Bachelor Degree in Renewable Energy Engineering

1. University Graduation Requirements

To receive a bachelor's degree in Renewable Energy Engineering, a student must fulfill all requirements related to credit hours, grade point average, program of study, and courses.

2. Degree Requirements

Type of Requirement	Credit Hours
University Requirements	37
College Requirements	40
Specialization Requirements	70
Specialization Electives	12
Total	**159**

3. University Requirements

➢ University Requirements: 37 credit hours distributed as follows:

Course ID	Course Title	Credit Hours	Prerequisite
ENG 100	General English	3	
MATH 110	Mathematics I	3	
MATH 120	Mathematics II	3	MATH 110
IT 100	Information Technology	3	
ARAB 101	Basic Academic Arabic	3	
ARAB 201	Advanced Academic Arabic	3	ARAB 101
ENGL 101	Basic Academic English I	3	ENGL 100
ENGL 102	Basic Academic English II	3	ENGL 101
SOCS 101	Islamic Civilization I	3	
ENGL 203	Advanced Academic English I	3	ENGL 102
ENGL 206	Technical Writing	3	ENGL 102
PHE 101	Physical and Health Education	1	
	Free elective	3	
Total		**37**	

➢ A Free Elective Course: 3 credit hours from the following list:

Course Number	Course Title	Credit Hours	Prerequisite
FREN 101	Basic French I	3	
CIT 101	Future Technologies	3	
SOCS 201	Islamic Civilization II	3	SOCS 101
SOCS 203	History of the Kingdome of Saudi Arabia	3	
ASTR 150	Introduction to Astronomy	3	
CHEM 150	Chemistry & Society	3	

SOCS 202	World Civilization	3	

4. College Requirements

➢ College Requirements (40 credit hours):

Course ID	Course Title	Credits	Pre-/Co-requisites
MATH 101	Calculus I	3	MATH 120
CSC 101	Introduction to Computing for engineers	3	IT 100
CHEM 101	General Chemistry I	3	
CHEM 101L	General Chemistry Lab	1	CHEM 101
PHYS 101	General Physics I	3	
PHYS 102	General Physics II	3	PHYS 101
PHYS 103L	General Physics Lab	1	PHYS 102 (co)
CIVE 205	Engineering Drawing	1	CSC 101
ELEE 230	Programming for Engineers	3	CSC 101
MATH 102	Calculus II	3	MATH 101
MATH 201	Calculus and Analytic Geometry III	3	MATH 102
MATH 202	Differential equations	3	MATH 102
MATH 215	Linear algebra and Numerical Techniques	3	MATH 202
STAT 230	Probability and Statistics	3	MATH 102
COEN 300	Engineering Economy	3	STAT 230
COEN 401	Communication Skills and Ethics	1	ENGL 203
Total		**40**	

5. Program Specialization Requirements

Program specialization requirements consist of **82** credit hours (**70** compulsory credit hours and **12** elective credit hours) distributed as follows:

➢ Compulsory Specialization Requirements (70 credit hours):

Course ID	Course Title	Credits	Pre-/Co-requisites
MECH 225	Engineering Mechanics	3	PHYS 101
MECH 230	Engineering Materials	3	CHEM 101
MECH 342	Heat Transfer	3	REE 260
ELEE 212	Circuits for non-Electrical Students	3	PHYS 102
ELEE 242	Electronics for non-Electrical Students	3	ELEE 212
ELEE 350	Signals and Systems	3	MATH 202, ELEE 212
ELEE 360	Electric Machines	3	ELEE 212
ELEE 380	Linear Control Systems	3	ELEE 350
ELEE 480L	Control Lab	1	ELEE380
ELEE 245L	Circuit and Electronics Lab	1	ELEE 242
REE 260	Fluid and Thermal Sciences	3	MATH 202, PHYS 101, CHEM 101
REE 310	Fundamental of Power Electronics	3	ELEE 242
REE 320	Fundamental of Renewable Energy	3	PHYS 102

Course ID	Course Title	Credits	Pre-/Co-requisites
REE 320L	Renewable Energy Lab	1	REE 320 (Co.)
REE 340	Fundamental of Power Systems	3	ELEE 360
REE 350	Solar Thermal Energy Design	3	REE 320, MECH 342
REE 400	Summer internship training	1	*Last Summer*
REE 420	Renewable Engineering I: Applied Photovoltaic	3	REE 320, ELEE 242
REE 460	Renewable Engineering II: Wind Energy	3	REE 320, REE 260
REE 420L	Photovoltaic Lab	1	REE 420
REE 460L	Wind Energy Lab	1	REE 460
REE 470	Renewable Engineering III: Other renewable energies.	3	REE 320, MECH 342
REE 474	Nuclear Energy	3	REE 320
REE 480	Power systems protection		REE 340
REE 487	Hydrogen Technologies and Fuel Cells	3	REE 470
REE 466	Energy Economics and Managements	3	4th year standing
REE 498	Final Year Project I	1	REE 320, 100 credits
REE 499	Final Year Project II	3	REE 498
Total		**67**	

➢ Elective Specialization Requirements (12 credit hrs. from the following):

Course ID	Course Title	Credits	Pre-/Co-requisites
REE 465	Smart City Applications	3	REE 320, REE 340
REE 471	Renewable Energy Policy and International Programs	3	REE 320
REE 472	Energy and Environment	3	REE 320
REE 475	Nuclear Reaction	3	REE 320
REE 476	Principles of Green Building Design	3	REE 320
REE 477	Photovoltaic Energy System Design	3	REE 420
REE 478	Biomass	3	REE 320
REE 479	Wind Energy Converters	3	REE 460
REE 481	Sustainable Energy Developing Countries	3	REE 320
REE 482	Energy Efficiency	3	REE 320, MECH 342
REE 483	Advanced Photovoltaic Manufacturing	3	REE 420
REE 485	Operational Research	3	REE 260
REE 486	Low Energy Buildings and PV	3	REE 320
REE 473	Life Cycle Assessment	3	REE 320
REE 480	Special Topics in Renewable Energy	3	REE 320

Proposed Sequence of Study

Year I

➢ ***First Semester*** ***18 Credit hours***

Course	Title	Credits	Pre-requisites
ENG 100	General English	3	
IT 100	Information Technology	3	
MATH 110	Mathematics I	3	
ARAB 101	Basic Academic Arabic	3	
SOCS 101	Islamic Civilization I	3	
PHYS 101	General Physics I	3	
Total		**18**	

➢ ***Second Semester*** ***19 Credit hours***

Course	Title	Credits	Pre-requisites
ENGL 101	Basic Academic English I	3	ENG 100
MATH 120	Mathematics II	3	MATH 110
CSC 101	Introduction to Computing for Engineers	3	IT 100
PHYS 102	General Physics II	3	PHYS 101
ARAB 201	Advanced Academic Arabic	3	ARAB 101
PHE 101	Physical and Health Education	1	
CHEM 101	General Chemistry I	3	
Total		**19**	

Year II

➢ ***Third Semester*** ***14 Credit hours***

Course	Title	Credits	Pre-requisites
ENGL 102	Basic Academic English II	3	ENGL 101
MATH 101	Calculus I	3	MATH 120
PHYS 103L	General Physics Lab	1	PHYS 102
CHEM 101L	General Chemistry Lab	1	CHEM 101
MECH 230	Engineering Materials	3	CHEM 101
ELEE 212	Circuits for non-Electrical Students	3	PHYS 102
Total		**14**	

➢ ***Fourth Semester*** ***16 Credit hours***

Course	Title	Credits	Pre-requisites
ENGL 203	Advanced Academic English I	3	ENGL 102
MATH 102	Calculus II	3	MATH 101
ELEE 230	Programming for Engineers	3	CSC 101
ELEE 242	Electronics for non-Electrical Students	3	ELEE 212
CIVE 205	Engineering Drawing	1	CSC 101
MECH 225	Engineering Mechanics	3	PHYS 101
Total		**16**	

Year III

➢ ***Fifth Semester*** ***19 Credit hours***

Course	Title	Credits	Pre-requisites
ENGL 206	Technical Writing	3	ENGL 102
STAT 230	Probability and Statistics	3	MATH 102
MATH 201	Calculus and Analytic Geometry III	3	MATH 102
MATH 202	Differential equations	3	MATH 102
ELEE 245L	Circuits and Electronics Lab.	1	ELEE 242
REE 320	Fundamentals of Renewable Energy	3	PHYS 102
REE 260	Fluid and Thermal Sciences	3	PHYS 101, CHEM 101 Co- MATH 202
Total		**19**	

➢ ***Sixth Semester*** ***16 Credit hours***

Course	Title	Credits	Pre-requisites
MATH 215	Linear algebra and Numerical Techniques	3	MATH 202
MECH 342	Heat Transfer	3	REE 260
ELEE 350	Signals and Systems	3	MATH 202, ELEE 212
ELEE 360	Electric Machines	3	ELEE 212
REE 320 L	Renewable Energy Lab	1	REE 320
COEN 300	Engineering Economy	3	STAT 230
Total		**16**	

Year IV

➢ ***Seventh Semester*** ***15 Credit hours***

Course	Title	Credits	Pre-requisites
REE 340	Fundamental of Power Systems	3	ELEE 360
REE 350	Solar Thermal Energy Design	3	REE 320, MECH 342
REE 310	Fundamentals of Power Electronics	3	ELEE 242
ELEE 380	Linear Control Systems	3	ELEE 350
REE 420	Renewable Engineering I: Applied Photovoltaic	3	REE 320, ELEE 242
		15	

➢ ***Eighth Semester*** ***15 Credit hours***

Course	Title	Credits	Pre-requisites
REE 460	Renewable Engineering II: Wind Energy	3	REE 320, REE 260
REE 420L	Photovoltaic Lab.	1	REE 420
	Free Elective	3	
ELEE 480L	Control Lab	1	ELEE 380
REE 480	Power systems protection	3	REE 340
REE 470	Renewable Engineering III: other renewable Energies	3	REE 320, MECH 342
COEN 401	Engineering Ethics	1	ENGL 203
		15	

➢ ***Summer Semester 1 Credit hours***

Course	Title	Credits	Pre-requisites
REE 400	Summer Internship	1	Last summer in study
Total		**1**	

Year V

➢ ***Ninth Semester 14 Credit hours***

Course	Title	Credits	Pre-requisites
REE 460L	Wind Energy Lab.	1	REE 460
REE 487	Hydrogen Technologies and Fuel Cells	3	REE 470
	Specialization Elective	3	
	Specialization Elective	3	
REE 474	Nuclear Energy	3	REE 320
REE 498	Final Year Project I	1	REE 320, 100 credits
		14	

➢ ***Tenth Semester 12 Credit hours***

Course	Title	Credits	Pre-requisites
REE 466	Energy Economics and Managements	3	4th year standing
	Specialization Elective	3	
	Specialization Elective	3	
REE 499	Final Year Project II	3	REE 498
Total		**12**	

Course Description

1. Required Courses:

ELEE 212 Circuits for non-Electrical Students 3(3, 0, 0)
A course on fundamentals of electric circuits, basic elements and laws, Kirchhoff's current law (KCL), Kirchhoff's voltage law (KVL), techniques of circuit analysis: nodal and mesh analysis, superposition, source transformation, AC analysis, Thevenin and Norton equivalents; inductors and capacitors, A.C. Analysis, Phasor concept. ***Prerequisite: PHYS 102***

ELEE 242 Electronics for non-Electrical Students 3(3, 0, 0)
A course on electronics; PN junctions, diodes and its applications, Bipolar junction transistors (BJT), BJT amplifiers, Small Signal Analysis of BJT amplifier, Field Effect Transistor (FET) with applications, and operational amplifiers (OP- AMPs) with applications.
Prerequisite: ELEE 212

ELEE 350 Signals and Systems 3(3, 0, 0)
Signals and systems: definition, properties, and analysis; the Fourier series; the Fourier transform and its applications; the Laplace transformation and its applications; analysis and design of analog filters, MATLAB for analog signal processing. ***Prerequisite: ELEE 212 MATH 202***

ELEE 360 Electric Machines 3(3, 0, 0)
A course on three-phase circuits and power calculations; magnetic circuits; single-phase and three-phase transformers; DC and AC machines under steady-state: construction, equivalent circuit, and testing and performance characteristics. ***Prerequisite: ELEE 212***

ELEE 380 Linear Control Systems 3(3, 0, 0)
A course that covers mathematical modeling (transfer functions, block diagrams, signal flow graph) of linear continuous single input/single output dynamical systems; Open-loop and Closed-loop systems analysis; First and second order systems, Systems Stability (Routh-Hurwitz criterion); Steady-state error analysis of unity-feedback control systems; Frequency response analysis (Bode plots, Nyquist, Root-locus method); Introduction to PID controllers. ***Prerequisite: ELEE 350***

ELEE 480LControl Lab 1(0, 0, 2)
A laboratory course that covers analysis of linear systems; second order systems; effects of poles and zeros on the transient response; effect of gain on response and stability; compensation implementation.
Prerequisite: ELEE 380.

MECH 225 Engineering Mechanics 3(3, 0, 0)
A course outlining vector mechanics of forces and moments; free-body diagrams; equilibrium of particles and rigid bodies in two and three dimensions; plane and space trusses. Kinematics of particles; Rectilinear and curvilinear motion in various coordinate systems, Kinetics of particles; Newton's second law, Central force motion. Axial loading, Material properties obtained from tensile tests, Stresses and strains due to axial loading. Thermal Stresses. ***Prerequisite: PHYS 101***

MECH 230 Engineering Materials 3(3, 0, 0)
The course introduces fundamental concepts in materials science as applied to engineering materials: crystalline structures; imperfections, dislocations, and strengthening, mechanisms; diffusion; phase diagrams and transformations. Ferrous and non-ferrous metal alloys, ceramics, and polymers. Structure-property relationships. Material selection case studies. ***Prerequisite: CHEM 101***

MECH 342 Heat Transfer 3(3, 0, 0)
A course investigating steady and transient heat conduction; extended surfaces; numerical simulations of conduction in one and two-dimensional problems; external and internal forced convection of laminar and turbulent flows; natural convection; heat exchanger principles; thermal radiation, view factors and radiation exchange between diffuse and gray surfaces as well as the use of computer packages in problem solving. ***Prerequisite: REE 260***

ELEE 245L Circuit and Electronics Lab 1(0, 0, 2)
A laboratory course that covers the use of laboratory instruments: passive electronic components; voltage-divider circuits; sources and Thevenins's theorem; RC lead-lag networks, series resonance, and transformers, diode characteristics, diode applications; rectifier circuits; clamping and clipping; BJT characteristics; op-amp application; summer, integrator, and differentiator circuits.
Prerequisite: ELEE 242

REE 260 Fluid and Thermal Sciences 3(3, 0, 0)
A course on the thermodynamic state and properties of a pure substance, system and control volume concepts, work and heat, the first law of thermodynamics, energy and mass conservation, entropy, the second law of thermodynamics; applications to closed setups and flow devices; simple vapor and gas cycles applications. fluid proprieties, hydrostatics, basic control volume approach, continuity equation, Bernoulli equation, Euler's equation, energy equation momentum principle and its applications, flow through orifice, pipe, major and minor losses in pipe**.** ***Prerequisite: MATH 202, PHYS 101, CHEM 101***

REE 310 Fundamental of Power Electronics 3(3, 0, 0)
A course on diodes; diode circuits and rectifiers; thyristors; controlled rectifiers; power transistors; DC choppers; pulse width modulated inverters; introduction to gate and base drive circuits; switching power supplies. ***Prerequisite: ELEE 242***

REE 320 Fundamental of Renewable Energy 3(3, 0, 0)
A course that covers several topics of renewable energy, energy units and energy carriers, Energy sources, renewable energy sources; wind, PV, solar thermal, resource assessment, electric drive options, batteries control problems, environmental aspects of electricity generation, and stand- alone and utility applications. ***Prerequisite: PHYS 102***

REE 320L Renewable Energy Lab 1(0, 0, 2)

Series and parallel connection of solar cells, Dependency of the power on the surface area of the solar cell and the angle of incidence of the light and its intensity, Partial shading of solar modules and dark characteristic curve for the solar cells. Absorptivity and reflectivity of different materials, focusing of light by a Fresnel lens, solar thermal collector with pump circulation and Parabolic trough collector with pump cycle. Energy balance and efficiency of a wind turbine, voltage in dependence upon the wind speed, voltage and power in dependence on the number of blades. U-I characteristic curve of the single NiMH, NiZn, LiFePo, Lead and Lithium battery modules. *Co-requisite: REE 320*

REE 340 Fundamental of Power Systems 3(3, 0, 0)
Basic concepts and modeling of generation, transmission, and distribution systems; load flow analysis; economic load dispatch problem; symmetrical and asymmetrical short circuit studies; simplified power system stability analysis; introduction to power system. ***Prerequisite: ELEE 360***

REE 350 Solar Thermal Energy Design 3(3, 0, 0)
Characteristics of solar radiation and solar collectors. Collector efficiency evaluation and prediction of long term performance. Design and operation of a simple solar thermal system. Energy balance and the net power of the solar collector. Influence of illuminance, angle of incidence and flow rate. Influence of various absorbing surfaces. System modelling, energy storage.***Prerequisite: REE 320,***

MECH 342

MECH 400 Summer Internship (1 Credit)
This is an eight to twelve-week professional training course in renewable energy engineering.
Prerequisite: Senior standing.

REE 420 Renewable Engineering I: Applied Photovoltaic 3(3, 0, 0)
This course will cover main factors to the operation, design and construction of solar cells and PV system design. Solar cell loss mechanisms, design features to improve efficiency of solar cells and modules. In addition, Application and design of PV systems. Remote Area PV Power Supply systems. Grid-Connected PV systems. ***Prerequisite: REE 320***

REE 460 Renewable Engineering II: Wind Energy 3(3, 0, 0)
An overview of energy sustainability and wind energy history. Wind resources characteristics. Fundamentals of physical wind, basic meteorology of wind, extraction of energy from wind. Basic introduction to wind energy and energy conversion systems. Various types of wind energy, conversation systems and aerodynamics; blade and tower structural loads, kinematics of blades and meteorology. Wind plant development, and environment and ecological impact of wind energy plants.
Prerequisite: REE 260, REE 320

REE 420L Photovoltaic Lab 1(0, 0, 2)
Demonstration of the use of solar energy for power generation. Behavior of solar module on different effects: illuminance, temperature and shading. Parameter testing of solar module: short circuit current, open circuit voltage, maximum output voltage and current. Calculating efficiency of solar module. Function of charge controller and invertor in standalone solar system. Maximum power point (MPP) tracking control. Grid feeding circuits. ***Prerequisite: REE 420***

REE 460L Wind Energy Lab 1(0, 0, 2)

Wind turbine speed and voltage output relation. No load voltage of wind turbine. Independent wind energy AC output system. Cut-away wind power generator. Loaded output of hybrid solar module and wind turbine. Function of charge controller and inverter. *Prerequisite: REE 460*

REE 470 Renewable Engineering III: Other Renewable Energies 3(2, 0, 2)
This course will cover other kinds of renewable energy in more details including biomass (conversions), geothermal, hydro, and hydrogen. Energy conservation methods. An embedded lab with several experiments is included in this course to expand student understanding of the renewable energy resources covered in the theory. ***Prerequisite: REE 320, MECH 342***

REE 466 Energy Economics and Managements 3(3, 0, 0)
Energy management principles; energy conversion; energy auditing; analysis; formulation of energy management options; economic evaluation, implementation & control; energy conservation techniques-conservation in energy intensive industries; steam generation, distribution systems, integrated resource planning; demand-side management; cogeneration; thermal insulation; energy storage; economic evaluation of conservation technologies; and analysis of typical applications.
Prerequisite: 4th year standing

REE 498 Final Year Project I (1 Credit)
A supervised project in groups of normally three students aimed at providing practical experience in some design aspects of renewable energy engineering. Students are expected to complete a literature survey, to critically analyze, and to acquire the necessary material needed for their intended end product. ***Prerequisite: Senior Standing, ENGL 206, 90 credit hours, REE 320.***

REE 499 Final Year Project II (3 Credits)
A course in which the student integrates his/her acquired knowledge to deliver the product researched and planned in REE 498. ***Prerequisite: REE 498.***

COEN 300 Engineering Economy 3(3, 0, 0)
A course that covers principles, basic concepts and methodology for making rational decisions in the design and implementation of real engineering projects; time value of money, depreciation, comparing alternatives, effect of taxes, inflation, capital financing and allocation, and decision under uncertainty.
Prerequisite: STAT 230.

COEN 401 Communication Skills and Ethics 1(1, 0, 0)
A course on engineering ethics covering responsibility in engineering; framing the moral problem; organizing principles of ethical theories; computers, individual morality, and social policy; honesty, integrity, and reliability; safety, risk, and liability in engineering; engineers as employees; engineers and the environment; international engineering professionalism; and future challenges.
Prerequisite: ENGL 203.

REE 487 Hydrogen Technologies and Fuel Cells 3(3, 0, 0)

This course will cover hydrogen production, storage, distribution, and use. Specific energy scenarios such as renewable hydrogen cycles will be explored focusing on transportation applications. Introduction to fuel cell technologies; Fuel cell components and systems; field flow plates, electrolytes, electrode materials, electrode catalysts, on-board reformers. Portable devices, utility-scale power production, transportation systems. The concept of hydrogen economy will be discussed in the context of global energy crisis

Prerequisite: REE 470

REE 474 Nuclear Energy 3(3, 0, 0)
Introduction to nuclear energy. Atomic and nuclear physics, the interaction of radiation and matter. Nuclear reactor operation, reactor components, nuclear cycles, neutron diffusion and moderation. Reactor shielding. Fuel reprocessing and waste disposal. Reactor licensing and safety. Economics and environmental concerns. ***Prerequisite: REE 320***

2. Elective Courses

REE 465 Smart City Applications 3(3, 0, 0)
This course will cover the main definitions, needs, challenges and disciplines in smart and sustainable cities. Introducing the historical development, present and future sustainability deficits of metropolitan areas. The course introduces criteria to measure sustainability, and political guiding principles and action plans formulated in order to achieve smart sustainable cities.
Prerequisite: REE 320, REE 340

REE 471 Renewable Energy Policy and International Programs 3(3, 0, 0)
This course will review objectives and strategies of renewable energy policy, focusing on sustainable energy transitions, and the integration of renewable energy into electricity markets. Policy drivers, policy processes and relevant aspects of energy market structure and regulation. Selection and design of policy instruments, including regulation, taxation, tariffs, targets, incentives and market-based schemes will be explored. Specific policy and regulatory approaches, the views of different stakeholders and interaction with the broader policy regulatory environment will be examined for specific policy case studies. ***Prerequisite: REE 320***

REE 472 Energy and Environment 3(3, 0, 0)
Energy System and Environment; conventional and renewable energy sources. The Impact of RE in

reducing CO2 emissions. Pollution growth and its sequences; Air, Water, soil, thermal, noise pollution – cause and effect; Causes of climate change in the global, the regional and the local regions.
Prerequisite: REE 320

REE 475 Nuclear Reaction 3(3, 0, 0)
Energetic and kinetics of nuclear reactions and radioactive decay, fission, fusion, and reactions of low-energy neutrons; properties of the fission products and the actinides; nuclear models and transition probabilities; interaction of radiation with matters. ***Prerequisite: REE 320***

REE 476 Principles of Green Building Design 3(3, 0, 0)
This course will cover the principles of green building design and construction, including incorporating green principles in renovating and remodeling, and preservation of historic structures as well as new buildings. Energy efficiency, indoor environmental quality, and sustainable building materials. ***Prerequisite: REE 320***

REE 477 Photovoltaic Energy System Design 3(3, 0, 0)
This course will cover the basic principles of the planning, design, installation, and operation of photovoltaic (PV) systems. Examination of PV system components, planning and design of grid-connected and stand-alone PV systems, analysis of PV systems at the residential scale through utility scale, including engineering, economic, and policy considerations. ***Prerequisite: REE 420***

REE 478 Biomass 3(3, 0, 0)
This course will introduce a range of biomass energy sources, including forestry, wastes and crops, as well as various technologies for capturing the stored chemical energy in biomass: direct combustion, pyrolysis, anaerobic digestion, gasification, fermentation, landfill gas and cogeneration.
Prerequisite: REE 320

REE 479 Wind Energy Converters 3(3, 0, 0)
This course will cover the principles of wind energy, design and operation of different types of wind energy converters. Water pumping machines, remote power supply and grid electricity generation. Wind energy site selection, monitoring and analyzing data, estimating output from wind generators, integrating wind generators into hybrid power systems or the grid, economics, standards and environmental impacts. ***Prerequisite: REE 460***

REE 481 Sustainable Energy Developing Countries 1(0, 0, 2)
This course covers many of the technical and non-technical issues relating to introducing photovoltaics and renewable energy systems and technology in developing countries. The course will cover various Recommended Practice Guides developed by industry expert groups in the areas of financing and investment mechanisms, capacity building, implementation models and quality assurance. Considering practical components related to design, implementation and maintenance of photovoltaic and renewable energy systems in developing countries and case studies will be also considered herein.
Prerequisite: REE 320

REE 482 Energy Efficiency 3(3, 0, 0)
This course will cover current and predicted energy use and associated GHG emissions; residential and commercial passive solar design; energy management programs; building management systems; heating, ventilation and air conditioning; and consumer products and office equipment. Impacts of transport. Opportunities to reduce transport energy with efficient engines, public transport, and urban design. Industrial systems examined include heat recovery; cogeneration; compressed air and steam distribution; and motor systems, pumps and fans. Barriers to improved energy efficiency such as up-front cost, lack of information are also covered. ***Prerequisite: REE 320, MECH 342***

REE 483 Advanced Photovoltaic Manufacturing 3(3, 0, 0)
Solar cells operating. Manufacturing of silicon solar cells. Trends in commercial, manufacturing

process of environmental aspects of cell technology. Tools/methods used to improve solar cell performance and reduce solar cell cost in manufacturing, namely statistical decision making, cost modelling and regression modelling. Production processes for both screen-printed solar cells and buried contact solar cells. Quality control techniques used for PV manufacturing.

Prerequisite: REE 420

REE 485 Operational Research 3(3, 0, 0)

This course will cover the topics of linear programming, Graphical and Algebraic solutions, Simplex Method. Duality and Sensitivity analysis. Transportation and assignment problems. Network analysis. Queueing theory. ***Prerequisite: REE 260***

REE 486 Low Energy Buildings and PV 3(3, 0, 0)

Greenhouse gas production, climate-appropriate building design, implementing energy efficiency measures. Prediction of building thermal, lighting, and solar access. PV modules in greenhouse building envelope. Technical aspect of the use of PV in buildings and the urban environment, such as heat transfer processes, partial shading, and mismatch and system siting, sizing and configuration will be investigated. System performance assessment and prediction. ***Prerequisite: REE 320***

REE 473 Life Cycle Assessment 3(3, 0, 0)

This course will deal with life cycle analysis and its use for life cycle assessment of energy systems. Methodologies, boundary issues, data bases and applications will be studied. The uses of LCA will be illustrated with industrial case studies and with studies aimed at quantifying externalities associated with different electricity generation technologies.

Prerequisite: REE 320