جامعة اليرموك

كلية الحجاوي للهندسة التكنولوجية

قسم هندسة القوى الكهربائية

الخطة الدراسية المقترحه لدرجة الماجستير في تخصص هندسة القوىالكهربائية

(مسار الشامل)

2017

ماجستير في هندسه القوى الكهربائيه Master of Science in Electrical Power Engineering	
المؤسسه	جامعه اليرموك المملكه الأردنيه الهاشميه Yarmouk University Jordan
مده الدراسه	(سنتان، 33 ساعه معتمده) م ▪ تطلبات التخصص الأجباريه: 24ساعه معتمده بمستوى (600) ▪ متطلبات التخصص الأختياريه: 9 ساعات (600)
الفتره المرجعيه	2017-2021
الدرجه العلميه	ماجستير
رمز البرنامج	EPE

الهدف العام
تزويد الطلبه بالمعرفه و الأفكار و المهارات في مجال هندسه القوى الكهربائيه التي تمكنهم من اداء الواجبات المستقبليه المناطه بهم في أماكن عملهم بشكل مميز، بحيث يصبح المهندس مؤهل للبحث في المشكلات التي تواجهه و تقديم الحل العلمي المناسب و التدريس في الجامعات

الخصائص	
المواضيع المتخصصه	هندسه القوى الكهربائيه: الات كهربائيه، هندسه الضغط العالي، تحليل و حمايه و تحكم بانظمه القدره الكهربائيه، الطاقه المتجدده و كفاءه الطاقه.
توجه البرنامج	يعنى البرنامج بالجانبين البحثي و التدريسي
السمات المميزه	هناك مسارين: مسار الرساله و مسار الشامل

فرص العمل و مواصله التعليم	
التوضيف	- الشركات المعنية بصناعة الطاقة الكهربائية ونقلها وتوزيعها - مراكز التدريب والتأهيل والبحث والتطوير في مجال الطاقة الكهربائية - المؤسسات الصناعية بمختلف أنواعها - المؤسسات الحكومية المعنية بقطاع الكهرباء من حيث التخطيط والتصميم والإنشاء والإدارة - قطاع الاستشارات الهندسية - الشركات المعنية بتصميم و تركيب أنظمه الطاقة المتجدده - الجامعات
الدراسات العليا	دراسه الدكتوراه في مجالات هندسه القوى الكهربائيه (الات كهربائيه، هندسه الضغط العالي، انظمه القدره الكهربائيه، الطاقه المتجدده

اسلوب التعليم	
طرق التعليم و التعلم	محاضرات، مشاريع قصيره، نمذجه باستخدام الحاسوب،مراجعه شامله لمساقات الماجستير(لطلبه المسار الشامل) و بعض مساقات البكالوريوس استعدادا للامتحان الشامل، اعداد أطروحه الماجستير(لطلبه مسار الرساله)
طرق التقييم	الأمتحانات الكتابيه، المقالات، العروض، الامتحان الشامل (لطلبه المسار الشامل)، مناقشه رساله الماجستير (لطلبه مسار الرساله)

الكفايات

1. **مهارات البحث:** القدره على صياغه الأسئله و الفرضيات الجديده في مجال هندسه القوى الكهربائيه و تحديد طرق البحث لحل هذه الأسئله مع الأخذ بعين الأعتبار الأمكانات و الموارد المتوفره. القدره على عمل منشورات علميه في مجلات و مؤتمرات عالميه مع الألتزام بمعايير البحث العلمي بما في ذلك الأمانه الفكريه.
2. **مهارات التدريس:** القدره على تطبيق طرق و مهارات التدريس المناسبه و استخدام الوسائل التعليميه الحديثه
3. **حل المشكله:** القدره على صياغه و تحليل المشكلات المهنيه و الفنيه في القطاعات الصناعيه و الخدميه التي تواجه الخريج و من ثم ايجاد حلول عمليه مبنيه على المنطق العلمي وفقا للمواعيد المحدده.
4. **تقديم المشوره:** القدره على تقديم المشوره الفنيه المدروسه للاقران و ارباب العمل.
5. **التمثيل الرياضي و النمذجه:** القدره على التمثيل الرياضي و النمذجه باستخدام الحاسوب للانظمه الكهربائيه و ذلك من أجل تطوير أنظمه موجوده أو أستحداث أنظمه جديده.
6. **مهارات الحاسوب:** القدره على تصميم و تنفيذ برامج الحاسوب و كذلك أستخدام الحزم البرمجيه **في مجال هندسه القوى الكهربائيه**
7. **مهارات الأتصال:** القدره على التواصل مع الزملاء في العمل و كذلك مع المؤسسات و الأشخاص الذين لهم علاقه عمل مع المؤسسه التي يعمل بها المهندس. القدره على

على تقديم تقرير عن مسأله فنيه شفويا و كتابيا أو من خلال وسائط العرض المتعدده.

القدره على العمل ضمن الفريق الواحد و تحمل ضغوطات العمل المختلفه.

Requirements to Apply for the M.Sc. program in Electric Power Engineering / Comprehensive Examination Track

1) Applicants who apply for acceptance in this program must comply with the following conditions:

A. Must have a bachelor's degree in electrical power engineering, electrical engineering or equivalent
B. To pass the foreign language requirement to join the program in accordance with the university's instructions.
C. Any other conditions approved by the relevant committees and councils.

2) The Master Degree in Electrical Power Engineering / Comprehensive Examination Track is granted after completing the following requirements:

a) To fulfil the requirements stipulated in the Master's Program No. (3) 2011
b) Studying the additional and supplementary courses decided by the Graduate Studies Committee in the department.
c) Any other conditions deemed appropriate by the department and decided by the committees and councils concerned.
d) Studying at least (33) credit hours of level (600) and success in them with GPA not less than 75%.

A. mandatory courses of (24) credit hours given in the following table:

Course Code & No.	Course Title	C.H.	Semester the course provided
EPE 601	Advanced Engineering Mathematics	3	First
EPE 609	Power Systems Operation and Control	3	First
EPE 618	Distribution Systems	3	First
EPE 619	Modern Control Theory	3	First
EPE 629	Renewable Energy systems and energy efficiency	3	Second
EPE 632	Power Electronics	3	Second
EPE 647	Advanced Power Systems Protection	3	Second
EPE 683	Advanced Analysis of Electric Machines	3	Second

B. elective courses of (12) credit hours. A student can chose from the elective courses listed in the following table:

Course Code & No.	Course Title	Credit Hours
EPE 610	Power System Stability	3
EPE 617	Advanced Transmission Systems	3
EPE 639	Computer Methods in Power Systems	3
EPE 642	Power Systems Quality	3
EPE 644	Smart Power Grids	3
EPE 669	Restructuring of Electric Power Industry	3
EPE 671	Insulation Coordination	3
EPE 675	Electric Motor Drives	3
EPE 687	Advanced High Voltage Engineering	3
EPE 691	Special Topicsin Electric Power Engineering	3

C. Pass the comprehensive exam in accordance with the valid university regulations. For registration purposes, it is considered as zero credit hour

Course Description and Course Learning Outcomes

EPE 601 Advanced Engineering Mathematics

Course Description:
Complex functions, Fourier transform, Fourier series and integration, special functions (Gamma, Beta and Bessel function), Laplace transforms and its application to ordinary differential equations in electrical engineering, two sided Laplace transforms, Legendre transform, Legendre polynomials, algebraic topology and differential topology. This course is aimed to enhance student's skill in using engineering mathematics, like Fourier transform and Laplace transform, to model and solve engineering problems and electrical systems.

Course Learning Outcomes:
Upon successful completion of this course the student will be able to:

- Use complex functions
- Understand Fourier transform, Fourier series
- Apply Gamma, Beta and Bessel functions
- Apply Laplace transforms to ordinary differential equations in electrical engineering
- Understand Legendre transform, Legendre polynomials, algebraic topology and differential topology.

EPE 609 Power Systems Operation and Control

Course Description

power system control: load frequency control (LFC), automatic generation control (AGC), automatic voltage control (AVR), multi-area AGC; optimization techniques; continuation power flow; power system state estimation; contingency analysis; power system security; introduction to FACTS devices; steady-state stability measures; optimal power flow (OPF), unit commitment (UC). This course aims to provide students with knowledge about modern methods and techniques applied for power system operation and control including optimization techniques, AVR, FACTS devices, OPF and UC.

Course Learning Outcomes

Upon successful completion of this course the student will be able to:

1. Use proper optimization techniques for power system operations and control and analyze the economic and technical results.
2. Understand the interdependence of real power and frequency, and /real power and interdependence of reactive power and voltage.
3. Use proper power system approximations and Carryout power system security assessment.
4. Able to use appropriate software or simulation tools for power system control and operation purposes. Moreover, a student is aware of new technologies development trends in modern power system control and operation techniques.
5. Write technical reports and present the findings through individual effort as well as team work

EPE 610 Power System Stability

Course Description

synchronous machine detailed models; reduced-order models; excitation system models; turbine governor models; transmission system and load models; single-machine infinite-bus system model and simulation; interconnected multi-machine system model and simulation; linearized models; small-signal stability; transient stability; power system stabilizer design. This course is aimed to enhance student's skills in modeling and simulation of power system components, which affect the system stability, using different approaches.

Course Learning Outcomes

Upon successful completion of this course the student will be able to:

1. Understand of synchronous machine modelingand methods for dynamic power system analysis, including steady-state and transient stability.
2. Analyze and calculate the basic elements of power system stability.
3. Understand analysis of large power systems and the application of computer simulation tools for dynamic analysis of large power systems
4. Establish the differential/algebraic equations describing stability of power systems and perform detailed analyses. Moreover, student should be able to use control

engineering methods for design and tuning of turbine governors and voltage controllers.

5. Work with the fellow students to create and present a team project in a power system stability study.

EPE 617 Advanced Transmission Systems

Course Description:

Introduction to power system structure and the need for advanced transmission systems and interconnections. Overview of transmission system in Jordan.Modeling of overhead lines and underground cables.Basic operational principles of transmission systems. Conventional control capability and independent real and reactive power flow control.Optimization of transmission losses and load shedding.Objectives of shunt compensation and voltage regulation. End of line voltage support. Line loading capability.SVC and STATCOM.Comparison of V-I and V-Q characteristics.Real power exchange.Operation under unbalance conditions.Opportunities for FACTS into the transmission networks.Introduction to various types of FACTS, shunt, series and combined connections. Applications and case studies of FACTS controllers.Introduction to HVDC technology.Comparison of HVDC and FACTS.Modern advanced HVDC systems.Dynamic Voltage Restorer (DVR). Dynamic stability of transmission interconnection.The course is aimed to provide students with deep knowledge about power transmission systems including their operation, control, optimization and FACTS utilization.

Course Learning Outcomes:

Upon successful completion of this course the student will be able to:

1. understand the main concepts of transmission systems, in general, and that of Jordan network, in particular.
2. model different types of transmission lines. They also should understand the operational principles of transmission systems including the real and reactive control.
3. know the main issues of optimization of transmission losses, loading capabilities and load shedding. This includes the applications of various compensation and regulation techniques.
4. understand FACTS and modern HVDC technologies.
5. be familiar with dynamic stability and dynamic voltage restorer concepts of transmission interconnection

EPE 618 Distribution Systems

Course Description:

Introduction to power systems: generation, transmission and distribution. Overview of distribution system in Jordan. Types and characteristics of customers in distribution systems: residential, commercial, small and large industrial customers, water pumping and others. Analysis of loads: load factor, maximum demand, diversity and coincidence factors, loss factor and load loss factor. Calculations of load-related factors. Distribution transformers and cables: sizing, connections, characteristics, testing, de-rating factors, effect of harmonics, voltage drop

calculations, operation and maintenance challenges. Distribution substations: types, configuration, integration with renewable energy plants, protection and new control techniques. This course is aimed to provide students with deep knowledge about the components ofpower distribution system and all requirements to obtain reliable distribution system including load analysis, system protection, control and maintenance.

Course Learning Outcomes:

Upon successful completion of this course the student will be able to:

1- gain enough knowledge about power system industry in general and the existing Jordanian distribution sector, in particular
2- know the types and characteristics of customers supplied from certain distribution systems. They will know the operational mode of each type of customers, tariff schemes, technical and non-technical losses and other problems.
3- select the correct size of distribution transformers, know the issues and conditions of parallel connections and how to solve the problems of mismatch conditions. They will be able to calculate derating factors needed for transformer operation in areas with high harmonic levels.
4- calculate cable ratings, voltage drop and short circuit currents
5- know the types of distribution transformers, their components, the problems arising from connection renewable energy systems to various distribution nodes. They will know, which protection and control is needed for distributed generation connections.

EPE 619 Modern Control Theory

Course Description

The course covers the structure and properties of linear dynamic systems include state space model, its response, stability, and Laplace transformation (including discrete-time system, z-transformation). Properties of controllability and observability and their application to minimal realization. Feedback control: state feedback (pole assignment, LQR), output feedback (full and reduced order), set point regulation, discrete-time system. State space realization (including discrete-time system). An introduction to time varying systems is also included, as well as linear parameter varying (LPV) systems.

Course Learning Outcomes

Upon successful completion of this course the student will be able to:

1. apply knowledge of mathematics, science and engineering.
2. design and analyze linear dynamical systems
3. communicate effectively with other people and conduct research work in linear control systems

EPE 629 Renewable Energy systems and energy efficiency

Course Description:

Introduction to energy systems: fossil fuel and renewable energy resources, global and national demand for energy and energy status in Jordan.Solar energy basics: thermal and PV systems, concepts of energy conversion by PV systems, design of PV systems and integration of large solar plants into electrical grids. Wind Energy

Systems, concepts and types of wind turbines, energy conversion techniques of wind turbines and challenges of wind farms integration into transmission grids. Other types of renewable energy sources: hydro power plants, tidal, geothermal, waste and biomass. Energy storage techniques.Concepts and challenges of distributed generation in modern power systems.Introduction to energy efficiency: the importance and benefits of energy efficiency. Energy audit and assessment of current energy usage.Energy efficiency analysis: data processing and formulating action plans.Energy management methods: load assessment and analysis, building management systems. Strategies for raising awareness about energy management and evaluation of energy saving techniques. The course is aimed to provide students with knowledge about different types of renewable energy systems, energy management and energy saving techniques for high energy efficiency.

Course Learning Outcomes:

Upon successful completion of this course the student will be able to:

1- gain enough knowledge about the current energy status and the need for renewable energy resources globally and in Jordan
2- know solar energy systems from basics to advance techniques currently applied. They will also know the challenges of integrating large solar plants into distribution and transmission grids.
3- know the main concepts, current applications and technologies of wind energy systems. They will also gain enough knowledge about electrical problems of connecting large wind farms with transmission grids.
4- understand the importance of energy efficiency policies and applications.
5- make an action plan of raising an awareness about energy efficiency and energy savings

EPE 632 Power Electronics

Course Description:

The course aims to introduce the concept of advanced power electronics systems including isolated switch mode dc/dc power converters operating in continuous and discontinuous conduction modes. Moreover, the course focuses on the modeling and control of switch mode dc/dc converters and the derivation of small and large signal models. After that, the course presents the detailed operation of switch mode dc/ac power inverters including single phase, three phase, and multilevel inverters. A detailed review of inverter's modulation techniques including space vector modulation is presented.Additionally, resonant converters operation and soft switching techniques are discussed. Research based projects and class presentations covering advanced topics in power electronics are mandatory. The course is aimed to provide students with knowledge about modeling, analysis and switching of DC/DC and DC/AC converters. Moreover, the course is aimed to enhance student research skills

Course Learning Outcomes:

Upon successful completion of this course the student will be able to:

- analyze and design isolated switch mode dc/dc power converters in continuous and discontinuous operational modes.

- derive the equivalent average model of switch mode dc/dc power converters alongside small signal and large signal models. Moreover, design closed loop control of DC/DC convertes.
- analyze and designswitch mode dc/ac power inverter with different modulation techniques including space vector modulation.In addition students will be able to design closed-loop control for switch mode DC/AC power converters
- analyze resonant switching converters, load resonant converters, and resonant dc link converters.
- conduct research to review advanced topics in power electronics.

EPE 639 Computer Methods in Power Systems

Course Description

This course focuses on using computer software, programming languages, and simulation tools to formulate and study: networks matrices and calculations; advanced topics in load flow analysis; phase-shifting transformers; simulation of opening or shorting power system components; fault and disturbance calculations; state estimation; power system control; security-constrained economic dispatch; synchronous machine performance; load modeling; numerical methods with large sparse matrices. The course is aimed to provide students with computer software skill which enable them to conduct programming and simulations for different power system aspects such as load flow analysis, power system control and economic dispatch.

Course Learning Outcomes

Upon successful completion of this course the student will be able to:

1. Describe the procedure of determining the state variables of electrical power system
2. Explain mathematical procedures of power flow and short circuit calculations.
3. Estimate the power system security using computer.
4. Analyze results of electric power system simulations and calculations and write technical reports.
5. Use available state-of-the-art software packages and simulation tools in power system operations.

EPE 642 Power Systems Quality

Course Description:

Introduction to power quality problem: development of power systems and introduction of new non-linear loads into distribution systems. Concepts of power quality: power quality indices, measures and standards. Measurements and analysis of power quality: modeling of networks and components under non-sinusoidal conditions. Assessment of impact of poor power quality on power systems.Case studies.Loads and their impact on power quality, non-linear loads, harmonics and

voltage quality indices. Power quality improvements: solutions by rearrangements and by adding new equipment to solve power quality problems. Protection system and power quality problem: assessment of impact, solutions and case studies.Power quality and renewable energy: assessment of impact, introduced solutions and case studies.The course is aimed to provide students with knowledge about power system quality:measurement, analysis and assessment of the factors affecting power quality.

Course Learning Outcomes:

Upon successful completion of this course the student will be able to:

1- know the origin of power quality problems especially the presence of non-linear loads. In addition student will be able to know power quality indices and how to differentiate between power quality problem and normal fault.
2- Carry out analysis of power quality problems in terms of causes, indices, parameters and others.
3- The students should know the problem of harmonics and its relation to load type. Also, they should know how to assess the impact of harmonic on power system element
4- The students should know how to improve power quality by using special equipment or make new arrangements for the loads.
5- Finally, the students should know the impact of renewable energy equipment on power quality status

EPE 644 Smart Power Grids

Introduction to smart power grid; comparison between existing grid and smart grid; smart generation, energy storage, microgrids, substation intelligence, transmission systems, wide area monitoring system (WAMS), smart meters and advanced metering infrastructure (AMI), and phasor measurement units (PMU); distribution systems; smart grid monitoring and communications; asset management; renewable integration; demand side management; high performance computing applications for smart grid, smart grid security; analysis tools; future trends. The course is aimed to provide students with knowledgeabout smart grids: smart generation and transmission, smart components and devices such as smart meters and monitoring, smart tools and computing.

Course Learning Outcomes

Upon successful completion of this course the student will be able to:

1. Understand the fundamental elements ad fundamental structure of the smart grid.
2. Analyze drivers, challenges and benefits to the integration of renewable and distributed generation into large power grids.
3. Be introduced to communication, networking, sensing technologies, and cyber security involved with the smart grid.
4. Be introduced to computational techniques involved with the smart grid (decision support tools and optimization)

5. Work effectively in project teams using appropriate communication skills in order to present information about smart grid industry practices and community engagement.

EPE 647 Advanced Power Systems Protection

Course Description:

Introduction to power system protection: Basic relay types and characteristics including electromechanical, static, digital and numerical relays. Protective relaying units including measuring units, solid state units, logic circuits, integrated circuits, and microprocessors.Mathematical basis of numerical techniques: numerical relay characteristics, algorithms, design and problems. The role of numerical relays in substation automation and smart grids.The impact of poor power quality on numerical relays performance. Instrument transformers: measuring core and protection core CTs. Magnetic and capacitive voltage transformers. Characteristics, selection, design and calculations.Generator and large motors protection: stator ground fault, over-speed, loss of excitation, generator motoring, phase rotation, negative sequence, phase unbalance, load loss, out-of-step and loss of excitation. Differential protection of generator-transformer units, reactor protection, shunt capacitor bank protection, station-bus protection, load shedding and frequency relaying. The course is aimed to provide students with deep knowledge about the types and use of protection devices. It also aim to provide student with knowledge about the different protective relaying used to protect different power components.

Course Learning Outcomes

Upon successful completion of this course the student will be able to:

1- have general knowledge about power system protection and protective relaying concepts and techniques
2- understand the mathematical basis of numerical relays. They will also know the design, characteristics and problems of numerical relays. They will know the impact of harmonics and other power quality effects on protective relaying.
3- Calculate and correctly select CTs and VTs applied for metering and protection systems.
4- Select and specify the correct relays for large generators and motors subjected to various faults.
5- Know the main characteristics and details of differential protection of generator-transformer units, reactor protection, shunt capacitor bank protection, station-bus protection, load shedding and frequency relaying.

EPE 669 Restructuring of Electric Power Industry

Course Description:

Review of distribution factors and optimization, Reasons of restructuring, different structures of electricity markets (power pools, bilateral markets), the role of the independent system operator (ISO) in electricity markets, price-based unit commitment, market power, transmission open access and transmission pricing paradigms, ancillary services procurement and pricing, social-welfare problems in a

competitive environment, system security management and congestion management, wheeling transactions, restructured power systems worldwide, restructuring in Jordan. The course is aimed to provide students with knowledge about restructuring of electric power industry including the role of independent system operator in electricity market, transmission pricing and system security management.

Course Learning Outcomes:
Upon successful completion of this course the student will be able to:
1. Know what is meant by restructuring, the differences between regulated markets (old monopoly) and deregulated (competitive market) structures.
2. Know the main restructuring models and key entities and how restructuring is done in Jordan.
3. Know the formulation and solution of social-welfare problem in energy markets, and the main transmission pricing mechanisms in energy markets.
4. Know the basics of congestion management as well as the basics of market power.
5. Know the ancillary services in energy markets and their associated markets.

EPE 671 Insulation Coordination

Course Description:
Introduction to high voltage materials: solid, liquid, gas and vacuum insulating materials. Insulation materials and insulation strength characteristics: dielectric properties, dielectric constant, leakage current and tan delta. Switching overvoltages on transmission lines and in substations, lightning overvoltages, shielding of transmission lines and substations.Very fast transient and insulation capability. Travelling waves, overvoltage protective devices and surge arresters. Statistical approach to insulation coordination, station lightning insulation coordination, self restoring insulations, induced overvoltage, and line insulation coordination. The course is aimed to provide students with knowledge about characteristics and properties of insulation materials, overvoltage protection and surge arresters, insulation coordination.

Course Learning Outcomes:
Upon successful completion of this course the student will be able to:
1. Know enough information about high voltage materials and their applications.
2. Recognize various characteristics of insulating materials such as dielectric strength, leakage current and tan delta.
3. fully understand lightning and switching overvoltage, very fast transients and shielding techniques.
4. Know the problem of travelling waves, overvoltage protection devices such as surge arresters and others.
5. Applystatistical approach to insulation coordination and station lightning insulation coordination. The students should be able to understand self restoring insulations, induced overvoltage, and line insulation coordination.

EPE 675 Electric Motor Drives

Course Description:

The course aims to introduce the concept of system level modeling, analysis, design, and integration of electric motor drives. The first part of the course focuses on the derivation of the steady-state and dynamic-model of dc motor drives. Operation and closed-loop control of phase-controlled and chopper-controlled dc motor drives operating in continuous and discontinuous modes are introduced. Moreover, four quadrant operation, armature voltage control, and flux weakening control of dc motor drive are illustrated. The second part of the course focuses on the derivation of the steady-state and dynamic-model of induction machines. Operation of induction motor with two stage controllable converters and single stage pulse width modulated inverters is discussed. Stator-phase control, slip-energy-recovery control, variable-frequency control, and vector-control of induction motors are thoroughly presented. Finally, the course introduces the basic concept of brushless dc motor drives and switch reluctance motor drives. Research based projects and class presentations covering advanced topics in electric motor drives are mandatory.

Course Outcomes:
Upon successful completion of this course the student will be able to:

- define the steady-state and dynamic-model of dc motor drives. Moreover, the student will be able to analyze the operation and control of phase-controlled and chopper-controlled dc motor drives and explain four quadrant operation.
- Define the steady-state and dynamic-model of induction machines.
- Analyze the operation of induction motor drives under various control schemes.
- Understand the basic concept of brushless dc motor drives and switch reluctance motor drives.
- Conduct research to review advanced topics in electric motor drives.

EPE 683 Advanced Analysis of Electric Machines

Course Description:
Review for the fundamentals of Electrical Machines, Transformations: Three-Phase Transformation, *qd0*Parks transformations, Space Vectors and their Transformations. *DQ0* modeling and dynamic simulations of three phase and single phaseInduction Machines.*DQ0* modeling and dynamic simulations of three phase wound rotor and PM synchronous Machines.Special Machines:switched reluctance motors, linear motors, stepper motors. Research based projects and class presentations covering advanced topics in electric machines are mandatory. The course is aimed to provide students with knowledge about *DQ0* modeling and dynamic simulations of electric machines including induction and synchronous machines.

Course Learning Outcomes:
Upon successful completion of this course the student will be able to:

- Understand space vectors transformations and *dq0* Parks transformations
- understand *dq0* modeling and dynamic simulations of three phase and single phase Induction Machines
- understand *dq0* modeling and dynamic simulations of three phase wound rotor synchronous Machines and PMthree phase synchronous Machines
- conduct research in electrical machines

EPE 687 Advanced High Voltage Engineering

Course Description:

High voltage switchgears, Air and Gas Insulated Switchgear (AIS and GIS), High voltage substation elements. High voltage bushings: types, design, applications and technical problems. 3-High voltage measurement and testing techniques (DC, Impulse and AC), Partial Discharge (PD) measurement techniques, Two-Sphere measuring techniques, Lightning and Switching Tests, High Voltage Testing Standards. Corona discharge phenomena and related industrial applications. High voltage cables: construction, insulation and testing. The course is aimed to provide students with deep knowledge about high voltage engineering including switchgears, AIS and GIS, HV substation elements, HV measurements and testing techniques.

Course Learning Outcomes:

Upon successful completion of this course the student will be able to:

1- understand the concepts of advanced high voltage switchgear including air and gas switchgears, the main elements of high voltage substations and the main types of high voltage bushings, their design and applications.
2- understandhigh voltage measurement and testing techniques.
3- Understand the details of lightning and switching type tests, high voltage generation equipment, testing circuits, standards and result analysis. In addition students will understand corona discharge phenomena and the related industrial applications.
4- understand the problems of high voltage equipment and the required measurements to verify its validity including partial discharge tests. Moreover, They will understand the particularities of high voltage cables including the design and calculations.
5- Finally, the students should know optical fiber based monitoring of H.V equipment and condition monitoring of such equipment.

EPE 691: Special Topicsin Electric Power Engineering

The contents of the special topic course will be different than the contents of the offered courses and will be determined by the department.

EPE 699: Master Thesis (9 credit hours):

Each student will be required to prepare and successfully defend a master thesis on a research topic approved by the department.

Program Learning Outcomes

1.	**Knowledge**
1.1	A1. Recognize the concepts and application of advanced engineering mathematics
1.2	A2. Outline the concepts and applications of modern control theory
1.3	A3. Outline the concepts and theories of advanced electrical machines, power electronics and electric motor drives
1.4	A4. Describe the concepts, operation and performance of power system operation and control, power system protection, power system stability andinsulation coordination
1.5	A5. Define the concepts and theories concern with power transmissions and distribution, power smart grids, power system quality, renewable energy systems and energy efficiency and restructuring of Electric Power Industry
2	**Cognitive Skills**
2.1	B1. Evaluate design concepts of modern control
2.2	B2. Analyze the performance of advanced electrical machines
2.3	B3. Evaluate the design concepts of power electronics and electric motor drives
2.4	B4. Analyze the performance of power system operation and control, power system protection, power system stability andinsulation coordination
2.5	B5. Analyze the performance of power transmissions and distribution
2.6	B6. Evaluate design concepts of power smart grids, power system quality, renewable energy systems and energy efficiency and restructuring of Electric Power Industry
3	**Interpersonal Skills & Responsibility**
3.1	C1. Show the ability to interact professionally with others, to engage effectively in teamwork, and to function productively on multidisciplinary group projects.
3.2	C2. Show the ability to act ethically and technically while working in a group or independently and take responsibility
3.3	C3. Demonstrate the ability to acquire and develop leadership qualities such as taking initiative, listening effectively, and motivating others.
4	**Communication and Information Technology**
4.1	D1. Demonstrate effective communication through oral presentations and discussions.
4.2	D2. Demonstrate effective communication through written reports and presentation notes.
4.3	D3. Use of information technology, simulations, programming and computer based programs

Program Learning Outcome Mapping Matrix

	Knowledge					Cognitive Skills						Interpersonal Skills & Responsibility			Communication & Information Technology		
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	C1	C2	C3	D1	D2	D3
EPE 601	×											×	×	×	×	×	×
EPE 609				×		×			×			×	×	×	×	×	×
EPE 610				×					×			×	×	×	×	×	×
EPE 617					×					×		×	×	×	×	×	×
EPE 618					×					×		×	×	×	×	×	×
EPE 619		×										×	×	×	×	×	×
EPE 629					×							×	×	×	×	×	×
EPE 632			×					×				×	×	×	×	×	×
EPE 639												×	×	×	×	×	×
EPE 642					×						×	×	×	×	×	×	×
EPE 644					×						×	×	×	×	×	×	×
EPE 647				×					×			×	×	×	×	×	×
EPE 669					×						×	×	×	×	×	×	×
EPE 671				×					×			×	×	×	×	×	×
EPE 675			×					×				×	×	×	×	×	×
EPE 683			×				×					×	×	×	×	×	×
EPE 687												×	×	×	×	×	×
EPE 691												×	×	×	×	×	×

Equivalent Courses
M.Sc. in Electrical Power Engineering

ت	رمز و رقم المساق	اسم المساق	س	رمز و رقم المكافيء	اسم المكافيء	س
1	EPE 601	AdvancedEngineering Mathematics رياضياتهندسيةمتقدمة	3	هق 601	رياضياتهندسيةمتقدمة	3
2	EPE 609	Power system operation and control تشغيلوتحكمأنظمةالقوى	3	هق 609	تشغيلوتحكمأنظمةالقوى	3
3	EPE 610	Power System Stability استقراريةأنظمةالقوى	3	هق 610	استقراريةأنظمةالقوى	3
4	EPE 617	Advanced Transmission Systems	3	هق 617	أنظمةنقلمتقدم	3
5	EPE 617	Distribution Systems أنظمه توزيع	3	هق 618	أنظمه توزيع	3
6	EPE 619	Modern Control Theory نظريةالتحكمالحديثة	3	هق 619	نظريةالتحكمالحديثة	3
7	EPE 629	Renewable Energy Systems and Energy Efficiency أنظمةالطاقةالمتجددة و كفاءه الطاقه	3	هق 629	أنظمةالطاقةالمتجددة	3
8	EPE 632	Power Electronics الكترونياتالقوى	3	هق 632	الكترونياتالقوى	3
9	EPE 639	Computer Methods in Power System	3	هق 639	الطرقالحاسوبيةفيتحليلأنظمةا لقوى	3
10	EPE 642	Power System Quality جودةأنظمةالقوى	3	هق 642	جودةأنظمةالقوى	3
11	EPE 644	Smart Power Grids شبكات القدره الذكيه	3			
12	EPE 647	Advanced Power System Protection وقايه انظمه قوى متقدم	3	هق 647 هق 649	وقايةأنظمةالقوى + الوقايةالرقمية	3 3
14	EPE 669	Restructuring of Electric Power Industry إعادةهيكلةصناعةالطاقةالكهربائية	3	هق 669	إعادةهيكلةصناعةالطاقةالكهربائية	3
15	EPE 671	Insulation Co-ordination تنسيقالعزل	3	هق 671	تنسيقالعزل	3
16	EPE 675	Electric Motor Drives	3			

Equivalent Courses
M.Sc. in Electrical Power Engineering

ت	رمز و رقم المساق	اسم المساق	س	رمز و رقم المكافيء	اسم المكافيء	س
17	EPE 683	Advanced Analysis of Electric Machines تحليلألآتكهربائيةمتقدم	3	هق 683	تحليلألآت كهربائية متقدم	3
18	EPE 687	Advanced High Voltage Engineering هندسةجهدعاليمتقدم	3	هق 687	هندسةجهدعاليمتقدم	3
19	EPE 691	Special Topics in Electric Power Engineering موضوعاتخاصةفيهندسةالقوىالكهربائية	3	هق 691	موضوعاتخاصةفيهندسةالقوىالكهربائية	3

Modifications & Justifications
The Proposed Study Plan
M.Sc. In EPE

The proposed M.Sc. Plan of EPE department has some modifications compared with the previous M.Sc. plan. The modifications applied to the current M.Sc. plan are:

1. A new course called ***"Renewable Energy Systems and Energy Efficiency"***is added to the mandatory course list of both Tracks: Comprehensive Examination and Thesis.
2. A new course called ***"Advanced Power Systems Protection"***is added to the mandatory course list of Comprehensive Examination Track.
3. The course ***"Advanced High Voltage Engineering"***is deletedfrom the mandatory course list of boththracks: Comprehensive Examination and Thesis.
4. The course ***"Advanced High Voltage Engineering"***is addedto the elective course list of boththracks: Comprehensive Examination and Thesis
5. A new course called***"Electric Motor Drives"*** is addedto the elective course list of boththracks: Comprehensive Examination and Thesis
6. A new course called***"Smart Power Grids"***is added to the elective course list of boththracks: Comprehensive Examination and Thesis
7. The course***"Renewable Energy Systems"*** is deleted from the elective course list of boththracks: Comprehensive Examination and Thesis.
8. The course ***"Crisis Management in Power Systems"***is deleted from the elective course list of boththracks: Comprehensive Examination and Thesis
9. The course ***"Power System Protection"***is deleted from mandatory course list of both tracks: Comprehensive Examination and Thesis.

10. The course ***"Digital Protection"***is deleted from the elective course list of both tracks: Comprehensive Examination and Thesis.

The above modifications can be justified as presented in the following points:

a. Currently, renewable energy resources, mainly solar and wind, gain a great concern by the government, institutions and researchers in Jordan. Therefore, providing M.Sc. students with deep knowledge about renewable energy systems is of great importance.
b. The two courses ***Electric Motor Drives and Smart Power Grids*** are added to the current M.Sc. plan because of their importance in the industry and modern power systems. Bring students to the advanced technology in the field of electric motor drives and smart grids will be very beneficial for the Jordanian industry and power systems.
c. The study plan of EPE M.Sc. programs in many respectable international universities includes the coursesadded to the current plan; ***Renewable Energy Systems and Energy Efficiency, Electric Motor Drives and Smart Power Grids***. Therefore, the addition of these course to the proposed study plan is of great importance to co-op with international universities
d. Instead of having two power system protection courses, one course "***Advanced Power Systems Protection"*** will include all required topics and is enough for M.Sc. students.
e. The course ***"Crisis Management in Power Systems"***is deleted from the current study plan because students can gain the knowledge concern with this course from other resources, like a short course. The contents of the course can be gained from other M.Sc. courses and text books.