1. Module details

Module name

Introduction to Electronics for Renewable Energy

Module duration

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

Module code

NUER17

Discipline code

1105

2. Module purpose

This module provides basic skills and knowledge required by renewable power systems technicians. The theoretical component includes an introduction to the major semiconductor devices, terminology and concepts relevant to electronic components found in renewable energy systems. Practical skills include basic maintenance and repair of electronic equipment under the direction of an electronics technician, as required by technicians working at remote sites where technical support by telephone may be available.

3. Prerequisites

NUE058 – Electrical Concepts and Applications *or* equivalent modules;
NUER16 – Fundamentals of Renewable Energy Systems *or*
NUER01 – Introduction to Renewable Energy Technologies

4. Relationship to competency standards

This module provides part of the underpinning knowledge and skills identified in the "Evidence Guide" of specific units in the National Electrotechnology Competency Standards, namely NES112, NES113, NES114.

5. Content

Diodes and rectification

rectifier diodes:
- electrical characteristics
- ratings
- circuit symbol
- R.E. applications (gating, flywheel diode, blocking and bypass diodes in PV arrays, LED indicators)

other diodes: LEDs, zeners and Schottky diodes;
- characteristics, applications and circuit symbols

single phase half wave rectifier
single phase full wave bridge and centre tapped
voltage waveforms, capacitor filtering, ripple
block diagram structure and physical components of
- regulated d.c. power supply or battery charger

Switching power control circuits

Pulse Width Modulation (PWM) in switch mode regulators

comparison of linear and switch mode circuits: advantages and disadvantages
renewable energy applications for switchmode circuits
major areas of power loss in switching power control circuits
inverter bridge and centre tapped inverter bridge: function and operation
types of power switching devices in RE components: FETs, IGBTs, etc major characteristics

Digital Electronics

comparison of analogue and digital circuits basic boolean logic
representation of data in binary form
voltage comparators, A-D and D-A converters: operation and application
microcontrollers, volatile and non-volatile memory device types and uses

Maintenance

Safety procedures and practices; hazards in equipment containing LV equipment
functional testing of equipment
common faults in RE equipment
typical test equipment
Fault location and testing under the direction of an electronics technician
handling precautions for MOS circuits; PCB replacement
replace socketed ICs

6. Assessment strategy

Assessment methods

Assessment should encompass both progressive and holistic elements in recognition of the interdependence between learning outcomes to ensure the module purpose is met. To assist in ensuring validity, reliability and fairness assessment instruments should include practical and written exercises, consisting of a number of item types, such as multiple choice, short answer and problem solving.

Conditions of assessment

Normally learning and assessment will take place in a classroom/ laboratory environment.

7. Learning outcome details

Learning outcome 1	**Explain the major concepts relevant to semiconductor diodes and rectification circuits.**	
Assessment criteria	1.1	Draw and label circuit symbols for common semiconductor components including p-n junction rectifier diodes, Schottky rectifier diodes, LED's, zener diodes.
	1.2	Describe the basic function of these devices.
	1.3	List the major rating parameters of these devices.
	1.4	Draw and label circuit diagrams for half wave and full wave, single phase rectifiers.
	1.5	Draw and label voltage and current waveforms for these rectifier circuits with and without capacitor filtering.
	1.6	Calculate peak output voltages from single phase rectifier circuits.
	1.7	Identify each of the major components and their physical location in a regulated power supply or battery charger.
Learning outcome 2	**Explain the major concepts relevant to switching power control circuits used in renewable energy systems.**	
Assessment criteria	2.1	Describe, with the aid of waveform diagrams, how Pulse Width Modulation (PWM) can provide a variable output voltage from a switch mode regulator.
	2.2	Outline the advantages and disadvantages of switch mode power circuits compared with linear power circuits.
	2.3	List at least three (3) applications of switching power control circuits found in renewable energy systems.
	2.4	Describe the operation of an inverter full-bridge and centre tapped inverter bridge.
	2.5	List the major types of power switching devices used in renewable energy systems, and their distinguishing characteristics.
Learning outcome 3	**Describe the major concepts and devices relevant to digital electronic circuits used in renewable energy systems.**	

Assessment Criteria	3.1	Describe the characteristic features that distinguish analogue and digital devices and circuits.
	3.2	Describe how numbers or text information can be represented using binary numbers and how these are represented in digital circuits.
	3.3	Outline the function of voltage comparators and Analogue to Digital (A-D) converters, and give one example of each one's use in a renewable energy application.
	3.4	Outline the basic function of micro-controllers, volatile and non-volatile memory devices.
Learning outcome 4	**Perform basic maintenance on renewable energy electronics equipment.**	
Assessment Criteria	4.1	List the hazards that may be encountered when performing tests on inverters, battery chargers or other equipment containing LV circuits.
	4.2	State and apply the safety procedures for work on electronic systems, circuits and apparatus.
	4.3	Establish the functionality of electronic equipment through appropriate client questioning and application of systematic tests and observation.
	4.4	Specify the various types of common faults and their causes in renewable energy electronic equipment.
	4.5	List typical test equipment used to repair electronic and electrical equipment
	4.6	Demonstrate safe and correct use of tools and test equipment to locate electronic equipment faults under the direction of an electronics technician.
	4.7	Replace faulty circuit components under the direction of an electronics technician.
	4.8	Replace circuit boards, observing appropriate handling precautions for static sensitive devices.
	4.9	Identify and replace socketed ICs such as EPROMs or microprocessors, using appropriate tools and methods.

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 way to achieve this is by the integration of theory and practice where students learn by experimentation and practical application. It is recommended that learning and assessment be facilitated in a holistic manner which may require learning outcome sequence other than that indicated in the module. This module contains learning outcomes that require theory, practical instruction and demonstrations as well as practical work to be completed by the learner. For practical work it is recommended that there be a maximum of six (6) learners per teacher/tutor .
Resource requirements	Resources should be sufficient for students to carry out practical work in pairs. This will require a range of experimental devices and measuring instruments and programming of activities to allow access to costly equipment in turn.
Occupational health and safety requirements	A safe and healthy environment will be provided for students and teachers as well as adherence to safety procedures with regard to learning / teaching activity. Particular care should be exercised when working with lead acid batteries to avoid short circuit, acid or explosion due to the presence of hydrogen.
Minimum physical resources	Classroom or laboratory equipped with sample components, plug boards, multimeters, sample circuits, DC power supplies, simple circuits for demonstrations, inverters, regulators, CRO and isolating transformers, basic hand tools.