Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

ELECTRICAL MACHINES WINDING

GENMW501

Wind electrical machines

Competence

RQF Level: 5

Learning Hours 70

Credits: 7

Sector: Energy

Trade: Renewable energy

Module Type: General

Curriculum: ENGREN5001TVET CERTICATE V IN RENEWABLE ENERGY

Issue Date: May 2024

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Purpose statement	This particular module describes the skills, knowledge and attitude required to wind electrical machine. The learner will be able to Carry-out preliminary activities, Wind rotating electrical machine, Wind static electrical machines, carry out finishing activities. It applies to working in maintenance and electrical machines fabrication
Learning assumed to be in place	**N/A**

Delivery modality						
	Training delivery		**100%**	**Assessment**		**Total 100%**
	Theoretical content		30%		30%	50%
	Practical work:		70%	Formative assessment	70%	
	• Group project and presentation	30%				
	• Individual project /Work	40%				
			Summative Assessment			50%

Elements of Competency and Performance Criteria

Elements of competency	Performance criteria
1.**Carry-out preliminary activities**	1.1. Tools, materials and equipment are appropriately selected based on activities
	1.2. Electrical diagram is properly interpreted in line with type of machine

	1.3. Workplace is well prepared according to the workplace preparation policy and procedures
2. Wind rotating machine	2.1. The coils are properly formed according to the coil types, coil structure, coils inputs and outputs
	2.2. The insulators are correctly shaped according to the slots size
	2.3. The insulators and coils are correctly inserted into slots according to the process
	2.4. Windings are properly insulated according to the insulation method
	2.5. Electrical Motor is properly assembled according to the assembling procedures
	2.6. Rotating machines is properly tested according to the testing types
3.Wind a static machine	3.1. Laminated sheets are properly formed according to laminated sheets shapes and cutting techniques
	3.2. Windings of a static machine are appropriately fabricated according to the coil structure.
	3.3. Transformer windings are properly inserted into core based insertion techniques
	3.4. Windings are properly insulated according to insulation types
	3.5. Static machine is properly tested according to the testing types

4.Carry out finishing activities	4.1. Electrical Machines are properly cleaned according to the cleaning technics
	4.2. Electrical machines are painted according to the painting techniques
	4.3. Name plate is properly developed and attached according to nameplate attaching methods and electrical machine technical specifications.
	4.4. Workplace is properly rearranged according to the waste disposal procedures
	4.5. Cost is correctly estimated according to the cost estimation procedures

Knowledge, Skills, and Attitudes		
Knowledge	**Skills**	**Attitude**
✔ Ability to use hand tools ✔ Ability to use power tools ✔ Proficiency in the use of test meters ✔ Ability to diagnose the equipment ✔ Ability of electrical measurement ✔ Mathematical analysis ✔ Electrical circuits analysis	✓ Apply Computer skills ✓ Communication skills ✓ Troubleshooting skills ✓ Reporting skills ✓ Interpersonal skills ✓ Analytical skills ✓ Problem solving skills ✓ Use of tools skills	Honest ✔ Integrity ✔ Royalty ✔ Confident ✔ Time management ✔ Critical thinking ✔ Dignity

Learning outcomes	At the end of the module the learner will be able to: 1. Carry-out preliminary activities 2. Rewind rotating electrical machine 3. Wind static electrical machines 4. Carry out finishing activities
Learning outcome 1: Carry-out preliminary activities	**Learning hours:10**

Indicative content

- **Description of electrical machines**
  - ✓ Classification of the rotating machines
    - Electrical Motors
    - Electrical Generators
  - ✓ Classification of electrical transformers
    - According to construction
    - According to the number of phase
    - According to windings connection
    - Core structure
  - ✓ Windings connections, symbols and terminations

- **Selection of Tools, Materials, and Equipment**
  - ✓ Tools
    - Types

- Application and uses

✓ Materials

- Types
- Application and uses

✓ Equipment

- Types
- Application and uses

✓ Selection criteria

- **Interpreting electrical diagram of electrical machine**

✓ Interpret schematic diagram of rotating machine depending on

- Number of slots
- Poles
- Pitches
- Speed

✓ Interpret winding diagrams of rotating machine

- Lap winding
- Wave winding
- Concentric Winding

✓ Features of armature windings

- Pole pitch
- Coil span
- Coil pitch

✓ Interpret winding diagrams of electrical transformers

- Construction
- Number of phase
- Windings connection

- **Preparation of the Workplace**
  - ✓ Applying preparation procedures
  - ✓ Apply hazard control measures
    - Fire extinguishers and their application
    - Workplace ventilation

Resources required for the learning outcome	
Equipment	windings making machines, multimeter, PPE, Bench work, Wattmeter and Energy meter
Materials	Wires, rotating machines parts, static machines parts, soldering wires, winding cord, bamboo, scotches, Insulation materials, Connectors and Gain pipes
Tools	knives, Hammers, Screw drivers, Coil tamping tools, Mallet, Wire brushes, Wire strippers, slotting files, cutting pliers, Neon tester, Crimping tool, Multimeter, Nose Pliers, Line tester, soldering iron, Standard wire gauge, Soldering iron, hummers and Electromechanical tool kit.
Facilitation techniques	• Demonstration (Video show) • Individualized • Trainer guided • Group discussion • Practical exercises

Formative assessment methods	• Written assessment, • Presentation • Product based assessment • Performance assessment

Learning outcome 2: Wind Electrical rotating machine	**Learning hours:25**
Indicative content	

- **Forming the coils**
  - ✓ **Calculation and Design coils structures**
    - Calculation of winding parameters
    - Design Coils structures of DC motor
    - Design Coils structures of AC motor
  - ✓ **Applying Coil formation method**
    - Manual
    - Semi-automatic
    - Automatic
- **Shaping of the insulators**
  - ✓ Type of insulator
  - ✓ Slots size measurement methods
  - ✓ Cutting the insulator

- **Insertion of the insulators and coils**
  - ✓ Dismantle of electrical rotating machine
  - ✓ Cleaning of stator core
  - ✓ Insulation of stator core
  - ✓ Coils insertion
- **Insulation of winding**
  - ✓ Windings insulation types
  - ✓ winding insulation methods
- **Assemble electrical motors**
  - ✓ **Fix bearings**
  - ✓ **Covering**
  - ✓ **Insertion of rotor**
  - ✓ **Ventilation**
- **Testing of rotating electrical machines**
  - ✓ Insulation test
  - ✓ Continuity test
  - ✓ short-circuit
  - ✓ Resistance test
  - ✓ Functionality test

Resources required for the indicative content	
Equipment	Windings making machines, Multi-meter, PPE, Bench work Wattmeter and Energy meter
Materials	Wires, rotating machines parts, static machines parts, soldering wires, winding cord, bamboo, scotches, Insulation materials, Connectors and Gain pipes
Tools	Knives, Hammers, Screw drivers, Coil tamping tools, Mallet, Wire brushes, Wire strippers, slotting files, cutting pliers, Neon tester, Crimping tool, Multi-meter, Nose Pliers, Line tester, soldering iron, Standard wire gauge, Soldering iron, hummers, winding paddle and Electromechanical tool kit,
Facilitation techniques	▪ Demonstration (Video show) ▪ Individualized ▪ Trainer guided ▪ Group discussion ▪ Practical exercises
Formative assessment methods	▪ Written assessment ▪ Presentation ▪ Product based assessment ▪ Performance assessment

Learning outcome 3: Wind a static machine	Learning hours:25
Indicative content	

- **Formation of laminated sheets**
  - ✓ Laminated sheets shapes
  - ✓ Sheet metal cutting techniques
- **Fabrication of transformer windings (coils)**
  - ✓ Calculation of number of turns (primary and secondary)
  - ✓ Winding of step-up transformer
  - ✓ Winding of step-down transformer
- **Insertion of windings**
  - ✓ Winding insertion procedures
  - ✓ Connection of windings
  - ✓ Labelling electrical static components
- **Insulation of winding**
  - ✓ Windings insulation types
  - ✓ winding insulation methods
- **Testing of electrical static machines**
  - ✓ Insulation test
  - ✓ Continuity test
  - ✓ short-circuit
  - ✓ Resistance test
  - ✓ Polarity test
  - ✓ Turn ratio test
  - ✓ Functionality test

Resources required for the indicative content	
Equipment	Windings making machines, multi-meter, PPE, Bench work, Wattmeter, Energy meter, turn ratio tester
Materials	Wires, static machines parts, soldering wires, scotches, Insulation papers, Connectors, Gain pipes, varnish
Tools	knives, Hammers, Screw drivers, Coil tamping tools, Mallet, Wire brushes, Wire strippers, slotting files, cutting pliers, Neon tester, Crimping tool, Multi-meter, Nose Pliers, Line tester, soldering iron, Standard wire gauge, Soldering iron, hummers, Electromechanical tool kit
Facilitation techniques	• Demonstration, • Individualized, • Trainer guided, • Group discussion, • Practical exercises, • Video show
Formative assessment methods	• Written assessment, • Presentation, • Product based assessment, • Performance assessment.

Learning outcome 4: Carry out finishing activities	Learning hours:10
Indicative content	
• **Cleaning electrical machine** ✓ cleaning material ✓ Electrical machine cleaning technics • **Painting electrical machine** ✓ Electrical machine painting technics ✓ Paint curing techniques • **Developing and attaching electrical machine nameplate** ✓ Electrical machine technical specifications ✓ nameplate attaching methods • **Rearrangement of the workplace** ✓ cleaning techniques of workplace ✓ cleaning tool, materials and equipment of workplace ✓ Waste disposal procedures ✓ waste disposal treatment method • **Estimation of cost** ✓ Elements of bill of quantity (BOQ) ✓ BOQ table	

Resources required for the indicative content	
Equipment	PPE, Bench work, Painting machines, Riveting gun, Drill machine, Angle grinder and Sheet metal cutting machine, Computer, printer, scanner
Materials	Paint, thinner and rivets, Papers
Tools	knives, Hammers, Screw drivers, Coil tamping tools, Mallet, Wire brushes, Wire strippers, slotting files, cutting pliers, Neon tester, Crimping tool, Nose Pliers, Line tester, soldering iron, Standard wire gauge, Soldering iron, hummers, pen scriber, chisel, Electromechanical tool kit, Computer software
Facilitation techniques	• Demonstration • Individualized • Trainer guided • Group discussion • Practical exercises • Video show
Formative assessment methods	• Written assessment • Presentation • Product based assessment • Performance assessment

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Glossary

Wind Turbine: A device that converts kinetic energy from wind into electrical energy using rotor blades, a shaft, and a generator.

Rotor Blades: The blades attached to the rotor of a wind turbine that capture wind energy and convert it into rotational motion.

Nacelle: The housing on top of a wind turbine tower that contains the generator, gearbox, drive train, and braking system.

Yaw Control: A system used to rotate the nacelle of a wind turbine to keep the rotor blades facing the wind direction.

Pitch Control: A mechanism used to adjust the angle of the rotor blades to control the rotational speed and optimize power output.

Generator: A device within the nacelle that converts mechanical energy from the rotor into electrical energy.

Gearbox: A mechanical system that increases the rotational speed from the rotor to a suitable speed for the generator.

Cut-in Wind Speed: The minimum wind speed at which a wind turbine starts generating electricity, typically around 3-4 meters per second.

Cut-out Wind Speed: The wind speed at which a wind turbine shuts down to prevent damage, typically around 25 meters per second.

Anemometer: A device used to measure wind speed, often mounted on the nacelle or tower of a wind turbine.

Wind Farm: A collection of wind turbines in a particular area used to generate large amounts of electrical power.

Power Curve: A graph that shows the relationship between the wind speed and the electrical power output of a wind turbine.

Betz Limit: The theoretical maximum efficiency of a wind turbine, approximately 59.3%, indicating the maximum proportion of the wind's kinetic energy that can be converted into mechanical energy.

Hub: The central part of a wind turbine rotor to which the rotor blades are attached.

Tower: The structure that supports the nacelle and rotor blades at a sufficient height to capture wind energy efficiently.

Author's Note Page

Employable Skills for Sustainable Job Creation

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