



Republic of Rwanda
Ministry of Education



RTB | RWANDA
TVET BOARD

INDUSTRIAL ELECTRICAL MOTORS INSTALLATION

ELTEM401

INSTALL INDUSTRIAL ELECTRICAL MOTORS

Competence

RQF Level: 4

Learning Hours



Credits: 9

Sector: Energy

Trade: Electrical Technology

Module Type: Specific

Curriculum: ENGELT4001- TVET Level 4 in Electrical Technology

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Purpose statement	This module describes the skills, knowledge and attitude required to install an electrical motor. The learner will be able to select and arrange different materials, equipment and tools used when installing an electrical motor. He/she will be able to identify different types of DC and AC motors and run them.					
Learning assumed to be in place	Technical drawing, Industrial Electrical Control Circuits and Accessories Installation,					
Delivery modality	Training delivery		100%	Assessment		Total 100%
	Theoretical content		30%	Formative assessment	30%	50%
	Practical work:		70%		70%	
	• Group work and presentation	30%				
	• Individual 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 properly selected according to the types and use
	1.2 Control and power circuit symbols are correctly identified in accordance with electrical standard symbols
	1.3 Personal Protective Equipment (PPE)s are properly used based on safety precautions
2. Describe three phase system	2.1 Three phase AC system are properly described according to electrical parameters
	2.2 Electrical power in three phase AC is accurately calculated according to the standard formula

	2.3 Power factor is correctly tested according to the power factor improvement methods
3. Run electrical motors	3.1 Electrical DC motors are correctly identified according to DC motors types
	3.2 Electrical AC motor are appropriately identified according to AC motors types
	3.3 Drawing of electrical control and power circuit are properly interpreted according to drawn control, power circuit and automation studio software
	3.4 Electrical control and power circuit are properly installed according to the installation methods
	3.5 Electrical control and power circuit are properly tested according to the types of electrical testing
	3.6 Electrical motors are appropriately operated according to the starting methods
	3.7 Electrical motor is correctly braked according to braking method
4 Perform electrical motors post-installation activities	4.1 As-built drawing is correctly developed based on as built drawing diagram procedures
	4.2 Workplace is properly cleaned according to the cleaning technics
	4.3 Waste material are properly disposed according to the waste disposal
	4.4. Cost is correctly estimated according to the cost estimation procedures methods

Intended Knowledge, Skills, and Attitude

Knowledge	Skills	Attitude
✓ Site assessment ✓ Technical drawing	✓ Measurement with tape meter ✓ Read drawing	✓ Honest ✓ Polite ✓ Self-motivated

interpretation ✓ Tools, materials, and equipment ✓ Safety precautions ✓ Fixing machines on stands ✓ Control and power circuits ✓ Electrical test technics ✓ Ratings of machines ✓ Bill of material ✓ Market survey ✓ Budget estimation ✓ Running Parameters of the machine ✓ Warning signage ✓ As-built drawing ✓ Report elaboration	✓ Joint metal pieces ✓ Precision cutting ✓ Data recording ✓ Heavy machine Fixing process ✓ Installing electrical systems ✓ Testing electrical ✓ Operating electrical machines	✓ Skilful ✓ Decisive ✓ Punctual ✓ Humble ✓ Patient ✓ Responsible ✓ Flexible ✓ Observant ✓ Goal oriented ✓ Self-confident ✓ Attentive ✓ Cooperative ✓ Faithful
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Course content

Learning outcomes	At the end of the module the learner will be able to: 1. Carry out preliminary activities 2. Analyse three phase system 3. Run electrical motors 4. Perform electrical motors post-installation activities
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Learning outcome 1: Carry out preliminary activities		Learning hours: 10
Indicative content		
• Identification of Tools, materials, and equipment ✓ Types of Tools, materials and equipment ✓ Use of Tools, materials and equipment • Identification of Control and power circuit electrical symbols ✓ Standard electrical symbols • Using Personal Protective Equipment (PPE)s ✓ Safety precautions ✚ Identification of Personal Protective Equipment (PPE)s ✚ Function of Personal Protective Equipment (PPE)s		
Resources required for the learning outcome		
Equipment	Wattmeter, Voltmeter, Ammeter, Multi-meter, Tachometer, thermometer, frequency meter, clamp meter, earth resistance meters, insulation tester, manometer, head protection, eye and face protection, hearing protection, respiratory protection, hand protection, foot protection, body protection, first aid, DC generators, AC generators, DC motors, AC motors, computer	
Materials	Wires, cables, connectors cable clips insulators	
Tools	wire stripping plier, side cutter plier, combination plier, long nose plier, spirit level, tape measure, steel rulers, star screw driver, flat screw driver, hand drilling machine, electric screw driver, crimping tools, electrical hammer, claw hammer, ball pen hammer, mallet hammer, spring bender, hack saw, electrician knife, Allen key, steel brushes, span, scissor, Vernier caliper, winding paddle, engineering software	
Facilitation techniques	▪ Brainstorming ▪ Group discussion ▪ Physical demonstration	

Formative assessment methods I(CAT)	▪ Written assessment ▪ Oral presentation ▪ Performance assessment
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Learning outcome 2: Analyse three phase system	Learning hours: 20
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Indicative content

- **Description of three phase AC system**
 - ✓ Introduction to three phase system
 - ✓ three phase system connections
 - ✚ Star connection (voltage and current calculations)
 - ✚ Delta connection (voltage and current calculations)
- **Calculation of power in Three phase AC circuits**
 - ✓ Standard formula for types of power in AC three phase circuits
 - ✓ Phase angle (displacement)
 - ✓ Power measurements in three phase AC circuits
- **Testing Power factor improvement**
 - ✓ Methods of improving power factor
 - ✓ Benefits of improving power factor
 - ✓ Drawbacks of Low power factor

Resources required for the learning outcome
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Equipment	Synchronous motor, (PPE)s, Measuring instruments
Materials	Capacitors, wires, cables, connectors, Capacitors, Insulators, Cable Tie Contactors, Nails
Tools	wire stripping plier, side cutter plier, combination plier, long nose plier, spirit level, tape measure, Steel rulers, star screw driver, flat screw driver, Hand drilling machine, electric screw driver, crimping tools, electrical hammer, claw hammer, ball pen hammer, mallet hammer, Spring bender, hack saw, electrician knife, Allen key, Steell brushes, span, scissor, Vernier caliper
Facilitation techniques	▪ Brainstorming

	▪ Group discussion ▪ Practical exercises ▪ Documentary Research ▪ Site visit
Formative assessment methods I(CAT)	▪ Written assessment ▪ Oral presentation ▪ Performance assessment

Learning outcome 3: Run electrical motors	Learning hours: 50
Indicative content	
• Identification of electrical DC motors types ✓ Types of electrical DC motors • Identification of electrical AC motors ✓ Types of electrical AC motors • Interpretation of electrical control and power circuits and automation studio software ✓ Draw control circuit of different starting methods ✓ Draw power circuit of different starting methods ✓ Simulate power and control circuit using automation studio software • Installation of electrical control and power circuits ✓ Electrical Installation methods • Testing electrical control and power circuits ✓ Types of electrical test • Operation of electrical motors ✓ Methods of starting electrical motors  DC motor starting methods  Single phase AC motor starting methods  Three phase AC motor starting methods • Brake electrical motors ✓ Braking methods of electrical motors	

Resources required for the learning outcome	
Equipment	Wattmeter, Voltmeter, Ammeter, Multi-meter Tachometer, Thermometer, Frequency meter, Clamp meter, Earth resistance meters, Insulation tester, Manometer, Head Protection, Eye and Face Protection, Hearing Protection, Respiratory Protection, Hand Protection, Foot Protection, Body Protection, Fall Protection, Skin Protection, First aid, DC generators, AC generators, DC motors, AC motors, Computer
Materials	Contactors, Thermal relays, Switches, Fuses, OFF Delay, ON Delay, Wires, Timer, Switch (Analog)&Digital Timer, Timer relays, Lamps, Cable Tie, Lamp holders Screws, Nut, Bolt, Nails, Connectors, Cable clips, Cables, Insulators, wires, scotches, insulator tape markers, pipes and hoses, pipe fittings, Push button, Auxiliary contact, Switch box, Junction boxes, Rails, Miniature circuit breaker, Spring, Female plugs, Male Plugs, Extension Cords, Drill bits, Soldering wires, winding cord, cable lugs, distribution board, RCD (residual circuit device).
Tools	Wire stripping plier, Side cutter plier, Combination plier, Long nose plier, Spirit level Tape measure, Steel rulers, Star screw driver, Flat screw driver, Hand drilling machine, Electric screw driver, Crimping tools, Electrical hammer, Claw hammer, Ball pen hammer, Mallet hammer, Spring bender, Hack saw, Electrician knife, Allen key, engineering software.
Facilitation techniques	▪ Brainstorming ▪ Group discussion ▪ Physical demonstration ▪ Practical exercises ▪ Documentary Research ▪ Brainstorming on asynchronous motors
Formative assessment methods / (CAT)	▪ Written Assessment ▪ Oral Assessment ▪ Practical Assessment

Learning outcome4: Perform electrical motors post-installation activities		Learning hours: 10
Indicative content		
• Develop as-build drawing ✓ As-built drawing diagram procedures • Clean work place ✓ Cleaning techniques ✓ Tools, materials and equipment used in cleaning • Dispose waste material ✓ Types of waste materials ✓ Waste disposal methods ✓ Cost estimation procedures ✚ Elements of Bill of Quantity (BOQ) ✚ BOQ table		
Resources required for the learning outcome		
Equipment	Air blower	
Materials	Water, soap,	
Tools	Brush, Cycle bin, cleaning cloth	
Facilitation techniques	▪ Brainstorming ▪ Physical demonstration ▪ Practical exercises	
Formative assessment methods /(CAT)	▪ Written assessment ▪ Oral assessment ▪ Performance assessment	

Integrated/Summative assessment

Integrated situation

KFC Tea Factory company located in NIBOYI Sector, KICUKIRO district has inaugurated a new tea processing workshop composed with one main electrical motor, 3 phase 380/660V, 150 kW, 50Hz, power factor 0,8 driving a set of interconnected mechanical systems. As motor operator in KFC Tea Factory, you are asked by your technical director to install the motor with the right connection (star delta starter) and provide the way of reversing its rotational direction. The power supply is 220/380V. Those activities should be done within 5 hours

Resources

Tools	Wire stripping plier, Side cutter plier, Combination plier, long nose plier, Spirit level Tape measure, Steel rulers, Star screw driver, Flat screw driver, Hand drilling machine, Electric screw driver, Crimping tools, Electrical hammer, Claw hammer, Ball pen hammer, Mallet hammer, Spring bender, Hack saw, Electrician knife, Allen key, Span, cutting tools, Adjusting tools, Screws drivers, Cable holders
Equipment	Overall, Helmet, Gloves, Ear muff, Nose protection mask, Safety shoes, Goggles, Star-Delta Starter, Digital multi-meter, Thermometer, Tachometer, Phase Tester Frequency meter, Star-Delta motor.
Materials/ Consumables	Connecting cables, Connection boxes, Pipes, Contactors Emergency stop switch, Switching devices, Circuit breakers, Thermal relays, Electrical cables, Insulation tape.

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			Yes	No	
1. Carry out preliminary activities (10%)	1.1 Tools, materials, and equipment are properly selected according to the types and use	Tools, materials and equipment are well			1

		selected			
		Tools, materials and equipment are well used			2
	1.2 Control and power circuit symbols are correctly identified in accordance with electrical standard symbols	Control and power circuit symbols are well identified			4
	1.3 Personal Protective Equipment (PPE)s are properly used based on safety precautions	Personal Protective Equipment (PPE)s are well used			3
2. Describe three phase system (20%)	2.1 Three phase AC system connections are properly identified according to electrical parameters	Line voltage and line current in Star connection are well identified			6
		Line voltage and line current in Delta connection is well identified			6
	2.2 Electrical power in	Electrical			8

	three phase AC is accurately calculated according to the standard formula	power in three phase AC is well calculated			
3. Run electrical motors (60%)	3.1 Electrical DC motors are correctly Identified according to DC motors types	DC series motor is well Identified			3
		DC shunt motor is well Identified			3
		DC compound motor is well Identified			3
	3.2 Electrical AC motor are appropriately Identified according to AC motors types	Single phase AC motor are well identified			4
		Three phase AC motor are well identified			4
	3.3 Drawing of electrical control and power circuit are properly interpreted according to drawn control and power circuit	Drawing of control and power circuit are well interpreted			4

		Drawing of electrical power circuit are well interpreted			4
		Simulation of power and control circuit using automation studio software is well done			4
	3.4 Electrical control and power circuit are properly installed according to the installation methods	Electrical control circuit are well installed			4
		Electrical power circuits are well installed			4
	3.5 Electrical control and power circuit are properly tested according to the types of electrical testing	Electrical control circuit is well tested			4
		Electrical power circuit is well tested			4

	3.6 Electrical motors are appropriately operated according to the starting methods	DC motor is well operated			4
		Single phase AC motor is well operated a			4
		Three phase AC motor is well operated			4
	3.7 Electrical motor is correctly braked according to braking method	Electrical motor is well braked			4
4.Perform electrical motors post-installation activities (10%)	4.1 Workplace is properly cleaned according to the cleaning technics	Workplace is well cleaned			3
	4.2 Waste materials are properly disposed according to the waste disposal methods	Waste materials are well disposed			3
	4.3. Cost is correctly estimated according to the cost estimation procedures	Cost is well estimated			3
Total marks		100			
Percentage Weightage		100%			
Minimum Passing line % (Aggregate):		70%			

List of abbreviations

1. **ELT:** Electrical Technology
2. **EM:** Electrical Motor
3. **ENG:** Energy
4. **TVET:** technical vocation and education training
5. **RTB:** Rwanda TVET Board
6. **PPE:** Person Protective Equipment
7. **CAT:** Continuous Assessment Test

Reference

1. J. Bird, Electrical and Electronic Principles and Technology, Fourth edi., vol. 4, no. 1. Elsevier Ltd., 2016
2. Electric Motors, J.Kirtley ,
3. A textbook of electrical technology, Volume 2, B.L. Theraja, A.K. Theraja
4. AC motors starting and protection systems, Schneider Electrics
5. Bulletin;1991: Fundamental of Motor Control

Glossary

Motor: A device that converts electrical energy into mechanical energy.

DC motor: is any of a class of rotary **electrical** motors that converts direct current (DC) **electrical** energy into mechanical energy

AC motor is an **electric motor** driven by an alternating current (AC

Power Factor: The ratio of “apparent power” (expressed in kVA) and true or “real power” (expressed in kW).

A power circuit: is defined as any circuit used to carry electricity that operates a load.

A control circuit: is used to ensure that the motor is started and stopped in a safe manner for both the operator and the equipment.

The three-phase system: is a system that consists of a three-phase voltage source connected to a three-phase load by means of transformers and transmission lines

As-built drawing: is defined as a drawing created and submitted by a contractor after completing the project.

Waste (or wastes) materials: are unwanted or unusable materials. Waste is

any substance discarded after primary use, or is worthless, defective and of no use.

Cost estimation: is the process of forecasting the financial and other resources needed to complete a project within a defined scope. Cost estimation accounts for each element required for the project from materials to labour and calculates a total amount that determines a project's budget

A bill of quantities (commonly known as BOQ or BQ): is a document prepared by a quantity surveyor or cost consultant to define the quality and quantity of works required to be carried out by the main contractor to complete a project