Masters of Science Program in Environmental and Renewable Energy Engineering

Courses Description

ERE 721 Applied Mathematics for Engineers, 3 Crs.

Vector differential operators, computing multiple integrals and using integral theorems. Partial differential equations: Wave equation, Diffusion equation, Poisson Equation and Helmholtz equation. Special functions: Spherical harmonics, Bessel functions, and some more specialized functions. Greens functions and its use in solving partial Differential Equations. Complex Analysis and Residue theorem. Calculus of Variation.

ERE 722 Modeling, Simulation and Optimization of Energy and Environmental Systems, 3 Crs.

Modeling methodology including: system conceptualization. Model construction and validation (computational accuracy).Model evaluationand calibration. Simulation of energyand environmental systems.Optimization techniques; Classical direct search-for-optimum methods, Golden Mean, Conjugate Gradients, Modified Newton Method. Methods for constrained optimization such as Lagrange Multipliers, Search methods, Linear and Dynamic Programming. Use of software packages.

ERE723 Advanced Numerical Methods, 3Crs.

Overview of numerical errors, numerical solution of nonlinear equations and system of linear equations (matrix equation, eigenvalue problem). Curve fitting and interpolation, Numerical differentiation and integration. Discretization of Ordinary differential equation; Initial value

ERE 731 Advanced Renewable Energy Systems, 3Crs. (2cr lectures, 1 cr Lab*)

Review of renewable energy resources. Wind energy: horizontal-axis and vertical-axis wind machines, performance characteristics. Wave energy: principles of operation. Solar energy: solar flux and solar angles calculations, solar-thermal technologies. Biomass energy conversion: direct combustion and alcoholic fermentation. Applications include fuel reforming, hydrogen and synthetic fuel production, fuel cells and batteries, and photovoltaic. Hydroelectric power and geothermal energy.Computer modeling and simulation using software packages. Experimental and practical verifications in the form of projects will be given to the students in the above areas.

ERE 732 Advanced Energy Conversion, 3Crs.

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. Methods of extracting energy from oil shale. Introduction to combustion process and combustion systems.Conversion of thermal energy into mechanical energy, including power, and heat engine cycles, internal and external combustion systems andturbines. Conversion of thermal energy into electrical energy including thermoelectric converters, thermoelectric systems. Electric generators and alternators, solar and fuel cells. Verification where possible.

ERE 733 Energy Efficiency, 3Crs.

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 sectors: industrial, commercial, transportation and domestic. Economic regulatory and infrastructure issues affecting the implementation of energy efficiency measures as well as their potential for solving energy and environmental problems. **Energy flow simulations in buildings. Best practices in building design**. This course includes students performing real energy audits.

ERE 734 Techno Economic Feasibility, 3 Crs.

Technological, cost, and environmental fundamentals of emerging renewable sources of energy and environmental systems; including solar, wind, biomass, geothermal, hydropower and fuel cell, water supply assessment and cost recovery options, water use efficiency measures, Pollution and remediation and treatment options assessments.The economics of source reduction, recycling, reuse, and recovery of wastes. Renewable energy sources commercialization and measurement. Economic and technical performance indicators of renewable energy and energy efficiency systems and environmental systems; LCOE and payback periods. This course include using softwares and projects to carry out real techno economic studies for real systems.

ERE 735 PV – PhotoVoltaics, 3Crs.

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 and simulation of stand-alone photovoltaic systems. Specific purpose photovoltaic applications.Remote area supply systems. Grid-connected photovoltaic systems.

ERE 736 Wind Energy Systems, 3 Crs.

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.

ERE 737 Concentrated Solar Power (CSP), 3Crs.

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; Hybridization; 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.

ERE741 Meteorology and Climate Phenomenology, 3 Crs.

An overview of atmospheric dynamics and thermodynamics structure.Atmospheric constituents and their change over time. Defining weather and climate; predicting weather and climate, deterministic vs. statistical forecast; periodicities in climate; solar forcing and its variation; glaciations. Weather and climate; natural causes of climate variation.The equivalent temperature and the radiative equilibrium climate model.Fundamental concepts of atmospheric physics. Introduction to atmospheric radiation; one layer greenhouse. The gray model for the radiative equilibrium temperature structure of the atmosphere; the greenhouse effect. Introduction to the radiative properties of clouds. Classification of clouds and the processes forming high and low clouds ; introduction to the microphysics of cloud formation. Precipitation processes; cloud condensation nuclei and ice nuclei and the collisional coalescence process. Introduction to dynamics. Explanation of fictitious forces and derivation of Coriolis force. Thermal wind and the hypsometric relation.

ERE 742 Sustainability, 3 Crs.

Sustainability. Sustainable systems. Sustainable wastewater treatment by utilizing natural processes (aerobic digestion, photosynthesis, etc…), renewable sources of energy (e.g., sunlight, wind, geothermal, and biomass), etc... Sustainable wastewater treatment relies minimally on fossil fuel energy and the mechanical processes are operated through renewable energy resources, it is in general cost-effective. Sustainability and development of environmental systems assessment of current and potential future energy needs, with emphasis on meeting regional and global energy needs in this and coming century.

ERE743 Environmental Biotechnology and Bioenergy, 3Crs.

Basic concepts of biotechnology: Biomass characterization, Biomassgrowth and kinetics. Bioconversion systems: types of biomass, which are currently considered for conversion

into bioenergy conversion pathways available to turn biomass into bio-products. Identify energy potentials of biomass and biogas. Biofuels and Combustions Engines.

ERE 744 Climate Change and Predictability, 3 Crs.

Fundamental aspects of the predictability of weather and climate. Basic theory of the divergence of trajectories in phase space and the periodic and chaotic properties of the flow are illustrated using simple nonlinear dynamical models. The dynamics of error growth, local and global predictability, and predictability of flows with many scales will be discussed. The predictability and error growth in large weather forecasting systems, predictability in mid-latitudes and tropics, and targeted observations will be studied. Predictability of time-mean quantities in large climate models, the role of ocean and land boundary forcings, and predictability of coupled models.

ERE751 Advanced Water and Wastewater Treatment, 3 Crs.

Characteristics of wastewater. Principles of wastewater treatment process design, operation and economics. Unit operations. Biological treatment systems and oxidation kinetics. Advanced wastewater treatment and reuse. Sludge treatment processes, including public health engineering, wastewater disposal systems, and wastewater contamination indicators. Topics include wastewater quality parameters; unit operations in treatment of wastewater. Experimental and practical projects are given to the students in the above topics. Waste water treatment Plant design: case study. Use of renewable energy in water and waste water treatment.

ERE752 Water, Energy, and Environment Management, 3 Crs.

This course addresses major topics such as water quantity, water quality, , and energy. It also addresses topics related to Middle East water/energyresources situation and management. Socioeconomic factors. Recycling and conservation of water. Aquifers and its over-pumping. Discharge of human and industrial wastewater. National and international institutions. Militarization of water. Politics and research as part of the solution. Integrated water resource management. Principles and practice of water resources planning and management. Protocols employed at local, state, regional and international levels. Plan formulation, evaluation, and implementation. Stakeholder

involvement in planning processes. Analytical tools. Case studies with emphasis on the MENA region.

ERE761 Air Pollution Control, 3Crs.

Air pollution control law and regulations .Air pollution measurement, Emission estimates. Meteorology for air pollution control engineers. Air pollution concentration models. Designing air pollution control systems and equipment. Combustion and control systems (Particulate pollutants, primary particulates, VOCs, SOx and NOx). Air pollutants and global climate.

ERE771 Environmental and Energy Laws and Policies, 3 Crs.

An introduction into the environmental and energy justice system. An Introduction to environmental and energy values and policies.Economics and the environment. Overview of the structure of the environmental laws. Regulatory legislation, and the regulatory process. Air pollution problems and control. Contemporary climate litigation.Water pollution control. Statutory Authorities. Regulation from point sources. Effluent limitations. Water quality based controls.Environmental impact assessment. Environmental enforcement. Citizens law suits. Global climate change. Environmental and climate justice.

ERE 791 Special Topics in Renewable Energy Systems, 3Crs.

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

ERE 792 Special Topics in Environmental Systems, 3 Crs.

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

ERE 781 Seminar, 1Cr.

This seminar is to work on issues related the environment directly or by using renewable energy engineering solutions.

ERE799AMaster Thesis , 9 Crs.

ERE 799B Master Thesis, 6 Crs.

ERE 799C Master Thesis 3 Crs.

ERE 799D Master Thesis 0 Crs.

This course involves extensive research in environmental and renewable energy engineering and climate change. The Master's Thesis is based on field research and demonstrates student's background knowledge. A defense will be set to evaluate student's capabilities of carrying out research, with a focus on the analysis and interpretation of skills gained. Further elective courses in the above fields will be added as deemed by the School of Natural Resources Engineering and Management.*Wherever the word Lab appears in the courses headings we mean by that the projects carried out by the students in each course and evaluated by the instructor with a one credit weight.