

## 12.1.0 ELECTRICAL INSTALLATIONS TECHNOLOGY I

### 12.1.0.1 Introduction

This module unit is designed to equip the trainee with knowledge, skills and attitude necessary to carry out electrical installation work in domestic premises and related environments.

### 12.1.0.2 General Objectives

By the end of the module unit, the trainee should be able to:

- a) understand the operations of final circuits
- b) demonstrate safety awareness when handling electrical tools and equipment
- c) appreciate the correct use of tools and equipment
- d) determine appropriate types of cables for a particular purpose
- e) outline the distribution network in power systems
- f) apply relevant principles to operate electrical machines
- g) provide maintenance and service to electrical tools, equipment, cabling and accessories

### 12.1.0.3 Module Unit Summary and Time Allocation

#### Electrical Installation I

Code	Sub-Module Unit	Content	Time Hrs
12.1.1	Electrical Final Circuits	<ul style="list-style-type: none"> <li>• Definition of final circuit</li> <li>• Description of sequence of control</li> <li>• Connection of lighting circuits</li> <li>• Ring and radial final circuits</li> <li>• Procedure for testing and inspection</li> <li>• Types of accessories and equipment</li> <li>• I.E.E. regulations</li> </ul>	44
12.1.2	Electrical Power Supply	<ul style="list-style-type: none"> <li>• Authorities for supply systems</li> <li>• Types of power supply systems</li> </ul>	37

		<ul style="list-style-type: none"> <li>• Outline of electrical power supply system</li> </ul>	
12.1.3	Cables	<ul style="list-style-type: none"> <li>• Types and sizes</li> <li>• Construction</li> <li>• Cable sizing</li> <li>• Factors affecting cable ratings</li> </ul>	23
12.1.4	Protection And Earthing Of Electrical Installations	<ul style="list-style-type: none"> <li>• Reason for earthing</li> <li>• Terminologies</li> <li>• Types of fuses</li> <li>• Earthing of an electrical installation</li> <li>• Earth current protection</li> <li>• Methods of earthing</li> <li>• Parts of earth</li> <li>• Testing for earth</li> </ul>	33
12.1.5	Electrical Machines I	<ul style="list-style-type: none"> <li>• Construction of ac machines</li> <li>• Construction of dc machines</li> </ul>	33
<b>Total Time</b>			<b>170</b>

## 12.1.1 ELECTRICAL FINAL CIRCUITS

### *Theory*

#### 12.1.1T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) define a final circuit
- b) describe the sequence of control equipment at the consumer's intake point.
- c) Explain the connection of lighting circuit using joint boxes
- d) explain ring and radial final circuits
- e) state procedure for testing a final circuit
- f) describe the different types of accessories
- g) state the relevant IEE regulations

#### *Competence*

The trainee should have the ability to:

- i) Interpret electrical layout diagrams for final circuits
- ii) Draw wiring diagrams for final sub-circuits
- iii) Install lighting circuits
- iv) Install power circuits

- v) Apply manipulative skills to come up with lighting circuits for various purposes
- vi) performing electrical tests on an installation
- vii) performing inspection a completed domestic installation
- viii) Estimate materials for electrical installation work

### *Content*

#### 12.1.1T 1 Final Circuit

- i) Definition
- ii) Different type of final circuits
- iii) Relevant I.E.E regulations

#### 12.1.1T 2 Sequence of control

- i) Description of equipment at intake point
- ii) Consumers' equipment
- iii) Power supply's equipment
- iv) Correct sequence of connection
- v) Relevant I.E.E regulations

#### 12.1.1T 3 Lighting circuits

- i) Loop in method
- ii) Use of ceiling roses
- iii) Use of joint boxes
- iv) One way switching

- v) Two way switching
- vi) Two way and intermediate switching

12.1.1T 4 Ring and radial Power circuit

- i) Socket outlet (3A)
- ii) Protective devices
- iii) Relevant I.E.E regulations requirements
- iv) Water heater circuits
- v) Instantaneous water heater
- vi) Non instantaneous water heater
- vii) Astern type water heater
- viii) Relevant I.E.E regulations requirements

12.1.1T 5 Testing and inspection

- i) Visual inspection
- ii) Verification of polarity
- iii) Earthing tests
- iv) Insulation resistance test
- v) Continuity of ring continuity test
- vi) I.E.E regulations for tests and inspection of an electrical installation

12.1.1T 6 Accessories and equipment

- i) Definition
- ii) Accessory
- iii) switch plug

- iv) Socket outlet
- v) joint box
- vi) distribution board
- vii) Types of accessories for lighting circuits
- viii) Switches
- ix) Lamp holders
- x) Ceiling roses
- xi) joint boxes
- xii) (relevant I.E.E regulations)
- xiii) Clock connections
- xiv) Electric shaver sockets

12.1.1T 7 Relevant I.E.E.

- regulations
- i) Other types of accessories
- ii) Consumers control unit
- iii) Distribution board
- iv) Observe the relevant IEE regulations

*Practice*

*12.1.1P0 Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) interpret electrical drawings and complete install lighting final circuits
- b) install ring and radial final circuits
- c) inspect and test final circuits

- d) state the relevant IEE regulations in each case
- e) observe safety, standards and good workmanship while performing electrical installation work.
- f) estimate material requirements for an installation work
- g) carry out quality control checks

*Content*

- 12.1.1P1 Interpretation of electrical drawings
  - i) Symbols
  - ii) Dimensions and tolerance
  - iii) Lay out
  - iv) Special conditions
- 12.1.1P2 Installation of ring and radial final circuits
  - i) Taking measurements
  - ii) Level, tight and neat fixing of components
- 12.1.1 P3 Inspection and tests of final circuits
- 12.1.1P4 Testing and inspection
  - i) Visual inspection
  - ii) Testing procedures for all the tests
  - iii) Verification of polarity
  - iv) Earthing tests
  - v) Insulation resistance test

- vi) Continuity of ring continuity test
- vii) Expected readings
- 12.1.1P5 I.E.E regulations for tests and inspection of an electrical installation
- 12.1.1P6 Safety observation in electrical work
  - i) Safety of self
  - ii) Safety of others
  - iii) Safety of tools and equipment
- 12.1.1P7 Material estimate
  - i) Measured items
  - ii) Numbered items
  - iii) Fixes
- 12.1.1P8 Quality control checks
  - i) Correct usage of tools and measuring instruments
  - ii) Good quality finish and appearance
  - iii) Correct measurements and accuracy
  - iv) Application of set test procedures and
  - v) Performance as per specifications of the design

*Suggested teaching and learning resources*

- i) Electrical tool kit
- ii) PVC conduits
- iii) PVC sheathed cable
- iv) PVC mini-trunking
- v) Various cable sizes

- vi) Vertical wooden boards, masonry walls
- vii) Ohmmeter
- viii) Test lamp
- ix) Multi-tester for continuity and insulation resistance tests

### 12.1.2 ELECTRICAL POWER SUPPLY

#### 12.1.2T0 *Specific Objectives*

- By the end of the sub-module unit, the trainee should be able to:
- a) explain the main work of the authorities for power production in Kenya
  - b) describe various types of power supply systems
  - c) describe the outline of the various power transmission and distribution systems from generation to the consumer
  - d) describe different transmission and distribution systems
  - e) compare A.C. and D.C. systems of transmission

#### *Competence*

The trainee should have the ability to select and carry out installation for

a typical distribution system for a small plant

#### *Contents*

- 12.1.2T1 Authorities of power production
  - i) Kenya Power and Lighting Company (K.P.L.C)
  - ii) Ken Gen
  - iii) Independent power producer
  - iv) The electricity board
  - v) The development authorities
- 12.1.2T2 Power supply systems
  - i) Typical layout diagrams
  - ii) Types of generating stations
  - iii) Transmission stage
  - iv) Distribution stage
- 12.1.2T3 Transmission and distribution systems
  - i) D.C two wire
  - ii) D.C three wire
  - iii) A.C two wire
  - iv) A.C. four wire
  - v) Radial and ring distribution
- 12.1.2T4 AC and DC systems
  - i) Advantages of each
  - ii) Disadvantages of each
- 12.1.2T5 AC and DC power systems

#### *Practice*

- 12.1.2P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) select and carry out installation for a typical distribution system for small industrial plant
- b) observe the IEEE regulations on transmission and distribution

*Content*

- 12.1.2P1 Electrical installation
  - 3 phase, 4 wire distribution system with single phase loads
- 12.1.2P2 Safety observation
  - i) Personal safety
  - ii) Safety for others

*Suggested teaching and learning resources*

- i) 3 phase distribution board
- ii) Consumer control units
- iii) Planned industrial visit

**12.1.3 CABLES**

*Theory*

12.1.3T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) state types and sizes of cables

- b) describe the construction of cables
- c) calculate the correct size of cable for a given load using appropriate tables and rating factors
- d) explain the factors affecting cable ratings
- e) explain the methods of joining metals and their applications

*Contents*

- 12.1.3T1 Types and sizes of cables
  - i) Types of conductors
  - ii) Copper
  - iii) Copper properties
  - iv) Aluminum
  - v) Aluminum properties
  - vi) Cable sizes
  - vii) Determine the size of a cable given the strand diameter
  - viii) Applications of cable types

- 12.1.3T2 Construction
  - i) Armoured
  - ii) Non-armoured
  - iii) Purposes of stranding

- 12.1.3T3 Cable size calculations
  - Cable ratings

- 12.1.3T4 Factors affecting cable rating

- 12.1.3T45 Cable joints and terminations
- i) Cable joints
  - ii) Soldering twisted tee joints using blow lamp
  - iii) Soldering joints using pot and ladle
  - iv) Cable terminations
  - v) Clamping method
  - vi) Crimping method
  - vii) Regulations regarding joints
  - viii) Dangers of poor joints
  - ix) dry joint
  - x) high resistance in joints

*Practice*

- 12.1.3P0 *Specific Objectives*  
By the end of the sub-module unit, the trainee should be able to:
- a) make various cable joints such that they are electrically and mechanically sound
  - b) solder the joints effectively
  - c) perform cable terminations
  - d) perform tests on cable joints

*Content*

- 12.1.3P1 Performance of cable joints
- 12.1.3P2 Soldering procedure

- i) Soldering by use of pot and ladle
  - ii) Soldering by use of electric soldering iron
  - iii) Soldering by use of blow lamp
- 12.1.3P3 Cable terminations
- IEE regulations on cable joints
- 12.1.3P4 Tests on cable joints

*Suggested Learning Resources*

- i) Chalkboard
- ii) Books
- iii) Various types of cables
- iv) I.E.E regulations table for cable data
- v) Pot and ladle
- vi) Soldering gun
- vii) Crimping tool

**12.1.4T0 PROTECTION AND EARTHING OF ELECTRICAL INSTALLATIONS**

*Theory*

- 12.1.4T0 *Specific Objectives*  
By the end of the sub-module unit, the trainee should be able to:
- a) explain the reason for earthing
  - b) define various terminologies used in earthing and protection of electrical installations



- c) describe the different types of fuses
- d) define terms applied to earthing of an installation
- e) explain the different methods of earth current protection
- f) explain the different methods of earthing
- g) explain parts of an earthing system
- h) describe the tests for an earthing system

*Competence*

The trainee should have the ability to:

- i) Select and use circuit protection
- ii) Earth a domestic installation
- iii) Test the operation of various protective devices
- iv) Perform earth loop impedance tests

*Content*

12.1.4T1 Reasons for earthing

12.1.4T12 Definition of terms

- i) Over current
- ii) Short circuit
- iii) Earth leakage
- iv) Close excess current protection
- v) Coarse excess current protection
- vi) Discrimination
- vii) Fusing factor

viii) Fusing current

12.1.4T3 Types of fuses

- i) Rewirable fuses
- ii) Cartridge fuses
- iii) High rupturing capacity fuses
- iv) Construction and operation of various types of fuses
- v) Application of various fuses

12.1.4T4 Earthing terminologies

- i) Earth
- ii) Earthed
- iii) Solidly earthed
- iv) Earth electrode
- v) Earthing lead
- vi) Earth continuity conductor
- vii) Live metal work
- viii) Protective Multiple Earthing (PME)
- ix) Earth resistivity
- x) Earth resistance

12.1.4T5 Methods of earth currents protection

- i) Fuses
- ii) Circuit breakers
- iii) operation of excess current and earth leakage protection devices

12.1.4T6 Methods of earthing

- i) Connection of metal work to the supply earth conductor
- ii) Continuous Earth Wire (CEW)

- iii) The earth electrode
- iv) Protective Multiple Earthing (PME)
- v) Automatic fault protection
- vi) Miniature circuit breakers
- vii) Current operated earth leakage circuit breaker
- viii) Voltage operated earth leakage circuit breaker

- 12.1.4T7 Parts of an earthing system
- i) Earth Continuity Conductor (E.C.C)
  - ii) Earthing lead
  - iii) Earth electrode

- 12.1.4T8 Tests
- i) Earth continuity
  - ii) Earth loop impedance
  - iii) Earth loop resistance

*Practice*

*12.1.4P0 Specific Objectives*

- By the end of the sub-module unit, the trainee should be able to:
- a) perform earthing of domestic installation
  - b) install residual current circuit breakers
  - c) measure earth loop impedance
  - d) measure of earth resistance area

- e) carry out various earthing tests

*Contents*

- 12.1.4P1 Protection of domestic installations
- 12.1.4P2 Installation of residual current circuit breaker
  - i) Tests on the circuit breaker
  - ii) Installation of the circuit breaker
- 12.1.4P3 Measurement of earth loop impedance
  - i) Determination of the loop
  - ii) Identification of the test instrument

*Suggested teaching and learning resources*

- i) High Breaking Capacity(HBC) fuse
- ii) Cartridge fuse
- iii) Miniature Circuit Breaker
- iv) Consumer control unit
- v) Distribution board
- vi) Rewireable fuses
- vii) Earthing rods
- viii) Earth continuity conductor
- ix) Residue current devices
- x) Voltage operated Earth Leakage Circuit Breaker (E.L.C.B)

- xi) Institutes installation network
- xii) Insulation and continuity tester
- xiii) Earth resistance and Neutral Earth loop impedance tester

### 12.1.5 ELECTRICAL MACHINES I

#### *Theory*

#### 12.1.5 T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) draw and label the constructional parts of ac machines
- b) draw and label the constructional parts of dc machines

#### *Competence*

The trainee should have the ability to:

- i) Dismantle a.c. and d.c. motors
- ii) Assemble a.c. and d.c. motors
- iii) Inspect a.c. and d.c. motors
- iv) Test a.c. and d.c. motors
- v) Carry out quality control checks

#### *Content*

#### 12.1.5 T1 Constructional parts of different types of ac machines

- i) Single – phase motors
- ii) Split – phase motor
- iii) Capacitor start motor
- iv) Capacitor start and run motor
- v) Capacitor start, capacitor run motor
- vi) Shaded – pole motor

#### 12.1.5 T2 Constructional parts of dc motors

- i) Series motor
- ii) Shunt motor
- iii) Compound motor
- iv) Universal motor

#### *Practice*

#### 12.1.5 P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) dismantle single phase motors
- b) assemble single phase motors
- c) dismantle direct current motors
- d) assemble direct current motors
- e) inspect single phase and D.C motors for
- f) proper operation
- g) Carry out control checks at every stage

*Content*

- 12.1.5 P1 Dismantling of single phase motors
  - i) Single – phase motors
  - ii) Split – phase motor
  - iii) Capacitor start motor
  - iv) Capacitor start and run motor
  - v) Capacitor start, capacitor run motor
  - vi) Shaded – pole motor
- 12.1.5 P1 Assembly of single phase motors
  - i) Single – phase motors
  - ii) Split – phase motor
  - iii) Capacitor start motor
  - iv) Capacitor start and run motor

- v) Capacitor start, capacitor run motor
- vi) Shaded – pole motor
- 12.1.5 P1 Dismantling of direct current motors
- 12.1.5 P1 Assembly of direct current motors
  - i) Series motor
  - ii) Shunt motor
  - iii) Compound motor
  - iv) Universal motor
  - v) Inspection of single phase motors and d.c. motors for proper operations

*Suggested Learning Resources*

- i) Single phase motors
- ii) dc motors
- iii) Tools including
- iv) Markers
- v) Field visits