

1. Module details**Module name****Power Electronics for Renewable Energy****Module duration**

It is expected that students with the appropriate entry knowledge and skills will successfully complete this module in 18 - 20 hours.

Module code

NUE043

Discipline code

0701

2. Module purpose

The primary focus is on renewable energy systems, characteristics, ratings and applications of the devices and circuits This will be supported by the essential electronics concepts.

3. Prerequisites

NE05 Power Control Devices.

4. Relationship to competency standards

This module provides part of the underpinning knowledge and skills in the 'Evidence Guide' of specific units of competency in the National Electrotechnology Training Package and provides similar support, where mapped, to equivalent units in the National Metals and Engineering Competency Standards. For details refer to the module to unit maps, available from NUEITAB.

5. Content**Linear regulated DC power supplies**

Block diagram and major components of renewable energy electronic power supply

Simple zener shunt regulator

Emitter follower voltage regulator (qualitative treatment only)

Linear regulator integrated circuits (ICs)

Major features

Switching power control circuits

Bipolar transistors as switches

Field effect transistor (FET): structure, operation, symbol; major device ratings

Pulse width modulation (PWM) in switch mode regulators

Block diagram of switch mode regulators circuits

Simple photovoltaic voltage regulator

Other renewable energy applications

Silicon controlled rectifier (SCR), Triacs, silicon controlled switch (SCS) and gate turn off (GTO): symbols, operation and major device ratings

Radio frequency interference (RFI): cause and suppression methods

Converters

Operation and application

Differential controllers for SHW systems

Handling precautions for Metal Oxide Semiconductor (MOS) circuits

Inverters

Inverter bridge and half bridge

Functions and types: output waveforms; use of PWM techniques; block diagram structure

Function and block diagram of DC-DC converters

Harmonic content of inverter waveforms: significance in renewable energy systems; trouble shooting

6. Assessment strategy

Assessment methods

Assessment should be progressive reflecting a holistic approach to ensure the module purpose is met. To assist in ensuring validity, reliability and fairness assessment instruments should include practical exercises, assignments and written tests consisting of a number of item types, such as multiple choice, short answer and problem solving.

Conditions of assessment

Learning and assessment will take place in an environment that is conducive to a learner's development.

7. Learning outcome details

Learning outcome 1

Describe the operation of linear regulated DC power supplies and their major components for use in renewable energy applications.

Assessment criteria

- 1.1 Draw and label voltage and current waveforms for half wave and full wave single phase rectifier circuits with and without capacitor filtering.
- 1.2 Draw and label a block diagram showing the structure of a renewable energy regulated DC power supply.
- 1.3 Describe, with the aid of circuit diagrams, the operation of a simple zener shunt regulator.
- 1.4 Outline the main features of linear integrated circuit voltage regulator ICs.
- 1.5 Identify each of the major components and their physical location in a renewable energy regulated power supply.

Learning outcome 2

Describe the basic operating principles, characteristics and applications used in renewable energy application switching power control circuits.

Assessment criteria

- 2.1 Explain why the power dissipation of a transistor is low when operated as a switch.
- 2.2 Describe with the aid of waveform diagrams, how pulse width modulation can provide a variable output voltage from a switch mode regulator.
- 2.3 Outline the advantages and disadvantages of switch mode power circuits compared with linear power circuits.
- 2.4 Describe, with the aid of a block diagram, the structure of primary and secondary switch mode renewable energy voltage regulators and the function of their major components.
- 2.5 Draw and label a block diagram of a basic PV switching voltage regulator for battery charging.
- 2.6 List at least three applications of switch mode circuits found in renewable energy systems.
- 2.7 Describe with the aid of a waveform diagram how voltage control in AC circuits is achieved using SCRs and Triacs.
- 2.8 List four major semiconductor devices which can be used as power switching devices and a typical application for each.
- 2.9 Describe methods used to reduce (RFI) in DC and AC circuits utilising high speed switching.

Learning outcome 3

Assessment criteria

Outline the main features of converter circuits.

- 3.1 Describe the characteristics features that distinguish analog and digital devices and circuits.
- 3.2 Describe how numbers or text information can be represented using binary numbers.
- 3.3 Describe the operation of voltage comparators, analog to digital (A-D) converters and list one example of each device used in a renewable energy application.
- 3.4 Describe with the aid of a block diagram the structure and operation of a differential controller for solar water heating systems.
- 3.5 Outline the handling precautions required for components and circuits containing MOS devices.

Learning outcome 4

Assessment criteria

Describe the structure, operating characteristics and output waveforms of inverters.

- 4.1 Describe with the aid of a circuit diagram the operation of an inverter bridge and half-bridge.
- 4.2 Describe the types and function of the common forms of inverters.
- 4.3 Draw and label output voltage waveforms for square wave, modified square wave and synthesised sine wave inverters.
- 4.4 Describe with the aid of diagrams, the function of PWM techniques in modified square wave and synthesised sine wave inverters.
- 4.5 Draw block diagrams showing the structure of common forms of renewable energy DC-DC converters and inverters.
- 4.6 Describe methods of trouble shooting renewable energy inverters.

8. Delivery of the module

Delivery strategy

Delivery strategies must be suitable for learning both theoretical and practical aspects described in the module purpose. It is considered that the most effective method to achieve this is by integration of theory and practice where students learn by experimentation, research and reports. It is recommended that learning and assessment be facilitated in a holistic manner that may require learning outcome sequence other than that indicated in the module.

Resource requirements

Access to at least two types of inverters, CRO and isolating transformers will be provided as required

Occupational health and safety requirements

A safe and healthy environment will be provided for students and teachers as well as the particular safety procedures followed as part of the learning / teaching activity and content.