DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

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Electrical Power and Machines Engineering Program

Mission

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

Objectives

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

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

Student Outcomes

UPON COMPLETION OF THE PROGRAM GRADUATES SHALL HAVE:

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

7- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Degree Requirements

The undergraduate curriculum for the degree of Bachelor of Engineering in Electrical Power and Machines Engineering consists of 150 credit hours of course work + 30 credits transferred from the Lebanese Baccalaureate or equivalent.

Career Opportunities

Electrical power engineers are involved in a wide variety of technology ranging from huge global positioning systems that can pinpoint the location of a moving vehicle to gigantic electrical power generators. These engineers are responsible for designing, developing, and testing as well as supervising the production of electrical and electronic equipment and machinery. Electric motors, controls and drives of electric machinery, renewable energy including photovoltaic and wind energy, lights and wiring in building complexes, vehicles, power generations, transmission and protection devices used by electric utilities are all examples of equipment built by these engineers. Electrical power engineers may choose to specialize in various areas like power generation, transmission and distribution, sustainable energy, or one specialty within these areas.

These engineers are involved in designing new products, writing requirements for their performance, as well as developing maintenance schedules and charts. Testing equipment and machinery, solving operations problems, and estimating the time and cost of electrical and power electronic products also come under their responsibility.

Program Overview

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

I. Common Requirements	**Credits**
General Education Requirements	13
Basic Sciences and Mathematics	30
General Engineering Topics	11
General Electives	3
II. EPME Program-Specific Requirements	**Credits**
A. Engineering Topics from Outside the Major	16
B. Electrical Power and Machines Engineering Core	60
C. Electrical Power and Machines Engineering Technical Electives	12
D. Final Year Project	4
E. Internship	1

I. Common Requirements

The list of common requirement courses and descriptions are presented in this catalog's introductory pages of the Faculty of Engineering section. In particular, the EPME curriculum includes 11 credits offered as general engineering topics. These courses are listed on the table below.

Code	Name	Crs.	Pre-/Co-requisites
MCHE 213	Dynamics	3	
COMP 208	Programming I	3	
INME 221	Engineering Economy	3	
ENGR 500	Research Methodology	2	Pre: ENGL 211

ENGR 500 RESEARCH METHODOLOGY (2 Crs.: 2 Lec): Why to Conduct Scientific Research, Stepping in: Research Methodology, formulating a research problem, conceptualizing a research design, constructing an instrument for data collection, selecting samples, writing a research proposal, collecting data, processing & displaying data, writing a research report. Conducting Scientific Research at the faculty of Engineering. ***Pre-requisite: ENGL 211.***

II. EPME Program-Specific Requirements

A. Engineering topics from outside the major

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

Code	Name	Crs.	Pre-/Co-requisites
ENGR 002	Introduction to Engineering	2	
COME 214	Electric Circuits II	3	Pre: POWE 212
COME 212L	Electric Circuits Lab	1	Pre or Co: COME 214
COME 221	Electronic Circuits I	3	Pre: POWE 212, ENGR 002
COMP 225	Digital Systems I	3	
COMP 345	Intro. to Microprocessor	3	Pre: COMP 208, COMP 225
COMP 345L	Intro. to Microprocessor Lab	1	Pre or Co: COMP 345

A description of this group of courses is given below:

ENGR 002 INTODUCTION TO ENGINEERING (2Crs.: 2Lec.): Introducing the student to the engineering profession in general and the learning objectives that new students should attain, as aligned with the ABET requirements. Covering the basics of the engineering profession and engineering ethics. Introduction to the different engineering majors and the learning objectives as specified by ABET. Insight into different engineering courses that are not technical in nature (e.g., engineering economy). Engineering design tasks that allow the student to start thinking as engineers: problem definition, specification of constraints, investigation of different solution alternatives, implementation of the best solution, and writing technical reports. Fundamental tools and numerical software used in engineering. The tools and software covered could be generic or specific to a major.

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

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

COME 221 ELECTRONIC CIRCUITS I (3 Crs.: 3 Lec): Introduction to semiconductor physics, junction

diodes: construction, I-V characteristics, circuit models, applications, special purpose diodes: Zener diodes. Bipolar junction transistors (BJT) and field effect transistors (FET): types, physical structures, basic configurations, characteristic curves, circuit models, biasing circuits, and small-signal amplifiers. ***Pre-req.: POWE 212, ENGR 002.***

COMP 225 DIGITAL SYSTEMS I (3 Crs.: 2 Lec, 2 Lab Number systems and coding, Binary systems. Conversion from decimal to other bases. BCD numbers. Boolean algebra. Logic gates. Function minimization, Tabular method, Karnaugh mapping. Arithmetic functions and circuit design (HA, FA, and ALU). Combinational functions and circuit design (decoder, encoder, multiplexer, and de-multiplexer). Sequential circuit components (Latches, RS-FF, D-FF, JK-FF, T-FF). Introduction to VHDL. Several laboratory experiments will be based on simple logic gates.

COMP 345 INTRODUCTION TO MICROPROCESSOR (3 Crs.: 3 Lec): An introduction to basic computer organizations, design and implementation of a simple computer; microprocessor instruction sets; assembly, and machine languages. Detailed study of a particular microcomputer architecture and instruction set; assembly language programming and techniques; I/O port design; interrupt control systems; parallel and serial interfaces; the design of various types of digital as well as analog interfaces. Laboratory provides practical hands-on experience with microprocessor and/or micro-controller software application and interfacing techniques***. Pre-req.: COMP 225, COMP 208.***

COMP 345L INTRODUCTION TO MICROPROCESSOR LAB (1 Cr.: 2 Lab): This lab serves the COMP 345 course***. Pre or Co-req.: COMP 345.***

B. Electrical Power and Machines Engineering Core

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

Course	Title	Credits	Pre-/Co-requisites
POWE 212	Electric Circuits I	3	
POWE 271	Electromagnetic Fundamentals	3	Pre: PHYS 281
POWE 342	Control Systems I	3	Pre: MATH 283, COME 214
POWE 342L	Control Systems Lab	1	Pre or Co: POWE 342
POWE 324	Electrical Power Systems	3	Pre: POWE 271, POWE212
POWE 324L	Electrical Power Systems Lab	1	Pre or Co: POWE 324
POWE 344	Instrumentation and Measurement	3	Pre: MATH 381, COME 221
POWE 435	Electric Machinery I	3	Pre: POWE 271
POWE 435L	Electric Machinery I Lab	1	Pre or Co: POWE 435
POWE 423	Electrical Power System Analysis	3	Pre: MATH 284, POWE 324
POWE 433	Power Electronic Circuits I	3	Pre: COME 221
POWE 433L	Power Electronic Circuits Lab	1	Pre or Co: POWE 433
POWE 436	Electric Machinery II	3	Pre: POWE 435
POWE 436L	Electric Machinery II Lab	1	Pre or Co: POWE 436
POWE 420	Electrical Power System Protection	3	Pre: POWE 423
POWE 420L	Electrical Power System Protection Lab	1	Pre or Co: POWE 420
POWE 438	Electrical Installation Design	3	Pre: POWE 324
POWE 434	Power Electronic Circuits II	3	Pre: POWE 433
POWE 525	Introduction to Renewable Energy	3	Pre: POWE 434
POWE 525L	Introduction to Renewable Energy Lab	1	Pre: POWE 525
POWE 543	Industrial Automation	3	Pre: POWE 436, POWE 344
POWE 543L	Industrial Automation Lab	1	Pre or Co: POWE 543
POWE 531	Electric Drives	3	Pre: POWE 434, POWE 436

POWE 531L	Electric Drives Lab	1	Pre or Co: POWE 531
POWE 427	Electric Vehicle and its Control	3	Pre: POWE 342, POWE 436
POWE 480	Introduction to AI in Power Systems	3	Pre: MATH 380, POWE 420

Description of Core Courses

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

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

POWE 342 CONTROL SYSTEMS I (3 Crs.: 3 Lec): History and role of control systems. Transfer function models. Block diagram representation and reduction. Transient and steady-state response analyses. Root-locus analysis and design. Frequency-response analysis and design. Simulation using MATLAB. ***Pre-req.: MATH 283, COME 214.***

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

POWE 324 ELECTRICAL POWER SYSTEMS (3 Crs.: 3 Lec): Power networks structure. Overhead transmission lines: parameters, constants, performance, load ability and compensation. Insulators and corona effect. Mechanical design. Underground power cables. Distribution systems: design, equipment and layouts. Reactive compensation and power factor correction. ***Pre-req.: POWE 271, POWE 212.***

POWE 324L ELECTRICAL POWER SYSTEMS LAB (1 Cr.: 2 Lab): This lab serves the POWE 324 course. ***Pre or Co-req.: POWE 324.***

POWE 344 INSTRUMENTATION AND MEASUREMENT (3 Crs.: 2 Lec, 2 Lab): Measurement errors. Measuring elements. Analogue and digital measuring instruments: voltmeter, ammeter, power meter, and energy meter. Instrument transformers. Measuring amplifiers. Analogue and digital oscilloscopes. Measurement of electrical quantities. Measurement systems: sensors and transducers. Installation and calibration of instruments. ***Pre-req.: MATH 381, COME 221.***

POWE 435 ELECTRIC MACHINERY I (3 Crs.: 3 Lec): History of Electric Machinery. Magnetic circuits. Principles of energy conversion. Single-phase transformers: construction, theory of operation,

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

POWE 435L – ELECTRIC MACHINERY I LAB (1 Cr.: 2 Lab): This lab serves the POWE 435 course. ***Pre or Co-req.: POWE 435.***

POWE 423 ELECTRICAL POWER SYSTEM ANALYSIS (3 Crs.: 3 Lec): Power system modeling. Per-unit systems. Power flow analysis. Network stability analysis. Balanced faults. Symmetrical components and short circuit analysis. Introduction to economic dispatch and introduction to control of generation. Use of power system simulation packages. ***Pre-req.: MATH 284, POWE 324***.

POWE 433 POWER ELECTRONIC CIRCUITS I (3 Crs.: 3 Lec): Introduction to power switches: diode, thyristor, triac, diac, GTO, BJT, MOSFET, IGBT, characteristics, modes of operation, selection of switches, firing circuit design and application, analysis and design of suitable circuits and subsystems for practical applications such as dimmer circuit and dc motor control circuit, calculation of switching losses, evaluation of THD and associated power losses. Rectifying circuits: single-phase and three-phase, uncontrolled, half-controlled and fully-controlled rectifiers for different types of passive loads, evaluation and demonstration of steady state voltages and currents, calculation of efficiency, PF and THD of such converters. Circuit analysis software such as PSIM, PROTEUS or MATLAB. ***Pre-req.: COME 221.***

POWE 433L POWER ELECTRONIC CIRCUITS LAB (1 Cr.: 2 Lab): This lab serves the POWE 433 course. ***Pre or Co-req.: POWE 433.***

POWE 436 ELECTRIC MACHINERY II (3 Crs.: 3 Lec): Three-phase AC machines: winding connections, rotating magnetic field theory, three phase induced voltages and torque. Three-phase induction motors: construction, theory of operation, equivalent circuit, power flow and regulation, starting and testing, torque speed analysis. Synchronous generators and motors: construction, theory of operation, induced voltage, equivalent circuit, voltage regulation, electrical and mechanical diagrams, and parallel operation. Single phase induction motor: construction, theory of operation, equivalent circuit, different types of starting methods and applications. Variable reluctance machines: switched reluctance, synchronous reluctance, and stepper motor. Hysteresis motor. Linear machine: induction, synchronous reluctance. Universal motor: construction theory of operation. ***Pre-req.: POWE 435.***

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

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

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

POWE 438 ELECTRICAL INSTALLATION DESIGN (3 Crs.: 3 Lec): The course is a project-based course that covers electrical design in residential and commercial buildings, including AutoCAD for electrical engineering, electrical design standards, lighting and power design for residential and commercial buildings, cable and breaker design, panel boards and riser diagram design, load estimation, illumination design using DIALux, street lighting design and optimization, and power distribution using Ecodial. Earthing and lightning, introduction to the building management system, green buildings, and infrastructure. ***Pre-req.: POWE 324.***

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

POWE 525 INTRODUCTION TO RENEWABLE ENERGY (3 Crs.: 3 Lec): This course provides a comprehensive introduction to photovoltaic (PV) systems, covering fundamental concepts, modeling, analysis, design, construction, efficiency, and application. Students will learn about solar radiation, system components, and the design and installation of PV systems, with emphasis on both stand-alone and grid-connected electrical systems. The course also includes economic analysis, the use of PV systems design software, and an introduction to wind energy systems. ***Pre-req.: POWE 434.***

POWE 525L INTRODUCTION TO RENEWABLE ENERGY LAB (1 Cr.: 2 LAB): This lab serves the POWE 525 course. ***Pre-req.: POWE 525.***

POWE 543 INDUSTRIAL AUTOMATION (3 Crs.: 3 Lec): Automation and the economy. Hardwired logic versus programmable logic. Control system components. Industrial motor control: starting, braking, reversal, and sequencing. Introduction to programmable logic controllers. PLC hardware and memory organization. Ladder logic. Sequential and combinational logic instructions. Timers and counters programming. Data manipulation instructions. Math instructions. Installation practices and troubleshooting. ***Pre-req.: POWE 346, POWE 344.***

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

POWE 531 ELECTRIC DRIVES (3 Crs.: 3 Lec): History of electric drives and their elementary components, types of loads and dynamics of motor load combination, thermal limitation, considerations and classification of electric motors, analysis of different types of duties in drive systems, load cycle and motor rating selection of electric motors, steady-state stability of an electric drive. DC series, shunt, separately excited, characteristics curves with classical methods of speed controls (resistance, voltage and field control), design of chopper fed DC drives, first, second, and fourth quadrant drive. Induction motor drives: performance and characteristics of classical drives (rotor resistance, supply voltage, and supply voltage-frequency), modern drives (rotor injected voltage, slip power control, slip power recovery, stator voltage-current, and frequency control), modern and classical methods for starting and braking of induction motors, industrial applications of electric drives. ***Pre-req.: POWE 434, POWE 436.***

POWE 531L – ELECTRIC DRIVES LAB (1 Cr.: 2 Lab): This lab serves the POWE 531 course. ***Pre or Co-req.: POWE 531.***

POWE 427 – ELECTRIC VEHICLE AND ITS CONTROL (3 Crs.: 3 Lec): This course explains specialized motors and control techniques used in electric vehicles (EVs): Switched Reluctance Motor, Doubly Salient PM Motor, Flux-Reversal PM Motor, Flux-Switching PM Motor, Hybrid-Excited PM Motor, Magnetic-Geared Motor, Axial-Flux Magnet-less Motor. Planetary-geared electric Variable Transmission Systems, PMSM, etc. Controllability and observability. State equations and transfer function matrices. Pole-placement design. Direct and Indirect Vector Control for EV. Field Weakening Control, IM Sensor-less Control: Full Order Observer, Sliding Mode Observer. PMSM Sensor-less Control. Direct Torque Control, Space Vector PWM. ***Pre-req.: POWE 342, POWE 436.***

POWE 501 FINAL YEAR PROJECT I (1 Cr) ***Pre-req ENGR 500*** **/ POWE 502** ***Pre-req POWE501*** **FINAL YEAR PROJECT II (3 Crs):** After completing 120 credits of course work, the student becomes eligible to sign up for the Final Year Project (FYP) that extends over two semesters; beginning in Fall-

semester and ending in the following Spring semester. The FYP experience requires students to work in teams to complete a specific project, submit a technical report, and give a presentation on a significant, relevant, and comprehensive engineering problem. The FYP is intended to stimulate student creativity and critical thinking and build skills in formulating, designing, developing, building, communicating, and managing engineering projects. The project aims to provide students with a transitional experience from the academic world to the professional world.
Refer to the Final Year Project Policy for more details.

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

POWE 480 INTRODUCTION TO AI IN POWER SYSTEMS (3 Crs.: 3 Lec): This course provides an introduction to Artificial Intelligence (AI) and its applications in power systems. the course covers fundamental AI concepts, including machine learning, including classification, regression, and clustering. The course will explore how these tools are used to address challenges in power systems, such as energy forecasting, grid optimization, fault detection, economic dispatch, unit commitment, and hydrothermal scheduling. ***Pre-req.: MATH 380, POWE 420.***

C. Electrical Power and Machines Engineering Technical Electives

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

Course	Title	Credits	Pre-/Co-requisites
INME 482	Engineering Project Management	3	Pre: ENGL 300
POWE 444	Digital Control	3	Pre: POWE 445
POWE 528	Electrical Power Generation	3	Pre: POWE 436, POWE 423
POWE 522	High Voltage Engineering	3	Pre: POWE 420
POWE 523	Power System Planning	3	Pre: POWE 423
POWE 524	Power System Control and Operation	3	Pre: POWE 445, POWE 423
POWE 527	Advanced Photovoltaic Systems	3	Pre: POWE 525
POWE 529	Wind Energy Systems	3	Pre: POWE 434, POWE 436
POWE 530	Electric Vehicle and its Control	3	Pre: POWE 433, POWE 436
POWE 533	Specialized Modes of Machine Operation	3	Pre: POWE 436
POWE 535	Introduction To Micro-grids and Smart Grids	3	Pre: POWE 420
POWE 536	Solid-State Drives	3	Pre: POWE 434
COMP 215	Programming for Engineers	3	Pre: Comp208
COMP 425	Artificial Intelligence and Robotic for Engineers	3	Pre: Comp 208
MCHE 201	Engineering Drawing and Graphics	3	
POWE 551	EV Charging Stations and Grid Interaction	3	Pre: POWE 434
POWE 552	Electric, Hybrid, and Fuel Cell Electric Vehicles	3	Pre: POWE 434, POWE 436
POWE 553	Energy Storage and Fuel Cells in Transportation	3	Pre: POWE 342, POWE 344
POWE 554	Ev and Electric Aircraft Dynamics and Aerodynamics	3	Pre: POWE 342, POWE 525

Description of Technical Elective Courses

INME482 ENGINEERING PROJECT MANAGEMENT (3 Crs.: 3 Lec): The course covers the characteristics, techniques and challenges associated with initiating, planning, executing, controlling and

closure of projects. Project management skills are discussed as they apply to projects, with a special focus on leadership, teaming, and coordinating individual and group efforts. MS Project is introduced to provide hands-on practical skills with building a project plan, scheduling tasks, assigning resources, managing dependencies, monitoring progress and costs, keeping projects on track, and communicating project data through Gantt charts. ***Pre-req.: ENGL 300***.

POWE 444 DIGITAL CONTROL (3 Crs.: 3 Lec): Introduction to digital control. Difference equations. The *z*-transform. Time-response and frequency-response of discrete-time systems. Sampling theorem. Modeling of digital control systems. Stability analysis. *z*-domain root locus. *z*-domain design. Differencing methods. Pole-zero matching. Bilinear transformation. Frequency-response design. Direct control design. Representation and properties of discrete-time state-space models. ***Pre-req.: POWE 445***

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

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

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

POWE 527 ADVANCED PHOTOVOLTAIC SYSTEMS (3 Crs.: 3 Lec): Overview of solar resources, solar cell materials and fundamentals of PV solar systems, sources of losses and prevention, estimating power and energy demand, site selection, land requirements, choice of modules. Economic considerations and environmental impacts. Electric wiring of PV systems and electric load analysis. Applications of on-grid and off-grid systems including power electronic converters design and installation. PV system efficiency. Maximum power point tracking methods. Heat impact, cooling, maintenance, and safety including leakage current calculation and protection. PV quality and process standards. Design simulation (MATLAB, PSIM). Energy storage systems. ***Pre-req.: POWE 525.***

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

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

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

POWE 535 INTRODUCTION TO MICROGIRDS AND SMART GRIDS (3 Crs.: 3 Lec): This course gives the appropriate solution for the integration of distributed energy resources. Different categories of smart

grids have been classified, and the advantages, weaknesses, and opportunities of each one, are given besides operating conditions. Microgrids have been classified under different criteria. Micro-grid components have been discussed such as an energy management system along with several types of control and communication systems in addition to the economic study**.** ***Pre-req.: POWE 420.***

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

COMP 215 PROGRAMMING FOR ENGINEERS (3Crs.: 2Lec, 2Lab): Programming in Python for engineers: language, use of external libraries, runtime analysis, applications from data analysis and engineering. Topics include: Control statement and program development, functions, sequences: list and tuples, dictionaries and sets, a deeper look on strings, Array-Oriented Programming with NumPy, and plotting using Matplotlib**.** ***Pre-req.: COMP 208*****.**

COMP 424 ARTIFICIAL INTELLIGENCE AND ROBOTICS FOR ENGINEERS (3 Crs.: 2 Lec, 2Lab): Introduction to artificial intelligence and machine learning. Introduction to robotics. Programming in Python: data type, expressions, functions, loops and control. Data plotting and analysis. Smart agent models. Supervised and unsupervised learning. Knowledge representation and reasoning. ***Pre-requisite: COMP 208***

MCHE201 ENGINEERING DRAWING AND GRAPHICS (3Crs.: 1Lec,4Lab): Constructional Geometry-constructing tangents. Plane curves and polygons. Orthographic drawing and theory of sketching shapes and surface identification. Orthographic projection of views. Sectional views and conventions. Pictorial drawing. Applications of Auto-CAD software for 2D drawings.

POWE 528 – ELECTRICAL POWER GENERATION (3 Crs.: 3 Lec): Overview of thermodynamics. Characteristics and operation of thermal units. Introduction to optimization techniques. Economic dispatch of thermal units and methods of solution. Unit commitment and forward dynamic programming. Generation with limited energy supply. Hydrothermal coordination. Demand forecast and reliability of generation. ***Pre-req.: POWE 436, POWE 423.***

POWE 551 – EV CHARGING STATIONS AND GRID INTERACTION (3 Crs.: 3 Lec): This course offers an in-depth study of electric vehicle (EV) charging stations, including AC (Level 1 & 2) and fast chargers (Level 3), as well as wireless charging and advanced power conversion techniques. It covers key charger topologies, efficiency optimization, and control strategies for safe and reliable charging. Additionally, the course examines advanced power converters used in EV applications, such as high-efficiency DC-DC converters, bidirectional power converters, resonant converters, and grid-connected rectifiers. It also addresses the impact of EV charging on the power grid, including harmonic distortion, grid stability, and smart grid interactions like vehicle-to-grid (V2G) technology. ***Pre: POWE 434.***

POWE 552 – ELECTRIC, HYBRID, AND FUEL CELL ELECTRIC VEHICLES (3 Crs.: 3 Lec): This course offers an introduction to electric, hybrid, and fuel cell vehicles (EVs, HEVs, FCVs). It covers drivetrain design, and energy storage hybridization. Key topics include hybrid electric drivetrain architectures (series, parallel, and combined), regenerative braking, and electronic brake distribution. The course also addresses fuel cell hybrid drivetrain design, as well as equivalent circuit modeling for performance analysis. Safety considerations, such as crash hazards, electric shock risks, and regulatory standards, are also included. ***Pre: POWE 434, POWE 436.***

POWE 553 – ENERGY STORAGE AND FUEL CELLS IN TRANSPORTATION (3 Crs.: 3 Lec): This course covers the fundamentals of fuel cells and battery technologies for transportation. Topics include lithium-ion battery modeling, charging optimization, and performance testing. It also explores Battery Management Systems (BMS), safety protocols, and fault diagnosis. Additionally, the course examines fuel cell reactions, hydrogen production and storage, and Polymer Electrolyte Membrane (PEM) fuel cells. ***Pre: POWE 342, POWE 344.***

POWE 554 – EV AND ELECTRIC AIRCRAFT DYNAMICS AND AERODYNAMICS (3 Crs.: 3 Lec): This course covers vehicle dynamics and aerodynamics for electric and hybrid vehicles, including four-wheel planar dynamics, roll dynamics, steering systems, and chassis design. It also explores material selection, and energy-efficient design strategies. For electric aircraft, topics include hybrid and electric propulsion, battery power, range optimization, and propeller aerodynamics. Key concepts include boundary layer theory, drag reduction, high-temperature superconducting (HTS) motors, propulsion control, and flight path optimization for autonomous operation. ***Pre: POWE 342, POWE* 525.**

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

First Semester (17 credits)		**Crs.**	
MATH 281	Linear Algebra	3	Pre: MATH 112
MATH 282	Calculus	3	Pre: MATH 111
PHYS 281	Electricity and Magnetism	3	Pre: PHYS 120
CHEM 241	Principles of Chemistry	3	Pre: CHEM 110
CHEM 241L	Principles of Chemistry LAB	1	Pre or Co: CHEM 241
ENGR 002	Introduction to Engineering	2	
ENGL 001	General English	2	

Second Semester (17 credits)		**Crs.**	
POWE 212	Electric Circuits I	3	
MATH 283	Differential Equations	3	Pre: MATH 281, MATH 282
PHYS 280	Classical Physics	3	
MCHE 213	Dynamics	3	
MATH 381	Probability and Statistics	3	Pre: MATH 282
CHEM 405	Fundamentals of Solid-State Chemistry	2	

Summer I (6 credits)		**Crs.**	
ARAB 001	Arabic Language	2	
ENGL 211	Advanced Writing	2	Pre: ENGL 001

	General Elective	2	
Third Semester (17 credits)		**Crs.**	
COME 214	Electric Circuits II	3	Pre: POWE 212
COME 212L	Electric Circuits Lab	1	Pre or Co: COME 214
MATH 284	Numerical Analysis	3	Pre: MATH 283
POWE 271	Electromagnetic Fundamentals	3	Pre: PHYS 281
COME 221	Electronic Circuits I	3	Pre: POWE 212, ENGR002
COMP 225	Digital Systems I	3	
	General Elective	1	
Fourth Semester (17 credits)		**Crs.**	
POWE 342	Control Systems I	3	Pre: MATH 283, COME 214
POWE 342L	Control Systems Lab	1	Pre or Co: POWE 342
COMP 208	Programming I	3	
MATH 380	Discrete Mathematics	3	Pre: MATH 282
POWE 324	Electrical Power Systems	3	Pre: POWE 271, POWE 212
POWE 324L	Electrical Power Systems Lab	1	Pre or Co: POWE 324
POWE 344	Instrumentation and Measurement	3	Pre: MATH381, COME 221
Summer II (7 credits)		**Crs.**	
ENGR 001	Engineering Ethics	1	
BLAW 001	Human Rights	1	
WRNL 200	Work Ready Now	3	
ENGL 300	Speech Communication	2	Pre: ENGL 211
Fifth Semester (16 credits)		**Crs.**	
POWE 435	Electric Machinery I	3	Pre: POWE 271
POWE 435L	Electric Machinery I Lab	1	Pre or Co: POWE 435
POWE 423	Electrical Power System Analysis	3	Pre: MATH 284, POWE 324
POWE 433	Power Electronic Circuits I	3	Pre: COME 221
POWE 433L	Power Electronic Circuits Lab	1	Pre or Co: POWE 433
INME 221	Engineering Economy	3	
ENGR 500	Research Methodology	2	Pre: ENGL 211
Sixth Semester (18 credits)		**Crs.**	
POWE 436	Electric Machinery II	3	Pre: POWE 435
POWE 436L	Electric Machinery II Lab	1	Pre or Co: POWE 436
POWE 420	Electrical Power System Protection	3	Pre: POWE 423
POWE 420L	Electrical Power System Protection Lab	1	Pre or Co: POWE 420
POWE 434	Power Electronic Circuits II	3	Pre: POWE 433
POWE 438	Electrical Installation Design	3	Pre: POWE 324
COMP 345	Intro. to Microprocessor	3	Pre: COMP 225, COMP 208

COMP 345L	Intro. to Microprocessor Lab	1	Pre or Co: COMP 345
Summer III (1 credits)		**Crs.**	
POWE 499	Internship	1	
Seventh Semester (18 credits)		**Crs.**	
POWE 525	Introduction to Renewable Energy	3	Pre: POWE 434
POWE 480	Introduction to AI in Power Systems	3	Pre: MATH 380, POWE 420
POWE 543	Industrial Automation	3	Pre: POWE 436, POWE 344
POWE 543L	Industrial Automation Lab	1	Pre or Co: POWE 543
POWE 531	Electric Drives	3	Pre: POWE 434, POWE 436
POWE 531L	Electric Drives Lab	1	Pre or Co: POWE 531
POWE 501	Final Year Project I	1	Pre: ENGR 500
	Technical Elective	3	
Eighth Semester (16 credits)		**Crs.**	
POWE 427	Electric Vehicle and its Control	3	Pre: POWE 342, POWE 436
POWE 502	Final Year Project II	3	Pre: POWE 501
POWE 525L	Introduction to Renewable Energy Lab	1	Pre: POWE 525
	Technical Elective	3	
	Technical Elective	3	
	Technical Elective	3	

Courses offered to other majors

The EPME program offers 10 courses for other engineering majors in the following table. These courses are described below.

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

POWE 335 ELECTRIC DRIVES (for mechanical engineering students) (2 Crs.: 2 Lec,): DC motors, DC motor drives, single-phase and three-phase induction motors, induction motor drives, synchronous motors, stepping motors, universal motor, switched-reluctance motors. ***Pre-req.: MCHE 214***

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

POWE 282 POWER ELECTRONICS (for Renewable engineering students) (2Crs.: 2Lec, 0Lab): Power Switches: Diodes, Thyristor, Triac, GTO, BJT, MOSFET, IGBT. AC to DC conversion (Rectifying circuits: single-phase and three-phase, uncontrolled, fully controlled rectifiers). DC to DC conversion (buck boost system). ***Pre-req.: POWE 211, Co: POWE 282L.***

POWE 282L POWER ELECTRONICS AND SOLID STATE DRIVES LAB (for Renewable engineering students) (1Cr.: 0Lec, 2Lab): Experimental work related to the topics discussed in POWE 282. ***Co: POWE 282.***

POWE 381 ELECTROMECHANICAL CONVERSION SYSTEMS (for Renewable engineering students) (3Crs.: 3Lec, 0Lab): Magnetic circuits, single-phase and three-phase transformers, DC motors and generators, synchronous generators, three-phase induction motors and generators. ***Pre-req.: POWE 211.***

POWE 385 MODERN DRIVES (for Renewable engineering students) (2Crs. 2Lec, 0Lab): Concept, classification, parts and advantages of electric drive system. Fundamental torque and moment of inertia equations, Equivalent value of drive parameters for loads with rotational and translational motion. Overview of classical drives. Modern drive of DC motors (Single phase, three phases fully controlled and half controlled DC drives 1,2, and 4-quadrant drive circuits). Modern drive of Induction motors (Stator voltage variation by three phase controllers, Speed control using chopper resistance in the rotor circuit, slip power recovery scheme. Pulse width modulated inverter fed induction motor drive. Volts/Hertz drive technique) ***Pre-req.: POWE 211.***

POWE 382 POWER SYSTEMS OPERATION, PROTECTION, AND ANALYSIS (for Renewable engineering students) (3Crs.: 3Lec, 0Lab): General view of power system components, structure (power generation, transmissions, and distribution, transmission line) and modeling. Per unit systems, fault analysis, load flow analysis and advanced topics such as voltage stability, economic dispatch, optimal power flow, unit commitment and state estimation. Protective relays principals, fuse, circuit breakers and protection schemes. Complete protection of, induction motors, over speed, phase sequence and lose of excitation protection. ETAP and SCADA system. ***Pre-req.: POWE 381.***

POWE 481 GRID INTEGRATION (for Renewable engineering students) (3Crs.: 3Lec, 0Lab): This course presents the analytical framework used to evaluate the power system with high penetration levels of several renewable energy. It also elaborated the system operations improvements and the planning of gird integration. ***Pre-req.: POWE 282 and POWE 385.***

POWE 482 PHOTOVOLTAIC SYSTEMS (for Renewable engineering students) (3Crs.: 3Lec, 0Lab): Introduction to Photovoltaic systems. Solar radiation. Principles of photovoltaic systems. Mechanical integration of photovoltaic systems. System advantages and disadvantages. Site evaluation. Component operation. System design and sizing. Installation, commissioning, maintenance, and troubleshooting. Emphasis on stand-alone systems with a brief introduction to grid connected electrical systems. Cells, modules, and arrays of Photovoltaic systems, batteries, charge controllers and inverters. Recommended practices for important applications. Photovoltaic systems economic analysis. PV Systems Design Software will be used throughout the course. ***Pre-req.: CHEM 247 and PHYS 282.***

Elective University Requirement Course

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

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