COURSES DESCRIPTIONS

The following section gives a brief description of the contents of core Renewable Energy Engineering courses.

REE 201 - Introduction to Renewable Energy Engineering (3-3-0)

Introduction to Renewable Energy Engineering including survey of conventional energy resources; oil, gas, coal, and renewable energy resources; thermal solar energy, Principals of photo-voltage PV solar cells, wind mills, hydropower, tidal, wave, geothermal, hydrogen & bio-fuels, and nuclear. Conservation of energy, energy resources, energy efficiency, energy production, introduction to energy power plants.

Prerequisite: PHYS 102

REE 202 – Engineering Workshop (2-0-6)

Engineering workshop course introduces an engineering workshop, theory and practices, principal machine techniques, safety precautions and standard steps during urgent and hazards situations, basic hand tools and equipment, Electronic Components, PCB Layout, Lathing, Milling, Drilling, Welding, Casting, Sheet metal forming. The course includes skills planning, designing, and construction of mechanical and electronic equipment.

Prerequisite: NA

REE 203 – Applied Thermodynamics (3-3-0)

Basic concepts of applied thermodynamics: temperature, work, heat, internal energy and enthalpy. First law of thermodynamics for closed and steady-flow open systems. Thermodynamic properties of pure substances; changes of phase; equation of state. Second law of thermodynamics: concept of entropy. Power and refrigeration cycles.

Prerequisite: MATH 102, PHYS 102

REE 204 – Engineering Statics and Dynamics (3-3-0)

Engineering Statics and Dynamics course includes the following topics: Introduction to principles of statics and free body diagrams, forces and moment analysis; Introduction to dynamics: kinematics of rectilinear and curvilinear motion of particles, kinematics of rotation and plane motion of rigid bodies, dynamics of particles and systems of particles, work and energy relations, impulse and momentum principles, dynamics of rigid bodies in plane motion.

Prerequisite: MATH 102, PHYS 102

REE 205 - 3D-CAD and Modelling (1-1-0)

3D-CAD and Modelling course introduces the basics of engineering drawing and 3D-CAD; Topics include: Graphical interpretation of orthographic projection to include auxiliary views, section views, dimensioning, translation of design instructions into detail and assembly drawings, drawing conventions including weldments, piping, referencing and surface finish notation, election of tolerances based on design requirements.

Prerequisite: NA , **Co-requisite:** REE 2051

REE 2051 - 3D-CAD and Modelling Lab (1-0-4)

3D-CAD and Modelling Lab enables students to use an up to date version of 3D-CAD (SOLIDWORKS) to construct orthographic drawings during this course. Students will construct 3D-Parts, 3D-Assemblies and 2D-Drawings in addition to 3D-Motion study and simulation including stress analysis and life cycle assessment (LCA) of parts in order to introduce sustainable 3D-Design. Computer laboratory equipped with up to date software's are essential.

Prerequisite: NA , **Co-requisite:** REE 205

REE 301 - Power Electronics for REE (3-3-0)

Characteristics of power electronic (PE) semiconductor devices. Ideal and practical switches. Switching characteristics of devices. Power switch losses. Diode, thyristor, triac and power transistor. Firing angle control. High power devices. Power electronic converters in renewable energy applications: AC-DC Rectifiers and controlled rectifiers; DC-DC choppers: buck, boost, buck-boost; AC -AC cycloconverters; DC-AC inverters. PWM control, SVM control. Power quality issues. UPS and SMPS power supplies. DC adjustable speed drive systems. AC adjustable speed motor/drive combinations. Multilevel converters and applications.

Prerequisite: EE 205 **Co-requisite:** REE 3011

REE 3011 - Power Electronics for REE Lab (1-0-3)

Operation, simulation and design of the standard switching power converter: diode, thyristor, triac and power transistor, are used in power applications as switching devices. Application of high power converters in rectification, inversion, frequency conversion, DC and AC machine control, switch-mode power supplies, PV systems, wind energy conversion systems, storage systems and other renewable energy engineering applications. Design of the standard switching power supply topologies such as the rectifiers, inverters, buck, boost, buck-boost, and Cuk switch mode converters. PWM algorithms.

Co-requisite: REE 301

REE 302 - Power Systems Analysis (3-3-0)

Basic principles, Per-unit system, Power generation, Transmission and subtransmission, Distribution, Loads, Power factor correction, Balanced three-phase power, Generator and transformer models, line model, Power flow analysis, Power dispatch problem, Transient stability, Dynamic stability, Symmetrical components and unbalanced faults, Load frequency control, Automatic generation control, Reactive power and generation control, Power system stabilizer (PSS) design.

Prerequisite: EE 205 **Co-requisite:** REE 3021

REE 3021 - Power Systems Analysis Lab (1-0-3)

Per-unit system conversion, Parameters of a transmission lines, Formation of Y-bus using singular transformation method with and without mutual coupling, Power angle curve for synchronous machine, Formation of Jacobian matrix, Load flow studies for a given power system using software package, Fault studies for a given power system using software package, Optimal generator scheduling for thermal power plants using software Package, Critical clearing time, Design of PSS regulators using pole placement method.

Co-requisite: REE 302

REE 303 – Measurement and Instrumentation (3-3-0)

Introduction to instrumentation and control of renewable energy systems, Principles of measurements; Static characteristics, accuracy, precision, repeatability, reproducibility, resolution, sensitivity, linearity, drift, span, range, dynamic characteristics, transfer function, zero order instruments, first order instruments, step and ramp response of first order instruments, frequency response of first order instruments, second order instruments, step ramp response of second order instruments, dead time; Elements, errors types of errors, cross errors, systematic errors, random errors; Basic electronics and display instruments; Transducers, sensors, and actuators; Measuring instruments/devices for temperature, pressure, velocity, speed, flow, torque and solar flux, current, voltage and power factor; Industrial instrumentation; Environmental pollution monitoring devices, Metrological stations.

Prerequisite: EE 205 and REE 203 **Co-requisite:** REE 3031

REE 3031 – Measurement and Instrumentation Lab (1-0-3)

Introduction to laboratory instrumentation. Computerized data acquisition. Statistical analysis of data. Time series data and spectral analysis. Transducers for measurement of solid, fluid and dynamical quantities. Design of experiments. Basic instrumentation and measurements in conducting the experiments for electrical and mechanical measurements. Developing experimental system and experimental strategy.

Co-requisite: REE 303

REE 304 - Solar PV **(3-3-0)**

PV including the solar irradiation and the sunlight properties, semiconductors physics, PN junctions, PV principle of operation, PV materials, PV design, PV efficiency, limitations of PV cells, PV panel design aspects, techniques for testing PV systems and components, illustrations of solar PV systems, PV integration with electric grids, 3-hours in Lab including basics and characterization, measuring the effects of temperature, dust and light shading on the performance of the solar PV systems.

Prerequisite: REE 201, REE 301 **Co-requisite:** REE 3041

REE 3041 - Solar PV Lab **(1-0-3)**

This course covers the various aspects of solar photovoltaic systems including measurement of solar irradiance, solar photovoltaic modules, recent MPPT techniques, latest literature of converter design, energy storage for PV applications, balance of systems, grid integration of PV systems, PV system protection, economics of grid connected PV system and system yield performance using PV system.

Co-requisite: REE 304

REE 305 - Wind Energy Technology **(3-3-0)**

Wind Energy Systems including wind energy and wind power design and principles, operation of wind energy systems, economic analysis of wind energy system, site selection and limitations, wind conditions data monitoring and analysis, calculations of electrical power capacity from windmills, integration of windmills electricity with electrical network.

Prerequisite: ME 311, REE 302 **Co-requisite:** REE 3051

REE 3051 - Wind Energy Technology Lab **(1-0-3)**

Lab consists of 3 hours of practical applications about aerodynamics, dynamic behavior, electro-technical interrelations and loads on the wind turbine and related generator measurements and calculations. Students asked to perform measurements and data analysis concerning the power curve on a laboratory small wind turbine. Written report at the end of the semester is provided and evaluated by the Lab instructor.

Co-requisite: REE 305

REE 306 – Heat and Mass Transfer **(3-3-0)**

Heat and Mass Transfer including an introductory treatment of the governing laws for heat and mass transfer, covering topics of steady state and transient conduction, fundamentals and engineering treatment of convection heat transfer, heat transfer with phase change (boiling/condensation), radiation heat transfer and heat exchangers, fundamentals of mass transfer, differential equations of mass transfer, steady state and unsteady-state molecular diffusion, convective mass transfer, interface mass transfer, mass transfer

theories, mass transfer equipment, Absorption and humidification operations, both analytical and numerical solution methods are presented.

Prerequisite: ME 311 **Co-requisite:** REE 307

REE 307 – Heat and Fluid Laboratory (1-0-3)

Heat and Fluid Laboratory course covers the experimental applications related to both fluid mechanics and heat transfer courses. The main focus will be in the basic experiments related to heat transfer and fluid mechanics. The performed Tests will concentrate on the topics related to renewable energy applications such as heat exchangers, losses in pipe flow, pumps and turbines performance.

Co-requisite: REE 306

REE 350 - Summer Practical Training (0-0-0)

Summer Training including 8 working weeks in summer of real practical field training to increase students skills and offering a real career opportunities for both students in the field of sustainable and renewable energy engineering and industries, students are required to submit a technical report to the training supervisor and should fullfill the requirements of presentation and discussions by academic SEE committee.

Prerequisite: ENGL 214 and a completion of 97 CRT

REE 401 - Solar Thermal Energy (3-3-0)

Solar Thermal Energy including characteristics of solar radiation and solar collectors, collector performance, long-term operation behaviour, solar thermal system modelling, thermal storage process, concentrators and solar power systems, using PCM and nano- fluids to enhance solar thermal performance, 3D computer aided design and simulation.

Prerequisite: REE 304, REE 306

REE 402 - Energy Efficiency (3-3-0)

Energy Efficiency including analysis of energy systems efficiency, material targets core areas of efficiency in space heating and cooling design, detail design analysis of combustion engines and space heating and cooling processes, computer aided simulation of energy consumption and energy efficiency.

Prerequisite: REE 303, REE 305

REE 403 - Economics of Energy Applications (3-3-0)

Economics of Energy Systems including a fundamentals of the engineering economics then discussed the economics of energy statistics, demand for sustainable and conventional energy, supply of electricity produced by both sustainable and conventional energy techniques, exploration, production, transportation, processing and marketing of sustainable and renewable energy, energy tariff challenges, introduction to energy- economics of the environment.

Prerequisite: MATH 335

REE 404 – Energy generation and control equipment (3-3-0)

Basic principle of electricity generation. Development of generator design. Power transformers. Various motors used in power stations. Three phase induction generators, Doubly-fed induction generator (DFIG) and synchronous generators. Wind energy conversion system components. Wind turbine generators including asynchronous induction generators, power electronics, filters, transformers. Photovoltaic energy conversion system components. Maximum power point tracking (MPPT). Storage. Connection to the electric grid and maintenance. Synchronization. Single phase and three phase AC voltage regulators. Control systems. Phase controlled line commuted converters. Filters, Inductor filter and Capacitor filter. AC commutators machines. Load regulation.

Prerequisite: REE 301, REE 403

REE 405 - Energy Conversion and Storage Applications (3-3-0)

Energy Conversion and Storage Applications including examination of the principles and energy storage characteristics of electric energy storage techniques including batteries, electric-double layer capacitors and pseudo-capacitors, thermal energy storage techniques including PCM energy storage, and mechanical energy storage techniques including compressed air, flywheels, hydroelectric storage.

Prerequisite: REE 303, REE 305 **Co-requisite:** REE 4051

REE 4051 - Energy Conversion and Storage Applications Lab (1-0-3)

This laboratory course compliments the lecture course REE 405. It examines the fundamental physics and chemistry of selected energy conversion and energy storage devices and their use and interconnects strategies in electric power applications. This laboratory course provides hands-on experiences with the topics of 405.

Co-requisite: REE 405

REE 440 - Senior Design Project I (1-1-0)

Senior Design Project I course including an integration of various selective components of the renewable energy engineering curriculum. A comprehensive discussion of topics related to the senior design project issues is devoted by lecture, such as a project topic selection related to real field, format, writing and organization of the progress reports and final comprehensive report, presentation, teamwork, engineering experience and knowledge should be devoted in all project activities. Students divided into groups at the end of the semester, each group should provide a project topic proposal, presentation and final report. The project should be a comprehensive evaluation and/or case study providing analysis of a real REE issue.

Prerequisite: REE 350

REE 441 - Senior Design Project II (2-0-6)

Senior Design Project II course including an integration of a various selective components related to REE curriculum. Students should apply the basic knowledge related to their project topic such as physics, mathematics, writing skills, 3D-CAD, materials sciences and all engineering sciences studied in the entire REE program. A complete and comprehensive project based on the first stage of senior design project I experience should be fulfilled taking into considerations a real field issues related to coop summer training and/or industrial field of the renewable energy engineering. Student should provide a complete designed project including a presentation and progress reports and final report taking into consideration reliability, ethics, social impact, safety and economics of the proposed project. The topic of the project should cover a real issue related to REE providing suitable and applicable solutions.

Prerequisite: REE 440

REE 411 – Network Engineering and Management (3-3-0)

Network Engineering and Management including technologies for integrating renewable energy sources (RES) to the grid-modelling, analysing power network-data acquisition, control and associated software in the context of power electronic converters-sensors, data acquisition systems and control equipment.

Prerequisite: REE 302, REE 403

REE 412 - Electronic Devices (3-3-0)

Advanced topics of Electrical and Electronic materials and devices including an advanced electromagnetism and inductance, AC power circuit, circuits, resonant circuits, circuit theorems, Thevenin's, superposition, amplifiers, op-amp theory, boolean logic and logic gates, combination logic.

Prerequisite: REE 301

REE 413 - Advanced Solar Cells (3-3-0)

Advanced Solar Cells and Systems including novel solar cells technologies, in detailed solar cells modules operation principles an physics, measurement techniques and performance analysis of the solar cells. Including also the systems of tandem solar cells, concentrator (CPV and HCPV) and hybrid solar PV (3-generations).

Prerequisite: REE 304

REE 414 - PV Design and Manufacturing (3-3-0)

PV Design and Manufacturing including, solar cells operations, different trends in commercial cell technology, manufacturing processes, performance and product reliability depending on different solar cells parameters and processing, silicon-based and third generation solar cells complete production processes, heterojunction solar cells, suitability of materials, manufacturing technology and application.

Prerequisite: REE 304

REE 415 - PV for Buildings (3-3-0)

PV for Buildings course including PV systems in the buildings, integration of PV modules into the building. efficient buildings, building directions and its effect on and solar accessibility, building energy simulation software. PV in buildings and related challenges, Advanced topics related to efficient and smart buildings with PV systems.

Prerequisite: REE 304

REE 416 - Passive Solar Buildings (3-3-0)

Passive solar buildings course including the solar energy and passively heating and/or cooling of the buildings, solar radiations, zero building energy efficient design, passive solar heating, thermal mass, and passive cooling.

Prerequisite: REE 401, REE 402

REE 417 - Wind Turbines: Design and operation (3-3-0)

Wind Turbines: Design and operation including complications of production of electricity from wind power, wind turbines locations and atmospheric science, analysis of experimental data, design and control analysis of wind turbine components, wind turbines sizing and citing analysis, adaptation of wind turbines with smart grids.

Prerequisite: REE 305

REE 418 - Advanced Fluid Mechanics (3-3-0)

Advanced Fluid Mechanics including control volume analysis, dimensional analysis and similitude, compressible flow, flow in ducts, fluid flow in pipelines, effects of viscous flow and heat transfer, waves and shocks, viscous fluid flow: hydrodynamic lubrication and boundary layers, elasto-hydro dynamics theory and Reynolds equation.

Prerequisite: ME 311

REE 419 - Wind Turbines and Related Equipment (3-3-0)

Wind Turbine and related equipment including, design of Wind Turbines components includes wind turbines structure and frame, generator, and atmospheric science, analysis of experimental data, design and control analysis of wind turbine components, wind turbines sizing and citing analysis, adaptation of wind turbines with smart grids.

Prerequisite: REE 305

REE 420 – Engineering of Biomass and Energy Systems (3-3-0)

Biomass Energy Systems including biomass characterization techniques and range of biomass energy sources (forestry, wastes and crops), biochemical and thermochemical conversion processes (direct combustion, biomass co-firing, gasification, pyrolysis, anaerobic digestion, fermentation, landfill gas and cogeneration), chemical reactors and basic process design, biofuels from biomass (biodiesel, syngas, biogas).

Prerequisite: REE 402

REE 421 – Hydrogen and Fuel (3-3-0)

Hydrogen and Fuel Cells including thermodynamics of fuel cells, chemical reaction engineering, electrochemical engineering, studding various types of major fuel cells including polymer electrolyte membrane fuel cell (PEMFC), direct methanol fuel cell (DMFC), alkaline fuel cell (AFC), Urea Fuel Cells (UFC), molten carbonate fuel cell (MCFC), solid oxide fuel cell (SOFC), metal air fuel cell (MAFC), and microbial fuel cell (MFC), electrodes and membrane materials.

Prerequisite: REE 306

REE 422 - Hydroelectric Power Engineering (3-3-0)

Hydroelectric Power Engineering including advanced topics on hydro-power production, hydrology, power, head, flow-rate, turbines hydrodynamics; Francis, Kaplan, Pelton, cross-flow. System components; generators, governors, penstocks, spillways, valves, gates, trash racks. Large-scale and. Pumped storage.

Prerequisite: REE 402

REE 423 - Geothermal Energy Engineering (3-3-0)

Geothermal Energy Engineering including an introduction and exploration of heat mapping of geothermal, characteristics of the geothermal reservoir, analysis of temperature and heat transfer in a borehole (dry steam, flash steam and binary cycle power plants), test analysis of the geothermal well for electricity generation, heat pumps of the ground source, heating and cooling, economical assessment of geothermal projects.

Prerequisite: REE 306

REE 424 – Electromagnetic Field Analysis (3-3-0)

Electromagnetic Field Analysis course including an introduction to electromagnetic fields, electrical potential, magnetic materials, magnetic inductance, time varying fields and Maxwell's equations, plane wave propagation, reflection and refraction, fiberoptics and transmission lines.

Prerequisite: REE 301

REE 425 - Electric Power Distribution (3-3-0)

Electric power distribution system course including planning, design and operations, load characterisation and distribution transformers, design of local transmission lines, design considerations of the primary and secondary feeders, voltage regulation for distribution system, protection, reliability and smart grid performance.

Prerequisite: REE 402

REE 426 - Applied Control Engineering (3-3-0)

Applied Control Engineering course including analysis of a control systems, computer- based controller for continuous and discrete-time industrial process, parametric model identification, digital control design, z-transformation, digitizing analog controllers, PID and PLC controllers, and computer-based simulations.

Prerequisite: REE 302

REE 427 – Optoelectronics Devices (3-3-0)

Optoelectronics course including the principles, interaction of light with semiconductor materials in a p-n junction, including absorption phenomena, electroluminescence, and stimulated emission, direct and indirect compound semiconductors, basic devices, photodiodes, LEDs, semiconductor optical amplifiers, laser diodes, array detectors, CMOS, CCD, LEDs arrays, solar cells, imaging with array detectors and LED displays.

Prerequisite: REE 304

REE 428 - Microcontroller and Embedded Systems (3-3-0)

Microcontroller and Embedded Systems course including an introduction to microcontrollers and interfacing, operation, applications, organization, analysis of specific processors, software and hardware interface systems, different embedded systems.

Prerequisite: REE 302

REE 429 - Special Topics in Solar Energy (3-3-0)

This course covers emerging and advanced topics in the field of solar energy. The contents will vary depending on the topic.

Prerequisite: REE 304, REE 401

REE 430 - Special Topics in Wind Energy (3-3-0)

This course covers emerging and advanced topics in the field of wind energy. The contents will vary depending on the topic.

Prerequisite: REE 305, REE 402

REE 431 - Special Topics in Bio-energy (3-3-0)

This course covers emerging and advanced topics in the field of bio-energy. The contents will vary depending on the topic.

Prerequisite: REE 306, REE 402

REE 432 - Special Topics in Energy Systems (3-3-0)

This course covers emerging and advanced topics in the field of energy systems. The contents will vary depending on the topic.

Prerequisite: REE 302, REE 402