MASTER IN RENEWABLE ENERGY

Main Language of Instruction:
French ☑ Englis Arabic ○

Campus Where The Program Is Offered: CST

OBJECTIVES

The Master in Renewable Energy aims to train researchers and engineers in energy efficiency and renewable energy. The program aims to train specialists and experts who can design and implement high-efficiency energy systems powered by renewable sources. Graduates will be prepared to lead innovative projects in this field, whether in academic research or within cutting-edge technology centers and industrial sectors at local and regional levels. Additionally, the program supports students interested in pursuing PhD studies in renewable energy.
This Master's program aims to raise students' awareness of:

- Global energy consumption challenges, fossil fuel depletion, climate change, and air pollution.
- Renewable energy sources, including solar, wind, hydroelectric, biomass, geothermal, tidal and wave energy, as well as hydrogen fuel cells.
- Energy production, storage, and utilization techniques.
- Grid integration strategies using dedicated electronic interfaces, and energy flow optimization through appropriate control methods.

The program also trains:

- Teachers and researchers.
- Highly qualified specialists for public administrations and engineering consultancies.
- International researchers, particularly from the Mediterranean region, to foster cooperation and more efficient shared use of resources.

This interuniversity degree in Lebanon is delivered in collaboration with reputable institutions that contribute their academic and scientific expertise.

PROGRAM LEARNING OUTCOMES (COMPETENCIES)

Graduates will be able to:

- Acquire and apply advanced knowledge appropriate to the discipline.
- Solve critical issues and demonstrate expertise in key areas in the field of study.
- Analyze and think innovatively to develop novel solutions for real-world problems.
- Apply new and diversified theoretical and experimental methods as appropriate to the discipline.
- Integrate ethics and moral responsibility in engineering solutions in the field.
- Conduct independent, original research and contribute to the advancement of knowledge in the field.
- Communicate, at an advanced level, in oral and written form.
- Recognize the importance of standards of professional integrity.

ADMISSION REQUIREMENTS

Candidates are selected based on the review of their application file: Admission to the third semester of the Master's program (M3) is available for candidates holding an engineering degree in electrical, mechanical, civil, chemical, or petrochemical engineering.

COURSES/CREDITS GRANTED BY EQUIVALENCE

Courses in M1 and M2 semesters (which account for 60 credits) are prerequisite courses for M3 and are granted by equivalence for holders of a Bachelor's degree in electrical, mechanical, civil, chemical, and petrochemical engineering.

PROGRAM REQUIREMENTS

This program comprises 120 credits, spread over 4 semesters: M1, M2 (as prerequisites corresponding to the 5th year of engineering), M3, and M4, with 30 credits each.
This program provides instruction for the M3 and M4 semesters, including:

- Theoretical and practical courses.
- A research internship at an accredited center, culminating in the writing of a thesis.

Required Courses (54 credits), Institution's Elective Courses (6 credits)

Required Courses (54 Cr.)
Energy Efficiency (3 Cr.). Wind Energy (3 Cr.). Hydropower (3 Cr.). Solar Energy (4 Cr.). Biomass Energy (3 Cr.). Energy Storage (3 Cr.). Renewable Energy Project Evaluation (3 Cr.). Renewable Energy Seminars (2 Cr.). Research Internship with Thesis (30 Cr.).

Institution's Elective Courses (6 Cr.), to be chosen from the list below:
Distributed Generation Systems (3 Cr.). Advanced Power Electronics (3 Cr.). Thermal and Thermodynamic Conversion Systems (3 Cr.). Modeling and Optimization of Thermal Systems (3 Cr.). Low-Energy Green Buildings (3 Cr.). Smart Electrical Grids (3 Cr.). Recyclable Materials in Construction (3 Cr.).

SUGGESTED STUDY PLAN

Semester 3

Code	Course Name	Credits
MRER00M3	Energy Efficiency	3
MRER01M3	Wind Energy	3
MRER02M3	Hydropower	3
MRER03M3	Solar Energy	4
MRER04M3	Biomass Energy	3
MRER05M3	Energy Storage	3
MRER06M3	Renewable Energy Project Evaluation	3
MRER07M3	Renewable Energy Seminars	2
	Institution's Elective Courses	6
	Total	**30**

Semester 4

Code	Course Name	Credits
MRER00M4	Research Internship with Thesis	30
	Total	**30**

COURSE DESCRIPTION

MRER09M3 Advanced Power Electronics 3 Cr.

This course explores advanced topics in the following: power electronics, focusing on modern converter technologies and their applications. Multi-level converters with clamping diodes and floating capacitors. Matrix structures. Non-polluting converters. Direct current transportation. Active and hybrid filtering. Modeling and control.

MRER04M3 Biomass Energy 3 Cr.

This course provides a comprehensive introduction to biomass energy and its applications. Topics include the fundamental concepts of bioenergy, classification and types of biomass, management of urban solid waste, dry

and wet residual biomass treatment, and direct incineration processes. The course also covers the use of photo-bioreactors, the biochemistry behind biomass transformation, methanization processes, and the production and utilization of various biofuels.

MRER08M3 Distributed Generation Systems 3 Cr.

This course focuses on the analysis and management of electrical networks. Topics include: energy generation in isolated systems. Distributed energy generation. Smart electrical grids. Modelling and optimization techniques.

MRER00M3 Energy Efficiency 3 Cr.

This course examines the key aspects of energy efficiency within the broader global energy context. Topics include the status of energy reserves, environmental impacts, legal frameworks, international protocols and agreements, and energy consumption across various sectors. The course also explores passive energy-saving measures, the use of high-efficiency equipment, advanced energy conversion methods and the influence of user behavior on the demand.

MRER05M3 Energy Storage 3 Cr.

This course covers: The principles and technologies of electrical, mechanical, or thermal conversion systems. The operation of electrical generators, and the static conversion of electrical energy. A significant focus is placed on storage systems: batteries, accumulators, supercapacitors, modelling and control, numerical simulations.

MRER02M3 Hydropower 3 Cr.

This course provides an in-depth study of hydropower systems and technologies. Topics include the fundamentals of hydraulic mechanics, the design and operation of hydraulic turbines, the structure and functioning of hydroelectric power plants, as well as the role of dams and pipelines. The course also addresses the impact of rainfall variability on hydropower generation.

MRER12M3 Low-Energy Green Buildings 3 Cr.

This course explores sustainable building design and its environmental impact. Topics include initiatives in eco-friendly building design. Environmental impact of construction materials. Environmental impact of construction, demolition, and renovation. CO_2 emissions assessment. Integration of sustainable and passive principles in building architectural design. Solar geometry. Climate/regional limitations. Natural lighting. Passive design. Natural ventilation and infiltration. Insulation. Energy storage materials. Bioclimatic concept. Case studies.

MRER11M3 Modeling and Optimization of Thermal Systems 3 Cr.

This course focuses on the modeling and analysis of renewable energy thermal systems. Topics include: Renewable energy thermal systems. Phenomenological laws and conservation principles. General modelling approach. Modelling of thermal phenomena. Spatial discretization methods. Temporal resolution methods. Dynamic simulation. Inverse methods. Optimization methods.

MRER16M3 Recyclable Materials in Construction 3 Cr.

This course addresses waste management in the construction industry and explores opportunities for on-site recycling to reduce environmental impact. It covers fundamental construction materials and the process of transforming by-products and waste into new construction materials.

MRER06M3 Renewable Energy Project Evaluation 3 Cr.

This course covers the key aspects of evaluating energy generation systems, including cost analysis, feasibility studies, and assessments of reliability and maintainability. It also addresses the environmental impacts of energy systems and emphasizes life cycle analysis to evaluate sustainability.

MRER07M3 Renewable Energy Seminars 2 Cr.

This course involves a series of lectures on subjects and themes related to renewable energies: fuel cells (fuel cell electrochemistry, types and technologies, hydrogen production and storage, transportation, commercialization and applications, hybrid vehicles), geothermal (thermodynamics and fluid dynamics, geothermal fluids, geological exploration techniques, geophysical and geochemical, geothermal power plants), Green hydrogen (its production from renewable sources, its various applications in industry and transportation, as well as its environmental impact).

MRER00M4 Research Internship with Thesis 30 Cr.

This course serves as an initiation into research techniques. It is the synthesis of six months of research work in a research center or laboratory.

MRER14M3 Smart Electrical Grids 3 Cr.

This course explores the ecosystem of smart electrical grids, focusing on both conventional and renewable energy production. Topics include the quality and efficiency of electricity transmission, as well as the protection, automation, and control of electrical grids. The course also covers the management and global control of energy systems, distributed electricity storage, active building management, consumer management, and consumer behaviour in the residential sector. Additionally, it examines the integration of electric vehicles and the role of standardization, regulatory modification, and incentives for the development of smart electrical grids.

MRER03M3 Solar Energy 4 Cr.

This course examines a comprehensive study of solar energy systems, covering solar radiation and resource assessment in depth. Topics include the precise calculation of solar energy contributions and their distribution within receiving systems. The course explores both thermal solar systems and their applications, as well as photovoltaic systems and their integration into modern energy systems. Students will also investigate hybrid systems that combine thermal and photovoltaic technologies, with a focus on optimization and real-world applications in energy generation.

MRER10M3 Thermal and Thermodynamic Conversion Systems 3 Cr.

This course explores thermal and thermodynamic conversion systems. Topics include the concept of exergy and its application in exergy analysis, various engine cycles, and cogeneration systems. The course covers refrigeration cycles, heat pumps, fluid networks, and heat exchangers, with a focus on the Pinch method for energy optimization. Additionally, students will study the application of these principles to renewable energy systems, enhancing their understanding of energy conversion processes in sustainable technologies.

MRER01M3 Wind Energy 3 Cr.

This course provides a comprehensive study of wind energy systems, focusing on the aerodynamics of wind turbines and their design principles. Topics include electromechanical conversion systems, control mechanisms, and methods for resource assessment. Additionally, the course covers the feasibility of wind energy projects and explores various application areas, equipping students with the knowledge to evaluate and implement wind energy solutions.