



Republic of Rwanda
Ministry of Education



RTB | RWANDA
TVET BOARD

ELTIC401

INDUSTRIAL ELECTRICAL CONTROL CIRCUITS AND ACCESSORIES INSTALLATION

INSTALL INDUSTRIAL CONTROL CIRCUIT AND ACCESSORIES

Competence

RQF Level: 4

Learning Hours



90

Credits: 9

Sector: Energy

Trade: Electrical Technology

Module Type: Specific

Curriculum: ENGELT 4001-TVET Level 4 in Electrical Technology

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Purpose statement	This module describes the knowledge, skills and attitude required to install industrial electrical control circuits and accessories. At the end of this module, the learner will be able to install protective devices according to the types and sizes of load, install Industrial control circuit component, and install electrical accessories. He/she will be able to estimate the cost related to industrial electrical control circuits, accessories and testing of electrical control circuit. Qualified learner deemed competent to this competency might work under minimum supervision with others on routine tasks in various industries.					
Learning assumed to be in place	Perform industrial technical drawing					
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 appropriately identified based on the types and use
	1.2 Personal Protective Equipment (PPE)s are properly used based on safety precautions
	1.3 Work place is properly organized according to the arrangement method
	1.4 Control circuit diagram is correctly designed in accordance with elements of control circuit diagram
2. Carry out measurement and instrumentation	2.1 Measurement instruments are clearly identified according to the category and use
	2.2 Measurement methods are properly described in line with parameters being measured
	2.3 Measurement equipment and devices are properly handled according to the working principles
	2.4 Measurements are correctly executed according to measurement technics
3. Assemble electrical control circuits	3.1 Materials for control circuits installations are properly selected according to the drawn electrical diagrams
	3.2 Control circuit is properly simulated based on simulation software
	3.3 Electrical control circuits are clearly identified according to the electrical machines starting/running modes
	3.4 Electrical control circuit components are properly fixed according to the fixing techniques
	3.5 Components of electrical control circuit are appropriately installed according to the installation guidelines
4. Perform testing of electrical control circuit	4.1 Continuity, insulation and short circuit are properly tested according to the testing technics
	4.2 Power supply is appropriately tested according to the Power supply types and electrical rating parameters
	4.3 Components of electrical control circuit are appropriately tested according to the functionality
5. Perform control	5.1 components of electrical control circuits are correctly labelled according

circuit post-installation activities	to labelling methods
	5.2 As-built diagram is correctly developed based on As-built diagram drawing procedures
	5.3 Workplace is properly rearranged according to the wastes disposal procedures
	5.4 Cost is correctly estimated according to the cost estimation procedures

Intended Knowledge, Skills, and Attitude

Knowledge	Skills	Attitude
✓ Electrical Fundamentals	✓ Use of safety precaution	✓ Motivated
✓ Circuit Diagrams and Schematics	✓ Proper use of measurement instruments	✓ Good common sense
✓ Electrical Codes and Regulations	✓ Electrical drawing skills	✓ Self-confident
✓ Control Components	✓ Connection skills	✓ Task oriented
✓ Wiring and Termination	✓ Communication Skills	✓ Honest
✓ Testing and Troubleshooting	✓ Electrical control circuit Skills	✓ Customer focused
✓ Safety Practices	✓ Internet Skills	✓ Energetic
✓ Electrical Theory and Practice	✓ Reporting skills	✓ Able to work independently
✓ Industrial Control Systems	✓ Troubleshooting skills.	✓ Integrity
✓ Instrumentation	✓ machine skills	✓ Strong moral character
✓ National and Local Electrical Codes	✓ Electrical Symbols and Diagrams skills	✓ Personal hygiene/grooming
✓ Control	✓ Electrical Termination skills	✓ Time management
	✓ Power supply skills	✓ Open minded
	✓ Proper testing	✓ Organized
	✓ Proper bills of	✓ Maintain health
		✓ Positive work ethics
		✓ Gender sensitivity
		✓ Flexible
		✓ Problem solver
		✓ Goals oriented
		✓ Teamwork and

Devices ✓ Electrical Symbols and Diagrams ✓ Electrical Principles ✓ Protective devices ✓ Cost estimation	materials ✓ Use of protective device	Collaboration ✓ Professionalism ✓ Strong Work Ethic ✓ Adaptability ✓ Safety Consciousness ✓ Customer Service Orientation
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	Course content
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Learning outcomes	At the end of this module, the learner will be able to: 1. Carry out preliminary activities
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	2. Carry out measurement and instrumentation 3. Assemble components of electrical control circuits 4. Perform testing of electrical control circuit 5. Estimate cost
Learning outcome 1: Carry out preliminary activities	Learning hours:10
Indicative content	
• Identification of tools, materials and equipment used in industrial control circuit installation ✓ Definition of materials, tools and equipment ✓ Types of tools, materials and equipment ✓ Application of tools, materials and equipment • Personal protective equipment on safety precautions ✓ Types of PPE ✓ Use of PPE • Arrangement of tools, materials and equipment in workplace ✓ Arrangement methods ✚ Arrangement by type ✚ Arrangement by manufacturer instruction Method ✚ Arrangement by size • Designing control circuit diagram ✓ Elements of control circuit diagram ✓ Drawing of various control circuit diagrams	
Resources required for the learning outcome	
Equipment	PPE, powered electrical screw driver, multi-meter, reverting machine, drilling machine, Electric grinder, clamp-on ammeter, megohmmeter, wattmeter, phase sequence tester, multi-function tester
Materials	Electric cables, Junction Box, Lamps, Socket plug, Lamp holder, Electrical wires, Earth wire, Mild Steel tube
Tools	Screw Driver kit, Pliers Kit, Measurement tape, Spirit Level, Hack saw,

	Electric knife, Spanners Kit, Electrical wire short, Ladder, Notebook / Pen
Facilitation techniques	▪ Demonstration and simulation ▪ Individual and group work, ▪ Practical exercise ▪ Individualized ▪ Trainer guided ▪ Group discussion
Formative assessment methods /(CAT)	▪ Written assessment ▪ Oral presentation ▪ Performance assessment ▪ Product based assessment ▪ Project based assessment

Learning outcome 2: Carry out measurement and instrumentation	Learning hours:20
Indicative content	
• Identification of measuring instruments • Element of generalized measurement system ✓ Definition of measurement instrument ✓ Purpose of measurement instrument ✓ Primarily sensing Element ✓ Variable conversion element ✓ Data presentation element • Measurement methods ✓ Direct method ✓ Indirect method • Types of instruments ✓ Mechanical instruments ✓ Electrical instruments ✓ Electronic instruments	

- **Measurable parameters**
 - ✓ Voltage, Current, Resistance, Power, Inductance, Energy, Frequency, Capacitance, Power factor
- **Operation of measuring equipment and devices**
 - ✓ Watt meter, Earth resistance meter, Clamp ammeter, Insulation tester, Voltmeter, Ammeter, Tachometer, Multi-meter, Thermometer, Manometer, Frequency meter

Resources required for the learning outcome

Equipment	Projector, computer, Wattmeter, Earth resistance meter, Clamp ammeter, Insulation tester, Voltmeter, Ammeter, Tachometer, Multi-meter, Thermometer, Manometer, Frequency meter
Materials	Flip chart, chalks, marker pen and internet
Tools	Books ,hand-out note , compass, tape measure, spirit level
Facilitation techniques	▪ Demonstration ▪ Brainstorming ▪ Individual ▪ Trainer guided ▪ Group discussion
Formative assessment methods /(CAT)	▪ Oral presentation ▪ Written assessment ▪ Performance based assessment ▪ Product based assessment

Learning outcome 3: Assemble components of electrical control circuits

Learning hours:35

Indicative content

- **Selection of materials for control circuit installation**
 - ✓ Interpretation of drawing symbols
 - ✓ Analysis of control circuit installation drawing
 - ✚ Functionality of Control circuit diagram element
- **Simulating control circuit**
 - ✓ Simulation software

 Automation studio

- ✓ Identification of electrical control circuit
- ✓ Direct on line control circuit
- ✓ Star delta control circuit
- ✓ Autotransformer control circuit
- ✓ Stator resistance elimination Circuit
- ✓ Rotor resistance elimination circuit
- **Fixing electrical control circuit components**
 - ✓ Fixing techniques
- **Installation of electrical control circuit components**
 - ✓ Installation of protective devices
 -  Circuit breakers
 -  Protection relays
 -  Overcurrent protection devices
 -  Surge protection devices
 -  RCD
 -  Lighting protection devices and equipment
 - ✓ Installation of Switching devices
 -  Contactors
 -  ON/OFF push buttons
 -  Emergency stop switch
 -  Rotary switch (multi-position switch)
 -  Control switch
 -  break switch
 -  Electronic relays
 -  Timer delay (ON/OFF)
 -  Timer switch

Resources required for the learning outcome

Equipment	Projector, computer, watt meter, earth resistance meter, clamp ammeter, insulation tester, voltmeter, ammeter, tachometer, multi-meter, thermometer, manometer, frequency meter
Materials	Fuse, circuit breaker, miniature circuit breaker, residual current device ,

	thermal overload relay , surge arrestor
Tools	Screw drives, pliers, spanners, adjustable spanner
Facilitation techniques	▪ Demonstration ▪ Brainstorming ▪ Individual, ▪ Trainer guided ▪ Group discussion
Formative assessment methods /(CAT)	▪ Oral presentation ▪ Written assessment ▪ Performance based assessment ▪ Product based assessment

Learning outcome 4: Perform testing of electrical control circuit	Learning hours: 15
Indicative content	
• Testing technics ✓ Continuity testing technics ✓ insulation testing technics ✓ short circuit testing technics • Testing power supply ✓ DC power supply ✓ AC power supply ✚ Single phase supply parameters ✚ Three phase supply parameters • Functionality Test of electrical control circuit Components ✓ protective devices ✚ normal condition ✚ faulty condition ✓ Switching devices (ON and OFF operation)	

Resources required for the learning outcome

Equipment	Motors, wattmeter, earth resistance meter, clamp ammeter, insulation tester, voltmeter, ammeter, tachometer, multi-meter, thermometer, manometer, frequency meter
Materials	Wires, clips, insulation tape , Contactors, switches, circuit breaker, screws
Tools	Screw drives, pliers, spanners, adjustable spanner, tester
Facilitation techniques	▪ Demonstration ▪ Brainstorming ▪ Individual ▪ Trainer guide ▪ Group discussion
Formative assessment methods /(CAT)	▪ Oral presentation ▪ Written assessment ▪ Performance based assessment ▪ Product based assessment

Learning outcome 5: Perform control circuit post-installation activities

Learning hours:10

Indicative content

- **Labelling of electrical control circuit components**
 -  Labelling methods
 -  Heat Shrink Labels
 -  Self-Laminating Wire Labels
 -  Wire/Cable Tags.
- Developing as-build diagram
 - ✓ As-built diagram drawing procedures
- **Rearrangement of workplace**
 - ✓ cleaning techniques of workplace
 - ✓ cleaning tool, materials and equipment of workplace
 - ✓ Waste disposal procedures

✓ waste disposal treatment method • Cost estimation ✓ Elements of bill of quantity (BOQ) ✓ BOQ table	
Resources required for the learning outcome	
Equipment	Computer, projector, printer, barcode reader
Materials	Papers, marker, pen, cable tie, nails
Tools	Label design software, scissor, cutter, knife, screw driver, hammer
Facilitation techniques	▪ Demonstration ▪ Brainstorming ▪ Individual ▪ Trainer guided ▪ Group discussion
Formative assessment methods /(CAT)	▪ Oral presentation ▪ Written assessment ▪ Performance based assessment ▪ Product based assessment

Integrated/Summative assessment

Integrated Situation

Eng. PHILOS, Technical Director of ENERGY TECHNOLOGY Ltd has assigned different industrial electrical installation task to his group of electricians. You as one of electrician you have been assigned to install control circuit. This industry has two supplies of single phase (220V AC/50 HZ) and every supply contains its indicator which notify the type of supply operating. The 1st supply is priority and once that supply fails indicator of first supply provide notification then second supply activate automatically to keep

loads running. When the 1st supply has returned back, the 2nd supply takes 5 seconds to make 1st supply keep supplying the loads. As an electrician who is willing to compete with others at market you are requested to implement the control circuit and this work should be implemented within 3 hours.

Resources

Tools	Cutting pliers, stripping pliers, hummer, screw kits, measuring tape, split lever, phase tester.
Equipment	PPEs, clamp on meter, multi-meter.
Materials/ Consumables	Conductors, signalization lamps, contactors, relays, timer, circuit breaker, cable clips, insulation tape, push button, connectors, RCD.

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 appropriately identified based on the types and use	Tools, materials and equipment are well identified			2
		Tools, materials and equipment are well used			2
	1.2 Personal Protective Equipment (PPE)s are properly used based on safety precautions	PPEs are well worn			2
	1.3 Work place is properly organized according to the arrangement method	Hazards are well eliminated			1
		Working place is well organized			2
	1.4 Control circuit diagram is correctly designed in accordance with elements of control	Elements of control circuit are well designed			3

	circuit diagram				
2. Carry out measurement and instrumentation (15%)	2.1 Measurement instruments are clearly identified according to the category and use	Measurement instrument are well identified			4
	2.2 Measurement methods are properly described in line with parameters being measured	Measurement methods are well described			3
	2.3 Measurement equipment and devices are properly handled according to the working principles	Voltmeter is well handled			1
		Ammeter is well handled			1
		Multi-meter is well handled			1
		Ohmmeter is well handled			1
	2.4 Measurements are correctly executed according to measurement technics	Voltmeter is well used			1
		Ammeter is well used			1
		Multi-meter is well used			2
3. Assemble electrical control circuits (40%)	3.1 Materials for control circuits installations are properly selected according to the drawn electrical diagrams	Materials for control circuits installations are well selected			8
	3.2 Control circuit is properly simulated based on simulation software	Circuit simulation is well done			5

	3.3 Electrical control circuits are clearly identified according to the electrical machines starting/running modes	Control circuits are well identified			10
	3.4 Electrical control circuit components are properly fixed according to the fixing techniques	Circuit breaker is well fixed			1
		Contactor/s is/are well fixed			1
		Relay is well fixed			1
		Command devices are well fixed			2
		Timer is well fixed			2
	3.5 Components of electrical control circuit are appropriately installed according to the installation guidelines	Control circuit's elements are well installed			10
4. Perform testing of electrical control circuit (20%)	4.1 Continuity, insulation and short circuit are properly tested according to the testing technics	Continuity is well tested			2
		Insulation resistance is well tested			3
		Short-circuit test is well tested			3
	4.2 Power supply is appropriately tested according to the Power supply types and electrical rating parameters	Power supply is well tested			2
	4.3 Components of	Circuit breaker is well			2

	electrical control circuit are appropriately tested according to the functionality	tested			
		Command devices are well tested			3
		Relay is well tested			2
5. Perform control circuit post-installation activities (15 %)	5.1 Components of electrical control circuits are correctly labelled according to labelling methods	Electrical control circuit elements are well labelled			4
	5.2 As-built diagram is correctly developed based on as-built diagram drawing procedures	As-built diagram is well developed			5
	5.3 Workplace is properly rearranged according to the wastes disposal procedures	Working place is well rearranged			3
	5.4 Cost is correctly estimated according to the cost estimation procedures	The cost of installation is well estimated			4
Total marks		100			
Percentage Weightage		100 %			
Minimum Passing line % (Aggregate):		70%			

1. List of abbreviations

1. **RTB:** Rwanda Tvet Board
2. **TVET:** Technical and Vocational Education Training
3. **CAT:** Continuous Assessment Test
4. **DC:** Direct Current
5. **AC:** Alternating Current
6. **PPE:** Personal Protective Equipment
7. **RCD:** Residual Current Device
8. **BOQ:** Bill Of Quantity

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Glossary

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.

A power supply: is an electrical device that supplies electric power to an electrical load examples for others.

A measuring instrument: is a device to measure a physical quantity

Voltage: is the pressure from an electrical circuit's power source that pushes charged electrons (current) through a conducting loop, enabling them to do work such as illuminating a light

Current: is a flow of electrical charge carriers, usually electrons or electron-deficient atoms

Resistance: is a measure of the opposition to current flow in an electrical circuit

Power: is ability to do or act; capability of doing or accomplishing work.

Capacitance: is the ability of a component or circuit to collect and store energy in the form of an electrical charge.

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

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 labor 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

A single-phase supply: the flow of electricity is through a single conductor.

A three-phase supply: consists of three separate conductors that are needed for transmitting electricity.

Energy: is the ability to do work