ماجستير العلوم في علوم وهندسة الطاقه المتجدده

Master of Science Renewable Energy Science and Engineering

من خلال البرنامج سوف تنمى القدرة لدي الطلاب لإكتساب ركيزة المفاهيم العلمية الاساسية والمشاكل المتواجده حاليا بسبب نفاذ الطاقه والتي تعاني منها دول العالم والعمل علي حلها من خلال استبدالها بمصادر طاقه نظيفه ومتجدده، وابتكار طرق وتطبيقات جديده للطاقه المتجدده بإستخدام الطرق المعملية والبحثيه، خاصة في مجالات الخلايا الشمسيه وخلايا الوقود والعمل علي تطويرهم من خلال زيادة كفاءه كلاً منهما وتقليل تكلفه التصنيع حتى تطبيقها علي نطاق واسع والإستغناء تدريجياً عن إستخدام الطاقه المستنفذه.

الأهداف ومخرجات التعلم المقصودة:

1. توفير خريجين مؤهلين تأهيلا عاليا، مكتسبين القدره على المساهمة بشكل فعال فى تلبية الإحتياجات المتزايده للطاقه المتجدده فى المجتمع.
2. إمداد الطالب بالمعرفة والمفاهيم الأساسيه والوعى للتقنيات العلميه والهندسيه المختلفه للطاقه المتجدده واستخدامها علي نطاق واسع.
3. تعزيز مهارات الإداره والإتصال مع المحيطين والعمل الجماعى والتحليل والتفكير النقدى لدى الطالب، بالإضافه إلى إكساب الطالب المهارات البحثية اللازمه.
4. تمكين الطالب من إثبات المعرفة المنهجية التى قد اكتسبها أثناء دراساته النظريه والعمليه من خلال توفير حلول للمشاكل التقنيه فى أنظمة الطاقه المتجدده الحديثه المستخدمه فى المؤسسات والمصانع المحليه والخارجيه.
5. تدريب الطالب على جمع المعلومات اللازمه لدراساته وأبحاثه من مصادر مختلفه.

6. إعداد الطالب لإجراء أعمال الرساله البحثيه من خلال تدريبه علي اداء المشروع البحثى وكذلك الأنشطة المدرجة في المواد التدريسيه والأنشطه الأخرى.

تكون الدراسة علي مرحلتين

المرحله الاولي: دراسة نظرية لمده عام أكاديمي Pre-master courses

المرحله الثانية: تسجيل النقطة البحثية و إجراء الأبحاث المعملية و نشر بحث دولي واحد علي الأقل و كتابة الرسالة العلمية. و تمنح الدرجة بعد تحكيم الرسالة.

Pre-master Courses

1. Compulsory Courses:

First Semester							
Course code	Course title		Total Credit Hours	Lecture Credit Hours	Lab Credit Hours	Exam Duration (hour)	Final grades out of
	English	Arabic					
RE601	Energy Policy and Planning	سياسيات وتخطيط الطاقه	1	1	0	1	50
RE602	Advanced Energy and Environment	ماده الطاقه والبيئه - دراسيه متقدمه	2	2	0	2	100
RE603	Advanced Energy Conversion and Storage	تحويل وتخزين الطاقه - ماده دراسيه متقدمه	2	2	0	2	100
RE604	Biomass, Biofuels and Biogas	الكتله الحيويه والوقود الحيوى والغاز الحيوى	2	2	0	2	100
RE605	Advanced Renewable Hybrid Systems	النظم المختلطه للطاقه المتجدده - ماده دراسيه متقدمه	2	2	0	2	100
RE606	Bio-Energy Technology	تقنية الطاقه الحيويه	2	2	0	2	100
GC601	Scientific Thinking and Writing	التفكير والكتابه العلميه	1	1	0	1	50

A. Solar Energy Technology (SET) Specialization Track:

Second Semester							
Course code	Course title		Total Credit Hours	Lecture Credit Hours	Lab Credit Hours	Exam Duration (hour)	Final grades out of
	English	Arabic					
RE610	Heat Transport Technology Thermodynamic Cycles	تقنية انتقال الحراره والديناميكا الحراريه	2	2	0	2	100
RE611	Advanced Photovoltaic Systems Technology	تقنيه النظم الكهروضوئيه - ماده دراسيه متقدمه	2	2	0	2	100
RE612	Advanced Materials Preparation and Characterization	اعداد وتوصيف - ماده المواد دراسيه متقدمه	2	2	0	2	100
RE613	Solar Cell Fabrication and Module Technology	تقنية تصنيع الخلايا والألواح الشمسيه	2	2	0	2	100
RE614	Research Project*	المشروع البحثي	2	2	0	N/A	100

***Research Project course includes a presentation and a final report for the student activity assessment**

2. Elective courses:

Elective Courses							
Course code	Course title		Total Credit Hours	Lecture Credit Hours	Lab Credit Hours	Exam Duration (hour)	Final grades out of
	English	Arabic					
RE608	Energy Demand and Supply	إحتياجات وإمدادات الطاقه	2	2	0	2	100
RE609	Advanced Renewable Energy and Society	الطاقه المتجدده والمجتمع - ماده دراسيه متقدمه	2	2	0	2	100
RE615	Advanced Power Semiconductor Converters	اشباه موصلات محولات القوى - ماده دراسيه متقدمه	2	2	0	2	100
RE616	Advanced Solar Cell Technologies	تقنيات الخلايا الشمسيه المتقدمه	2	2	0	2	100

B. Fuel cells and Hydrogen production Technology (FHT) Specialization Track:

Second Semester							
Course code	Course title		Total Credit Hours	Lecture Credit Hours	Lab Credit Hours	Exam Duration (hour)	Final grades out of
	English	Arabic					
RE617	Advanced Fuel Cells	ماده خلايا الوقود - دراسيه متقدمه	2	2	0	2	100
RE618	Advanced Hydrogen Production and Storage	انتاج وتخزين - ماده الهيدروجي دراسيه متقدمه	2	2	0	2	100
RE619	Advanced Polymer Membrane Technology	تقنية أغشية البوليمر المتقدمه	2	2	0	2	100
RE612	Advanced Materials Preparation and Characterization	اعداد وتوصيف - ماده المواد دراسيه متقدمه	2	2	0	2	100
RE617	Advanced Fuel Cells	ماده خلايا الوقود - دراسيه متقدمه	2	2	0	2	100

***Research Project course includes a presentation and a final report for the student activity assessment**

2. Elective courses:

Elective Courses							
Course code	Course title		Total Credit Hours	Lecture Credit Hours	Lab Credit Hours	Exam Duration (hour)	Final grades out of
	English	Arabic					
RE608	Energy Demand and Supply	إحتياجات وإمدادات الطاقه	2	2	0	2	100
RE609	Advanced Renewable Energy and Society	الطاقه المتجدده والمجتمع - ماده دراسيه متقدمه	2	2	0	2	100
RE620	Advanced Hydropower Technology	تقنيه الطاقه الكهرومائيه - ماده دراسيه متقدمه	2	2	0	2	100
RE621	Advanced Renewable Energy Market and Commercialization	سوق الطاقه المتجدده وسبل تسويقها - ماده دراسيه متقدمه	2	2	0	2	100

To complete the pre-requisite courses (pre-master courses) you should finish total credit hours = 26

[Compulsory Courses (22 credit hours) + Elective Courses (4 credit hours)]

Course Specifications

RE601 Energy Policy and Planning

Global and local trends and developments in Renewable Energy Technologies (solar, wind, bioenergy, etc.) and energy efficiency, economics & pricing of renewable energy systems, overview of energy policies and policy instruments that facilitate investment in renewable energy technologies (renewable energy targets, feed-in-tariffs, etc.), policies for energy access and capacity building; case-studies and analysis of successful and unsuccessful policy options; introduction to energy planning and national energy balance calculations.

RE602 Advanced Energy and Environment

Introduction to Life Cycle Assessment (LCA) of energy technologies; calculation of carbon intensity of national energy generation systems and Greenhouse Gas (GHG) savings; and global environmental benefits of Renewable Energy Technology projects; Introduction to international climate and environmental conventions; carbon markets and clean development mechanism (CDM); Introduction to CDM Methodologies for Renewable Energy and energy efficiency projects.

RE603 Advanced Energy Conversion and Storage

Analysis of thermo-mechanical, thermo-chemical, electrochemical, and photoelectric processes and technologies of renewable energy conversion and storage systems; on-shore and off-shore energy conversion; innovative energy storage devices; energy carriers, synthesized fuels, and fuel reforming. Emphasis is on advanced energy technologies, energy efficiency, systems performance, innovative grid connections, and minimizing environmental impacts.

RE604 Biomass, Biofuels and Biogas

Biomass sources, Biomass conversion process to useful energy, thermal conversion, Chemical conversion, Biochemical conversion, Environmental impact. Biofuels, First-generation biofuels, Ethanol, Biodiesel, Other bio-alcohols, Biofuel gasoline, Vegetable oil, Bio-ethers, Syngas, Solid biofuels, Second-generation (advanced) biofuels, Sustainable biofuels, Debates regarding the production and use of biofuel, Ethanol biofuels, Algae biofuels, Fungi, Animal Gut Bacteria, Greenhouse gas emissions. Biogas Production, Landfill gas, Technical, Composition, Benefits, Applications, Biogas upgrading.

RE605 Advanced Renewable Hybrid Systems

Introduction to different types of renewable energy systems; the concept of hybrid energy systems that comprise renewable energy technologies, as well as renewable energy technologies with nonrenewable ones, such as the PV-diesel systems. Application of Renewable Hybrid Systems in Rural Electrification, as well as introducing the concept of minigrids. An overview on the design and optimization methodologies of renewable hybrid systems will be presented, as well as some case studies from literature.

RE606 Bio-Energy Technology

Sources, classification, chemical composition and properties of different biomass materials. Preparation of woody biomass: size reduction, briquetting, drying, storage and handling. Combustion of biomass and cogeneration systems: combustion of woody biomass - theory, calculations and design of equipment. Co- generation in biomass processing industries, co-generation plants - types - layout - energy recovery. Case Studies: combustion of rice husk, use of bagasse for cogeneration. Pyrolysis and Gasification of Biomass: Thermochemical degradation; History of small gas producer Engine systems - Chemistry of gasification - Gas producers - types - operating principles - Gasifier fuels-properties-preparation- conditioning of producer gas - applications - shaft power generation - thermal application - Economics. Thermo-chemical conversion of ligno-cellulose biomass – Biomass processing for liquid fuel production - Pyrolysis of biomass - Pyrolysis regime, effect of particle size, temperature, and products obtained. Thermo-

chemical gasification principles: Effect of pressure, temperature and of introducing steam and oxygen.

GC601 Scientific Thinking and Writing

Scientific Planning – How to use a research engine - How to write a proposal – How to write a paper – Research ethics – Publication – social media.

RE608 Energy Demand and Supply

Energy Units and Conversion Factor; Primary, Secondary, Final and Useful Energy; Global and National Energy Demand and Supply; Energy Balance in the National Context; Energy Planning and Forecasting; Rural and Urban Energy.

RE609 Advanced Renewable Energy and Society

Awareness on renewable energy and its environmental and social impact on society, public participation in developing and managing renewable energy projects as well as low carbon society.

RE610 Heat Transport Technology Thermodynamic Cycles

Introduction to thermodynamics; Properties of pure substances; Energy transfer by heat, work, and mass; Energy and mass conservation; Entropy and the second law; Gas and vapor power cycles. Heat transfer by conduction, convection and radiation. Numerical analysis of steady and unsteady conductions. Natural and forced convection. Heat exchangers. Third law of thermodynamics and programmed applications.

RE611 Advanced Photovoltaic Systems Technology

Introduction about renewable energy resources and the most widely utilized renewable Energy technologies. Introducing the electrical power engineering basics, in addition to the solar energy fundamentals. Following that, the PV modules fundamentals and PV systems and components will be introduced, as well as the PV performance analysis. The basic sizing principles of PV systems will be presented, as well as the most common and widely used fabrication methods.

RE612 Advanced Materials Preparation and Characterization

Fundamentals of nanoscience, Preparation of nanomaterials by different techniques. Structural characterization (XRD, XRF, XPS, SAX, Auger, SIMS, etc.), Electrochemical characterization (CV, EIS, E-I curves, etc.), Morphological characterization (SEM, TEM, AFM, STM, etc.), Thermal and mechanical properties, Spectroscopic characterization (UV, VIS, IR, Raman, etc.), Electrical properties and Optical properties. The course includes lab work for providing the students with relevant hands-on experiments.

RE613 Solar Cell Fabrication and Module Technology

Semiconductor Materials: Conduction theory, E-k curves, energy bandgaps, effective mass, direct and indirect transitions. Carrier statistics, intrinsic and extrinsic behavior, mobility, diffusion, is scattering. Equilibrium and non-equilibrium behavior, recombination, Optical and thermal properties. Semiconductor Devices: p-n junctions, depletion region, derivation of I-V characteristics in the dark. Ideal diode under illumination, Loss mechanisms for real diodes, series and shunt resistances, interface states. Heterojunctions, Anderson model, current transport models, window layers. Introduction to multijunction concepts. Material Fabrication Technologies: Purification of silicon, zone refining and guttering, segregation coefficient. Growth of crystalline silicon, Bridgman, Czochralski and floating zone methods. Epitaxial growth methods, MBE, MOCVD, LPE, VPE. Thin film deposition methods, evaporation, sputtering, wet chemical, spray pyrolysis, and devices-printing. Device Fabrication: Doping, alloying, diffusion and implantation Device processing methods. Deposition of anti-reflection coatings. Photolithography. Dry and wet etching. Surface texturing and passivation techniques.

RE614 Research Project

This project module allow student to choose an area to research relating to a specific industrial, scientific, or development problem and recommend a solution; utilizing relevant hardware and software methods, in order to produce a scientific article and an oral discussion. Such project might be the concept of the student’s future master thesis.

RE615 Advanced Power Semiconductor Converters

Semiconductor devices: Driving, snubber and protection circuits; Resonant converters; Switching D.C power supplies; Power conditioners; Applications in the fields of electrical energy utilization.

RE616 Advanced Solar Cell Technologies

Cell and Module Concepts: Flat plate and concentrator cells and modules. Multijunction concepts, Overview of cell types and technology status. Advanced Devices: High efficiency crystalline silicon designs. Passivation, light trapping and contact structures. Cost reduction strategies. III-V devices, high concentration, quantum wells devices, multijunction structures, thermophotovoltaic devices. Thin film solar cells, structures and fabrication, novel device designs. Characterization Methods: Cell measurement, solar simulation, conversion efficiency and spectral response. I-V-T and C-V-f measurements. Measurement and performance standards.

RE617 Advanced Fuel Cells

Introduction to fuel cells, difference between fuel cells, batteries and other energy storage applications. Characteristics of fuel cells (energy efficiency, environmental issues, operating performance, etc.). Fuel cells basics: (thermodynamics and kinetics of electrochemical reactions, types of overpotentials, electrodes reactions in fuel cells, gas diffusion electrode, electrocatalysis, fuel cell efficiency). Fuel Cell electrode based material, catalyst material selection. Nano catalyst fabrications, Characterization of catalysts and investigation of catalyst performance. Fuel cell design and configurations, stack components, Types of Fuel Cell systems: (Phosphoric Acid Fuel Cells, Molten Carbonate Fuel Cells, Solid oxide Fuel Cells, Polymer Electrolyte Fuel Cells, Direct Methanol Fuel Cells, and Alkaline fuel cells). Fuel Cell Applications: Stationary Power Plants, Automotive Power Plants, other Applications. The course includes lab work for providing the students with relevant hands-on experiments.

RE618 Advanced Hydrogen Production and Storage

Chemical Production of hydrogen, Electrochemical Hydrogen Evolution, Solar hydrogen evolution, Partial Oxidation, Steam Reforming, Thermal Decomposition, Syngas, Shift reaction, Methanation, Hydrogen Purification, Desulfurization, CO_2 Removal, Electrolytic Hydrogen, Liquid Electrolyte Electrolyzers, Solid Polymer Electrolyte Electrolyzer, Ceramic Electrolyte Electrolyzer, Photolytic Hydrogen, Solar Photolysis. Storage of Hydrogen by Adsorption, Storage of Hydrogen in Chemical Compound, Metal/Metal oxide Hydrides, Hydrogen Storage Materials, carbon Nanofibres, Sponge Iron, Glass Microspheres, Carbon nanotubes, Aerogels. Materials selection, Catalyst Preparation including nano catalysts, Characterization of catalysts, Infrastructure and distribution of hydrogen, Economic aspects of using hydrogen, Innovation in hydrogen technology. The course includes lab work for providing the students with relevant hands-on experiments.

RE619 Advanced Polymer Membrane Technology

Introduction to polymer science; Needs of Fundamental Materials for Proton Exchange Membranes (PEM) Fuel Cells; Membranes for PEM Fuel Cells, Proton Exchange Membranes, PEMs for DMFCs, Anion Exchange Membranes (AEMs), Organic–Inorganic Composites; Testing of PEMs; Fluoropolymers for Proton Exchange Membranes; Nonfluorinated Polymers for Proton Exchange Membranes; Anhydrous Proton-Conducting Polymers for High-Temperature PEMFCs; Anion Exchange Membranes for Alkaline Fuel Cells; Polymers for New Types of Fuel Cells.

RE620 Advanced Hydropower Technology

Introduction to hydropower, status of large and small hydropower development in the MENA region and the world in terms of potential, installed capacities and on-going projects in the context of rural electrification and agriculture (run-off-river, canal fall based, dam toe, small hydropower, micro hydropower, and Pico hydropower).

RE621 Advanced Renewable Energy Market and Commercialization

Introduction to renewable energy markets and status. The concepts of marketing and sales (consumer behaviors, managing sales, marketing plans, business negotiations) and how to use them in marketing and selling renewable energy technologies.