

**Curriculum of Master of Science in**  
**Renewable Energy Engineering**  
**(REE)**  
*Under*  
**Department of Electrical Engineering**  
**College of Engineering**



جامعة المجمعة  
Majmaah University

With the recent growing demand for renewable energy sources, such as solar energy, wind energy and geothermal energy, it is essential to provide a graduate program in renewable energy engineering and contribute to the growth industry in that field.

Master of Science in Renewable Energy Engineering (REE) program provides students with advanced knowledge of all the major of renewable energy sources and the engineering skills associated with them. The key areas covered include renewable energy sources, energy storage, and energy efficiency.

## **Mission**

To graduate professionals specialized in Renewable Energy Engineering who have knowledge and skills to conduct advanced and sustainable research, develop the leadership and communication skills necessary to provide specialized support to the community, and lifelong learning.

## **The objectives:**

The objectives of the Master of Science in Renewable Energy Engineering are to prepare professionals that are able to:

1. Demonstrate the ability to solve complex renewable energy engineering problems.
2. Practice and inspire high ethical and academic standards and communicate their achievements and accomplishments to colleagues and to the community.
3. Lead their professional disciplines, organizations, and communities and maintain a desire for research, innovation, and lifelong learning.

## **Program Learning Outcomes**

After completing the program, the graduates of this program should be able to demonstrate the following learning outcomes:

### **Knowledge and Understanding**

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

### **Skills**

- 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.
- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

### **Values**

- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- An ability to communicate effectively with a range of audiences.
- 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.

## **Admission Requirements**

- Students should have a bachelor's degree in engineering from national or international college or university with an overall grade Good 3.25 out of 5 or 2.25 out of 4 or its equivalent.
- Applicants must take the Academic Proficiency Test (The National Center for Assessment in Higher Education). Minimum Acceptable Score is 70.
- Applicants must pass an internal interview.
- Applicants must satisfy the following additional English language requirements:  
IELTS (or its equivalent): overall band score of 4.5.

## Program Structure:

The program is conducted in four semesters, where the semester lasts for 15 weeks besides a thesis as partial fulfillment. The academic load is based on the credit hours system. Language of instruction is English.

## Master of Science Degree:

### Degree Requirements for Master of Science in Renewable Energy Engineering:

The student must complete 35 credit hours distributed as follows:

1. Completing 29 credit hours of course work:
  - 23 credit hours of compulsory courses.
  - 6 credit hours of elective courses following the Electrical Engineering Department regulations.
  
2. The student must successfully complete and defend a thesis (6 credit hours) on a selected research topic in the area of specialization.

## Study Plan

Level	Course Code	Course Title	Pre-requisite	Credit hours		
				Theory	Laboratory	Total
I	EE 711	Engineering Analysis		3	0	3
	EE 712	Renewable Energy Sources		2	1	3
	EE 713	Power Electronics applications in RES		2	1	3
II	EE 721	Power System stability and reliability	EE 712	3	0	3
	EE 722	Power Quality	EE 713	3	0	3
	EE 723	Energy Economics (online)		3	0	3
III	EE 731	Integration of renewable energy sources into power grid	EE 722	3	0	0
	EE 732	Sustainable Distributed Generation		3	0	3
	EE 7XX	Elective (1)	Department Approval	3	0	3
	EE 7XX	Elective (2)		3	0	3
	EE 733	Research Methodology		2	0	2
IV	EE 740	Thesis		6	0	6
		Total Hours				35
Elective Courses	EE 714	High-Voltage DC Transmission Systems		3	0	3
	EE 724	Intelligent control of Electrical Power system		3	0	3
	EE 725	Advanced Electrical Machines		3	0	3
	EE 726	Energy Efficiency in the Power Sector	EE 721	3	0	3
	EE 734	Selected topics in renewable energy	EE 712	3	0	3
	EE 735	Energy storage systems	EE 713	3	0	3
	EE 736	Smart Grid Systems	EE 721	3	0	3

## Courses description

### **EE 711: Engineering Analysis (تحليل هندسي)**

Fourier analysis, Differential Equations, Linear Algebra, Complex variables, discrete mathematics. MATLAB Introduction and Working Environment, Numbers, Operators, Variables and Functions Complex Numbers and Functions of Complex Variables, Graphics in MATLAB: Curves, Surfaces and Volumes, Limits of Sequences and Functions. Continuity in One and Several Variables, Numerical Series and Power Series, Derivatives. One and Several Variables, Integration in One and Several Variables. Applications: Simulation of Electrical Systems in Matlab.

### **EE 712: Renewable Energy Sources (مصادر الطاقة المتجددة)**

Solar energy: Solar Radiation, Solar Collectors in solar thermal energy generators, photovoltaic converters, Thermo-photovoltaic Cells, Maximum power point tracking with and without partial shading, Future of Space Solar Power Project, Wind Energy: Wind Turbine Configurations, wind turbine Characteristics, Efficiency of a Wind Turbine, maximum power point tracking of wind turbines, Wave Energy, Wave-Energy Converters, Offshore Wave, Shoreline Wave, Tidal Energy, Marine Current Turbines System. Fuel Cells: Electrochemical Cells, Fuel Cell Classification, Fuel Cell Reactions, Fuel Cell Applications, Efficiency of Practical Fuel Cells. Biomass: The Composition of Biomass, Ethanol, Dissociated Alcohols, Photosynthesis.

### **EE 713: Power Electronics Applications in Renewable Energy systems (RES) (تطبيقات إلكترونيات القوى في أنظمة الطاقة المتجددة)**

A course that reviews converter topologies for AC/DC, DC/AC, and DC/DC; power supply applications; converter applications to generators drives of renewable energy systems; utility interface of distributed energy systems; static VAR systems; active and passive harmonics compensation; design and implementation of Converters for renewable energy systems.

### **EE 714: High-Voltage DC Transmission Systems (أنظمة نقل التيار المستمر عالي الجهد)**

Evolution of HVDC Transmission, Comparison of HVAC and HVDC systems, Type of HVDC Transmission systems, Components of HVDC transmission systems, Analysis of simple rectifier circuits, Required features of rectification circuits for HVDC transmission, Analysis of HVDC converter: Different modes of converter operation; Output voltage waveforms and DC voltage in rectification; Output voltage waveforms and DC in inverter operation; Thyristor voltages, HVDC system control features: Control Modes; Control Schemes;

Control comparison, Converter mal-operations, Commutation failure, Starting and shutting down the converter bridge, Converter protection, Smoothing reactor and DC Lines, Reactive power requirements, Harmonic analysis, Filter design, Multi-terminal HVDC system, Advances in HVDC transmission, HVDC system applications.

**EE 721: Power System Stability and reliability (موثوقية نظام القدرة)**

Concept of Power system stability; Transient stability analysis; Voltage Stability Analysis; Static Analysis; Determination of Shortest distance to instability; The continuation load flow Analysis-Important voltage stability Indices-Prevention of Voltage Collapse. Concept of reliability, System reliability, Methods of system reliability, fault free analysis. Generating capacity reserve evaluation; generation expansion planning, uncertainties in generating unit Failure rates and in load forecasts. Operating reserve evaluation; the security function approach. Interconnected systems.

**Prerequisite: EE 712**

**EE 722: Power Quality (جودة القدرة)**

Power quality issues in distribution systems, need for power quality monitoring, IEEE guides, standards and recommended practices, Modeling of networks and components under non sinusoidal conditions, Harmonic Analysis, Effects of Power System harmonics on Power System equipment and loads, Harmonic elimination, Power Quality Management in Smart Grid, Electromagnetic Interference.

**Prerequisite: EE 713**

**EE 723 : Energy Economics (اقتصاديات الطاقة)**

This course examines the economics of competing energy resources from the perspective of corporate investors and households who will adopt clean energy solutions only if it is in their self-interest. Learn how to compare alternative energy systems that require vastly different capital expenditures and ongoing operating costs. Evaluate the role of public policy instruments including taxes, regulations, and incentives in accelerating the transition away from traditional fossil fuels. Real-world case studies illustrate the issues faced by decision makers.

**EE 731: Integration of renewable energy sources into power grid (دمج مصادر الطاقة المتجددة في شبكة الكهرباء)**

Grid integration terminology (Balancing area, Capacity value, Flexibility, Demand response), Grid integration of renewable energy, Grid integration study, optimal power flow studies with low to high penetration of renewable resources, power market analysis under environmental policy constraints including low to high penetration of renewable resources, contingency analysis, stochastic power flow studies, dynamic security assessment and security analysis with stochastic models that capture the uncertainty of renewable resources, resource scheduling algorithms that co-optimize the network topology along with resource commitment.

**Prerequisite: EE 722**

**EE 732 Sustainable Distributed Generation**

This course deals with the essential aspects of Distributed Generation, starting from the drivers for these technologies, their key types to the detail issues associated with their operation and planning. The contents of this course can be divided into three main parts; general issues, operation, planning and economics. The general issues part deals mainly with the drivers for distributed generation, definitions, key types, and interface connections. The operation part includes power quality issues, technical impacts of distributed generation installation, operation of flexible distributed generation, reliability issues and required protective schemes. The planning and economics part is dedicated to highlight different planning strategies and economical impacts of distributed generation installation.

**EE 735: Energy Storage Systems (نظم تخزين الطاقة الكهربائية)**

Introduction to Energy Storage, Scope of energy storage needs and opportunities, Power vs. Energy, Electrochemical Energy Storage, Mechanical Energy Storage, Thermal Energy Storage, Gravity Power Energy Storage, Mobile vs. Fixed Energy Storage, Present status of energy storage applications, New trends in applications of energy storage

**Prerequisite: EE 713**

**EE 726: Energy efficiency in the power sector (كفاءة الطاقة في أنظمة القوى الكهربائية)**

Energy Auditing and Economics, Electricity tariff types, Energy economics, Reactive Power Management, Energy conservation in lighting and electric drives. Peak Demand controls, Energy management opportunities with electric drives and electric heating, management of heating, ventilating and air-conditioning (HVAC)

systems, Energy conservation in compressors and electrolytic processes, Computer aided energy management, Cogeneration.

**Prerequisite: EE 721**

**EE 734: Selected topics in renewable energy (موضوعات مختارة في الطاقة المتجددة)**

Solar Energy technology: PV, CSP, Solar thermal, Solar cooling (thermal & absorption vs electric & compression), Resource measurements (satellite, ground based), Yield calculations, Layout, Mounting (fixed tilt vs tracker), Civil works, Wind Energy technology, Geared vs direct drive, Blade technology, Output control, Power curve and Betz limit, Resources assessments (satellite, mesoscale modelling, met masts, lidar), Wind farm layout, Yield calculation, Weibull distribution, Civil works (foundation)

**Prerequisite: EE 712**

**EE 724: Intelligent control of Electrical Power system (التحكم الذكي في نظام الطاقة الكهربائية)**

Intelligent Systems, Control and Intelligent Systems, Dimensions of Intelligent Systems, Working Definitions; Techniques in Intelligent Control; Control System Architectures Need for Learning, Learning and Adaptation, Learning Algorithms, Expert Systems - Components of an Expert System, Historical Perspectives, Different Development Levels in Expert Systems; Neural Networks, Fuzzy Systems, Heuristic Optimization Techniques, Representation of Plants; Modeling Architecture; Supervised Control Architectures; Reinforcement Learning Systems; Adaptive Critic Design, Parameterizing Linear Controller, Neural Network Based Control System - Architecture for Diagonal Recurrent Neural Network (DRNN)-Based Control System, Neuro-Identifier, Neuro-Controller, Dynamic Back propagation Algorithm for DRNN, Convergence and Stability; Optimal Tracking Neuro-Controller for Nonlinear Dynamic System, Neural Dynamic Programming, Control of Active Power, Reactive Power and Frequency by Intelligent Control and its simulation in Matlab.

**EE 725: Advanced Electrical Machines (الآلات الكهربائية المتقدمة)**

Winding functions and dynamic modeling of AC machines, D-Q transformation and reference frame theory, Vector control and field orientation principles, Variable speed operation and energy efficiency, Application example: electric traction motors for electrical and hybrid electrical vehicles, Application example: electric generators for wind turbine applications.



### **EE 736: Smart Grid Systems (نظم الشبكة الذكية)**

The emissions and economics costs of peak power, Microgrids, Renewable energy sources as a distribution generation, Advanced Metering Infrastructure (AMI) & the smart meter, Home area networks, Business cases for AMI, Commercial & Industrial energy management, Demand response programs & technology, Energy Efficiency programs & technology, Smart Grid & distribution, Distributed renewables & storage, Distribution network reconfiguration and other intelligent distribution control methods, Smart Grid & transmission, Estimating and mitigating blackout, particularly cascading failure blackout, risk.

### **Prerequisite: EE 721**

### **EE 740: Thesis (الرسالة)**

The master thesis work is a research project dealing with renewable energy production, power converters control and electrical machines for renewable energy applications. The objective is developing the knowledge of the students in selected advanced and up-to-date topics related to electrical power and renewable energy systems. A research-based thesis course that offers students the opportunity to work on a comprehensive, individual project that demonstrates mastery of interaction design. The thesis is an independent piece of scientific research demonstrating the student's competence in higher education in relation to the aims of the program. The thesis should make an original contribution to knowledge in the field of electrical engineering. Following Steps are required to complete the thesis work: • Identify and construct a problem/thesis statement • Bibliography • In-depth survey • carry out research • analyze data Statistical and cost analyses • Societal and environmental impact • develop defensible conclusions • thesis writing and make a persuasive argument.

### **Research Methodology: EE 733 (طرق البحث)**

Formulating Research Problems, Research Planning, Academic Honesty, how to read journal papers, Finding Information, Literature Review Process, Gathering and Summarizing Information, Documenting Literature Review, Referencing, Thesis Proposal Main Sections, how to Write Thesis Proposal, Thesis Proposal Examples, MATLAB Tool Boxes Overview, Building Math Models in MATLAB, Simulation and Results Analysis, how to Write Research papers, where to Submit, how to Submit.

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