Jordan University of Science and Technology

JUST

Faculty of Engineering

Mechanical Engineering Department

A Master's Program Proposal

In Mechanical Engineering

Renewable Energy and Sustainable Development

Jordan University of Science and Technology

Faculty of Graduate Studies

Course Curriculum for Master Degree in Renewable Energy and Sustainable Development

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SECTION 1. OBJECTIVES, CURRICULUM DESIGN, AND OUTCOMES

1.1 Objectives

The primary objectives of the program are:

1. To foster high quality graduate level for Renewable Energy and Sustainable Development education and research and to generate graduates with high levels of competence in fundamental and applied concepts of the Renewable Energy and Sustainable Development with focus on electrical and mechanical power generation
2. To motivate students to seek life-long learning and professional development to help them advance rapidly in their careers and/or doctoral studies.
3. To enhance the students' recognition and understanding of the professional and societal responsibilities associated with working in the industry and academia.
4. To produce graduates well prepared for various mechanical engineering specializations to contribute effectively to the expansion of the country's economic development.
5. To enrich the research collaboration between the university and the industrial sectors in the country and worldwide.
6. To provide opportunities to address industrially important problems and to propose and investigate possible solutions.
7. To produce graduate professionals and leaders in the global industries.

1.2 Design of the Curriculum

The curriculum design includes an integrated Renewable Energy and Sustainable Development fields. Aimed at fostering competency in

1. conducting quality research and development works;
2. showing mastery of the concepts, methodologies and techniques specific to their field of study;
3. communicating both orally and in writing with a high level of proficiency in their field of study;
4. team and leadership characteristics at work;
5. Perform in their field of study at a professional level

Consequently, the graduates of the Renewable Energy and Sustainable Development program will be leading in technology transfer and industry modernization. They are prepared to be better decision makers and team leaders of multidisciplinary engineering systems. This is in concurrence with the University mission to enable students to comprehend the dynamism and complexity of contemporary global processes and to empower them to guide these processes in constructive directions.

1.3 Expected Student Outcomes

Graduates of the MS in Renewable Energy and Sustainable Development will have the following abilities:

1. Integrated systems: Work with, and develop, integrated renewable energy systems through all stages. This includes modeling, design, development and fabrication.

2. Leadership: Lead industry modernization and automation effort; make decisions when selecting, procure and commission advanced engineering systems; lead and manage their multidisciplinary technical teams.

3. Innovation: Develop competitive and innovative technical solutions to complex engineering problems while driving innovations into the resulting product.

4. Broad-based: Adapt research and development to achieve optimal technical solutions, and take into account socioeconomic, environmental, and innovative technology.

SECTION 2. PROGRAM EVALUATION AND ASSESSMEN

2.1 Evaluation Procedures and Assessment Strategies

Evaluation will be conducted for the following program elements:

- Curriculum: How the curriculum accomplishes the program objectives?
- Students: How the student demonstrates course outcomes. Performance in class projects and open-ended engineering problems? How student performs on a multidisciplinary team. Are they learning to be innovative and creative?
- Faculty: How are the faculty interacting, motivating and challenging students to be more creative? Are students involved in research activities?
- Resources: How are resources serving program needs? Are they being developed to enhance program elements?

To assess these outcomes, evaluation tools other than regular course work assessment have been developed. These tools are managed, developed, and transformed into corrective measures for all the elements of the program from goals and objectives to individual course introduction, restructuring, or elimination. The assessment tools are as follows:

- Academic oriented tools for online tuning of the program (affecting individual courses)

1. Course portfolios and students feedback
2. Projects, presentations
3. Comprehensive exams (course option) and thesis defense (thesis option)

- Industry feedback regarding a graduate's performance (affecting short term program goals and objectives)

1. Industry questionnaires
2. Graduate's promotion
3. Leadership of graduates in their workplace
4. Activities of graduates in local, regional, and international professional societies
5. Attracting industry projects and funds
6. Alumni feedback
7. Professional societies feedback
8. Local workshops and seminars

- Program response emerging and projected trends in science and technology (affecting long term and short term program goals and objectives)

1. Faculty participation in major professional meetings
2. Graduates participation in major professional meetings
3. Publication in refereed journals and major conferences
4. Admission to PhD programs in high quality research institutions
5. Partnership with world class institutions in the field

SECTION 3. RENEWABLE ENERGY AND SUSTAINABLE DEVELOPMENT PROGRAM COURSES

3.1 Course titles and classification

3.2 Catalog description of courses

The Master Degree in Renewable Energy and Sustainable Developments, is awarded by the Faculty of Graduate Studies at Jordan University of Science and Technology (JUST) upon the fulfillment of the following requirements:

1) Compliance with the J.U.S.T. Master Degree regulations approved by the Dean Council (No. 25/2017), dated 19/6/2017.
2) Successful completion of (34) credit hours in one of the following track:

First: Thesis Track

1. Compulsory Requirements: (16) credit hours as follows:

Course No.	Course Title	Credit Hours
ME710	Research Methodology	3
ME720	Renewable Energy Systems	3
ME722	Energy Efficiency	3
ME723	CSP – Concentrated Solar Power	3
ME724	Wind Energy	3
ME790	Seminar	1

2. Elective Requirements: (9) credit hours from the following*:

Course No.	Course Title	Credit Hours
ME725	Environment and sustainable development	3
ME726	Economic Aspects of REEE	3
ME727	Energy regulations	3
ME728	Bio-fuels	3
ME729	Energy Conversion Technologies	3
ME750	Modeling, simulation and optimization	3
ME751	PV - Photovoltaic	3
ME752	Solar Desalination	3
ME753	Low Carbon Buildings	3
ME754	Market Communication, Strategies and Tools	3
ME 755	Technical and Economic Feasibility of RE	3
ME 756	Energy Management	3
ME759	Special Topics in Renewable Energy Technology	3

* The student may study not more than 6 credit hours from courses of 700 or 800 level offered by other programs related to his/her field of study upon approval of the Dean of Graduate Studies based on the recommendation of the departmental graduate studies committee.

3. Master Thesis: total of 9 credit hours as follows:

Course No.	Course Title	Credit hrs.
ME799 A	Master Thesis	9
ME799 B	Master Thesis	6
ME799 C	Master Thesis	3
ME799 D	Master Thesis	0

Second: Comprehensive Exam Track

1. Compulsory Requirements: (25) credit hours as follows:

Course Symbol and Number	Course Name	Credit
ME710	Research Methodology	3
ME720	Renewable Energy Systems	3
ME722	Energy Efficiency	3
ME723	CSP – Concentrated Solar Power	3
ME724	Wind Energy	3
ME728	Bio-fuels	3
ME729	Energy Conversion Technologies	3
ME751	PV - Photovoltaic	3
ME 790	Seminar	1

2. Elective Requirements: (9) credit hours from the following*:

Course Symbol and Number	Course Name	Credit
ME725	Environment and sustainable development	3
ME726	Economic Aspects of REEE	3
ME727	Energy regulations	3
ME750	Modeling, simulation and optimization	3
ME752	Solar Desalination	3
ME753	Low Carbon Buildings	3
ME754	Market Communication, Strategies and Tools	3
ME 755	Technical and Economic Feasibility of RE	3
ME 756	Energy Management	3
ME759	Special Topics in Renewable Energy Technology	3

*The student may study not more than 6 credit hours from courses of 700 or 800 level offered by other programs related to his field of study upon approval of the Dean of Graduate Studies based on the recommendation of the departmental graduate studies committee.

3. Must pass the comprehensive Exam ME 798 (0.0 cr.)

Course Description (English)

ME710 Research Methodology (3 credit hours)

Methods of research in advanced fields of mechanical and energy engineering. Design of Experiments. Statistical tools. Methods of solution: analytical, numerical and experimental methods. Measurement systems, instruments and data acquisitions. Report writing: abstract, introduction, analysis, description of the experiment, experimental procedure, results, discussion, conclusions, recommendations and references.

ME720 Renewable Energy (RE) Systems (3 credit hours)

Scientific and technological fundamentals of renewable energy sources: passive and active solar systems (high, medium and low temperature thermal solar collectors; photovoltaic systems); wind energy; biomass and bio-energy; waste management; hydrogen production, hydroelectric power; geothermal. Practical aspects of renewable energy systems; design development, exploitation and monitoring. Introduction to social, legal and market challenges of RE systems. Prospective of RE technologies, factors affecting the deployment of RE systems.

ME722 Energy Efficiency (3 credit hours)

Techniques and approaches adapted to improve the efficiency of energy generation, utilization, conversion, transport, storage and management. Energy audits. Energy conservation opportunities for efficiency improvements in different industrial, commercial, transport and domestic sectors. The economic, regulatory, and infrastructure issues affecting implementation of energy efficiency measures as well as their potential for solving energy and environmental problems.

ME723 CSP – Concentrated Solar Power (3 credit hours)

Introduction to the solar energy, Solar radiation; Review of the basics of thermodynamics and heat transfer, Power plant Technologies; Types of CSP systems including CSP parabolic trough systems, CSP dish technology, CSP Fresnel technology and Solar tower; Heat storage systems; Hybridisation; Secondary use of CSP systems; Operation and maintenance of CSP systems; Power quality control and grid integration; CSP plant project planning: economical, social and environmental considerations and site assessment.

ME724 Wind Energy (3 credit hours)

Basic characteristics of wind, site characterization, Statistical methods of wind analysis, wind resources assessment, fundamental principles of wind energy utilization, aerodynamics, mechanical and electrical design aspects. Wind machine technologies and wind turbines performance analysis. Wind power integration into the power systems, environmental impact of wind power utilization.

ME725 Environment and sustainable development (3 credit hours)

Theory and practice of environment and sustainable development at urban, national and international levels. Environmental degradation by deforestation, loss of biodiversity, pollution, soil erosion, decreasing quality and quantity of water, poor sanitation services and poor urban conditions; CO_2 emissions and global warming, interactions among society. Development and environment: implications for sustainable development. Technical, economic, ethical and philosophical aspects of sustainable development.

ME726 Economics of Renewable Energy and Energy Efficiency (REEE) Systems (3 credit hours)

Basics of energy supply and demand; The national energy balance, energy related units, conversions and formulas; criteria and indicators of the concept of sustainable energy supply, trade, and security. Role of market, role of private sector, decentralization, standardization, policy options and mix, laws, law enforcement, division of labor among organizations, feed-in-tariff. Economic and social functions of tariffs; functions and structure of public and private organizations in the energy sector on the national, regional and international levels.

ME727 Energy Regulations (3 credit hours)

Overview of developments in energy regulations, technical and economic characteristics of the energy sector, regulation and competition, generation and wholesale markets for energy, energy networks: Pricing and investment, distribution and supply of energy, benchmarking and comparative competition, regulatory governance and institutions for energy regulation, competition and retail markets, Jordan forum, energy regulation and welfare, Assessing the Effects of Reforms in the Energy Sector. The Implications of Climate Change for Energy Regulation

ME728 Biofuels (3 credit hours)

Types of Biofuels; ethanol, biodiesel, biogas, … etc. Their feedstocks, production processes, differences, advantages, and challenges. Fundamentals of thermochemical and biochemical conversions of biomass to biofuel/bioenergy. Economic trend, environmental, ethical, social, and technical innovation and technological issues associated with the use and management of biofuels.

ME729 Energy Conversion Technologies (3credit hours)

Forms of energy. Development of energy, sources and energy needs. Petroleum. Coal, oil shale and tar sand. Natural gas and hydrogen power. Principles of nuclear power. Conversion of chemical energy into thermal energy, including gas, liquid and solid fuel combustion systems. Conversion of thermal energy into mechanical energy, including power, and heat engine cycles, internal and external combustion systems and turbines. Conversion of thermal energy into electrical energy including thermoelectric converters, thermoelectric systems, electric generators and alternators, solar and fuel cells.

ME750 Modeling, Simulation and Optimization (3 credit hours)

Fundamentals of mathematical modeling and simulation of energy systems. Optimization techniques; Classical direct search-for-optimum methods, Golden Mean, Conjugate Gradients, Modified Newton Method, methods for constrained optimization such as Lagrange Multipliers, Linear and Quadratic Programming. Use of non-commercial software packages.

ME751 PV – Photovoltaic (3 credit hours)

The characteristics of sunlight. Semiconductor and P-N junctions. The behavior of solar cells. Cell properties and design. PV cell interconnection and module fabrication. Stand-alone photovoltaic system components. Designing stand-alone photovoltaic systems. Specific purpose photovoltaic applications. Remote area supply systems. Grid-connected photovoltaic systems. Photovoltaic water pumping system components. PV water pumping system design.

ME752 Solar Desalination (3 credit hours)

Physical and chemical properties of water, scale formation and control, the various desalting technologies such as Thermal Processes: Multi stage flash evaporation and multi effect distillation, membrane processes: electrodyalisis and reverse osmosis. Freezing and solar humidification desalinations. Matching desalination processes with solar energy utilization technologies.

ME753 Low Carbon Buildings (3 credit hours)

The fundamentals of conventional energy sources used in buildings; renewable energy technology; policies and drivers that are leading to the more widespread uptake of low carbon building technologies; low carbon building codes, global policies and planning from the past, present and future. Integrated design: urban micro-climate design, passive architectural interventions, active interventions. Low carbon buildings design and operation.

ME754 Market Communication, Strategies and Tools (3 credit hours)

Advertising, sales promotion, public relations, personal selling, word of mouth, social media, website content and presence, internal marketing and coordinated marketing communications strategy. Concepts, approaches and tools in integrated marketing communications. Tools and methods for setting promotional budgets and the factors affecting the design of the promotion mix.

ME 755 Technical and Economic Feasibility of REEE (3 credit hours)

Technical, cost, and environmental fundamentals of emerging renewable sources of energy, including solar, wind, biomass, oceanic, geothermal, hydropower and fuel cell (hydrogen). Renewable energy sources commercialization and measurement. Economic and technical performance indicators of renewable energy and energy efficiency systems; levelized cost of electricity and payback periods.

ME 756 Energy Management (3 credit hours)

Short and long term planning. Restructuring and privatization: models of electricity industry. Problems of contracts, markets and transmission pricing. De-regulation around the world. Costing techniques. Financial appraisal and profitability. Cost optimization. Energy auditing and monitoring. Saving of energy in: heating, ventilation, air conditioning, refrigeration, and lighting. Electrical demand control and power factor correction. Load forecast. Generation side management. Characteristics of power generating units. Economic dispatch of generating units. Transmission losses. Unit commitment. Interchange evaluation and power pools.

ME759 Special Topics in RE Technology (3 credit hours)

Covers specified cases with special interest for industry and modern technology in the areas of renewable energy.

ME 790 Seminar (1 credit hour)

Covers disciplines related to applied energy technology, where specialists from industry and academia will participate in seminars pertinent to hot research areas and problems in industry and government.