Diploma in Renewable Energy Engineering

This course provides the necessary knowledge and skills required to assess, plan, select and design the renewable energy engineering.

It integrates renewable energy principles, electrical/ mechanical and civil engineering principles in renewable contexts.

The program will equip graduates with the knowledge and ability to design and apply a range of technologies in the renewable energy spectrum, with specialisation in either electrical and mechanical/civil engineering. These specialisations reflect the diverse opportunities within the industry, from the process of conversion and storage of energy to infrastructure and associated civil engineering activities. The program will provide educational and career pathways to students from multiple industry backgrounds across a range of different career aspirations.

Pre-requisites

- AGTI, BE Degree in any discipline
- B.Sc Degree
- B C Sc, B C Tech degrees

List of subjects

RE001- Foundation Studies in Renewable Energy and Sustainability

RE002- Grid Connected Photovoltaic Power Systems

RE003- Solar and Thermal Energy Systems

RE004- Energy Storage Systems

RE005- Renewable Energy Resource Analysis

RE006- Wind Energy Conversion Systems

RE007- Energy System Efficiency

Duration of the course

(A) Publics Seminar Mode

Part 1-

Day 1 Morning

RE001- Foundation Studies in Renewable Energy and Sustainability

Day 1 Afternoon

RE002- Grid Connected Photovoltaic Power Systems

Day 2 Morning

RE003- Solar and Thermal Energy Systems

Day 2 Afternoon

RE004- Energy Storage Systems

Part 2-

Day 3 Morning

RE005- Renewable Energy Resource Analysis

Day 3 Afternoon

RE006- Wind Energy Conversion Systems
RE007- Energy System Efficiency

The participants who attends the session will receive the Certificate of Attendances

(B) Formal Attendance Mode

One year

RE001- Foundation Studies in Renewable Energy and Sustainability

In this subject you will learn about the areas of renewable energy technologies and sustainability. On completing this subject you will be able to:

- investigate the factual basis behind climate change and its impact on Earth;
- utilise Engineering Principles to evaluate both non-renewable and renewable energy systems;
- analyse the principles and benefits of renewable energy technologies; and
- propose principles of sustainable living and how society can move to a sustainable post-carbon economy.

RE002- Grid Connected Photovoltaic Power Systems

In this subject you will learn the basics about photovoltaics and grid design. On completing this subject you will be able to:

- perform calculations relating to solar geometry and available solar energy;

□□design and cost a grid connected photovoltaic power system to suit a client's load requirement, location and budget, in accordance with workplace health and safety, Australian and industry standards; and

□□provide advice to clients on selection of a grid connect photovoltaic power system.

RE003- Solar and Thermal Energy Systems

In this subject you will learn about solar and thermal energy systems. On completing this subject you will be able to:

□□analyse relevant background issues in solar and waste heat based heating, cooling and mechanical power generation systems;

□□perform heating load calculations for domestic, commercial and industrial applications;

□□identify the solar/-thermal environment for any terrestrial location;

□□examine the various generic types of solar thermal collectors, together with limitations and typical applications of each type;

□□identify various methods of thermal energy storage, together with typical applications;

□□identify various methods of cooling and mechanical power generation using solar and/or waste heat, together with typical applications; and

□□perform calculations aimed at sizing components of heating, cooling and mechanical power generation systems powered from solar or waste heat.

RE004- Energy Storage Systems

In this subject you will learn about energy storage systems. On completing this subject you will be able to:

□□establish a rationale for energy storage technology in energy systems;

□□investigate the application of energy storage in renewable and non-renewable energy systems;

□□relate physical principles associated with energy storage systems;

□□perform calculations related to development of energy storage systems;

□□assess the environmental impacts and benefits of energy storage; and

□□design and cost a small-scale energy storage system to suit a given engineering requirement.

RE005- Renewable Energy Resource Analysis

In this subject you will learn about renewable energy resource analysis. On completing this subject you will be able to:

□□undertake calculations on energy generation and consumption, and relate findings to behavioural trends;

□□explain contemporary thermodynamic power cycles and relate scope of fossil fuel consumption;

□□investigate renewable energy initiatives and technologies, including solar, wind, hydro and biomass initiatives and technologies;

□□investigate regional approaches to using renewable energy sources, including geo-thermal and ocean energy; and

□□analyse and critique concepts related to the hydrogen economy, and explain physical and political constraints associated with its practical operation.

RE006- Wind Energy Conversion Systems

In this subject you will learn about wind energy conversion systems. On completing this subject you will be able to:

□□undertake various kinematic, power, wind and site related calculations;

□□use instruments, internet resources, site features to undertake wind energy calculations;

□□analyse WECS turbine construction and characteristics;

□□select and position a tower to suit anemometer and turbine and undertake basic DC wiring of a system;

□□use site and turbine data to fully design and evaluate energy yield with payback; and

□□identify workplace health and safety considerations related to the design and construction of wind conversion systems.

RE007- Energy System Efficiency

In this subject you will learn about the efficiency of energy systems. On completing this subject you will be able to:

perform calculations related to energy conversion and energy auditing, and outline their underlying principles;

outline the economic and environmental benefits of energy efficiency;
explain current methods employed to improve energy efficiency in all areas of the energy supply sector; and

explain the principles of distributed generation systems in relationship efficiency and renewable energy systems.

Advanced Diploma in Electro-Mechanical Engineering (Renewable Energy Construction) (International)

The program will provide broad trans-disciplinary knowledge and skills across the range of Engineering disciplines required to design and implement complex custom distributed energy generation solutions. At the same time students will have an opportunity to acquire in-depth knowledge and skills in either Electrical, Mechanical/Civil Engineering through the selection of a specialisation.

Semester (1)

RE008-Mathematics & Physics (I)

RE009-Mathematics & Physics (II)

RE010-Engineering Materials

RE011-Civil & Mechanical Engineering

Semester (2)

RE012-Electrical Engineering

RE013-Electrical Machines

RE014-Electronics Control

RE015-Electrical Project

Final Project

RE016-Design & Management

RE008-Mathematics & Physics (I)

In this subject you will learn basic principles of mathematics and physics for engineer You will develop knowledge relating to:

Mathematics:

- Essential algebra
- The number system
- Functions and relations
- Introductory Calculus

Physics:

- Common topics:
- SI units (International System of Units)
- Vectors and scalars

Statics:

- Equilibrium of static forces

Kinematics:

- Motion in one-dimension
- Motion in two-dimensions
- Newton's Laws of Motion
- Work and energy
- Momentum and collisions
- Rotational mechanics

Wave Mechanics:

- Types of waves
- Sound waves
- Oscillations
- Water waves.

Mathematics:

- Ordinary differential equations
- Techniques of integration
- Optimisation
- Riemann integral
- Lines and planes
- Vectors and scalars
- Graphs illustrating various functions

Physics:

- Thermal physics
- Fluid mechanics and hydrostatics
- Electrostatics

Electromagnetism:

- Current electricity.

RE009 Mathematics & Physics (II)

In this subject you will build upon previous study and gain further knowledge and expertise in applied mathematics and physics. You will develop specific knowledge and skills relating to:

Mathematics:

- Sequences, series and approximations
- Statistics
- Partial Differential Equations
- Matrices

Physics:

- Particle physics and cosmology
- Electromagnetic waves and the EM Spectrum
- Nature of light
- Reflection, refraction and diffraction of light and lenses.

In this subject you will gain advanced skills in mathematics and physics. You will develop specialised knowledge and skills relating to:

Mathematics

- Functions and Coordinates
- Eigenvectors and Eigenvalues
- Introduction to Comsol Simulation Program

Physics

- Elements and compounds
- Quantum Mechanics
- Nuclear Physics.

RE012-Electrical Engineering

In this subject you will learn about basic principles of electrical engineering. You will develop a range of foundation knowledge and skills relating to:

- Notation and units
- Circuit topologies

Direct current (DC) circuit principles:

- Voltage, current, power, resistance, conductance
- Ohm's Law; Kirchhoff voltage and current laws
- Series and parallel configurations
- Linearity and Superposition
- Thévenin and Norton equivalent circuits (simple cases)
- Nodal and mesh analysis (simple cases)
- Maximum power transfer
- Capacitors
- Passive and switched resistor-capacitor (RC) circuits
- Inductors
- Passive and switched resistor-inductor (RL) circuits
- Diodes

Alternating current (AC) circuit principles:

- Amplitude, frequency and phase
- Voltage
- Current and power in resistors, inductors & capacitors
- Time domain analysis of ac circuits
- Review of complex numbers
- Phasors and phasor notation
- Complex impedance and admittance
- Thévenin and Norton equivalents (simple cases)
- AC power (real, reactive, complex)
- Root-mean-square (RMS) values
- Maximum power transfer.

In this subject you will build on basic engineering knowledge gained in previous and develop further knowledge and skills relating to electrical engineering:

Circuit analysis:

- DC and AC Network theorems (Kirchhoff's, Superposition)
- Resonance
- Magnetically coupled circuits

Communications and signalling processing and applications:

- Analogue and digital communications principles
- Filters
- Amplifiers and attenuators
- Communication protocols

Analogue and digital communication systems and control circuits:

- Telemetry and monitoring systems
- Control systems and applications.

RE010-Engineering Materials

In this subject you will learn about the structure, properties and usage of a variety of materials used in engineering applications. You will develop specialised knowledge relating to:

- Material structure and properties
- Mechanical properties
- Metals - ferrous and non-ferrous
- Polymers
- Ceramics
- Composites, concrete, other
- Basic destructive testing
- Steel – FeC (Iron/Carbon), heat treatment
- Casting - perm/non-perm
- Forming - hot, cold
- Processes - PowderM, welding, Rapid Proto
- Polymer processes - IM, BM, extrus, thermoset, composites
- Joining - fasteners, weld, non-fusion
- Corrosion
- Surface treatments - plating, coatings, peening, anodising
- Non-destructive testing
- Quality assurance and control, certified testing, safety, materials safety data sheets (MSDS)
- Economic and environmental issues - production/recycling.

RE011-Civil & Mechanical Engineering

In this subject you will learn the basics about mechanical and civil engineering principles. You will develop knowledge and applied skills relating to:

- Reactions at beam supports
- Force couples
- Shear and bending in beams
- Analysis of trusses
- Axial tension and compression
- Direct shear
- Bolted connections
- Welded connections
- Concrete structures
- Torsion
- Thermal stresses
- Basic properties of fluids
- Fluid system components (friction and losses)
- Fluid statics (storage of energy)
- Fluid flow (hydro systems)
- Fluid power (wind and wave)
- Forces developed by flowing fluids (turbines).

In this subject you will learn about advanced mechanical and civil engineering principles. You will develop specialised knowledge and skills relating to:

- Dynamics of motion
- Momentum, Energy and Power
- Mechanical Vibration
- Balance and reaction of rotating masses
- Stress and Strain
- Strain Energy and dynamic loads
- Centroid and second moment of area
- Bending and sheer in beams and shafts
- Combined Stress
- Beam Deflection
- Concrete Structures
- Reynolds number and flow regime
- Head loss in pipes and fittings
- Pipe flow series and parallel
- Fluid machinery (Wind and wave energy)
- Pumping Systems (Hydro energy storage systems).

RE013 Electrical Machines

In this subject you will learn basic principles of electrical machinery. You will develop specialised knowledge and skills relating to:

Transformers:

- Transformer Principles and Construction
- Efficiency
- Impedance
- Equivalent circuit
- Polarity
- Vector groups
- Parallel operations
- Special Transformers (Auto and Instrument etc)

Induction Motors:

- Principle of Induction Motor
- Construction and operation of Squirrel Cage Induction Motors (SCIM) and Wound Rotor Induction Motors (WRIM)
- Operation and characteristics
- Induction Generator
- Single Phase Induction Motor

Synchronous Machines:

- Principles of operation
- Characteristics
- Motors
- Alternators

DC Machines:

- Principles of operation
- Shunt Series Compound Machines
- Characteristics

Single Phase and Special Motors:

- Split Phase motor
- Capacitor Sturt/Run motor

- Shaded Pole motor
- Universal motor
- Hysteresis motor
- Stepper motors
- Brushless DC motors
- Permanent magnet motors
- Variable reluctance motors
- Stepper motors
- Brushless DC motors

Electronic Control of Motors

- DC Motors
- AC Motors.

RE014-Electronics Control

In this subject you will learn about electronics and power control. You will develop specialised knowledge and skills relating to:

Semiconductors, diodes, transistors and integrated circuits:

- Semiconductor materials and junctions
- Diode construction, operation, ratings and applications
- Transistor construction, operation, ratings and applications
- Integrated circuit construction, operation, ratings and applications especially as related to operational amplifiers

Linear regulated dc power supplies:

- Basic power supplies (ac to dc and dc to dc), circuits and applications
- Regulation requirements and applications

Switching power control circuits:

- Basic types, operation
- Critical issues, solutions and applications

Digital electronics

- Digital logic, circuits and power control applications

Power Inverters (DC to AC):

- Basic types, operation
- Critical issues, solutions and applications.

RE015-Electrical Practice

In this subject you will learn about the practices of an engineering professional within a multidisciplinary framework. You will develop basic knowledge and skills relating to electrical and other engineering specialisations, including:

Introduction to the Regulatory System:

- Electricity Act
- Electricity Regulation Australian
- Standards State Regulators
- Workplace Health and Safety
- Engineers Code of Ethics

Drawings And Specifications:

- Drawing Interpretation
- Overview of Computer Aided Design (CAD)
- Writing a Specification

Generation and Distribution:

- Generating Plant
- Transmission Grid
- Substations

Fasteners and Fastening Methods:

- Methods of securing electrical equipment to various surfaces

Wiring Systems:

- Load Calculations
- Max. Demand
- Cables and Systems
- AS3008

Control and Protection:

- Earthing
- Protection for safety
- Faults and overloads
- Protective devices and methods

Illumination:

- Basic Lighting Concepts
- Vision and Colour
- Lamps and luminaires
- Control
- Photometric calculations

Emergency Systems:

- Batteries
- Emergency Lighting
- Fire/Smoke detection systems.

RE016-Design & Management

In this subject you will learn the fundamentals of engineering management. You will develop foundation knowledge and skills relating to:

Foundation Engineering Management:

- Management past and present
- Management versus leadership
- Managing technology
- Management processes
- Management decision making / problem solving

Engineering in society:

- Role and social responsibilities of engineering
- Engineering ethics / professional practice
- Sustainability management
- Managing innovation
- Engineers in business
- People and organisations:
- Leadership
- Culture in organisations
- Human resource management
- Building interpersonal and communication skills
- Workplace health and safety
- Organisational structures

Managing projects:

- Project team dynamics
- Project lifecycle and phases
- Client management and contracts
- Project scoping and planning
- Project resources (human, financial, physical etc.)
- Project task analysis and budgeting
- Project task control
- Project finalisation

Advanced Study

Bachelor of Engineering (Renewable Energy Engineering)

Associate Degree in Applied Engineering (Renewable Energy Engineering)

(4 points / unit x 15 units = 60 points)

Year 1	BE (RE)Units of UNSW
RE101	Mathematics 1A (MATH1131)
RE102	Mathematics 1B (MATH1231)
RE103	Physics 1A (PHYS1121)
RE104	Physics 1B (PHYS1221)
RE105	Engineering Design (ENGG1000)
RE106	Electronics & Telecomm Engineering (1) (ELEC1111)
RE107	Sustainable Energy (SOLA1070)

Year 2	BE (RE)Units of UNSW
RE201	Electronics & Telecomm Engineering (2) (ELEC1111)
RE202	Numerical Methods & Statistics (MATH2089)
RE203	Engineering Materials and Chemistry (MATS1101)
RE204	Project in PV and Solar Energy (SOLA2051)
RE205	Sustainable & Renewable. Energy. Technology (SOLA2053)
RE206	Introduction to Electronics Devices (SOLA2060)
RE207	Applied Photo Voltaics (SOLA2540)
RE208	Project Presentation

Bachelor of Applied Engineering (Renewable Energy Engineering)

(4 points / unit x 15 units = 60 points+ Thesis)

Year 3	BE (RE)Units of UNSW
RE301	Low Energy Buildings and PV (SOLA3010)
RE302	PV Technology & Manufacturing (SOLA3020)
RE303	Software Engineering (COMP3111)
RE304	Analogue Electronics (ELEC2133)
RE305	Power Electronics (ELEC4614)

RE306	Electromagnetic Engineering (ELEC3115)
RE307	Circuits and Signals (ELEC2134)
RE308	Control Systems (ELEC3114)

Year 4	BE (RE)Units of UNSW
RE401	Fluid Mechanics (MMAN2600)
RE402	Thermodynamics (MMAN2700)
RE403	Computational Fluid Dynamics (MECH9620)
RE404	Strategic Leadership & Ethics (ELEC4122)
RE405	Grid-Connect PV System (SOLA4012)
RE406	Wind Energy Converters (SOLA5053)
RE407	Semiconductor Devices (SOLA5055)
RE408	Thesis

Total 120 Points + Thesis for award of Bachelor of Engineering (Renewable Energy Engineering)

PATHWAY (1)

PUBLIC SEMINAR + ASSIGNMENT ---Diploma in Renewable Energy Engineering--------then continue ---- BE (RE)

OR

Diploma in Renewable Energy Engineering (International)

--------then continue ---- BE (RE)

PATHWAY (2)

PUBLIC SEMINAR + ASSIGNMENT --- Diploma in Renewable Energy Engineering

OR

Diploma in Renewable Energy Engineering (International)

Then continue to do Advanced Diploma in Electro-Mechanical Engineering (Renewable Energy Construction)

Then do the advanced units in BE (RE) & complete BE (RE)

Detailed description of subjects in BE (Renewable Energy Engineering)

RE101-Mathematics 1A - MATH1131

Description

- Complex numbers, vectors and vector geometry, linear equations, matrices and matrix algebra, determinants. Functions, limits, continuity and differentiability, integration, polar coordinates, logarithms and exponentials, hyperbolic functions. Introduction to computing and the Maple symbolic algebra package.

  Assumed knowledge: HSC Mathematics Extension 1. Students will be expected to have achieved a combined mark of at least 100 in Mathematics and Mathematics Extension 1

RE102-Mathematics 1B - MATH1231.

Description

- Vector spaces, linear transformations, eigenvalues and eigenvectors. Introduction to probability and statistics. Integration techniques, solution of ordinary differential equations, sequences, series, applications of integration.

RE103-Physics 1A - PHYS1121.

Description

- This course provides an introduction to Physics. It is a calculus based course. The course is examined at two levels, with Physics 1A being the lower of the two levels.
  Mechanics: particle kinematics in one dimension, motion in two and three dimensions, particle dynamics, work and energy, momentum and collisions.
  Thermal physics: temperature, kinetic theory and the ideal gas, heat and the first law of thermodynamics. Waves: oscillations, wave motion, sound waves.

RE104-Physics 1B - PHYS1221

Description

- This is the second of the two introductory courses in Physics. It is a calculus based course. The course is examined at two levels, with Physics 1A being the lower of the two levels.

  Electricity and Magnetism: electrostatics, Gauss's law, electric potential, capacitance and dielectrics, magnetic fields and magnetism, Ampere's and Biot-Savart law, Faraday's law,

induction and inductance. Physical Optics: light, interference, diffraction, gratings and spectra, polarization. Introductory quantum theory and the wave nature of matter. Introductory solid state and semiconductor physics: simple energy band picture.

RE105-Introduction to Engineering Design and Innovation - ENGG1000

Description

- In this course, students will experience first hand one of the major things that engineers do: designing and building creative solutions to problems. They will learn to think the way that engineers think, coming up with good solutions to problems despite being limited by budget, time and resources, the requirement to also meet environmental and social objectives and of course the limitations of the laws of physics. This will help them to appreciate the central ideas of engineering design as an on-time, on-budget and fit for purpose solution to a poorly specified, open-ended problem. They will be assigned to a team to work over a ten week period to solve a practical problem. The projects on offer change from year to year. In doing all this they will start to build key skills for engineers that will be called upon repeatedly in their academic and professional lives, including concept development, critical thinking and evaluation skills, clear communication, research and information literacy skills and the skills involved in successfully functioning within a team environment to complete a given task.

RE106-Electrical and Telecommunications Engineering - ELEC1111

Description

- An introduction to the art and science of Electrical Engineering and Telecommunications, and the systems approach to engineering design. Examples of electrical and electronic devices, circuits and analogue and digital systems. Analogue circuit analysis. Digital electronics and combinatorial logic. Transformers, power sources and electrical energy systems including DC and AC motors. Feedback control. Telecommunications systems, including frequency, spectra, modulation and Internet systems. Safety standards.

RE107-Sustainable Energy - SOLA1070

Description

- Students will be introduced to the concept of energy in its different forms through a range of lectures and demonstrations. These demonstrations will also introduce the concepts of energy storage, energy efficiency, energy conversion and sustainability. An overview is given of issues surrounding sustainable energy for future generations. The status and impact of

present day sources of energy are covered, including the sustainability of fossil fuel reserves and the impact of pollution and greenhouse gas emissions on the environment. Energy efficiency, as an important way to conserve our natural fuel reserves and reduce environmental and financial costs, is covered. Building design, appliance efficiency and other issues related to the smart and efficient use of energy are covered. Trends in the renewable energy industry are considered. An overview is given of renewable energy sources, their harnessing and their conversion into electricity via various technologies. In particular, an overview is given of solar cells and their applications with emphasis on visual presentations and interesting case histories, including some fascinating mistakes and disasters. Students will also explore the design and fabrication of silicon solar cells while working as engineers on the "Virtual Solar Cell Production Line".

RE201-Electrical and Telecommunications Engineering (2)- ELEC1111

Description

- An introduction to the art and science of Electrical Engineering and Telecommunications, and the systems approach to engineering design. Examples of electrical and electronic devices, circuits and analogue and digital systems. Analogue circuit analysis. Digital electronics and combinatorial logic. Transformers, power sources and electrical energy systems including DC and AC motors. Feedback control. Telecommunications systems, including frequency, spectra, modulation and Internet systems. Safety standards.

RE202-Numerical Methods and Statistics - MATH2089

Description

- Numerical Methods: Numerical differentiation, integration, interpolation and curve fitting (regression analysis). Solution of linear and non-linear algebraic equations. Matrix operations, and applications to solution of systems of linear equations, elimination and tridiagonal matrix algorithms. Introduction to numerical solution of ordinary and partial differential equations.
  Statistics: Exploratory data analysis. Probability and distribution theory including binomial, Poisson and normal. Large sample theory including the Central Limit Theorem. Statistical inference including estimation, confidence intervals and hypothesis testing. One-sample and two-sample tests. Linear regression. Analysis of variance. Design and analysis of experiments. Applications will be drawn from mechanical, mining, photovoltaic and chemical engineering and surveying. Matlab will be used in this course.

RE203-Engineering Materials and Chemistry - MATS1101

Description

- The course covers: stoichiometry, atomic and molecular structure, states of matter, equilibrium, oxidation and reduction, electrochemistry; an introduction to organic chemistry and polymers; microstructure and structure-property relationships of the main types of engineering materials (metals, ceramics, polymers and composites); micromechanisms of elastic and plastic deformation; fracture mechanisms for ductile, brittle, creep and fatigue modes of failure in service; corrosion; metal forming by casting and wrought processes; phase equilibria of alloys; microstructural control by thermomechanical processing and application to commercial engineering materials.

RE204-Project in Photovoltaics and Solar Energy 1 - SOLA2051

Description

- .The main emphasis of the second year group project course is hands-on project engineering. The course has a lecture component covering project engineering, report writing, presentation skills, occupational health and safety, and theoretical principles specific to the project work to be undertaken. The project comprises a research component, a planning and design component, a significant hands-on component, and a presentation/reporting component.

RE205-Sustainable & Renewable Energy Technologies - SOLA2053

Description

- This course includes an introduction to issues in sustainable and renewable energy, including environmental impact, resource depletion, basic engineering economic analysis, embodied energy, payback times and the integration of renewable energy sources with conventional infrastructure. The course reviews key concepts such as basic thermodynamics, heat transfer and fluid dynamics to allow analysis of the physical operation of energy generation systems, with key renewable energy sources and generation systems examined including wind, biomass, solar thermal, hydroelectric, geothermal, tidal and wave energy. The course emphasises engineering problem solving, design skills and creative thinking.

RE206-Introduction to Electronic Devices - SOLA2060

Description

- Operation, circuit characteristics, basic design principles and applications of a range of semiconductor devices. Material covered includes pn junction theory, bipolar junction transistors, avalanche diodes, MOSFET's, basic digital circuits, solar cells, light emitting diodes, semiconducting lasers and photodetectors.

RE207-Applied Photovoltaics - SOLA2540

Description

- Photovoltaic (PV) devices convert sunlight directly to electricity with low levels of greenhouse gas emissions per kWh of electricity produced. This course covers factors important to the operation, design and construction of solar cells and PV system design. Students will learn principle of operation of solar cells, loss mechanisms and design features to improve efficiency of solar cells and modules. In addition, students are introduced to application and design of PV systems. System design is focused on stand-alone PV systems but other specific applications such as Remote Area Power Supply systems and Grid-Connected PV systems are also discussed. Importantly, simulation and laboratory exercises are used to reinforce an understanding of modelling and characterisation of solar cells and PV modules.

RE301-Low Energy Buildings and Photovoltaics - SOLA3010

Description

- There is currently significant interest in reducing energy use and greenhouse gas production in buildings by designing buildings that are climate-appropriate, implementing energy efficiency measures and producing energy from renewable sources. Prediction of building thermal, lighting performance and solar access, and techniques for energy efficient design will be introduced, with a focus on residential buildings. A competency in the use of building energy simulation software will be developed.

  Photovoltaics (PV) is one of the few renewable electricity generation options that can be readily used in urban areas and has no environmental impacts at the site. This course will examine the integration of PV modules into the building envelope. Technical issues associated with 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 will be introduced.

RE302-Photovoltaic Technology and Manufacturing - SOLA3020

Description

- Sufficient theory relating to the operating principles of solar cells is covered to give an appreciation of the strengths and weaknesses of the dominant commercial cell technologies. Trends in commercial cell technology and the corresponding manufacturing processes and environment are considered. The impact of various processing and device parameters on performance, yields and product reliability are studied. Insight is given into complete production processes for both screen-printed solar cells and buried contact solar cells. In-line quality control techniques are studied with laboratory classes used to give students first-hand experience in their use as well as exposing them to manufacturing processes. Students will also be given the opportunity to take control of the "virtual production line" to adjust the equipment controls and processing parameters to try and optimize performance and maximize yields, etc. In-line quality control procedures are available to the student to aid in this optimization and will prove to be particularly useful in identifying and rectifying computer generated faults associated with the production. Other laboratory work focuses on the use, measurement and analysis of encapsulated modules of cells. Modules with a range of faults are examined and techniques for fault diagnosis developed.

- Solar cells harness the energy of sunlight and convert it directly into electricity. This course covers factors important in the understanding, design and characterisation of solar cells. It will extend students’ existing semiconductor device understanding and provide a sound basis in key practical processes such as solid state diffusion and device contacting. Students are introduced to a range of laboratory-based and commercial solar cell technologies in this course including silicon (wafer-based) technologies, thin film technologies, multi-junction, concentrator and third generation concepts and technologies. Simulation exercises, using the PC1D program, are used to reinforce an understanding of device physics and the different solar cell technologies. In addition, students will learn about characterisation techniques that will enable them to study solar cells with regard to their effects on spectral response, temperature sensitivity, resistive losses, current generation and open-circuit voltages.

RE303-Software Construction: Techniques and Tools - COMP2041

Description

- Software system decomposition and design. Overview of the software development life-cycle. Command languages. Version control and configuration management, programming for reliability. Testing and debugging techniques. Profiling and code improvement techniques. Practical work involving programming-in-the-large.

RE304-Analogue Electronics - ELEC2133

Description

- Device physics of diodes, BJTs and MOSFETs. Nonlinear transistor models: Ebers-Moll, transport. Full and simplified models of BJTs and MOSFETs (inc. small-signal models). Zener and Schottky diodes. DC biasing, biasing using current sources, operating point, large-signal analysis. Linearisation, small-signal analysis. Input- and output impedances, power gain. Two-ports. Feed-back, effects of feed-back; stability and compensation techniques. Circuits with non-ideal op-amps. Common base, emitter and collector amplifiers; differential pairs. Multistage amplifiers, cascades, cascodes. AC response of 1-stage amplifiers, Miller effect. Non-linear circuits: oscillator, Schmitt trigger. A-D and D-A converter principles

- Non-ideal effects in electronic circuits and systems: Noise; device noise, external noise, CMRR, PSRR, mixed A/D. Distortion; non-linearity, dynamic range, saturation. Stability and performance sensitivity to parameter variations. Some simple design for stability and performance. Design optimisation. Power-supply distribution and decoupling. Mixed analogue/digital system design, including grounding and shielding. Device modelling in SPICE. Data sheet interpretation. Design of analogue and digital circuits and system components: Non-linear circuits; oscillators, PLLs, multipliers, AGCs, schmitt triggers. Introduction to filter design; active filters; op-amp. Sensors and actuators, PTAT; instrumentation amplifiers and signal conditioning. Low-level design and optimisation of digital CMOS gates. Gate delay, power dissipation, noise margins, fan-out. Introduction to integrated circuit design.
  Thermal consideration, power supplies, reliability, uC watchdongs

RE305-Power Electronics - ELEC4614

Description

- Power semiconductor switching devices and their limitations; Switching characteristics, protection and limitations of various types of power semiconductor switches; Elementary concepts in power electronics; Application of power electronic converters in energy conversion, utility applications and power supplies and utilizations; Diode rectifier circuits, multi-pulse rectifiers, input and output waveform characterization, filter design. Non isolated DC-DC converters, circuits topologies, characteristics with continuous and discontinuous conduction, circuit design and control considerations, Quadrant operation; Isolated DC-DC converters, transformer design issues, core resetting; Single-phase and three-phase DC-AC inverters, modulation strategies, output waveform analysis and filter design; Utility interfaces; High power applications; Converter system implementation

RE306-Electromagnetic Engineering - ELEC3115

Description

- Review of vector calculus, Electric Fields: Coulomb's and Gauss's laws and Maxwell's equations, Electric potential, Laplace's and Poisson's equations; Magnetic Fields: Biot-Savart law, Vector potential and Ampere's law and Maxwell's equations;Application of Gauss's law; Solution of Poisson's and Laplace's equations for electric field; Boundary value problems and method of images; Dielectric materials, capacitance, electrostatic energy and forces, losses; Field and current density, conductance; Application of Ampere's law; Magnetic materials, inductance, coupling in magnetic circuits; Magnetic energy and forces.Application of Faraday's law, transformers; Skin effect and skin depth, hysteresis and eddy current losses. Electromagnetic spectrum. Time-varying fields and Maxwell's equations: forms, boundary conditions. Plane electromagnetic waves in lossless/lossy media: polarization, group velocity dispersion, energy flows, Poynting vector, reflection/refraction at boundary. Transmission lines: wave characteristics, impedance and matching.Waveguides: modal analysis of rectangular metallic waveguides. Antennas: antenna patterns and parameters, linear dipole, antenna array.

RE307-Circuits and Signals - ELEC2134

Description

- Circuit elements - energy storage and dynamics. Ohm's Law, Kirchhoff's Laws, simplifying networks of series/parallel circuit elements. Nodal analysis. Thivenin and Norton equivalents, superposition. Operational amplifiers. Transient response in first-order RLC circuits. Solutions via solving differential equations. Transient response in second-order RLC circuits. State equations, zero input response, zero state response. Using MATLAB to solve state equations. Sinusoidal signal: frequency, angular frequency, peak value, RMS value, and phase. DC vs AC, average vs RMS values. AC circuits with sinusoidal inputs in steady state. Use of phasor and complex impedance in AC circuit analysis. AC power (real, reactive, apparent), power factor, leading/lagging. Resonance. Transformers and coupled coils. Laplace transforms of signals and circuits. Network functions and frequency response. Periodic signals and Fourier series. Introduction to filter design. Introduction to nonlinear circuits and small signal analysis.

RE308-Control Systems - ELEC3114

Description

- Recognition of what a control system is, and the distinction between simple and complex control systems. Analysis and design tools for dealing with simple control systems up to second order: Differential equations, Laplace transforms, transfer functions, poles and zeros, state space models, modeling, first and second order systems, stability, steady-state errors, root locus, Bode and Nyquist plots, transient response analysis and design, PID control, lead-lag compensation, simple frequency response techniques. Stabilising feedback control for transfer function and state-space models.

RE401-Fluid Mechanics - MMAN2600

Description

- Fluid properties. Fluids in static equilibrium. Buoyancy. Pressures in accelerating fluid systems. Steady flow energy equations. Flow measurement. Momentum analysis. Dimensional analysis and similarity. Pipe flow. Incompressible laminar and turbulent flow in pipes; friction factor. Laminar flow between parallel plates and in ducts. Elementary boundary layer flow; skin friction and drag. Pumps and turbines. Pump and pipeline system characteristics.

RE402-Thermodynamics - MMAN2700

Description

- Thermodynamic concepts, systems, property, state, path, process. Work and heat. Properties of pure substances, tables of properties and equations of state. First law of thermodynamics. Analysis of closed and open systems. Second law of thermodynamics, Carnot cycle, Clausius inequality, entropy, irreversibility, isentropic efficiencies. Air-standard cycles. Vapour cycles.

RE403-Computational Fluid Dynamics - MECH9620

Description

- Incompressible flow: primitive equations, stream function, vorticity equations. The conservative property. Stability analysis. Explicit, implicit methods. Upwind differences. SOR methods. Fourier series methods. Pressure, temperature solutions. Solving the primitive equations.

RE404-Strategic Leadership & Ethics - ELEC4122

Description

- Theories of leadership; leadership of teams. Organisational behaviour. Strategic planning. Uncertainty and risk. The interaction of laws with engineering projects and innovations. The role of engineering in society; assessment of innovation in processes and products. Engineering ethics principles and practice: an introduction to ethical systems; the application of ethical frameworks to engineering practice with particular reference to electrical engineering and computing; codes of ethics in the professions; social, political, environmental and economic considerations.

RE405-Grid-Connected Photovoltaic Systems - SOLA4012

Description

- This course familiarizes students with issues relevant to the use of photovoltaics in systems connected to the electricity distribution network with the aim of attaining competency in design and specification. The types of systems considered include residential, building

integrated, distributed grid-support and central station. System components, design, operation, safety, standards and economics are addressed making extensive use of past field experience and site visits where appropriate.

RE406-Wind Energy Converters - SOLA5053

Description

- This course will cover the principles of wind energy and wind power, as well as the design and operation of different types of wind energy converters. It will include machines for water pumping, remote area power supply and grid electricity generation. It will cover issues of site selection, monitoring and analysing wind data, estimating output from wind generators, integrating wind generators into hybrid power systems or the grid, economics, standards and environmental impacts.

RE407-Semiconductor Devices - SOLA5055

.Description

- This course describes the operating principles of modern semiconductor devices, relates terminal properties to their internal structure, and gives an understanding of how terminal properties will change with operating conditions. Devices covered include p-n junction diodes, solar cells, bipolar junction transistors, field effect transistors (MOSFETs), light-emitting diodes and semiconductor lasers, with emphasis on photovoltaic (semiconductor solar cells) and photonic (semiconductor LEDs and lasers) applications. This course may be taught concurrently with SOLA9005.