



University of Bahrain
Quality Assurance & Accreditation Center

Offering/ an Academic Program Form

Faculty: Engineering

Department: Electrical and Electronics Engineering

Program (in English): Master of Science in Power Systems Engineering

Program (in Arabic): ماجستير في علوم هندسة نظم القوى الكهربائية

1.1 Study Plan

Year 1 - Semester 1

Course Code	Course Title	Course Hours	Course Type	Pre requisite
REE 601	Renewable Energy Systems Fundamentals	4-0-4	MR	
PSE 601	Advanced Power Systems Engineering	4-0-4	MR	
PSE 602	Power Electronics Applications in Power Systems	4-0-4	MR	

Year 1 - Semester 2

Course Code	Course Title	Course Hours	Course Type	Pre requisite
PSE 603	Power Systems Operations and Optimization Techniques	4-0-4	MR	
PSE 604	Stability and Control of Electric Power Systems	4-0-4	MR	
PSE 605	Special Topics in Power Systems Engineering	4-0-4	MR	

Year 2 - Semester 3

Course Code	Course Title	Course Hours	Course Type	Pre requisite
PSE 699	Thesis	0-0-12	MR	Completion of 20 credits

Courses Descriptions:

Course Code:	REE601	Course Title:	Renewable Energy Systems Fundamentals (4 Credits)
Course Description:	<p>Gaining an understanding of the principles of renewable energy technologies is key to understanding the technological basis of the systems and their applications. This is particularly important with regards to the overall energy mix of a specific country. This course provides you with the fundamentals of renewable energy technologies and their impact on global and national energy systems. The purpose of this course is to introduce the basis for assessment of the performances of solar, wind, wave and tidal, hydro-electricity, biomass and waste technologies, and geothermal technologies. Basic introduction to the relevant market and financial management, policies, regulations and incentives will be experienced.</p>		
Course Code:	PSE 601	Course Title:	Advanced Power Systems Engineering (4 Credits)
Course Description:	<p>This course provides advanced tools for the analysis and design of power systems. Topics include: Incidence and network matrices; Programming considerations: Sparsity programming and triangular factorization; Optimal power flow studies: feasibility, convergence and ill conditioning in large networks, advance solution techniques; Control of real and reactive power flows; Study of faults in large power system networks: symmetrical and asymmetrical faults, short and open circuit faults.</p>		
Course Code:	PSE 602	Course Title:	Power Electronics Applications in Power Systems (4 credits)
Course Description:	<p>This course provides advanced methods for the analysis and design of power electronic converters suitable for AC/DC, DC/DC and DC/AC electrical energy conversions including resonance converters. The application of power electronic converters in the fields of sustainable energy technologies such as wind energy, solar power, wave energy, and fuel cells are described in depth. Furthermore, industrial applications like Switch-Mode Power Supplies (SMPSs), Uninterruptible Power Supplies (UPSs), and induction heating as well as application of power electronics for transmission (FACTS), distribution</p>		

	(DFACTS) and control in the future power system, including Smart Grid, are extensively analysed.
--	--

Course Code:	PSE 603	Course Title:	Power Systems Operations and Optimization Techniques (4 credits)
Course Description:	This Course provides an advanced knowledge related to the way the power industry market is run from an economic perspective. It will cover the following broad topics in depth: optimization and optimal economic system operation. Load forecasting and generation scheduling. Nonlinear optimization and economic dispatch problem. Necessary and sufficient conditions for global optimality. Unit commitment. Optimal power flow and Long-term optimization of power systems. Contingency analysis. Concepts of power system security.		

Course Code:	PSE 604	Course Title:	Stability and Control of Electric Power Systems (4 credits)
Course Description:	The course provides advanced knowledge about stability problems and dynamic mechanisms in electric power systems. Dynamic modeling, stability analysis, and control of multi-machine power systems. Single-machine dynamic modeling, multi-machine dynamic modeling, network differential-algebraic equations and solution methods, small-signal stability analysis, and design of power system stabilizers. Different control algorithms for improving power system stability.		

Course Code:	PSE 605	Course Title:	Special Topics in Power Systems Engineering (4 credits)
Course Description:	<p>Depending on the request of the majority of the M.Sc. Candidates and the availability of a specialized instructor, one of the following advanced topics in Power Systems Engineering may be offered:</p> <p><u>Smart-Grids in Sustainable Energy Systems</u> This course provides an in-depth knowledge about Smart Power Grids (SPG). Topics include: detailed understanding of the electric power systems structure, the constituents of SPG, the network protection control, and management; automation in distribution networks, information and communications technologies (ICT) solutions applied to SPG, Integration of distributed generation, Data analysis in SPG.</p> <p><u>Design of Electrical Machines</u> The course provides advanced tools for the design and construction of electrical machines. Topics include: Design algorithms; Selection of electromechanical materials for constructions of machines and devices; Determination of main dimensions of transformers, induction machines and synchronous machines; Scaling laws in construction of electrical machines; Calculation of magnetic circuit and electric machine parameters; Capability curves, losses and efficiency; Choice of the cooling method; Thermal equivalent circuit and calculation of heat distribution; Computer aided design; The application of 2D and 3D finite element method in the machine design; detailed knowledge for design optimization; The use of standards and regulations in the design process.</p> <p><u>Advanced Electric Drives</u> This course provides the students an advanced treatment of electric machine drives: Kron's machine, modeling of dc machines, induction machine, synchronous machine, scalar and vector control of induction machine, direct torque and flux control of induction machine, sensor-less control and flux observers. Self-controlled synchronous motor, unity power factor operation, vector control of synchronous motor and cycloconverter-fed synchronous motor drive. Permanent magnet synchronous motor drive,</p>		

	<p>brushless dc motor drive, switched reluctance motor drive and stepper motors.</p> <p><u>Power Systems Digital Protection</u> This course provides an in-depth knowledge of the evolution, benefits, and functional blocks of microprocessor-based relays. Relay hardware: Analog signal conditioning and isolation, Digital signal processing. Digital relaying algorithms: Phasor estimation algorithms, Differential equation-based algorithm, Frequency estimation algorithms. Applications of the protection algorithms: Protection of transmission lines, transformers, generators, motors, and bus bars. Adaptive relaying. Fault location techniques. Relay testing.</p> <p><u>Linear and Nonlinear Control Systems</u> This course provides the students with advanced control techniques applied to power systems. Topics include: State variable models, Stability analysis, Routh and Nyquist criteria, Controllability and observability analysis, Open-loop control system, State feedback control design, PID controller design, Z-transform, Stability analysis of discrete system, State estimator, advanced linear control, Extended Kalman filter, Nonlinear systems, trajectory in phase plane, Stability of nonlinear system, Lyapunov stability criteria, Popov hyperstability, Taylor-series expansion, Linearizable control systems, Sliding-mode control, Decoupling state feedback, Fuzzy-logic controller.</p> <p><u>Power Systems Reliability and Quality of Supply</u> This course provides advanced topics and detailed objectives related to power system reliability: Essential parameters, indicators and functions for non-reparable and reparable systems. State-space representation, Markov's model, network models: series-parallel connection, state enumeration, Monte Carlo simulation. Generation systems: advanced methods, operating reserve, interconnected systems. Composite generation and transmission systems: enumeration technique and Monte Carlo simulation. Distribution systems: radial networks, analytical techniques. Quality of Supply: Essential terms and definitions, importance and relevance. Voltage variations and transients: causes, consequences and solutions. Harmonics: causes, consequences and solutions.</p> <p><u>Power System Economics and Electricity Markets</u></p>
--	--

	<p>This Course provides an in-depth knowledge of the following topics: Micro-economics. Electricity markets and trading. System structure (monopoly, spot market, open market & Competitive market). System marginal pricing, nodal pricing and bidding. Risk management. Market players, pool and bilateral. Game Theory. Privatization in generation, transmission and distribution. Power system investment. Quality standards and Ancillary services. Centralized control. Regulation vs De-regulation.</p>
--	---

Course Code:	PSE 699	Course Title:	Master's Thesis (12 credits)
Course Description:	<p>The last semester of the Master program provides the student with an opportunity to undertake extensive investigation of an advanced or specialized topic relating to his/her MSc program; to provide the opportunity to plan and execute a significant project of research, investigation or development.</p>		