineering (40 credit hours)
- Electric Power & Machines -

			Cr.
PORE	799	Thesis	22
			22

*The remaining 18 credits should be taken as elective courses.

MA Degree in Electrical & Computer Engineering (36 credit hours)
- Computer Engineering -

			Cr.
COMP	601	Distributed Operating Systems	3
COMP	602	Advanced Computer Architecture	3
COMP	603	Advanced Algorithms	3
COMP	604	Network Interconnections	3
COMP	605	Fuzzy Sets, Logic, & Applications	3
COMP	699	Thesis	6
			21

*The remaining 15 credits should be taken as elective courses.

PhD Degree in Electrical & Computer Engineering (40 credit hours)
- Computer Engineering -

			Cr.
COMP	799	Thesis	22
			22

*The remaining 18 credits should be taken as elective courses.

MA & PhD Degrees in Electrical & Computer Engineering - Communication & Electronics -

Mandatory Courses

COME 601 - Advanced Communication Theory (3 Cr.)

Advanced digital carrier modulation and M'ary signaling. Multiple - access techniques, FDMA, TDMA, CDMA. Detection of digital signals, optimum receivers. Error control coding.

COME 602 - Propagation of Electromagnetic Waves in Different Media (3 Cr.)

Uniqueness theorem and boundary conditions. Electromagnetic potentials and Hertz vector. Wave equation in different kinds of media including inhomogeneous, anisotropic and time - varying plane waves in lossy dielectric media. Reflection, transmission, and scattering principles. Propagation in layered media.

COME 603 - Advanced Electronic Circuits (3 Cr.)

Analog electronic circuits, digital integrated circuits, electronic circuits used in communication systems, signal - processing circuits.

COME 604 - Microprocessor - Based Systems (3 Cr.)

Methodologies, tools and practical experience in the design and implementation of digital systems using Microprocessors. Memories and peripheral devices. Proposal design, implementation and evaluation of individual projects. Use of logic state analyzers and microprocessor stations.

COME 699 - Master's Thesis (6 Cr.)

The Master's project aims to develop an understanding of the field of study beyond the undergraduate degree with emphasis on the conduct of original research, the application of theory into practice through real life models, and the effective communication of information through the appropriate channels. A comprehensive knowledge, as well as training in data interpretation and analytical skills is essential. One of the key goals for the Master's project is to give students the tools and confidence to carry out independent research. In addition, the student must possess the ability to express thoughts clearly, both verbally and in written form.

COME 799 - PhD Thesis (28 Cr.)

Since the PhD is the highest earned degree conferred by Faculty of Engineering, the thesis should demonstrate superior quality both in scientific, creativity and presentation capabilities. It must be rationally related. Research oriented, and should reflect scholarly and literary merit, beyond the master's degree, which is indicative of the candidate's ability to conduct original research in engineering.

Elective Courses

COME 605 - Advanced Communication Systems (3 Cr.)

Applications of communication theories to digital communication systems such as satellites, microwave links, radar & mobile systems, as well as communication networks.

COME 606 - Neural Networks (3 Cr.)

Anatomical and physical properties of neural networks, mathematical modeling, Information capacity, network adaption, learning, and self organization, applications to pattern recognition, associative memory and classes of optimization problems, algorithmic approaches, single and multi - layered, deterministic and stochastic, the problem of connectivity and implementation approaches.

COME 607 - Special Topics in Digital Signal Processing (3 Cr.)

Topics covered in this course are advanced topics in digital signal processing, theory, design and applications, and / or other topics as selected by the instructor.

COME 608 - Antenna Engineering (3 Cr.)

Linear and planar uniform arrays. Circular and elliptical arrays. Coupling between elements. Broad - Band antennas. Experimental investigation of antenna parameters such as gain, input impedance. Random arrays and aperture thinning.

COME 609 - Microwave Engineering (3 Cr.)

General theory of waveguides. Inhomogeneous filling - surface waveguides. Periodic structures, components. Scattering parameters representations. Passive microwave devices; directional couplers, filters, isolators and circulators. Six - port couplers. Microwave circuits. Integrated microwave circuits. Laboratory measurements of the scattering parameters of some treated components and circuits.

COME 610 - Remote Sensing (3 Cr.)

Basic concepts. Airphotos. Interpretation for terrain evaluation. Thermal and multi - spectral scanning. Microwave sensing. SAR - LIDAR. Earth resource satellites. Digital image processing.

COME 611 - Theory of Guided Optical Waves & Integrated Optics (3 Cr.)

Analysis of propagation of guided waves in a variety of structures including cylindrical, slab and strip optical guides. Optical fibers, single and multimodes, step, graded and W - type. Leaky waveguides. Symmetric and asymmetric waveguides, periodic and elaborate guiding structures. Bragg reflection. Mode coupling. Floquet theorem. Distributed - feedback lasers. Optical activity. Directional coupling. Surface plasmons. Applications to integrated optics and acousto - optics.

COME 612 - Special Topics in Propagation (3 Cr.)

Topics covered in this course are advanced topics in microwave propagation systems, and / or other topics as selected by the instructor.

COME 613 - Analysis & Design of Digital Integrated Circuits (3 Cr.)

Analysis and design of MOS and bipolar large - scale integrated circuits at the circuit level, Fabrication processes, device characteristics, parasitic effects and dynamic digital circuits for logic and memory functions, Calculation of speed and power consumption from layout and fabrication parameters, ROM, RAM, EEPROM circuits design, Use of SPICE and VHDL computer aids.

COME 614 - Modeling of Semiconductor Devices (3 Cr.)

Computer simulation techniques for integrated circuit process and device modeling, such as bipolar current gain and MOS threshold voltage. Use of computer packages.

COME 615 - Advanced Analog Integrated Circuits (3 Cr.)

Analysis and design of bipolar analog lcs emphasizing quantitative study of circuit performance, figure of merit, limitations, and recent techniques for optimization. Topics: Linear lcs operational amplifiers, wide - band, high - frequency and low noise amplifiers: quasi - linear circuits for signal processing multipliers and translinear circuits, phase locked loops.

COME 616 - Very Large Scale Integrated Circuits (VLSI) (3 Cr.)

Analysis and Design of CMOS and bipolar large - scale integrated circuits at the circuit level. Fabrication processes, device characteristics and parasitic effects. Dynamic digital circuits for logic and memory functions. Semiconductor memory design: ROMs, RAMs, EEPROMs. Use of full - custom and simulation computer aids.

COME 617 - Radio Frequency Communication Circuits (3 Cr.)

Radio frequency (RF) passive integrated circuit components: Resistors, capacitors, inductors. Noise in electronic circuits. Low noise amplifier (LNA) design. RF mixers. RF power amplifiers. RF phase locked loops. RF oscillators and synthesizers. Use of computer aided design tools for RF design and simulation.

COME 618 - Special Topics in Electronics (3 Cr.)

Topics covered in this course are advanced topics in electronic circuits, theory, design and applications, and / or other topics as selected by the instructor.

COME 619 - Advanced Computer Architecture (3 Cr.)

Machine mapping issues. Design of instruction sets. Analysis of the effectiveness of various instruction set constituents. Issues in multi - processor system design.

COME 620 - Advanced Embedded Systems (3 Cr.)

Overview of embedded systems: Design challenge, processor technology, IC technology, custom single purpose processors. Peripherals: Timers, counters, watchdog timers, interrupts, UART, pulse width modulator, real time clocks, ADC, DAC - Serial protocols: I2C bus, SPI bus, CAN bus, USB - Overview of ARM architecture. Introduction to real time operating systems.

COME 621 - Robotics (3 Cr.)

Special transformations. Kinematics and dynamic issues in the analysis and design of manipulators. Control of mechanical hands. Trajectory planning, generation and control for mobile robot - off - line programming and graphic simulation of industrial robots and their work cells.

COME 701 - Advanced Special Topics in Communications (3 Cr.)

This course is offered only for PhD students. It covers very specialized topics in communications closely related to the students intended research as deemed necessary by the student supervisor.

COME 702 - Advanced Special Topics in Digital Signal Processing (3 Cr.)

This course is offered only for PhD students. It covers very specialized topics in digital signal processing closely related to the students intended research as deemed necessary by the student supervisor.

COME 703 - Advanced Special Topics in Propagation (3 Cr.)

This course is offered only for PhD students. It covers very specialized topics in microwave propagation closely related to the students intended research as deemed necessary by the student supervisor.

COME 704 - Advanced Special Topics in Electronics (3 Cr.)

This course is offered only for PhD students. It covers very specialized topics in electronics closely related to the students intended research as deemed necessary by the student supervisor.

COME 705 - Advanced Topics in Modern Wireless Communication (3 Cr.)

This course is offered only for PhD students. It covers topics in Modern Wireless Communication closely related to the students intended research as deemed necessary by the student supervisor.

COME 706 - Advanced Topics in Modern Microwave Engineering (3 Cr.)

This course is offered only for PhD students. It covers topics in Modern Microwave Engineering closely related to the students intended research as deemed necessary by the student supervisor.

MA & PhD Degrees in Electrical & Computer Engineering - Electric Power & Machines -

Mandatory Courses

PORE 601 - Advanced Power System Analysis (3 Cr.)

Modern techniques in VAR control of HV / EHV interconnected power systems. Advanced power flow analysis: FACTS equipment representation in power flows, power flow analysis in compensation and control studies, HVDC light power flow modeling and solution. Stability of multimachine power systems, Advanced fault analysis including open circuits and simultaneous faults, Analysis of Power system harmonics, State estimation.

PORE 602 - Advanced Power Electronics (3 Cr.)

Advanced power electronic converters, techniques to model and control switching circuits, resonant converters, Pulse Width Modulation (PWM) techniques, soft switching methods, and low - voltage high - current design issues are studied. Single - phase and multi - phase, controlled and uncontrolled rectifiers and inverters with different operating techniques and their design and control issues are explained.

PORE 603 - Introduction to Robust Control (3 Cr.)

Modeling and paradigms for robust control, robust stability and measures of robust performance, analysis of robust stability and performance, design for robust stability and performance.

PORE 604 - DSP Microprocessors (3 Cr.)

Device architecture, various aspects of hardware / software design, problems related to real - time acquisition and processing of analog data, design principles for the state - of - the - art data conversation interfaces.

PORE 699 - Master's Thesis (6 Cr.)

The Master's project aims to develop an understanding of the field of study beyond the undergraduate degree, with emphasis on the conduct of original research, the application of theory into practice through real life models, and the effective communication of information through the appropriate channels. A comprehensive knowledge, as well as training in data interpretation and analytical skills is essential. One of the key goals for the Master's project is to give students the tools and confidence to carry out independent research. In addition, the student must possess the ability to express thoughts clearly, both verbally and in written form.

PORE 799 - PhD Thesis (28 Cr.)

Since the PhD is the highest earned degree conferred by Faculty of Engineering, the thesis should demonstrate superior quality both in scientific, creativity and presentation capabilities. It must be rationally related; research oriented, and should reflect scholarly and literary merit, beyond the master's degree, which is indicative of the candidate's ability to conduct original research in engineering.

Elective Courses

PORE 605 - Optimal Operation of Power Systems (3 Cr.)

Unit commitment and application of dynamic programming, Fuel budgeting and planning, Probabilistic production cost modeling, Hydrothermal coordination, Power system security and application of expert systems, State estimation, Optimal power flow, Interchange evaluation and power pools.

PORE 606 - Fault - Tolerant Power Systems (3 Cr.)

Critical fault events in a large power system, Sparsity techniques. Contingency screening process. Modeling of local controls in load flow. Adaptive localization method. Injection outage analysis. Security constrained dispatch. LP - based OPF. Real - time security analysis. Dynamic security analysis.

PORE 607 - Optimal Use of Power Production & Transmission Facilities in Hydro Power System (3 Cr.)

Overview of the scheduling process in hydro - thermal power systems (long -, mid -, and short - term). Methods applicable for optimization of system resources. Issues related to transmission system use (transmission access, transfer capacity, technical limitations caused by thermal ratings, possible contingencies and stability problems). Methods used to study phenomena related to transmissions use. Theoretical challenges in System Operation, Markets of the future, System planning in a competitive environment.

PORE 608 - Power System Reliability & Security (3 Cr.)

The course will cover methodology and techniques for reliability and security analysis of power systems. The topics in the course can be grouped in three parts:

- Techniques for reliability evaluation, such as minimum cut set and Markov models to model weather effects and maintenance. Models for evaluation of generation systems (LOLP, LOLE and Energy not supplied)
- Load flow models applied to contingency analysis
- Combination of load flow modeling and reliability evaluation for analysis of meshed networks (regional and main grid). To give a deeper understanding of the problems in power system reliability and security, and to provide methods and techniques to solve these problems

PORE 609 - Power Market Operations (3 Cr.)

Market design in restructured power systems, artificial neural network applications to power systems, short - term load forecasting, electricity price forecasting, price - based unit commitment, arbitrage in electricity market, gaming and market monitoring, asset valuation and risk analysis, security - constrained unit commitment, ancillary services auction, transmission pricing and regional transmission organizations.

PORE 610 - Deregulated Power Systems (3 Cr.)

Overview of key issue in electric utilities restructuring, Poolco model, bilateral contracts, market power, stranded costs, transmission pricing, electric utility markets in the Arab region, OASIS, tagging electricity transactions, electric energy trading ,risk in electricity markets, hedging tools for managing risks, electricity pricing, volatility in power markets, RTO.

PORE 611 - Power System Transaction Management (3 Cr.)

Power interchange transaction management in the deregulated electric power industry. Course topics include power system security assessment, total and available transfer capability (TTC / ATC), transaction management system (TMS), transaction information system (TIS), tagging, interchange distribution calculator (IDC), congestion management, transmission loading relief (TLR).

PORE 612 - Power System Stability & Control (3 Cr.)

General background and overview of power system stability issues (angle and voltage stability, transient, midterm and long - term stability), Synchronous machine theory and modeling, Machine representation in stability studies, AC transmission components, Power System Loads, Excitation systems, Prime movers and energy supply systems, HVDC, Control of active power and reactive power, Small - signal stability, Transient stability, Methods for improving stability. The course material gives an in - depth description of the topics where parts of it are covered in the prerequisite courses. MATLAB / SIMULINK software package is used in the analysis and design of application problems.

PORE 613 - Voltage Instability in Power Systems (3 Cr.)

The following topics are included: Description of phenomena and problem based on recent incidents in the power systems, Fundamental theory and mechanisms describing voltage stability: Static analysis based on load flow equations and nose curves, and dynamic mechanisms as automatic tap - changers and rotating machines. Methods for calculation of static stability, reactive power reserves and margins to voltage collapse: Load flows, sensitivity analysis, continuation power flows methods and techniques from a dynamic perspective: For example load characteristics. Colloquiums, written assignments using MATLAB / SIMULINK as well as self study. So as to give a deep understanding of the mechanisms contributing to voltage instability and collapse. Also analytical techniques used to study the voltage collapse phenomena will be described.

PORE 614 - Modeling & Simulation of Power System Components (3 Cr.)

This course is recommended for those interested in learning to use computer simulation to investigate the dynamic and controlled behavior of electrical power components. Being with an introduction to MATLAB / SIMULINK, the course goes through the key steps of modeling, implementing and verifying the simulation of single and three, phase transforms, single and three, phase induction machines, three, phase wound filled synchronous machines and permanent magnet machines useful in power application. Students are expected to implement and verify simulation projects, and also discuss observed behaviors on topics such as inrush current in transformers, motoring, generating and braking operation of machines, and pulsating torque from sub synchronous resonance.

PORE 615 - Power System Design of Alternative Energy Sources (3 Cr.)

System design modeling, economic feasibility, and applicants of alternative and renewable energy sources including: Fuel cells, storage batteries, bioelectrochemical cells, redox flow cells, ocean thermal energy converters, and magnetohydrodynamic converters. The modes of system interconnections, including linkage to conventional power systems, are also studied.

PORE 616 - Computer Relays for Electric Power Systems (3 Cr.)

Protection Function Requirements, Computer Relay Hardware and Software. Digital Algorithms Based on Fundamental Frequency. Digital Algorithms Based on Traveling Waves. Relay Design Characteristics, Integrated / Coordinated System Concept for Substitutions. Substation System Hardware, Software, Communications, Adaptive and System.

PORE 617 - Modern Trends in Power System Protection (3 Cr.)

Typical protective static and digital relay systems, Directional sensing of faults, Modern trends in backup and line protection of generators, transformer, reactors, shunt capacitors, bus bar, motor, and long EHV series - compensated lines, Stability, reclosing, and load shedding, Systems swings, grounding, and transient over voltage protection, Coordination and CAD applications.

PORE 618 - Design of HV / EHV Power Transmission Systems (3 Cr.)

Detailed analysis and design of HV / EHV transmission systems, Modern trends in reactive power control, Reactive power management - Flexible AC Transmission Systems (FACTS) and high voltage DC links.

PORE 619 - High Voltage DC Transmission Systems (3 Cr.)

Line - commutated converter analysis, Rectifier and inverter controls, System Protection, Harmonics, Supplementary controls and multi - terminal operation.

PORE 620 - International Standards & Technical Specifications of Electrical Power Equipments (3 Cr.)

Regulations and practices for design, maintenance requirements, and special equipment, International Electro - technical Commission (IEC) Code applied in the industrial environment, IEC standards regarding the main specifications, testing, inspection and commissioning of power equipment, Electric safety regulations and standards.

PORE 621 - Transients in Power Systems (3 Cr.)

Switching transients and over voltages: Causes, effects, modeling, and measurement, Harmonics: Sources, characteristics, effects, and mitigation, Static lightning protection: Surge nature, surge arresters, insulation coordination, measuring techniques and surge testing, System neutrals - Protective grounding.

PORE 622 - Dynamics & Simulation of Electric Machines (3 Cr.)

Direct current machines: Circuit model and dynamics of different types. Induction machines: Circuit model and dynamics of different types. Synchronous machines: Effect of saliency and inductances, circuit model and transient performance. MATLAB / SIMULINK is used in the analysis and design of application problems.

PORE 623 - Advanced Electrical Machines (3 Cr.)

Performance and control of special types of electrical machines: Stepper motors, Reluctance motors, Permanent magnet machines. Linear induction motors. Linear synchronous motors. Self excited generators.

PORE 624 - Advanced Solid State Drives (3 Cr.)

DC Drives: Single and three phase converter - fed drives. Half wave converters, full wave converters and dual converters. Chopper - fed drives: Principle of power control and break control. Two / Four quadrant chopper drives. AC Drives: Induction motor drives: Voltage, current and frequency control, closed, loop control of induction motors, and synchronous motor drives.

PORE 625 - Adjustable Speed Drives (3 Cr.)

Basic principles of variable speed control, field orientation theory, direct torque control, vector of AC drives, induction machines, switched reluctance and synchronous reluctance motors, permanent magnet brushless DC drives, converter topologies of DC and AC drives, and sensor less operation.

PORE 626 - Advanced Industrial Automation (3 Cr.)

Point - to - point protocol to control an inverter or 2 soft starter using PLC, control over an Ethernet network - Master and slave connections, built - in controllers and their use. Management of analog signals. Special functions.

PORE 627 - Power Active Filter Design (3 Cr.)

Analysis and design of linear active filters with emphasis on realization using embedded controllers. Sensitivity analysis. Switched capacitor filters.

PORE 628 - Digital Control Systems (3 Cr.)

Introduction to sampling theory and signal reconstruction. Z - transformation. Composite signal flow graph for digital systems. Time response and noise in digital systems. Frequency response. Synthesis of digital controllers. Analysis and design of digital control systems. Non linear control systems.

PORE 629 - Optimal Control Systems (3 Cr.)

Design of optimal control systems. Topics include optimization under constraints, linear quadratic regulators, Riccati equation, suboptimal control, dynamic programming, calculus of variations, and Pontryagins minimum principle.

PORE 630 - Adaptive Control Systems (3 Cr.)

Fundamentals of adaptive control: Terminology, parameter identification, basic adaptive controller design techniques, analysis of stability, parameter convergence, and robustness. Nonlinear adaptive control. Application examples.

PORE 631 - Intelligent Control Systems (3 Cr.)

Principles of intelligent control including adaptive, learning, and self, organizing systems. Neural networks and fuzzy logic systems for feedback control. Discrete event systems and decision, making supervisory control systems. Manufacturing work cell control. Advanced sensor processing including Kalman filtering and sensor fusion.

PORE 632 - Robotics (3 Cr.)

Principles of Kinematics, dynamics, and control of robot manipulators and mobile robots. Analysis of dynamical equations and design of robot control systems using modern nonlinear techniques. Computer simulation of robotic and mobile robot systems. Path planning, work cell coordination and control. Robot languages and programming.

PORE 633 - Nonlinear Control Systems (3 Cr.)

Nonlinear system analysis techniques: Phase plane, limit cycles, harmonic balance, expansion methods, describing function. State space description. Methods of linearization. Harmonic linearization. Assessment of stability of nonlinear systems by phase plane and describing function methods, circle and Popov criterion, Lyapunov criterion. Construction of Lyapunov function by methods of Krassovskii and Lu're. Introduction to nonlinear control system design.

PORE 634 - Computational Intelligence in Engineering (3 Cr.)

Introduction to soft computing, fuzzy set theory, neural networks, genetic algorithms, intelligent software agents, comparison with traditional alternatives, advanced engineering applications.

PORE 635 - Special Topics in Power Systems (3 Cr.)

Advanced topics of current interests in Electric Power Engineering. Topics are selected by the instructor from current literature.

PORE 636 - Special Topics in Automatic Control Systems (3 Cr.)

Topics covered in this course are related to subjects such as: Optimal control, stochastic control, fuzzy logic control systems, PLC controllers, and / or other topics as selected by the instructor.

PORE 637 - Special Topics in Power Electronics (3 Cr.)

Advanced topics of current interests in modern trends of power electronics. Topics are selected by the instructor from current literature.

PORE 638 - Special Topics in Electric Machines (3 Cr.)

Advanced topics of current interests in modern trends of power electronics. Topics are selected by the instructor from current literature.

PORE 639 - Electrical Power Quality (2 Cr.)

Power quality problem: Concepts, sources and impacts on utility and industry, voltage sags and swells, power system harmonics, voltage noise and flickers, measurements and assessments, mitigation techniques.

PORE 701 - Advanced Special Topics in Power Systems (3 Cr.)

This course is offered only for PhD students. It covers very specialized topics in power systems closely related to the students intended research as deemed necessary by the student supervisor.

PORE 702 - Advanced Special Topics in Automatic Control Systems (3 Cr.)

This course is offered only for PhD students. It covers very specialized topics in power systems closely related to the students intended research as deemed necessary by the student supervisor.

PORE 703 - Advanced Special Topics in Power Electronics (3 Cr.)

The course is offered only for PhD students. It covers very specialized topic in power electronic closely related to the students intended research as deemed necessary by the student supervisor.

PORE 704 - Advanced Special Topics in Electric Machines (3 Cr.)

This course is offered only for PhD students. It covers very specialized topics in power systems closely related to the students intended research as deemed necessary by the student supervisor.

PORE 705 - Power System Quality (3 Cr.)

This course is offered only for PhD students. It covers very specialized topics in power systems closely related to the students intended research as deemed necessary by the student supervisor.

PORE 706 - Advanced Topics in Electrical Drives (3 Cr.)

This course is offered only for PhD students. It covers very specialized topics in power systems closely related to the students intended research as deemed necessary by the student supervisor.

MA & PhD Degrees in Electrical & Computer Engineering - Computer Engineering -

Mandatory Courses

COMP 601 - Distributed Operating Systems (3 Cr.)

Operating System Structures. Distributed Systems. Resource Management: Resource allocation and deadlocks, deadlock prevention, avoidance and detection. Resource management in distributed systems: Failure, recovery and distributed deadlocks. Protection and security. File systems. Middleware.

COMP 602 - Advanced Computer Architecture (3 Cr.)

Structure of computer systems using processors, memories, input / output devices and interfaces as building blocks. Instruction set design and implementation. Memory hierarchies and pipelining. Issues and trade offs involved in the design of computer system architectures with respect to the design of instruction sets. Parallelism and its exploitation in specific machines such as hypercube and transporters.

COMP 603 - Advanced Algorithms (3 Cr.)

Topics include advanced data structures, randomized algorithms, approximations algorithms and online and parallel algorithms.

COMP 604 - Network Interconnections (3 Cr.)

Bridges, routers, brouters, tunnels, node and link failures and robust networks.

COMP 605 - Fuzzy Sets, Logic, & Applications (3 Cr.)

Fuzzy set and related concepts. Logical connectives. Mapping of fuzzy sets. Extension principle. Fuzzy relations and fuzzy set ordering. Fuzzy logic inference. Applications: fuzzy control, signal processing, pattern recognition, decision making and expert systems.

COMP 699 - Master's Thesis (6 Cr.)

The Master's project aims to develop an understanding of the field of study beyond the undergraduate degree, with emphasis on the conduct of original research, the application of theory into practice through real life models, and the effective communication of information through the appropriate channels. A comprehensive knowledge, as well as training in data interpretation and analytical skills is essential. One of the key goals for the Master's project is to give students the tools and confidence to carry out independent research. In addition, the student must possess the ability to express thoughts clearly, both verbally and in written form.

COMP 799 - PhD Thesis (28 Cr.)

Since the PhD is the highest earned degree conferred by Faculty of Engineering, the thesis should demonstrate superior quality both in scientific - creativity and presentation capabilities. It must be rationally related; research oriented, and should reflect scholarly and literary merit, beyond the master's degree, which is indicative of the candidate's ability to conduct original research in engineering.

Elective Courses***COMP 606 - Randomized Algorithms (3 Cr.)***

Introduction to randomization. Las Vegas and Monte Carlo algorithms. Markov and Chebyshev inequalities. Randomized selection. Two - point sampling. Graph applications: Minimum spanning trees, minimum cuts. Chernoff bound. The probabilistic method. Random walks.

COMP 607 - Advanced Microprocessor - Based Systems (3 Cr.)

Methodologies. Tools and practical experience in the design and implementation of digital systems using microprocessors. Memories and peripheral devices. Proposal design, implementation and evaluation of individual projects. Use of logic - state analyzers and microprocessor stations.

COMP 608 - Advanced Topics in Computer Graphics (3 Cr.)

Review of basic concepts in 2 - D graphics. Representation of 3 - D models. Generation of 3 - D models (Creating perspective drawing and perspective transformations). Hidden lines / hidden surface algorithms. Shading models (Illumination and reflection models). Realistic images.

COMP 609 - Neural Networks (3 Cr.)

Perception, back propagation, and adaptive neural networks. Transformation by layered networks, statistical neurodynamics, associative memory and neural learning. Applications to functional approximations, signal filtering, and pattern classification.

COMP 610 - On - Line Algorithms (3 Cr.)

Defines the concept of on - line algorithms and the competitive ratio with various applications in a diverse range of computer fields.

COMP 611 - Non - Traditional Database Systems (3 Cr.)

Object oriented; Spatial; Temporal; Multimedia database systems.

COMP 612 - Data Mining (3 Cr.)

Data mining and knowledge discovery, motivation of using data mining, data mining models, data mining techniques: Association rules, classification in data - mining clustering, deviation detection. Sequential patterns mining, applications and case studies.

COMP 613 - Data Warehousing (3 Cr.)

The characteristics and applications of data warehousing, advantages and disadvantages, developing a data warehouse architecture, data issues in creating a data warehouse, change detection and monitoring, data warehouse models, integrated meta data: The information superstructure of the data warehouse, view maintenance and virtual data warehouse, data warehouse case studies.

COMP 614 - Security Protocols (3 Cr.)

Cryptographic primitives are used in implementing a variety of secure protocols in different applications.

COMP 615 - Advanced Computer Control & Robotics (3 Cr.)

Robot manipulators: Kinematics, control, programming, task planning, and effect of load. Design of robot controllers: Path tracking, force feedback control, real - time computation issues. A set of laboratory experiments and a design project.

COMP 616 - Modern Trends in Computer Engineering I (3 Cr.)

Advanced topics and latest research work in the field of computer engineering.

COMP 617 - Modern Trends in Computer Engineering II (3 Cr.)

Advanced topics and latest research work in the field of computer engineering.

COMP 701 - Structure & Design of Programming Languages (3 Cr.)

Formal syntax. Formal semantics. Semantics of programming languages. Data types. Control structures. Object - oriented methodology. Functional programming.

COMP 702 - Parallel Computing (3 Cr.)

Discusses the design, analysis and implementation of algorithms for parallel computers. Models of parallel machine structures: Array, tree, mesh, hyper - cube. Topics include selection, merging, sorting, searching, matrix processing, numerical problems, fast fourier transforms, complexity of parallel computations, parallel architecture including SIMD machines, MIMD machines, and VLSI systolic arrays.

COMP 703 - Special Topics in Artificial Intelligence (3 Cr.)

Search techniques, games, knowledge representation, logic and theorem proving. Expert systems. Natural language understanding. Vision. Learning from experience. Lisp (Prolog) is used to write programs related to the course.

COMP 704 - Advanced Database Systems (3 Cr.)

Higher - order normal forms. Semantic models. Advanced topics in security, integrity, concurrency and recovery. Concepts of distributed databases.

COMP 705 - Image Understanding (3 Cr.)

Manipulation of digital images: Enhancement, restoration, change - detection and compression techniques. Orthogonal transforms. Clustering and feature extraction.

COMP 706 - Computational Geometry (3 Cr.)

Basic geometric concepts: Points, lines, polygons, subdivisions, arrangements. Constructing convex hulls. Plane - sweep algorithms: Line - segment intersections. Proximity problems: Closest pair, furthest pair, Voronoi diagrams. Point location. Geometric data structures: Segment tree, interval tree, range tree, priority search tree.

Department of Civil & Environmental Engineering

MA & PhD Degrees Curricula

MA Degree in Civil & Environmental Engineering (36 credit hours)

- Public Works, Structural & Geotechnical Engineering, Water Resources & Environmental Engineering, Surveying Engineering -

Cr.

CVEE	601	Transportation Planning & Traffic Engineering	3
CVEE	602	Water Resources Engineering	3
CVEE	603	Advanced Structural Systems	3
CVEE	604	Finite Element Method	3
CVEE	605	Construction Economics & Cost Control	3
CVEE	699	Thesis	6

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*The remaining 15 credits should be taken as elective courses.

PhD Degree in Civil & Environmental Engineering (40 credit hours)

- Public Work, Structural & Geotechnical Engineering, Water Resources & Environmental Engineering, Surveying Engineering -

Cr.

CVEE	799	Thesis	22
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*The remaining 18 credits should be taken as elective courses.

Mandatory Courses

CVEE 601 - Transportation Planning & Traffic Engineering (3 Cr.)

Introduction. Urban and inter - regional transportation planning. Aggregate demand models, sketch planning, evaluation of alternative plans, risk and uncertainty. Urban and intercity public transport systems. Freight transport. Traffic surveys and analysis. Facilities at intersections, parking facilities, pedestrian and bicycle facilities, network design. Traffic control systems. Traffic safety.

CVEE 602 - Water Resources Engineering (3 Cr.)

Types of sprinkler irrigation systems: Solid set systems, periodically sprinkler systems and continuously moved systems, design and operation of sprinkler irrigation system, Trickle irrigation system, Economical study, Evaluation of modern irrigation systems in practice.

CVEE 603 - Advanced Structural Systems (3 Cr.)

Composite systems for gravity and lateral loads. Elastic design of composite beams. Ultimate design of composite beams and columns. Lateral resisting systems: Special moment resisting frames, concentrically braced frames, eccentrically braced.

CVEE 604 - Finite Element Method (3 Cr.)

Fundamentals. Structure idealization and discretization. Selection of approximating (shape) functions, deriving the element equation. System equation. Condensation of stiffness matrix. Boundary conditions and solving techniques. Applications in frames, thin plates, bending shear walls, shell structures, and dams. Buckling, plasticity problems, and structural dynamics. Computer implementation. Introduction to model similarity. Finite strip method.

CVEE 605 - Construction Economics & Cost Control (3 Cr.)

Introduction to feasibility study and its measures. Budgeting of a project and cost of project financing. Budgeting of a construction company. Discretization and coding of cost items. Cost control and its automation. Importance of site planning and control on economizing of costs.

CVEE 699 - Master's Thesis (6 Cr.)

The Master's project aims to develop an understanding of the field of study beyond the undergraduate degree, with emphasis on the conduct of original research, the application of theory into practice through real life models, and the effective communication of information through the appropriate channels. A comprehensive knowledge, as well as training in data interpretation and analytical skills is essential. One of the key goals for the Master's project is to give students the tools and confidence to carry out independent research. In addition, the student must possess the ability to express thoughts clearly, both verbally and in written form.

CVEE 799 - PhD Thesis (28 Cr.)

Since the PhD is the highest earned degree conferred by Faculty of Engineering, the thesis should demonstrate superior quality both in scientific, creativity and presentation capabilities. It must be rationally related; research oriented, and should reflect scholarly and literary merit, beyond the master's degree, which is indicative of the candidate's ability to conduct original research in engineering.

Elective Courses**- Public Works Engineering -*****CVEE 606 - Traffic & Transportation Engineering (3 Cr.)***

Introduction, Public transport systems, Planning and operation - data collection and analysis, urban, rural, inter - city public transport planning, network planning, route planning, headway and scheduling, timetable creation. General planning concepts - system economic, system financing, transit fare, environmental consideration, planning policies.

CVEE 607 - Alignment & Geometric Design for Highways & Airports (3 Cr.)

Road intersections at grade. Choice of intersection location and type - vertical and horizontal positions. Vertical Alignment of road in Tunnels, design of Islands, Grade separations, ramp profile, apparent grade. Effect of wind on Geometric design. Classification of Airports, Airport Geometric standards (Runways, Taxiways and aprons). Obstacle limitation surfaces (Take off - Approach, Transition surface, conical and horizontal), Navigation Aids.

CVEE 608 - Managements of Construction Projects (3 Cr.)

Time planning using critical path method. Gantt chart. Cost - time relation. Measurement of labor productivity and site efficiency. Labor relations and recruitment. Program evaluation and review technique (PERT). Financial planning for projects. Resource leveling and resource management.

CVEE 609 - Transportation & The Environment (3 Cr.)

Introduction. The ecology and the environment. Traffic noise. Vibrations (nature, causes, impacts, calculation and prediction, reduction). Air pollution (types, emissions measuring, assessment, abatement measures). Visual impacts. Impact on resources (land use, natural conservation, transport systems in scenic landscape, environmental evaluation), Environment oriented transportation planning (policy, planning, prices, cost accounting strategies, car technology).

CVEE 610 - Railways Engineering (3 Cr.)

Railway dynamics (characteristics, models, resistance models, travel distance relationships, fuel consumption). Railways construction. Geometric design (planning elements, curves). Railway switching (types calculations, capacity). Railway stations (types, planning, capacity). Railway operation. Optimization and simulation of railway routes and networks, Maintenance and Renewals of railways. Railway transportation planning. Railways and the environment.

CVEE 611 - Transportation Economy (3 Cr.)

Transport financial analysis. Transport cost analysis. Transport operating costs. Tariff analysis (price analysis process, discount rate, shadow prices, utility of income, practical and social aspects). Transport economic analysis (net present value, benefit - cost ratio, internal rate of return). Overall evaluation of transportation plans.

CVEE 612 - Pavement Design & Highway Materials & Equipments (3 Cr.)

Design of flexible pavements: Stress distribution in sub grades, design of flexible pavement. Highway pavement using different methods, design of flexible pavement in Airports. Design of rigid pavements. Aggregates. Bituminous materials (native asphalt's - Manufacture, Asphalt cement, liquid Asphalt - Emulsions), Asphalt tests. Highway machinery (Earth moving, compaction, Aggregates crushing), Asphalt machinery. Plants, Spreaders.

CVEE 613 - Highway Maintenance (3 Cr.)

Maintenance of asphalted highways (Failure of flexible pavement, Pavement distress, Maintenance methods), Maintenance of concrete Highways (failure of rigid pavement, Maintenance of cracks and joints, strengthening of pavement), Maintenance of earth and WBM roads (Earth problems, Maintenance of WBM roads and earth roads), Methods of measuring effects.

CVEE 614 - Construction Specifications (3 Cr.)

Quality control of compaction for sub grade - Quality control of the different component of the pavements, sub - base, Base, Binder course, Surface course, macadam pavements, concrete slab pavements, interlocking pavements.

CVEE 615 - Railway Stations & Yards (3 Cr.)

Type of stations, Planning elements of stations, Wayside, Junction and End stations, Requirements of railway stations for passenger and freight transport, Infrastructure of passenger and freight stations, Passenger and freight yards, Multi - modal Container Terminal, Marshalling yards, locomotive yards.

CVEE 616 - Permanent Way Technique (3 Cr.)

Components of permanent way, Ballasted track, Slab track, Geo-technical analysis of sub grade, Dynamic analysis of sub grade, Curing of sub grade (additives, geotextiles), Geo - technical characteristics of Ballast, Mechanical behavior of ballast, Ballast dimensioning, Laying of track, Mechanical equipment, Sequence of construction of various track works.

CVEE 617 - Environmental Impacts of Railway Systems (3 Cr.)

Energy Consumption by railway systems, Air pollution, Prediction Models, Measure to control air pollution, Noise pollution, sources of railway noise, Factor affecting, Prediction models, American method, German method, Countermeasure to control railway noise, Noise barrier.

CVEE 618 - Track Maintenance & Renewal (3 Cr.)

Parameters influencing track maintenance, track defects, track defects recording methods, limit value of track defects, progress of track defects, mechanical equipment for maintenance works, scheduling of maintenance operations, technical consideration for track maintenance works, weed control.

CVEE 619 - Multi - Modal Transport Systems (3 Cr.)

Freight transport systems, Freight types, Economic transport distances, Iso Container. Transport chain, Handling equipments, Handling systems, Choice of handling systems, Demand prediction, Inland container terminal, planning and design.

CVEE 620 - Urban Railways (3 Cr.)

Introduction to railway transit systems, Railway transit systems (Street cars, rapid rail system, regional and subway systems), Planning requirements for different city railway transport systems (Cross sections, track alignments, speed, gradient, super - elevation, stations, signaling and control systems), Integration and rationalization of urban transport systems, example of urban rail transport systems.

CVEE 621 - Traffic Engineering (3 Cr.)

Traffic surveys and analysis (Traffic flow between and at intersection, Speeds and delays, parking), Traffic characteristics (Definitions, Capacity, Service levels, Fundamental relationships), Design of traffic facilities (Predicting demands, Route classification, Geometric design, Facilities at intersection, Parking facilities, Pedestrian and bicycle facilities, Network design), Traffic control systems (Signs, Signals, Cycle time calculations, Parking control system, Area traffic control, Integrated traffic control systems for public transport on public roads), Traffic safety (Accidents, Accident danger, Measures for traffic safety).

CVEE 622 - Transportation Planning (3 Cr.)

Introduction (Transportation problems, Trends in transportation planning), Urban transportation planning (Elements of transportation planning, Transportation planning process, Goods movement planning), Forecast of urban transport demand (Data collection and analysis, Goals and objectives, Aggregate sequential demand models), Sketch planning and project Planning (Generation, Analysis and evaluation of alternative plans, Risk and uncertainty).

CVEE 623 - Transportation Facilities (3 Cr.)

Plan and design of highway facilities (Roadway structure, Parking, Pedestrian and bicycle facilities), Airport facilities (Air side area: "Runway configuration, Geometry and capacity, Taxiway layout, Guidance signing, Lighting, Pavement design", Land side area: "Terminal building, Vehicular Circulation and parking"), Railway facilities (Track structure, Passenger and freight stations, Marshaling yards, Container terminals, Operating facilities), Water transport facilities (Inland waterways, Seaport capacity, Wharf structures, Fenders, Navigation aids, Transit sheds, Container terminals).

CVEE 624 - Logistics Concepts (3 Cr.)

Development of trade logistics philosophies, information technology of trade (electronic commerce, electronic market, internet commerce, electronic data interchange), Transport logistics costs, Organization system, Barriers of trade logistics, Planning of logistics.

CVEE 625 - Ustainable Transportation (3 Cr.)

Definitions of sustainable development, Unsustainable of present transport system, Alternatives Philosophies for transportation planning concepts, Development of mobility, Sustainable - oriented transportation planning, Saving motorized traffic (Integrated land use / transportation planning, Effective use of telecommunications), Shifting motorized traffic (Increasing the role of public transport, creation of pedestrian and cycling facilities, Private car use restrictions, Ride - sharing and Car - sharing), Smoothing motorized traffic (Introducing traffic control measures, Improving the accessibility in central areas, Residential traffic cells, Parking control, Freight traffic management, Introduction of intelligent traffic systems 'Telematics').

CVEE 701 - Transport Modeling (3 Cr.)

Methods of demand forecasting (trends and extrapolation, category analysis, econometric models, land use models, gravity models), Travel demand models, Trip generation models, trip distribution models, Mode choice models, Trip assignment models Application of models (Intercity, urban, international, regional), Calibration of demand models (multiple regression, error analysis).

CVEE 702 - Tunnel Engineering (3 Cr.)

Classifications of tunnels site, construction methods, investigation, selection, site in hard stones, weak stones, soil mechanics for Tunnels, primary, secondary stress, settlements, Tunnel Alignment, cross section, vertical profile, Tunneling methods, open, surface, deep and under surface methods, Tunnel construction - under sea water - Expulsion technology, Tunnel isolation water isolation - sound isolation. Tunnel ventilation - natural - mechanical - vent. Calculations, special provisions for tunnels - regulations - Emergency situations.

CVEE 703 - Advanced Railway Control Systems (3 Cr.)

Types of technology applied for control systems, Centralized traffic control centers, Computerized electronic interlocking, Communication systems for railway, Automatic railway control systems, Subway control systems, Problems of railway control systems, Examples of railway control systems, Magnetic trains.

CVEE 704 - Underground Rail Transport Systems (3 Cr.)

Characteristics of subway transit system, Slab track design, Operation and control systems, Performance characteristics, Rolling stock, Track construction, Track facilities, Operating and Capital costs.

CVEE 705 - Railway Simulation (3 Cr.)

Objectives of simulations, Model and systems of simulations (Model building for economical and technical systems), Statistical evaluation, Application of simulation technique in railway, Movement performance simulation, Track simulation.

CVEE 706 - Railway Planning for High Speed Systems (3 Cr.)

Track types, slab track, Ballasted track, Curve planning (Planning elements, Theoretical and practical values of super elevation, Transitions Curves, Ramps, Gradients, Vertical alignment), Track junction specifications, Control systems.

CVEE 707 - Traffic Theory (3 Cr.)

Traffic stream parameters volume and rates of flow, Speed and travel time, Density and occupancy, Spacing and head way, Relationship among volumes, Speed and density, Speed studies definitions, Spot speed, Measurement techniques, Travel time studies field techniques, Statistical analysis, Delay studies.

CVEE 708 - Intelligent Traffic Systems ITS (3 Cr.)

The Range of ITS applications, Actuated Signal control and detection, Network optimization, Sensing traffic using virtual detectors, in - vehicle routing and personal route information, Smart car, Commercial routing and delivery, Electronic toll collection, Smart card, Congestion pricing, Dynamic assignment, Traffic enforcement, Bus transit and Para - transit, Emerging issues, use of GPS.

CVEE 709 - Transportation Logistics (3 Cr.)

Introduction, International trade, Transport Chains, Classification of carriers and modal characteristics, Multi - modal Transport Concept, Warehousing and material handling (Loading and unloading facilities, costs, designs, vehicle design, storage), Distribution strategies (Networks, collection - distribution systems), Marketing of transport services (Concepts and approach in transport sector; Location theory).

CVEE 710 - Evaluation of Transport Projects (3 Cr.)

Economic evaluation techniques (annual return, rate of return, benefit cost analysis), environment impact assessment (environment impact statements, transportation environmental impacts), transportation evaluation techniques, process of project appraisal (appraisal path, methodology, procedures and documentation, multi disciplinary analysis), risk analysis, sensitivity analysis.

CVEE 711 - Air Transport Planning (3 Cr.)

Components of air transport (airport activity, types of airport, aircraft characteristics), airport planning (organization and finance, development of study design, demand and technology forecasts, determination of facility requirements), airspace traffic control (airways, navigation aids, air traffic control facilities, air traffic control operations, air traffic control development trends), design of air side area (runway configuration, runway geometry, runway length, runway capacity analysis, taxiway layout, holding aprons, markings, lighting, pavement design, drainage), design and operation of land side area (air terminal building, vehicular circulation and parking, terminal ground access).

CVEE 712 - Magnetic Train Technology (3 Cr.)

MAGLEV systems, suspension systems, propulsion systems, guidance systems, overview of system concepts (tran rapid 07, Japanese Maglev), assessment of MAGLEV technology, the potential for Maglev applications, comparison of Maglev and high speed rail systems, option for acquiring Maglev.

- Structural & Geotechnical Engineering -***CVEE 626 - Advanced Reinforced Concrete Structures (3 Cr.)***

Introduction. Design of floor slabs using yield line and strip methods. Analysis and design of composite beams. Theory and design details of plates subjected to out - of - plane and in - plane loads. Folded plates and thin shell roofs. Silos and Bankers.

CVEE 627 - Advanced Foundations (3 Cr.)

Engineering decision making, engineering economy, feasibility studies, equipment costs, depreciation, construction planning, CPM and project scheduling, equipment and labor productivity, material management, and project safety.

CVEE 628 - Computer Analysis of Structures (3 Cr.)

Matrix equation solving techniques. Developing computer programs for the static and dynamic analysis of plane frames, grids, plane trusses, space trusses, space frames, shear walls, tubular buildings, bridges and shell problems. Applications using the available structural analysis computer software.

CVEE 629 - Earthquake Engineering (3 Cr.)

Elements of structural dynamics. Nature, causes and characteristics of earthquakes. Strength and deformations of structural materials and elements under loads similar to seismic loads. Effect of some previous created earthquakes, determination of seismic loads. Probability theory methods in problems of seismic resistance.

CVEE 630 - Analysis of Tall Buildings (3 Cr.)

Historical development. Structural systems of steel and reinforced concrete tall buildings. Design loads. Design criteria. Wind response. Seismic response. Structural analysis of tall buildings. Lateral resisting structural systems.

CVEE 631 - Elastic - Plastic Analysis of Structures (3 Cr.)

Elastic - plastic theory. Strain hardening. Inelastic behavior of metal structural frame works. Multi - story frames. Strength and stability under combined loading. Minimum weight design of structures. Yield - line theory for flat plates. Yielding conditions. Incremental load method - step by step procedure.

CVEE 632 - Soil Improvement (3 Cr.)

Needs for soil improvement. Mechanical modification: Shallow and deep compaction, principles and methods. Hydraulic modification: Dewatering methods, seepage control, preloading and vertical drains. Modification by admixtures: Modification by inclusions / confinement: Use of geosynthetics in hydraulic and mechanical applications.

CVEE 633 - Soil Dynamics (3 Cr.)

Fundamentals of vibration: Stress waves in elastic medium. Foundation vibration: Theories of elastic half space, oscillation of foundations, vibration screening, dynamic bearing capacity. Earthquake engineering: Rock motion and soil amplification, shear modulus and damping, compressibility and liquefaction of soils, dynamic stability of retaining walls and earth dams. Pile foundations under dynamic loads: Pile - soil dynamic interaction.

CVEE 634 - Soil Hydraulics (3 Cr.)

Basic concepts: Soil permeability, equation of continuity. Two - dimensional flow: Laplace's equation, Monte - Carlo method, flow nets, method of fragments, flow in layered systems, flow in anisotropic medium, safety of hydraulic structures. Numerical analysis of seepage. Seepage through and beneath earth dams: Foundation dewatering: Theory of wells, flow net around excavations, design of well - points and deep wells. Dewatering-induced settlement.

CVEE 635 - Environmental Geotechnics (3 Cr.)

Sources of subsurface contamination. Contaminant migration. Waste disposal facilities. Engineering assessment and re - use of landfill areas. Coastal environment: Sea water intrusion into coastal aquifer, littoral processes, shoreline erosion, coastal protection methods, offshore and shore-connected breakwaters, seawalls and revetments.

CVEE 636 - Prestressed Concrete Structures (3 Cr.)

Methods of prestressing. Materials and their properties. Losses in prestressing: Instantaneous and long term analysis and design of members subjected to flexural moments, ultimate strength design. Shear and Torsion strength design. Camber, deflection and crack control. External prestressing.

CVEE 637 - Concrete Techniques & Repair (3 Cr.)

Quality Assurance in concrete construction. Durability of concrete. Concrete Permeability. Water proofing and Dam proofing systems. Assessment of concrete structures. Surface Materials repair. Repair strategy and strengthening.

CVEE 638 - Stability & Plastic Analysis of Structures (3 Cr.)

Differential equations of beam - column with different loads. Elastic critical loads. Experimental determination of critical loads. Stability functions. Stability of beam, column, trusses, and rigid jointed frames. Basic concept of plastic analysis. Development and analysis of collapse mechanisms. Analysis using step - by - step method. Uniqueness theorem. Lower and upper bounds of collapse load. Method of combining mechanisms. Deflection at collapse limit, cyclic loading and shakedown theorem. Applications for local failure of steel profiles. Computer applications.

CVEE 639 - Theory of Plates & Shells (3 Cr.)

Introduction. Assumptions, formulation of governing equations for rectangular plates. Plates subjected to normal loads. Different edge conditions. Continuous rectangular plates. Thermal stresses in plates. Finite difference method. Deflection and buckling of thin plates. Shell theory for circular cylindrical surfaces. Membrane theory and bending theory for surfaces of revolution. Applications.

CVEE 640 - Construction Management (3 Cr.)

Planning, organizing, staffing, directing and controlling construction firms, departments, projects and operations. Construction business function, marketing, management information systems. Job site layout, labor, material procurement, time, cost, quality control, construction operation planning, supervision analysis work improvement. Case studies, projects, form construction.

CVEE 641 - Rehabilitation of Structures (3 Cr.)

Need for rehabilitation. Rehabilitation techniques. Rehabilitation of flexural RC members. Design of composite simple and continuous girders. Rehabilitation of RC columns and walls. Design for semi - composite sections. Rehabilitation of RC frames for gravity and seismic loads. Methods of construction. Technical research papers.

CVEE 642 - Advanced Steel Structures (3 Cr.)

Factor of metallic materials, Fatigue of metallic materials and weld elements. Corrosion theories of metallic materials. Stability of frames. Lateral Buckling. Buckling of plates. Design of steel elements for fatigue Design of sections and connections of space structures, Metallic tall Buildings. Ultimate design of steel structures. Limit state design of steel structures. Plastic design of metallic structures. Optimum design of steel structures.

CVEE 643 - Theory of Elasticity of Concrete Structures (3 Cr.)

Basic concept of elasticity. Theory of small elastic concept deformations. Differential equations of equilibrium. Boundary conditions. Stress function. Energy principles. Fundamental formulae of linear elasticity. Plane stress problems. Plane strain, ventant bending of curved beams. Effect of circular holes on stress distribution in plate.

CVEE 644 - Numerical Methods for Solving Soil Problems (3 Cr.)

Method of finite difference: Seepage problems, consolidation problems, and elasticity problems. Method of boundary element: Seepage problems, consolidation problems, two - dimensional and three - dimensional elasticity problems, dynamic problems, and elasto - plastic problems.

CVEE 645 - Fire Engineering of Structures (3 Cr.)

General introduction to problem of fire; Building fires; Fire protection; Testing; BS5950 part 8: Simple design of steel and composite structures; Unprotected members; Analysis of portal frames in boundary conditions; Introduction to Euro - code structural fire engineering; The Cardington full - scale fire tests; Whole - structure behavior; Post - Cardington design guidance; Performance - based design; Alternative routes to fire resistance and the use of advanced calculation approaches; Alternative design strategies.

CVEE 646 - Concrete Technology (3 Cr.)

Hot weather concreting. Massive concrete. Effect of volume change on cracks of massive concrete. Concrete testing in existing structures. Design of mixes for normal, and heavy weight concrete. Admixtures for concrete. Evaluation of strength test results of concrete. Selection and use of aggregates for concrete. Structural Composite materials. Refractory concrete materials.

CVEE 647 - Fatigue of Metallic Materials & Welding Techniques (3 Cr.)

Types of repeated and cyclic loading. Welding techniques and monitoring. Fatigue limits for common types of welding. Residual stresses and its monitoring. Brittle fracture of steel weld elements. Failure of metals and weld elements under repeated loading. Damage theories for welded and un welded metals. Applications and selection of design parameters. Testing of welds. Welding techniques, methods and non - destructive tests of welds. Residual stresses and its measurements.

CVEE 648 - Corrosion Theories of Metallic Materials (3 Cr.)

Theory of galvanic cells. Properties of corroded metals. Fatigue corrosion and creep stresses. Crack diffusion in metals subjected to corrosive media. Design limit of metals in corrosive cells. Application: Pressure vessels, chemical settlers, reinforced steel bars. Protection and prevention method. Cathodic protection concept. Corrosion tests and monitoring.

CVEE 649 - Mechanics of Concrete Structures (3 Cr.)

Modes of failure under multiaxial stresses. Nature of bond and distribution of stresses between cracks. Representation of concrete structures by the finite element. Methods to study the behavior of reinforced concrete members, elastic and plastic buckling for element subjected to concentric and eccentric loads.

CVEE 650 - Analysis & Stability of Suspended Structures (3 Cr.)

Introduction, shapes; Economy; Materials; Cables; Connections; Structural behavior of cables; Static analysis; Nonlinear analysis and stability; Performance under wind and earthquake loading; Design; Erection; Prereq: Nonlinear Analysis I + (Structural dynamics I or Introduction to Structural Dynamics).

CVEE 651 - Reliability & Safety Analysis (3 Cr.)

Probabilistic models for loads and resistance variables; Central limit theorem; Estimation (point estimation and interval estimation). Monte Carlo simulator; Hypothesis testing; Analysis of variance; Simple linear regression; Probability concepts in engineering planning and design; Mathematical background of reliability theory; Probability - based limit state design; Decision analysis; Computer implementation.

CVEE 652 - Inelastic Seismic Performance & Damage Evaluation of Bldg. (3 Cr.)

Modeling various structural systems including; Moment - resisting steel frames, concentrically and eccentrically braced steel frame, moment - resisting RC frames and RC shear walls using computer programs of inelastic dynamic analysis. Evaluating global strength and ductility of various structural systems under pushover static loading and real earthquake records; Assessing the local performance of individual structural elements and determining the effect of the geometric nonlinearity ($P - \Delta$); Evaluating local damage of individual elements and of global damage of whole structural system using damage indices; Applications on capacity - design and seismic rehabilitation. Prereq.: Hysteretic modeling Structural dynamics I.

CVEE 653 - Value Engineering in the Construction Industry (3 Cr.)

The value concept: History, definitions, application to the construction industry, incentive provisions in construction contracts, factors to be considered, application to design. Value engineering methodology: Information phase, speculative phase, analytical phase, proposal phase, and final report phase. Value engineering study procedures: Objective, selecting the input required, required documentation, life cycle cost methodology including weighted evaluation.

CVEE 654 - Construction Aspects & Earth Work in Geotechnical Engineering (3 Cr.)

Execution planning and management. Economical and engineering factors controlling decision making in selection the proper execution equipment. Performance and selection of equipment to carry out the following jobs: Equipment of earth work, soil stabilization and compaction, soil excavation, supporting side excavation, soil grouting, driving and drilling piles, dewatering and lowering ground water level, tunnel drilling, and drilling in soil and rocks. Slope stability and method of stabilization. Controlling of ground water movement near permanent, source of water and in the presence of old building. Inspecting levels of ground water during pumpin.

CVEE 713 - Nonlinear Analysis of Structures (3 Cr.)

Basic equation for individual members. Elastic stability. Bowing. Elastic instability and change in geometry. Finite deflection theory. Material nonlinearity. Principles of incremental analysis. Inelastic analysis of large - deformation problems. Analysis of cables and pipelines with geometric nonlinearity.

CVEE 714 - Analysis of Composite Design (3 Cr.)

Introduction. Full interaction of simple and continuous composite beams. Types of connections. Partial interaction theory of simple and continuous composite beams. Effect of slip and uplift at the interface concrete slab - steel beams. Analysis of composite columns.

CVEE 715 - Analysis of Space & Non Conventional Structures (3 Cr.)

Stiffness matrices of space elements and grillage elements. Transformation matrices and structural stiffness matrix. Analysis of grids. Lattice shells and lattice domes. Types of non conventional structures. Approximate methods of analysis. Analysis of deployable (foldable) structures. Analysis of fabric and cable net structures.

CVEE 716 - Advanced Soil Mechanics (3 Cr.)

Basic concepts on continuum mechanics: Axioms, tensorial and indicial forms of strains and stresses. Non - linear behavior. Stress and strain paths. Constitutive models in elasticity, hypo elasticity and quasilinear models. Plasticity: Yield criterion, flow rule, incremental equations, isotropic and anisotropic hardening. Von Mises and Tresca models. critical state concepts. Applications in shallow foundations, retaining walls, and slope stability analysis.

CVEE 717 - Numerical Modeling of Concrete Structures (3 Cr.)

Introduction to numerical method techniques. Approaches of analysis. Assumptions. Modeling of high - rise buildings. Modeling of bridges. Modeling of shells. Reduction techniques. Application of different structural programs.

CVEE 718 - Dynamics & Seismic Analysis of Structures (3 Cr.)

Types of dynamic loads, and structural systems. Formulation of equations of motion. Free and forced vibration of single - degree - of - freedom systems. Response to different dynamic loads. Free vibration of lumped multi - degree of freedom (MDOF) systems, natural frequencies and mode shapes. Deterministic time domain approach and design response spectra. Earthquake risk in Lebanon. Seismic response of structures. Peak response. Code requirements.

CVEE 719 - Behavior & Stability of Metal Structures (3 Cr.)

Introduction: Failure and Yield criteria. Bending Members: Symmetrical and Unsymmetrical Bending. Torsion: Uniform Torsion, Shear Center For Closed Section, Non - Uniform Torsion, Combined Bending and Torsion. Columns: Axial Loading, Elastic and Inelastic Buckling. Beams: Lateral Torsional Buckling. Beam - Columns: Combined Axial and Bending, Elastic and Inelastic Behavior, P - Δ Effect. Frames: Instability, Effective Length Concept.

CVEE 720 - Advanced Finite Element Method (3 Cr.)

Formulation of the finite element method: Displacement based finite element method, Convergence of analysis results, incompatible and mixed finite element models. Finite element nonlinear analysis: Incremental equations of motion, displacement formulation for large deformations, structural elements, use of constitutive relation, contact conditions. Solution of equilibrium equations in static analysis: Direct solutions, iterative solution methods, solution of nonlinear equations, Equilibrium equations in dynamic analysis: Direct integration method, mode superposition, analysis of direct integration method, solution of non - linear equations in dynamic analysis.

CVEE 721 - Mathematical Programming (a) (3 Cr.)

A two - variable model and its graphical solution. Linear programming (LP) formulations. Additional linear programming formulations. Overall idea of the simplex method. Development of the simplex method. Primal simplex method. Dual simplex method. Special cases in simplex method application. Interpreting the simplex tableau: Sensitivity analysis. Mathematical foundations. Revised (primal) simplex method. Definition of the dual problem. Solution of the dual problem. Economic interpretation of the dual problem. Complementary slackness. Post - optimal or sensitivity analysis. Parametric linear programming. Definition and application of the transportation model. Solution of the transportation problem.

CVEE 722 - Mathematical Programming (b) (3 Cr.)

The assignment model. The transshipment model. Bounded variables primal simplex method. Decomposition algorithm. Karmaker interior - point algorithm. Network definitions. Minimal spanning tree problem. Shortest - route problem. Maximal - flow problem. Minimum - cost capacitated flow problem. Illustrative applications of integer programming (IP). Solution methods of integer programming. Branch - and - bound algorithms. Cutting - plane algorithms. Zero - one integer problem. Elements of dynamic programming (DP) model. Definition of the state. Examples of dynamic programming models and computations. Problem of dimensionality in dynamic programming. Solution of linear programs by dynamic programming. Prereq: CVEE 520.

CVEE 723 - Vibration Control (3 Cr.)

Passive energy dissipaters; Metallic yield dampers; Viscoelastic dampers; Viscous fluid dampers; Tuned mass dampers; Tuned liquid dampen; Active control; Optimal mix of active and passive control; Adaptive control; Intelligent control; Hybrid control; Hybrid mass dampers; Hybrid base isolation; Semi active control systems; Variable orifice dampers; Controllable fluid dampers; Semi active impact dampers; Sensors for structural control; Civil engineering applications; Smart material systems; Code development. Prerequisites: Structural dynamics I or Introduction to Structural Dynamic.

CVEE 724 - Conditions of Contracts for Works of Civil Eng. Onstr. (Fidic) (3 Cr.)

General conditions. Definitions and interpretation. Engineer and engineer's representative. Assignment and subcontracting. Contract documents. General obligations. Labor. Materials, plant and workmanship. Suspension. Commencement and delays. Defects liability. Alterations, additions and omissions. Procedure for claims. Contractor's equipment, temporary works and materials. Measurement. Provisional sums. Nominated subcontractors. Certificates and payment. Remedies. Special risks. Release from performance. Settlement of disputes. Notices. Default of employer. Changes in cost and legislation. Currency and rates of exchange.

- Water Resources & Environmental Engineering -

CVEE 655 - Surface & Ground Water Pollution (3 Cr.)

Pollution parameters and sources, effects of pollutants on water quality of rivers, lakes and estuaries, handling of surface water quality problems, analysis of existing water quality management systems, infiltration ponds & ground water contamination, soil exploration at contaminated sites, vertical cutoff walls, cover systems, bioremediation of soils, soil washing.

CVEE 656 - Hydraulic & Structural Design of Pipelines & Pipe Networks (3 Cr.)

Storage of water: Ground tanks, elevated tanks & domestic water tanks, pumping water system, design of distribution network, network maintenance, maintenance of storage tanks, methods of computing the discharge, pressure and concentration in pipe network.

CVEE 657 - Design & Construction of Pipelines (3 Cr.)

Design construction procedure and optimization of gravity and pumped pipelines. Pump selection for simple and compound systems. Cavitations. Valves and appurtenances. Numerical analysis of transients. Protection devices against water hammer.

CVEE 658 - Hydrologic & Hydraulic Measurements & Modeling (3 Cr.)

Equipment and methods for measurements of discharges: Pressure velocity and water levels in the laboratory and field, methods of measuring rainfall, run off, evaporation and evapotranspiration. Fields measurements of bet levels and cross sections. Ground water measurements. Hydraulic models theory and practice. Errors evaluations.

CVEE 659 - River Engineering (3 Cr.)

Sediment properties. Incipient motion of sediments particles. Regimes of flow. Resistance to flow and velocity distribution in alluvial streams. Total load transport. Stream bed valuation in alluvial streams. Lateral migration of alluvial streams. River training and bank protection. River morphology.

CVEE 660 - Design of Pumping Stations (3 Cr.)

Types of pump stations. Component parts. Dimensioning. Seepage underneath the structure. Design of superstructures. Design of suction and delivery pools. Design of steel pipes. Effect of vibration on structure. Design of gates. Design of weed barrier. Collection of operational data.

CVEE 661 - Design of Small Canal Hydraulic Structures (3 Cr.)

Water conveyance structures; Stability of canal banks in filling zones, aqueducts, culverts and syphons. Control, regulation and distribution structures; Check structures (head and cross), drops, weirs and water divisors. Protective structures. Measuring structures; Weirs, flumes and falls. Excess energy dissipation structures; Stilling basins, baffled piers and hammering of flow with other reverse flow. Transitions and protection works against scour. Pipes and their appendices. Features of earthen embankments. Seepage control problems. Embankment design and stability analysis. Construction of canal embankments. Canal lining. Necessity and advantages of lining. Water losses from canal. Types of Lining. Design of lined canals.

CVEE 662 - Design of Small Dams (3 Cr.)

Types of small dams, Selection of type of dam, foundations, Construction materials, Design of earth fill dams, Design of rock fill dams - design of concrete gravity dams, spillways - outlet works, Construction of dams, Operations and maintenance.

CVEE 663 - Surface Water Hydrology (3 Cr.)

Unit hydrography analysis, lumped flow routing, distributed flow routing, dynamic wave routing, hydrologic statistics, frequency analysis, hydrologic design, design storms, design flows.

CVEE 664 - Ground Water Hydrology (3 Cr.)

Ground water and aquifers, physical properties of aquifers, Darcy's law and hydraulic conductivity, well flow systems, measurements of aquifers properties, groundwater exploration, well construction and pumping, groundwater quality, ground water contamination.

CVEE 665 - Fluid Mechanics (3 Cr.)

Equation of motion of ideal fluid, complex potentials for streams, sources, sinks and doublets, Images, vortex motion - Fluid thrust, flow through porous media: Governing equations, flow towards wells, seepage under dams, analogy concepts for flow fields and force fields.

CVEE 666 - Finite Element Method in Hydraulics (3 Cr.)

Review of mathematical background, variational formulations and applications, local and global finite element equations - Applications of boundary conditions and solution, applications of finite element method in water flow: Surface flow, seepage under hydraulic structures, wells and estuaries.

CVEE 667 - Unsteady Flow in Closed Conduits (3 Cr.)

Analysis of water hammer in gravity and pumped pipelines, hydro - electric power plants and oil pipelines, cavitations and column separation, method for controlling transients, surge tanks and air chambers.

CVEE 668 - Modern Design of Small Irrigation Structures (3 Cr.)

Conveyance structures, regulating structures, protective Structures, water measurement structures, energy dissipaters transitions and erosion protection, pipes and pipe appurtenances, safety.

CVEE 669 - Advanced Topics in Hydraulics & Irrigation Engineering (3 Cr.)

Advanced topics selected by the department from the current literature of hydraulics and irrigation engineering to suit the needs and background of students.

CVEE 670 - Sewer Systems (3 Cr.)

Collection methods of domestic sewage, industrial wastes, storm water types of collection sewers, design of storm water sewer system, design of domestic sewers, primary studies of collection systems, pipelines construction, appurtenances of sewer systems, collection sumps, pump stations and rising mains.

CVEE 671 - Storm Water Collection (3 Cr.)

Measurement of precipitation, types of rainguages, measurement of snow, computation of average rainfall and hydrograph analysis, intensity duration curve, rainwater discharges used in collection sewer design.

CVEE 672 - Solid Wastes Control (3 Cr.)

Refuse collection and transport from urban and rural areas, fuel recovery, air and water pollution consideration.

CVEE 673 - Coastal & Marine Structures (3 Cr.)

Classifications of tunnels, site Investigation, construction methods, selection parameters, tunnels in hard / weak rocks, soil mechanics for tunnels, primary and secondary stresses, settlements, under water construction, expulsion technology, tunnel isolation: Water isolation, sound isolation, tunnel ventilation. Tunnels lighting: Special provisions for tunnels, regulations.

CVEE 674 - Harbor Engineering & Navigation Channels (3 Cr.)

Introduction, wave theories. Spectrum description of irregular waves. Waves, currents and water level predictions. Harbor reconnaissance, interaction of structures and waves. Tidal dynamics in Estuaries, pollution in Estuaries, sedimentation in Estuaries. Diffusion, field observation. Navigation channels. Harbor entrances, design of harbor facilities, planning, harbor pollution and control, navigation aids, model and simulation, numerical computation method.

CVEE 675 - Wastewater Collection Systems (3 Cr.)

Topography, soil investigations, preliminary plans. Locations of rising pressure pipes and treatment plants, Flow in sewer pipes, Hydraulic characteristics. Flow measurements in sewer pipes, Storm run off. Intensity duration curve of rainfall, Sewer systems. Inspection chambers, Manholes, Street inlets, Sewer pipes materials, Collection sumps, pumping stations, different types of wastewater pumps. Rising force main pipes. Safety in maintenance and operation.

CVEE 676 - Drinking Water Supply (3 Cr.)

Surface water, constituents of fresh water bodies, fresh water pollution control, ground water characteristics, possibility of using ground water for domestic supply. Effect of drinking water pollution on public health and rate of mortality. Guidelines for drinking water quality. Water consumption rates. Wells. Design and operation of water treatment units. Water distribution systems. Economic pressure in distribution system and analysis of supply systems.

CVEE 677 - Environmental Engineering (3 Cr.)

The ecology and the environment. Natural resources. Energy (types, measuring consumption, conservation). Water pollution, wastewater (characteristics and quantities, treatment). Solid waste. Hazardous waste. Air pollution (meteorology and climatology, unites of expressions, acidic pollution, particulate pollution, stratospheric, ozone destruction, greenhouse pollution). Evaluation of noise impact and mitigation measures. Environmental impact assessment and life cycle analysis.

CVEE 678 - Coastal Engineering (a) (3 Cr.)

Introduction, waves in the surf zone, beach morphologies and their change. Mechanism of sediment transport, sediment transports rate, sand transport by wind, currents. Coastal structure, sea walls, bulkheads and revetments, protective beaches, sand bypassing, groins jetties, detached breakwaters, submerged and floating breakwater. Environmental considerations, deterioration of structure in the sea. Numerical model of beach topographical change.

CVEE 679 - Coastal Engineering (b) (3 Cr.)

Waves and current movements - stability of shore line - erosion and sedimentation in unstable shore line movement of sediment particles.

CVEE 680 - Marine Structure (3 Cr.)

Dry basins - slipways - ship lift structures - floating basins - mooring structures - floating structures. Response of marine structure to dynamic loads - Impact loads due to vessel approach - Soil geotextile behind retaining walls, Dynamic analysis of gravity berths.

CVEE 725 - Water Logging & Drainage Systems (3 Cr.)

Effect and causes of water logging. Remedial measures. Land Drainage systems: Benefits of drainage. Types of drainage: Open, covered (tile, mole) and vertical. Movement of groundwater flow to drains. Planning and design of drainage systems (steady and unsteady). Design of transporting system. Maintenance. Dewatering of construction sites.

CVEE 726 - Environmental Impact of Irrigation & Drainage Projects (3 Cr.)

Effect of storage projects on the environment table, effect of major irrigation projects on irrigation system, effect of drainage projects.

CVEE 727 - Wave Hydraulics & Coastal Engineering (3 Cr.)

Linear wave theory, wave properties, shallow water transformations, higher order theories, wave spectra and wave generation, littoral currents, sea currents, breaker and surf, breakwaters, surf zone dynamics, coastal sediment transport, shore protection measures.

CVEE 728 - Water Purification Engineering (3 Cr.)

Water resources, portability of water, drinking water standards, ground water, advanced technology of water treatment, sedimentation processes, water filtration, water disinfection.

CVEE 729 - Wastewater Reuse & Waste Recycle (3 Cr.)

Collection methods, simplified and economic treatment methods, reuse of wastewater, land treatment, wastewater reuse applications, standards, origin of wastes, process industry wastes, food processing industries, material industries, chemical industries, metals recycling, waste paper recycling, paper recovery, paper recovery from urban waste, particulate collection.

CVEE 730 - Industrial Wastewater Treatment (3 Cr.)

Water and wastewater characteristics, rates & quality of water supply and wastewater for different industries, treatment methods, origin of wastes, process industry wastes, food processing industries, material industries, chemical industries, metals recycling, waste paper recycling, paper recovery, paper recovery from urban waste, particulate collection.

CVEE 731 - Surface Water Pollution Control (3 Cr.)

Pollution, environment, pollutants, air pollution, water, land wastewater, industrial wastes, irrigation drains, pesticides, hyacinth effect in reducing pollutants in water, transport of wastes in water bodies, self purification, shore pollution, lakes pollution.

CVEE 732 - Economics of Water & Wastewater Projects (3 Cr.)

Characteristics of (raw water, surface water and ground water, domestic sewage, storm runoff, industrial wastewater), capital cost of treatment works (civil, mechanical, electrical and control), maintenance and operation cost benefits from (water, gas, sludge), recycle water price in the future, environmental impacts.

- Surveying Engineering -***CVEE 681 - Adjustment of Horizontal & Vertical Networks (3 Cr.)***

Classification of horizontal control systems. Adjustment of triangulation, trilateration and hybrid systems. Adjustment of the system of transverse networks. Classification of vertical control systems. Adjustment of precise leveling networks. Trigonometric leveling.

CVEE 682 - Higher Geodesy I (3 Cr.)

Reference figures of the earth, basic ellipsoidal geometry, geodetic coordinate system, conventional terrestrial system, local geodetic system, principal radii of the curvature of the Ellipsoid, Meridian arc, Parallel arc, computation of geodetic positions of the reference Ellipsoid: Direct problem & inverse problem using Puissant's Formula & Bessel's formula.

CVEE 683 - Map Projections I (3 Cr.)

Introduction, classification of projections, general properties of conical projections: Equal area conical and azimuthal projections, Equidistant conical and Azimuthal projections, Cylindrical projections: Mercator, TM, and UTM, perspective and some other azimuthal projections: Stereographic projection, etc...

CVEE 684 - Precise Surveying Works (3 Cr.)

Adjustment of structure verticality, study of crustal movement and geodetic techniques for detecting horizontal and vertical structural deformations, laser instruments and techniques in various surveying applications such as leveling, land reclamation, etc - Precise methods for measuring horizontal angles, the use of EDM & total stations in surveying works, applications of total stations in civil engineering.

CVEE 685 - Surveying by Global Positioning System (GPS) (3 Cr.)

The main segments in the system (satellite, control and user segments), the different applications of GPS, satellite signal structure, denial of accuracy and access, Geometry Dilution of Precision (GDOP), mask angle, error sources in GPS, coordinate system in GPS, positioning mode: Single point positioning concept, differential GPS positioning, static GPS surveying, rapid static, reoccupation, true kinematics, stop and go positioning, real time GPS surveying, collecting observations in RTK GPS: By SDR 33 data collector and by penmap for GPS.

CVEE 686 - Higher Geodesy II (3 Cr.)

Basic concepts of geodesy. The gravity field of the system of natural coordinates. Approximating the natural system. The geoids, the ellipsoid, basic surface geometry. Coordinate transformations, cartesian, curvilinear, global, local, geocentric, non - geocentric. Datum problems. Celestial coordinate systems and the realization of an inertial frame of reference. The rotation of the Earth. Time and time systems. Dynamic coordinate systems and geodynamic.

CVEE 687 - Global Positioning System (GPS) (3 Cr.)

The GPS constellation - GPS satellites - orbits of the satellites - control segment and other support - User segment - GPS signal structure - The navigation message - GPS observable: Pseudo ranges and carrier phases - DOP factors - Effect of mask angle - Errors in the GPS observables: Ephemeris errors, clock errors, ionosphere errors, troposphere errors, multipath and phase center errors - Reference coordinate systems for GPS measurements and converting between them. The direct and reverse problems. GRS 1980 and WGS 1984. Coordinate changes from datum changes. Types of positioning by GPS: Standalone, static, rapid static, pseudo static, pseudo static, kinematics, stop & go, DGPS positioning, real time kinematics (r+k). Geodetic and surveying applications of GPS. Land applications of GPS.

CVEE 688 - Management of Surveying Projects (3 Cr.)

Time planning using critical path method. Gantt Chart. Cost - time relation, measurement of labor productivity and site efficiency. Labor relations and recruitment. Program evaluation and review technique (PERT). Financial planning for projects. Resource leveling. Resource management.

CVEE 689 - Adjustment of Observations (3 Cr.)

Familiarization with geomatics engineering methodology and estimation. Classes and combination of mathematical models. Least squares method: Parametric, condition and combined cases. Problem formulation and solution: Theory of errors and adjustment of observations, analysis of trend, problems with a priori knowledge of the parameters. Step by step methods, sequential solution methods, summation of normals. Univariate and multivariate statistical testing applied to geomatics engineering.

CVEE 690 - Global Geophysics & Geodynamics (3 Cr.)

Elasticity, figure of the Earth, Earth structure and seismology, gravity and its temporal variations, isostasy, tides, Earth relation and orientation, time, plate flexure, glacial rebound, continental drift, geodetic observation methods for geodynamics.

CVEE 691 - Inertial Surveying & INS / GPS Integrations (3 Cr.)

Principles of inertial position and inertial gravimetry: Their relation to inertial navigation. Definition of an operational inertial frame. Inertial error models as perturbation solutions about a reference trajectory. State space formulation and the computation of the transition matrix. Real - time estimation using zero velocity updates; Kalman filtering and alternatives. Post - mission estimation, optimal and empirical smoothing, use of different observables. Existing inertial survey systems; New developments in strap down technology. Practical aspects of inertial positioning and inertial gravimetry. INS / GPS integration. Current research activities.

CVEE 692 - Geometric Reference Systems (3 Cr.)

Introduction. Coordinate changes from datum changes. Reductions to the ellipsoid. The ellipsoidal surface model. Terrestrial coordinate system and associated transformation (2-D and 3-D). Geodetic computations involving short lines, geodetic computations involving long lines. Terrestrial distances and directions. Satellite directions and distances. Astronomical distances and directions. Terrestrial distance differences. Satellite distances differences.

CVEE 693 - Advanced Topics in Analytical & Digital Photogrammetry (3 Cr.)

Aerial triangulation: Introduction, strip triangulation, block adjustment of independent models, bundle block adjustment, automatic aerial triangulation, direct versus indirect orientation. Mapping from space: Modeling the perspective geometry of line cameras, epipolar geometry for line cameras. Multi - sensor aerial triangulation: Integrating aerial and satellite imagery with navigation data. The role of features in photogrammetric operations: Utilizing road network captured by terrestrial navigation systems in various orientation procedures.

CVEE 694 - Map Projections II (3 Cr.)

Theory and classification of map projection. Properties of the different types of map projections. Distortion in map projection. Mercator cylindrical projection (MP). Transverse mercator projection TM. UTM projection. Lambert's conical conformal projection. Stereographic projection. Grid and geodetic azimuth on conformal projections. Arc to chord connection. Convergence of the meridians.

CVEE 695 - Hydrographic Surveying (3 Cr.)

Elements of oceanography, tides and water levels, principle of underwater acoustics. Fundamental of RF and acoustic propagation. Marine positioning; Shore - based and satellite - based radio navigation systems, optical methods, dead reckoning systems, underwater positioning integrated positioning systems. Depth determination: Ship borne echo sounding and mechanical methods. Airborne laser and electromagnetic methods, related corrections.

CVEE 696 - Digital Terrain Modeling (3 Cr.)

Digital Terrain Modeling (DTM, DEM, DHM, DTEM) concepts and their implementation and applications in geometrics engineering and other disciplines. Emphasis will be on mathematical techniques used in the acquisition (e.g. photogrammetric data capture, digitized cartographic data sources capturing, other methods: IFSAR, and laser altimeters) processing, storage, manipulation, and applications of DTM. Models of DTM (Grids, Contours, and TINS). Surface representation from point data using moving averages, linear projection, and Kriging techniques. An introduction to digital image processing (IP) and computer vision (CV) concepts, methods and algorithms which will enable the students to implement IP / CV systems or use IP / CV software with emphasis on remote - sensing and photogrammetry applications and problem solving. Course components include: Digital image characteristics, image preprocessing, image analysis, pattern recognition, and introduction to image compression.

CVEE 697 - Remote Sensing (3 Cr.)

A survey of modern quantitative remote sensing using optical, infrared and microwave radiation. Topics include: Physical principles, including governing equations; Imaging system geometries; Radiometric corrections, including calibration and atmospheric correction; Geometric corrections, including registration and land cover classification algorithms, accuracy assessment and geospatial data integration, computer applications.

CVEE 698 - High Precision Surveys (3 Cr.)

Geodetic work on construction sites. Special features of geodetic work in road location. Bridgework and hydrographical geodetic work. Geodetic work hydro technical construction. Setting out bridge centre lines. Setting out tunnel centre lines and carrying down elevation from surface to shaft. Staking out a pipeline. Construction surveys using total station instruments and laser beams. Cristal movements and methods of monitoring horizontal and vertical displacement in huge projects.

CVEE 699 - Advanced Physical Geodesy (3 Cr.)

Potential theory and geodetic boundary value problems (GBVPs). Solutions approaches to the Molodensky problem. Least - squares collocations (LSC). Hilbert spaces with kernel functions. Variation principles, improperly posed problems and regularization. The altimetry - gravimetry and over determined GBVPs. Solution of GBVPs by integral techniques, fast Fourier transforms and LSC. Use of heterogeneous data sets and noise propagation. Applications to gravity predictions, geoid determination, deflection estimation, satellite and altimetry and airborne gravimetry and gradiometer. Current research activities.

CVEE 733 - Atmospheric Effects on Satellite Navigation Systems (3 Cr.)

Theoretical and observed aspects of radio wave propagation in the ionosphere and troposphere, with an emphasis on L - band (GPS) signals. Fundamentals of absorption, attenuation, depolarization, and diffraction will be covered, in addition to characteristics and physical properties of the propagation medium and atmospheric constituents. The impact of such effects, and methods of mitigation, will be interpreted with the respect to satellite navigation applications.

CVEE 734 - Digital Stereo Image Processing (3 Cr.)

Design characteristics of digital imaging devices for metric data capture. Comparison of various systems: Electronic scanners, solid - state scanners and electro - optical scanners. Calibration and geometric distortion modeling. Image enhancement techniques and operators. Correlation techniques: Electronic correlation, digital correlation and coherent optical correlation. Applications to manufacturing and robotics.

CVEE 735 - Advanced Spatial Information Systems (3 Cr.)

Principle of advanced spatial information systems. Topological modeling and spatial data representations. Automated data sources and integration of remote sensing. Data quality and uncertainty. Advanced spatial data handling methods and algorithms. Spatial database management including relational database, object-relational database and object - oriented databases. Data warehousing and data mining. Open GIS and distributed GIS issues. Spatial data and meta data management.

CVEE 736 - Satellite Altimetry & Application (3 Cr.)

Overview of satellite altimetry missions, achievements and potentials. Altimeter measurements analysis technology and specifications. Orbit determination with ground tracking and perturbation analysis. Altimetry profile data processing, regularization and gridding. Sea surface topography, ocean and coastal geoids modeling. Inversion for gravity and mass anomalies. Ocean and related monitoring applications. Geodetic, global change and geophysical exploration applications. Current research activities.

CVEE 737 - Advanced Topics in Photogrammetry (3 Cr.)

Overview of aerial triangulation procedures (strip triangulation, block adjustment of independent models, bundle block adjustment, automatic aerial triangulation, direct versus indirect orientation. Mapping from space (modeling the perspective geometry of line cameras, epipolar geometry for line cameras). Multiple - sensor aerial triangulation (integrating aerial and satellite imagery with navigation data). Photogrammetric products (digital elevation models, ortho - photos). The role of features in Photogrammetric operations (utilizing road network captured by terrestrial navigation systems in various orientation procedures).

CVEE 738 - Advanced Remote Sensing (3 Cr.)

Advanced techniques for analysis and interpretation of remotely sensed imagery, with emphasis on data acquired from satellite and airborne platforms Topic include: Review of physical principles, including governing equations, imaging system geometries, radiometric extraction, geometric corrections, including rectification and registration. Geophysical algorithms such as leaf area and biomass and land cover classification algorithm.

CVEE 739 - Advanced Estimation Methods & Analysis (3 Cr.)

Concepts of optimal estimation and different optimization criteria. Least squares estimation and different adjustment models. Fundamental of random process and kinematics modeling. Development of the kalman filter equations. Implementation aspects of Kalman filtering. Concept of signal and least square collocation. Robust estimation and analysis and advanced statistical testing. Application to geomatics engineering problems.

Department of Mechanical Engineering

MA & PhD Degrees Curricula

MA Degree in Mechanical Engineering (36 credit hours)

				Cr.
MECH	601	Condition Monitoring & Diagnosis		3
MECH	602	Advanced Combustion Engines		3
MECH	603	Theory & Design of Hydraulic Machines		3
MECH	604	Power Plants & Renewable Energy		3
MECH	605	Advanced Thermodynamics		3
MECH	699	Thesis		6
				21

*The remaining 15 credits should be taken as elective courses.

PhD Degree in Mechanical Engineering (40 credit hours)

				Cr.
MECH	799	Thesis		22
				22

*The remaining 18 credits should be taken as elective courses.

Mandatory Courses

MECH 601 - Condition Monitoring & Diagnosis (3 Cr.)

Vibration motion concepts, causes of vibration, maintenance, transmissibility, and impedance, sideband frequencies, fourier analysis, vibration sensors, data acquisition, vibration monitoring, preventive maintenance program, vibration limits, machine performance criteria.

MECH 602 - Advanced Combustion Engines (3 Cr.)

Modern analytical approach to the design and performance analysis of advanced internal combustion engines. Study of thermodynamics, fluid flow, combustion, heat transfer, and other factors affecting the design, operating and emissions characteristics of different engine types.

MECH 603 - Theory & Design of Hydraulic Machines (3 Cr.)

Fluid motion in hydraulic - machines, fluid - rotor energy transfer; Axial and centrifugal pumps and turbines, performance and design criteria; Cavitations and two - phase flow considerations.

MECH 604 - Power Plants & Renewable Energy (3 Cr.)

Fuels and water supply. Plant components. Cycle optimization and combined cycles. Load curves. Economics. Solar - energy plants. Wind energy. Tidal waves. Geothermal energy. Thermo - electric, thermo - ionic and magneto - hydrodynamic plants. Fuel cells. Energy storage.

MECH 605 - Advanced Thermodynamics (3 Cr.)

Statistical thermodynamics, thermodynamic relations, mixtures and solutions, activity and fugacity - Real-gas equations - Development of gas charts and tables - Chemical equilibrium, availability and irreversibility.

MECH 699 - Master's Thesis (6 Cr.)

For students working on an advanced research program leading to the completion of the Master's degree requirements.

MECH 799 - PhD Thesis (28 Cr.)

For students working on an advanced research program leading to the completion of the PhD dissertation.

Elective Courses

- Mechanical Engineering -

MECH 606 - Directed Research (3 Cr.)

The project thesis is dedicated field of research to a chosen area in coordination with both of advisor and the elective courses undertaken. Research preparation could start prior to enrollment to this subject.

- Combustion & Automotive Engineering -

MECH 606 - Directed Research (3 Cr.)

The project thesis is dedicated field of research to a chosen area in coordination with both of advisor and the elective courses undertaken. Research preparation could start prior to enrollment to this subject.

MECH 607 - Modern Automotive Engineering (3 Cr.)

Modern trends in engine design, combustion chambers, valve trains, fuel injection systems, electronic ignition systems, motronic - type systems, cooling and lubrication, intake and exhaust tuning, emission - control requirements.

MECH 608 - Engineering & Management of Automotive Service Centers (3 Cr.)

Periodic maintenance. Fault diagnosis (for all automotive systems). Man - hour calculations. Maintenance and repair equipment. Optimal workshop planning. Maintenance schedules.

MECH 609 - Fundamentals of Diesel Engineering (3 Cr.)

Basic types of diesel engines, fuel pumps, injectors, governor.

MECH 610 - Turbomachinery (3 Cr.)

Classifications of turbo machinery, design calculations for compressors, combustion chambers and gas turbines - performance charts - matching considerations and off - design operation.

MECH 611 - Combustion, Emissions & Pollution Control (3 Cr.)

Combustion processes, Emission formation in spark - ignition engines, gas turbines and other combustion systems - Standards of emissions and air quality - Techniques of emission measurements - Standard test procedures - Pollution - control systems - Calculations of emission dispersion in the atmosphere - Stack design.

MECH 612 - Performance & Maintenance of Diesel Engines (3 Cr.)

Combustion chambers, operating conditions, performance maps, emissions, super - and turbo charging, condition monitoring, testing, maintenance.

MECH 613 - Special Topics in Combustion Engineering (3 Cr.)

The contents of this course shall cover topics of particular relevance to the research project, topics may differ according to the title of the project, topics may include (but not limited to): Combustion process - internal combustion engines and gas turbines.

MECH 701 - Thermodynamics of Combustion (3 Cr.)

Thermodynamic relations, real - gas equations, mixtures and solutions, chemical reactions, stoichiometry and adiabatic flame temperature, gas tables and JANAF tables, phase and chemical equilibrium, association and dissociation, simultaneous reactions.

MECH 702 - Heterogeneous Combustion (3 Cr.)

Diesel injectors and nozzle types, spray characteristics and droplet sizing, spray penetration and air entrainment, heat transfer and mass diffusion, droplet burning and film combustion, group combustion, soot formation and particulate growth, filters and trap regeneration, NO_x formation and catalytic converters.

MECH 703 - Advanced Gas Dynamics (3 Cr.)

Unsteady flow in ducts, the method of characteristics, boundary conditions, numerical procedures of solution, case studies.

MECH 704 - Applications of Unsteady Flow in Combustion (3 Cr.)

Fundamentals of unsteady flow, dynamic - pressure exchangers, pressure - wave utilization in reciprocating - engine manifolds, supercharging, pulsating combustors, pulse ejectors, passive wave - energy converters.

MECH 705 - Combustion Kinetics & Flames (3 Cr.)

Chemical thermodynamics, orders of reactions and chemical kinetics, multi - component reaction systems, flame - propagation theories, premixed laminar flames, diffusion flames, combustion stability and flame quench.

MECH 706 - Special Topics in Combustion Engineering (3 Cr.)

The contents of this course shall cover topics of particular relevance to the research project, topics may differ according to the title of the project, topics may include (but not limited to): Combustion process - internal combustion engines and gas turbines.

- Design & Dynamic Systems -***MECH 606 - Directed Research (3 Cr.)***

The project thesis is dedicated field of research to a chosen area in coordination with both of advisor and the elective courses undertaken. Research preparation could start prior to enrollment to this subject.

MECH 614 - Vibration Control (3 Cr.)

Vibration analysis (proximity analysis, frequency analysis, spectral analysis, and real time analysis), analyzer selection, data processing. Free & forced vibration of continuous systems, transient response of lumped parameter systems, critical speeds of shafts & rotor dynamics, gyroscopic effects of discs & rotor balance - Noise control, case studies in vibrations.

MECH 615 - Robot Dynamics (3 Cr.)

Basics of Robotics, homogeneous transformation, arm kinematics, inverse kinematics, arm dynamics, trajectory planning, robot control system, position, speed and force control of robot grippers, practical examples.

MECH 616 - Lubricants & Lubrication Systems (3 Cr.)

Liquid, solid, grease and gas lubricants, additives, selection of lubricant type, oil and grease lubrication systems, system selection, warning and protection devices, lubricant change period and tests.

MECH 617 - Mechanical Behavior of Composite Materials (3 Cr.)

Macro - mechanical behavior of lamina, micro - mechanical behavior of lamina, macro - mechanical behavior of laminate, mechanics of metal - matrix fibrous composites.

MECH 618 - Tribology (3 Cr.)

Surface qualities of mechanical parts, contact of rough surfaces, methods and instrumentation for measuring the properties of contacts, calculation of the coefficient of friction and of wear rate. wear of tribological joints, bearing characteristics, choice of materials for rubbing parts.

MECH 619 - Fracture Mechanics (3 Cr.)

Conditions for crack growth, stress intensity factor, cracks in linearly elastic bodies, cracks in elastic plastic bodies, cracks in linearly viscoelastic media, thermal problems in fracture mechanics, dynamic problems in fracture mechanics.

MECH 620 - Elastohydrodynamics (3 Cr.)

Lubrication and elasticity equations, elastohydrodynamic theory, lubrication of rolling contact bearings, lubrication of gears, measurements of film thickness and film shape.

MECH 621 - Nonlinear Vibrations (3 Cr.)

Nonlinear oscillations (free and forced using graphical iteration, and perturbation methods) - Self excited vibrations, Hill and Mathieu equations, stability analysis - Introduction to random vibrations.

MECH 622 - Modern Control Analysis (3 Cr.)

State - Space system analysis, controllability, observability, Lyapunov stability - Pole placement, design of servo systems, state observer, quadratic optimal control, design of control system with observer, applications with MATLAB.

MECH 623 - Intelligent Control Systems (3 Cr.)

Introduction to intelligent control, fuzzy sets, fuzzy relations, rules, fuzzy models, structure and design of fuzzy controller, principles of neural networks, learning methods, neural networks for control and modeling, neuro fuzzy control systems, genetic algorithm.

MECH 707 - Theory of Elasticity (3 Cr.)

Analysis of stress and strain in three dimensions, equations of equilibrium, conditions of compatibility, displacements, plane stresses and strains in rectangular, polar, and curvilinear coordinates, applications.

MECH 708 - Theory of Plates & Shells (3 Cr.)

Bending of plates with various edge conditions, special and approximate methods in the theory of plates, deformation of shells without bending, general theories of cylindrical spherical, and conical shells, general shells of revolution.

MECH 709 - Theory of Plasticity (3 Cr.)

Fundamentals of continuum mechanics, equations of plastic state, equations of elastic plastic equilibrium, plane stresses and strains, behavior of elastic plastic bodies under variable loads.

MECH 710 - Viscoelasticity (3 Cr.)

Classification of viscoelastic materials, creep and relaxation tests, harmonic tests, notation of time response, analogous study of viscoelastic behavior, superposition principles of Boltzmann.

MECH 711 - Theory of Elastic Stability (3 Cr.)

Elastic buckling of bars and frames, torsional and lateral buckling, buckling of thin plates, buckling of shells, experiment and design formulas.

MECH 712 - Advanced Dynamics (3 Cr.)

Lagrange's equation, hamiltonian mechanics, canonical transformations (Hamilton, Jacobi), theory of variation principles of mechanics, stability of multi - degree - of - freedom autonomous systems, no autonomous systems - perturbation techniques.

MECH 713 - Noise & Vibration Control (3 Cr.)

Fundamentals of acoustics and vibrations, spectral analysis, active control of noise propagating in ducts, active control of free field sound radiation, vibration isolators.

MECH 714 - Nonlinear Control (3 Cr.)

Nonlinearities in physical systems, phase plane analysis, transformation and scaling methods, stability analysis Lyapunov's first and second method, frequency domain methods, equivalent linearization; Harmonic response, K&B, Galerkin's method, describing functions, controller synthesis, riccati approach, absolute stability approach.

- Fluids Engineering -***MECH 606 - Directed Research (3 Cr.)***

The project thesis is dedicated field of research to a chosen area in coordination with both of advisor and the elective courses undertaken. Research preparation could start prior to enrollment to this subject.

MECH 624 - Design of Pipelines (3 Cr.)

Hydraulic and mechanical design of pipe lines Economical Considerations Construction, operation, maintenance, and applications.

MECH 625 - Hydraulic Power Circuits (3 Cr.)

Hydraulic system components - Components design - System design and circuit analysis - Performance testing of system components - Applications.

MECH 626 - Hydraulic & Pneumatic Systems (3 Cr.)

Hydraulic and pneumatic systems components. Component design. System design and circuit analysis. Performance testing of the components and the system. Applications.

MECH 627 - Theory of Lubrication (3 Cr.)

Introduction. Governing equations of lubricating film. Hydrostatic bearings (pad characteristics, optimisation, operation, and flow restrictors). Hydrodynamic bearings (journal and thrust bearings, squeeze film bearings, and gas bearings).

MECH 628 - Viscous Fluid Flow (3 Cr.)

Fundamental laws of motion for viscous fluid, equations of viscous incompressible flow, solutions of Navier - Stokes equations, laminar boundary layers, incompressible turbulent mean flow, compressible boundary layer flow, three, dimensional boundary layers.

MECH 629 - Boundary Layer Theory (3 Cr.)

Fundamental laws of motion for a viscous fluid. Laminar boundary layers. Transition. Turbulent boundary layers.

MECH 630 - Multi Phase Flow (3 Cr.)

Introduction. Homogeneous flow. Separated flow. The drift flux model. Velocity and concentration profiles. One dimensional waves. Interfacial phenomena.

MECH 631 - Special Topics in Fluid Mechanics (3 Cr.)

The contents of this course shall cover topics of particular relevance to the research project, topics may differ according to the title of the project, topics may include (but not limited to): Fluid mechanics - Hydraulics.

MECH 715 - Computational Fluid Mechanics (3 Cr.)

Governing equations for fluid mechanics - Grid generation techniques: (Algebraic methods - differential methods), Numerical methods for in viscid flow equations - Numerical methods for boundary - layer type equations. Numerical methods for Navier - Stocks equations - Numerical methods for viscous - in viscid interaction techniques.

MECH 716 - Turbulent Flow (3 Cr.)

Turbulent transport of momentum and heat. The dynamics of turbulence. Boundary free shear flows. Wall bounded shear flows. The statistical description of turbulence.

MECH 717 - Flow Transients (3 Cr.)

Review of steady flow in pipes. Fundamental concepts of unsteady flow. Rigid water column theory. Elastic theory. Solution by method of characteristics. Complex pipe systems. Pumps in systems. Problems resulting from unsteady flow in pipe systems. Control devices and techniques.

MECH 718 - Non - Newtonian Fluid Mechanics (3 Cr.)

Definitions. Viscosity formulae for non Newtonian fluids. Equations of motion for non Newtonian fluids. Non Newtonian fluid flow through pipes. Applications.

MECH 720 - Aerodynamics (3 Cr.)

In viscid flow concepts including: Euler equations, stream function, velocity potential, singularities, vorticity and circulation laws. Viscous flow topics including: Boundary layers, separation, and turbulent flow. In addition, external flows, lift and drag, thin airfoil theory, finite wing theory and airfoil design.

MECH 721 - Special Topics in Fluid Mechanics (3 Cr.)

The contents of this course shall cover topics of particular relevance to the research project, topics may differ according to the title of the project, topics may include (but not limited to): Fluid mechanics - Hydraulics.

- Thermal Engineering -***MECH 632 - Cooling Systems (3 Cr.)***

Mechanical chillers - Absorption chillers - Air cooled and water cooled chillers, selection and specifications.

MECH 633 - Air Conditioning Equipment & System (3 Cr.)

All air systems - Air and water systems - All water systems - Air handling units - Selection and specifications - Fan coil units - Control and instrumentations.

MECH 634 - Heating Systems (3 Cr.)

Different types - Hot water boilers - Solar systems - Boiler room design - Safety devices in heating systems - Pollution control in fired heating system.

MECH 635 - Heat Exchangers (3 Cr.)

Types of heat exchangers, the overall heat transfer coefficient, analysis of heat exchangers, the selection of heat exchangers, thermal design of heat exchangers using TEMA code, heat exchanger: Materials, construction and corrosion, flow induced vibration phenomena, testing and inspection.

MECH 636 - Advanced Heat Transfer (3 Cr.)

Conservation equations for viscous flow, dimensionless parameters, boundary - Layer theory - Similarity - Exact and approximate solutions of boundary layer - Natural and forced flow - Flow in ducts and around boilers - Heat transfer correlations.

MECH 637 - Water Treatment & Desalination Units (3 Cr.)

Methods of desalination and water treatment, water chemistry, design of thermal and membrane units, other desalination and water treatment units, water treatment of: Boilers, condensers, cooling towers and water chillers, economical assessment, technologies - Operation and maintenance of desalination and water treatment units, treatment of corrosion and scale deposits and industrial waste water treatment.

MECH 638 - Special Topics in Thermal Engineering (3 Cr.)

The contents of this course shall cover topics of particular relevance to the research project, topics may differ according to the title of the project, topics may include (but not limited to): Heat transfer - Heat exchange - Internal combustion engines - Power stations - Heating - Ventilation - Air conditioning and refrigeration.

MECH 722 - Advanced Engineering Thermodynamics (3 Cr.)

Classical thermodynamics of a general system; Conservation of energy and principles of increase of entropy; Fundamental relation of thermodynamics; Legendre transformations; Phase transitions and critical phenomena; Equilibrium and stability criteria in different representation; Irreversible thermodynamics.

MECH 723 - Heat & Mass Transfer (3 Cr.)

Steady and unsteady heat transfer by conduction, convective heat transfer by laminar and turbulent fluid flow, natural convection, mixed convection, heat transfer by radiation through participating media, mass transfer by steady state diffusion in gases and liquids, and mass transfer in laminar and turbulent flow.

MECH 724 - Two - Phase Flow Heat Transfer (3 Cr.)

Generalized constitutive equations for various two - phase flow regimes. Interfacial heat and mass transfer. Equilibrium and non - equilibrium flow models. Two - phase flow instability. One - dimensional wave propagation. Two - phase heat transfer applications: convective boiling, preserve drop, critical and oscillatory flows.

MECH 725 - Humidification & Drying (3 Cr.)

Humidification system components, Theoretical analysis and performance of humidification systems, classification and selection of dryers, drying mechanism, calculation of drying rates and periods, practical dryer design.

MECH 726 - Numerical Methods in Transport Phenomena (3 Cr.)

Numerical techniques for solving selected problems in heat and mass transfer. Applications include free convection, boundary layer flow, two - phase flow, separated flow, flow in porous media. Effects of concentration and temperature gradients, chemical reactions, radiation and electric and magnetic fields.

MECH 727 - Special Topics in Thermal Engineering (3 Cr.)

The contents of this course shall cover topics of particular relevance to the research project, topics may differ according to the title of the project, topics may include (but not limited to): Heat transfer - Heat exchange - Internal combustion engines - Power stations - Heating - Ventilation - Air conditioning and refrigeration.

Department of Industrial & Management Engineering

MA & PhD Degrees Curricula

MA Degree in Industrial & Management Engineering (36 credit hours)

- Project Management, Engineering Management, Management Planning, & Production Service Systems -

Cr.

IEEM	601	Project Planning & Time Management	3
IEEM	602	Advanced Operation Research	3
IEEM	603	Feasibility Studies	3
IEEM	604	Research Methodology	3
IEEM	605	Plant Design & Material Handling	3
IEEME	699	Thesis	6
			21

*The remaining 15 credits should be taken as elective courses.

PhD Degree in Industrial & Management Engineering (40 credit hours)

- Project Management, Engineering Management, Management Planning, & Production Service Systems -

Cr.

IEEM	799	Thesis	22
			22

*The remaining 18 credits should be taken as elective courses.

Mandatory Courses

IEEM 601 - Project Planning & Time Management (3 Cr.)

Deterministic activity networks, probabilistic activity networks, structures, terminology, time, cost tradeoffs: linear, resource consideration in project planning networks, heuristic approaches in resource allocation, analytical models for resource allocation generalized activity networks, project management packages.

IEEM 602 - Advanced Operations Research (3 Cr.)

Integer programming, goal and multi objective programming, non - linear programming, stochastic processes, replacement theory, game theory.

IEEM 603 - Feasibility Studies (3 Cr.)

Technical feasibility, financing, financial analysis, capital structure and credit risk, financial statement, engineering economy, economical and financial analysis, business plans, market analysis, market research, consumer behavior.

IEEM 604 - Research Methodology (3 Cr.)

Research methodologies, data gathering, information processing, statistical and mathematical modeling, design of experiments, presentation skills, report writing, communications skills. Within an interdisciplinary model, this course is designed to help students learn about different genres of qualitative and quantitative research and the various issues in designing a research study. Students become familiar with the ontological, epistemological and methodological assumptions within both qualitative and quantitative paradigms. In addition, students will: Construct a research project design; Collect, analyze and interpret data; and present findings.

IEEM 605 - Plant Design & Material Handling (3 Cr.)

Comprehensive design of industrial systems, integrated analysis of manufacturing systems, process and product design, synthesis and design of materials flow, selection of facilities and equipment, plant layout and sequencing analysis, location, selection, materials handling, layout of equipment for operation of industrial and service facilities, techniques, analysis and design industrial plant, computerized facilities allocation, automated material handling systems, robotics, equipment utilization, evaluation procedures.

IEEM 699 - Master's Thesis (6 Cr.)

The Master's project aims to develop an understanding of the field of study beyond the undergraduate degree, with emphasis on the conduct of original research, the application of theory into practice through real life models, and the effective communication of information through the appropriate channels, comprehensive knowledge, as well as training in data interpretation and analytical skills is essential, one of the key goals for the Master's project is to give students the tools and confidence to carry out independent research, in addition, the student must possess the ability to express thoughts clearly, both verbally and in written form.

IEEM 799 - PhD Thesis (28 Cr.)

For students working on an advanced research program leading to the completion of the PhD dissertation.

- Engineering Mathematics & Physics -

EMPH 601 - Numerical Analysis (3 Cr.)

Curve fitting and interpolation, numerical differentiation and integration, solution for nonlinear equation, numerical solutions for ordinary differential equation, boundary value and Eigen value problems.

EMPH 602 - Advanced Numerical Analysis (3 Cr.)

Numerical analysis for the solution of linear and nonlinear systems of equations, partial differential equations, stability, convergence and consistency analysis.

EMPH 603 - Stochastic Processes (3 Cr.)

A systematic account of several principal areas in stochastic processes: Branching processes, Markov chains (discrete and continuous parameter), Poisson processes, Gaussian processes, Brownian motion. Univariate and multivariate Brownian motion theory, classification integrals. Examples and applications.

EMPH 604 - Linear & Nonlinear Optimization (3 Cr.)

Classical optimization of functions of a single variable and multiple variables, constrained optimization, inequality constraints. Search techniques, unconstrained problems, one and multiple dimensional problems (simultaneous and sequential methods). Various types of mathematical programming. Unconstrained optimization, nonlinear programming, non - differential optimization, applications.

EMPH 605 - Mathematical Modeling (3 Cr.)

This course is directed towards the development of necessary modeling concepts and skills. Case studies based on the instructor and audience interests are considered.

EMPH 606 - Discrete Mathematics (3 Cr.)

Set theory, relations - algebraic structure, (semi groups, groups, rings, fields). Homomorphism and Isomorphism. Linear Algebra: Vector spaces and subspaces. Linear dependence and Independence. Eigen values and eigenvectors. Matrix relations. Systems of Linear equations. Lattices and Boolean algebra.

EMPH 607 - Reliability Analysis (3 Cr.)

Life models, relevant distribution (Poisson, Weibull distribution), reliability and hazard functions, decision making in life testing, design of experiments in life testing.

EMPH 608 - Engineering Statistics & Probability (3Cr.)

Concepts of Probability, conditional expectation, independence, laws of large numbers, probability models and distribution. Introduction to stochastic processes sampling theory, estimation theory.

EMPH 609 - Advanced Engineering Mathematics (3 Cr.)

Eigenfunctions / Eigenvalues problems. Diffusion / Wave problems, expansion of characteristics and Green's function. Integral transforms, variations, perturbation and distribution theoretical methods for solving differential, difference and integral equations.

EMPH 610 - Finite Difference (3 Cr.)

Introduction to finite difference approximations, notation, Taylor series expansions, operator notation, finite difference approximation in two dimensions, additional concepts, consistency, convergence and stability, applications in solution different types of partial differential equations.

EMPH 611 - Finite Element (3 Cr.)

Finite elements approximation, method of weighted residuals, choice of basic functions, two dimensional basic function, triangular elements, isoperimetric finite elements, boundary conditions, applications in solution different types of partial differential equations.

EMPH 612 - Analytical Mechanics (3 Cr.)

The differential Equations of motion of arbitrary system of particles, The equations of motion in a potential field. Variational Principles and integral invariants. Canonical Transformations and the Hamilton - Jacobi Equation. Stability of Equilibrium and the motion of a system. Small oscillations. Systems with cyclic coordinates.

EMPH 613 - Perturbation & Asymptotic Methods (3 Cr.)

Expansion of various methods, regular perturbation theory, singular perturbation theory, initial and boundary layers, method of multiple scales, ray theory, two times methods and application problems.

EMPH 614 - Theory of Elasticity (3 Cr.)

Two Analysis of strain. Analysis of stress. Equations of Elasticity Extension, Torison, and Flexure of Beams. Dimensional Elastostatic problems. Three - dimensional problems. Variational methods. Introduction to the theory of Plasticity.

EMPH 615 - Advanced Topics in Differential Equations (3 Cr.)

Diffusion equations for no uniform media, solution of non homogeneous equation subjected to time dependent boundary conditions both in Cartesian as well as other coordinate systems. The Laplace and Poisson equations. The method of Characteristics for the wave equation and propagation of discontinuities. Using integral transforms in solving differential equations. Discussion and error estimation.

Elective Courses**- Project Management -*****IEEM 611 - Project Risks Management (3 Cr.)***

Plan risk management, identify risk, risk identification tools and techniques, qualitative risk analysis, qualitative risk analysis tools and techniques, quantitative risk analysis, quantitative risk analysis risk response, monitoring and controlling of risk.

IEEM 612 - Project Quality Management (3 Cr.)

Introduction to TQM, quality improvement tools, project quality management tools and techniques, project quality assurance, project quality assurance tools and techniques, project quality control, project quality control tools and techniques.

IEEM 613 - Project Cost Estimation & Control (3 Cr.)

Cost estimation, budgeting, budgeting tools and techniques, cost control, internal auditing, financing, financial analysis, cash flow, time value of money, appraisal, selection between alternatives.

IEEM 614 - Contracting & Human Resource Management (3 Cr.)

Plan procurements, plan procurements tools and techniques, conduct procurements, administer procurements, close procurements, develop human resource plan, acquire project team, develop project team, manage project team.

IEEM 615 - Decisions Models & Analysis (3 Cr.)

Decision making tools, modeling and decision analysis, managerial decision modeling, decision tree, data mining, management support systems, knowledge base, artificial intelligent, expert systems, MIS, research process, e-business decision support.

- Engineering Management -***IEEM 621 - Safety Engineering & Management (3 Cr)***

Accident prevention, accident cost analysis, safeguarding machine and equipment, sensing devices, safety analysis techniques, safety performance measurements, accident reports, investigation and cause analysis, safety training, human factors, industrial health engineering, environmental monitoring, hazardous and toxic chemicals, noise control, personal protective equipment, fire protection, prevention and control, product safety engineering, hazard analysis, fault tree analysis, risk analysis.

IEEM 622 - Expert Systems (3 Cr.)

Introduction to expert systems, expert system architecture, expert system generations, expert system application areas, knowledge representation by production rules, knowledge representation methods, frames, semantic networks, inference process, search strategies, interaction of inference engine, rule base and working memory in the process of inference, control of inference, forward chaining algorithm, backward chaining algorithm, knowledge acquisition tools, rule induction, reasoning based on uncertainty, fuzzy reasoning, estimation of expert system performance, expert system development tools, expert system shells, expert system environment.

IEEM 623 - Engineering Economy & Cost Analysis (3 Cr.)

The concept of equivalence, depreciation accounting, evaluation of replacement involving risk and unequal lines, analysis of public activities and benefit - cost analysis, inflation in economic analysis, cost aggregation, remuneration methods, production accounts and cost sheets, the company balance sheet and profit loss statement, budgetary control and standard costing, introduction to cost estimation.

IEEM 624 - Productivity Enhancement Methods (3 Cr.)

Systems, models and decision making approaches, analysis of environmental conditions for management, system analysis and design for improving productivity and effectiveness, identification of bottlenecks, impact of human performance on productivity, effect of the interaction between technological advances and human capabilities on performance and productivity, cost reduction and productivity improvement programs.

IEEM 625 - Decisions Models & Analysis (3 Cr.)

Decision making tools, modeling and decision analysis, managerial decision modeling, decision tree, data mining, management support systems, knowledge base, artificial intelligent, expert systems, MIS, research process, e-business decision support.

- Maintenance Planning -***IEEM 631 - Maintenance & Reliability (3 Cr.)***

Failure types and analysis, reliability, reliability center and maintenance RCM, block failure diagram, modes, reliability testing, reliability parameters, system reliability, reliability optimization, maintenance types and objectives, maintenance effectiveness.

IEEM 632 - Maintenance Planning (3 Cr.)

Planned maintenance objective, forms of maintenance, maintenance programs, maintenance planning techniques, maintenance records, maintenance optimization, total production maintenance TPM, maintenance database, spare parts management, human element maintenance, economics of maintenance, computerized management system.

IEEM 633 - Industrial Safety & Human Factor (3 Cr.)

Study of the relationship between man and his environment, working Anatomical, sociological and physiological factors underlining the design techniques of a specific environment, work optimization in perception, reaction, energy expenditure and bodily action, advanced study on work center design for improving human work, industrial codes and legislation, safety.

IEEM 634 - Condition Basec Maintenance CBM (3 Cr.)

Condition monitory, fault detection, tools and instrumental, automated data acquisition, vibration analysis, CBM cost analysis, remain life and reliability.

IEEM 635 - Decisions Models & Analysis (3 Cr.)

Decision making tools, modeling and decision analysis, managerial decision modeling, decision tree, data mining, management support systems, knowledge base, artificial intelligent, expert systems, MIS, research process, e-business decision support.

- Production & Service Systems -

IEEM 641 - Modern Product / Service Systems (3 Cr.)

Basic concepts and techniques in hierarchical design, planning, and control of manufacturing systems, assembly lines, general serial systems, group technology and cellular manufacturing, flexible manufacturing systems, process technology, context, management and strategies.

IEEM 642 - Supply Chain Strategies & Logistics (3 Cr.)

Vendor and supplier selection, multimodal transportation systems, vehicle routing and dispatching models, warehouse and distribution center location problem, inventory models, geographic information systems, e - commerce, global supply chains, case studies.

IEEM 643 - Business Process Re - Engineering (3 Cr.)

Introduction to best practices in business process reengineering. Diagnosis, design, and development of the business processes for firms. Organizational restructuring. Process simplification. Job optimization. Management systems modeling. Performance improvement. Company culture and corporate values reinforcement.

IEEM 644 - Service Management (3 Cr.)

Integration of service systems management, human behavior, and marketing in the creation, delivery, and assurance of service quality and customer satisfaction.

IEEM 645 - Decisions Models & Analysis (3 Cr.)

Decision making tools, modeling and decision analysis, managerial decision modeling, decision tree, data mining, management support systems, knowledge base, artificial intelligent, expert systems, MIS, research process, e-business decision support.

IEEM 701 - Organizational Behavior (3 Cr.)

Studies the scientific generation, formalization, and application of the knowledge of individual and group behaviors that engineers need to function effectively within contexts.

IEEM 702 - Transportation & Supply Chain System (3 Cr.)

Topics include supply chain characterization, site location, mode selection, distribution planning, vehicle routing, demand management, replenishment management, geographic information systems, and real - time control issues.

IEEM 703 - Human - Machine Systems (3 Cr.)

The development and use of mathematical models of human behavior are considered. Approaches from estimation theory, control theory, queuing theory, and fuzzy set theory are considered.

IEEM 704 - Human Decision Making (3 Cr.)

Prescriptive and descriptive theories of human decision making are discussed / contrasted. Approaches to aiding human decision making are considered in context of these theoretical frameworks.

IEEM 705 - Productivity Analysis (3 Cr.)

Modern measurement of productivity measurement and analysis including principles, issues, and latest techniques associated with benchmarking, efficiency measurement, and productivity tracking. Empirical studies and group projects.

IEEM 706 - Economic Decision Analysis (3 Cr.)

Topics include preferences and utilities, social choice, equilibrium concepts, non cooperative and cooperative game theory, price mechanisms, auction mechanisms, voting theory, and incentive compatibility.

IEEM 707 - Computational Statistics (3 Cr.)

This class describes the available knowledge regarding statistical computing. Topics include random deviates generation, importance sampling, Monte Carlo Markov chain (MCMC), EM algorithms, bootstrapping, model selection criteria, (e.g. $C - p$, AIC, etc.) splines, wavelets, and Fourier transform.

IEEM 708 - Discrete Optimization (3 Cr.)

Fundamentals of integer and combinatorial optimization. Topics include polyhedra, cuts, Lagrangean duality, complexity, and others. This course is intended for PhD students.

IEEM 709 - Nonlinear Optimization (3 Cr.)

Fundamentals of nonlinear optimization. Topics include optimality conditions; Convex programming and duality; Unconstrained and constrained methods. Polynomial algorithms and interior point methods. Dual methods.

IEEM 710 - Stochastic Processes (3 Cr.)

Continuous time Markov chains; Uniformization, transient and limiting behavior; Brownian motion and martingales; Optional sampling and convergence; Discrete time Markov chains, Poisson and renewal processes; Transient and limiting behavior; Average cost and utility measures of systems.

IEEM 711 - Financial Data Analysis (3 Cr.)

Fundamentals of statistical inference for models used in the modern analysis of financial data.

IEEM 712 - Reliability Engineering (3 Cr.)

Topics include hazard functions, life distributions, censoring, life tables, nonparametric and parametric estimation and inference, accelerated life testing, structure functions, reliability and maintenance systems, replacement theory.

IEEM 713 - Special Topics (3 Cr.)

Special topics in Industrial and Systems Engineering.

IEEM 714 - Special Topics in OR. (3 Cr.)

Special Topics in the field of Operations Research.

IEEM 715 - Topics in Manufacturing (3 Cr.)

Current topics in manufacturing including: Manufacturing automation and controls, advanced planning systems, heuristic scheduling techniques, stochastic models of manufacturing systems, advanced warehousing, and materials handling.

IEEM 716 - Topics in Optimization (3 Cr.)

Topics may vary with each offering and include subjects such as integer programming, combinatorics, graphs and networks, matching, matroids, polyhedral combinatorics, as well as others.