

## 16.1.0 ELECTRICAL MEASUREMENTS AND FAULT DIAGNOSIS

### 16.1.01 Introduction

This course module unit is intended to provide the trainee with knowledge, skills and attitudes in order to carry out basic measurement and fault diagnosis, and understand reliability concepts.

### 16.1.02 General Objectives

By the end of this course, the trainee should be able to: -

- a) Explain fundamental and standard units of measurements
- b) Carry out measurements on various electrical quantities
- c) Diagnose faults in electrical and electronic equipment and devices
- d) Understand concepts of reliability

### 16.1.03 Module Unit Summary Module Unit

#### Electrical Measurements and Fault Diagnoses

Code	Sub module units	Contents	Time Hrs
16.1.1	Units	<ul style="list-style-type: none"><li>• Fundamentals</li><li>• Standard of units</li><li>• Calculation</li></ul>	6
16.1.2	Measurement techniques	<ul style="list-style-type: none"><li>• Measurement errors</li></ul> <i>Measurement of:</i> <ul style="list-style-type: none"><li>• dc Voltage and current</li><li>• Resistance</li><li>• Ac current and voltage</li><li>• Inductance and capacitance</li><li>• Magnetic</li><li>• Modulation</li><li>• Frequency</li><li>• Power</li></ul>	24
16.1.3	Electrical Circuits and common faults	<ul style="list-style-type: none"><li>• The soldering process</li><li>• Testing procedures for electrical circuits</li></ul>	8
16.1.4	Repair aids	<ul style="list-style-type: none"><li>• Manuals</li><li>• Instruments and Tools</li></ul>	6
16.1.5	Fault location and repair	<ul style="list-style-type: none"><li>• Methods of fault location</li></ul>	10

16.1.6	Maintenance	<ul style="list-style-type: none"> <li>• Corrective maintenance</li> <li>• Preventive maintenance</li> <li>• Planned maintenance</li> <li>• Routine maintenance</li> </ul>	8
16.1.7	Equipment Reliability	<ul style="list-style-type: none"> <li>• Design and development</li> <li>• Types of failures</li> <li>• Periods of failures</li> <li>• Assessment, testing and inspection</li> <li>• Reliability analysis</li> </ul>	4
<b>Total Time</b>			<b>66</b>

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## 16.1.1 UNITS

### Theory

#### 16.1.1T0 *Specific Objectives*

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

- a) explain the fundamental of units
- b) explain the standards of units
- c) perform calculations using the various systems of units

### Content

#### 16.1.1T1 Fundamental unit

- i) Absolute
- ii) Mechanical fundamental units
- iii) Auxiliary fundamental units
- iv) Derived units
- v) Multiples and sub-multiples of fundamental units

#### 16.1.1T2 Standards of units

- i) International
- ii) Primary
- iii) Secondary
- iv) Working

#### 16.1.1T3 Calculations

- i) Dimensions
- ii) E.S.U systems
- iii) E.M.U systems
- iv) M.K.S systems
- v) Errors

### 16.1.1C Competence

The trainee should have the ability to: use standard units in an electrical standards room

## 16.1.2 MEASUREMENT TECHNIQUES

### Theory

#### 16.1.2T0 *Specific Objectives*

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

- a) describe various types of measurement errors
- b) analyze methods of direct current and voltage measurement
- c) analyze the methods of measurement of resistance
- d) analyze the methods for alternating current and voltage measurement
- e) analyze methods of measurement of inductance and capacitance
- f) analyze the methods and instruments used for magnetic measurement
- g) analyze the methods of measurement of frequency
- h) describe the methods of modulation measurement
- i) analyze the methods for measurement of power

### Content

#### 16.1.2T1 Measurement errors

- i) Relative
- ii) Instrumental
- iii) Environmental
- iv) Random
- v) Observation

- 16.1.2T2 Measurement of direct current and voltage
- i) Shunt and ammeter method
  - ii) Universal shunt method
  - iii) Multi-range voltmeter method
  - iv) D.C valve voltmeter.
- 16.1.2T3 Resistance measurement
- i) Continuity testers
  - ii) The voltmeter method
  - iii) The ammeter method
  - iv) The voltmeter-ammeter method
  - v) The ohmmeter method
  - vi) Valve ohmmeter method
  - vii) Bridge method
- 16.1.2T4 Alternating current and voltage measurements
- i) Thermal instrument method
  - ii) Rectifier instrument method
  - iii) Source of errors
  - iv) Temperature
  - v) Frequency
  - vi) waveforms
  - vii) Multimeter
  - viii) A.C valve voltmeter method
  - ix) Electrostatic voltmeter method.
- 16.1.2T5 Measurement of inductance and capacitance
- i) Equivalent circuit of a capacitor
  - ii) Equivalent circuit of an inductor
  - iii) The voltmeter-ammeter method
  - iv) Bridge method
  - v) Resonance (tuned circuit) methods
  - vi) Q-meter
- 16.1.2T6 Magnetic measurement
- i) Construction and principles of operation of instruments
  - ii) Flux meter
  - iii) Ballistic galvanometer
  - iv) Hibert's magnetic standard
  - v) B-H curve and hysteresis loop
  - vi) Step by step method
  - vii) Lloyd Fisher square
  - viii) Hall effect
- 16.1.2T7 Frequency measurement
- i) Digital frequency meter
  - ii) Oscilloscope method up to 30MHz
  - iii) Zero beat method
  - iv) Absorption wave meter method
  - v) Comparison method
  - vi) Direct method
  - vii) Resonance method
  - viii) Heterodyne frequency method
- 16.1.2T8 Modulation measurements
- i) The CRO method
  - ii) Ammeter of voltmeter method
  - iii) Modulation meters
  - iv) Frequency deviation meter
- 16.1.2T9 Power measurement
- i) Bolometer method
  - ii) Coaxial wave meter
  - iii) Wattmeter method
  - iv) Thermocouple method

### Practice

#### 16.1.2P0 *Specific Objectives*

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

- a) measure electrical quantities
- b) Magnetic quantities

### Content

#### 16.1.2P1 Measurement of electrical quantities

- i) Direct current and voltage
- ii) Resistance
- iii) Alternating current and voltage
- iv) Inductance
- v) Capacitance
- vi) Power
- vii) Frequency
- viii) Modulation
- ix) Magnetic

#### 16.1.2P1 Measurement of magnetic quantities

#### 16.1.2C Competence

The trainee should have the ability to:

- Measure electrical quantities
- Measure magnetic quantities

#### *Suggested teaching/Learning Activities*

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations
- Visits to industries

#### *Suggested teaching/Learning Resources*

- Electrical and magnetic quantities measuring instruments

#### *Suggested Evaluation Methods*

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

### 16.1.3 CIRCUITS AND COMMON FAULTS

#### Theory

#### 16.1.3T0 *Specific Objectives*

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

- a) explain the process of soldering
- b) explain the procedures for testing and diagnosing common faults in electrical circuits.

#### *Content*

#### 16.1.3T1 Soldering

- i) Definition
- ii) Types
- iii) Faults
- iv) Soldering iron

#### 16.1.3T2 Circuits and faults

- i) Circuit components
  - Short circuits
  - Open circuit
- ii) Integrated circuits and PCB
  - Input
  - Output
- iii) PCB's
  - Open circuit
  - Short circuit

#### Practice

16.1.3P0 *Specific Objectives*

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

- a) Perform soldering
- b) test and diagnose common faults in electrical circuits.

*Content*

16.1.3P1

**Soldering**

- i) Soldering materials and tools
- ii) Types of solder
- iii) Types of Soldering iron

16.1.3P2

**Circuits and faults**

- i) Circuit components
  - Short circuits
  - Open circuit
- ii) Integrated circuits and PCB
  - Input
  - Output
- iii) PCB's
  - Open circuit
  - Short circuit

16.1.3C **Competence**

The trainee should have the ability to: test, diagnose and repair common faults in electrical circuits.

*Suggested teaching/Learning Activities*

- Demonstration
- Note taking
- Observation
- Practical exercise

*Suggested teaching/Learning Resources*

- i) Electrical and electronic tool kits
- ii) Electrical and electronic circuits
- iii) Electrical and electronic devices
- iv) Electrical and electronic measuring instruments

*Suggested Evaluation Methods*

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

16.1.4 **REPAIR AIDS**

**Theory**

16.1.4P0 *Specific Objectives*

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

- a) interpret electrical equipment manuals
- b) use electrical measuring instruments and tools to in testing repaired faults and interpret the readings

*Content*

16.1.4P1

**Interpretation of manuals**

- i) Installation manuals
- ii) Operation manuals
- iii) Maintenance manuals

16.1.4P2

**Tools and Measuring instruments**

- i) Measuring instruments
  - Multimeter
  - Frequency meters
  - Signal generators

- Other testing Instrument
- Curve tracers
- ii) Tools
  - Screw drivers
  - Wire cutters
  - Adjustable spanners
  - Pliers, long nose
  - Soldering iron
  - Solder sucker
  - Solder wire
  - Probes

#### 16.1.4C Competence

The trainee should have the ability to: repair faults in electrical circuits

#### *Suggested teaching/Learning Activities*

- Demonstration
- Note taking
- Observation
- Practical exercise

#### *Suggested teaching/Learning Resources*

- i) Electrical and electronic tool kits
- ii) Electrical and electronic circuits
- iii) Electrical and electronic devices
- iv) Electrical and electronic measuring instruments

#### *Suggested Evaluation Methods*

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

### 16.1.5 FAULT LOCATION AND REPAIR

#### Theory

#### 16.1.5T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to describe the various methods of fault location

#### *Content*

#### 16.1.5T1 Methods of fault location

- i) Functional test
- ii) Physical checking
- iii) Use of specified voltages and currents at test points
- iv) Random and static tests
- v) Input and output
- vi) Half split
- vii) Use of troubleshooting charts

#### Practice

#### 16.1.5P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to repair electrical and electronic equipment, appliances and machines

#### *Content*

#### 16.1.5P1 Repair

- i) Soldering of dry joints and open circuits.
- ii) Replacement of components
- iii) Test and calibration

#### 16.1.5C

#### Competence

The trainee should have the ability to: repair electrical and electronic

equipment, appliances  
and machines

*Suggested teaching/Learning  
Activities*

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise

*Suggested teaching/Learning  
Resources*

- Electrical and electronic tool kits
- Electrical and electronic circuits
- Electrical and electronic devices
- Electrical and electronic measuring instruments

*Suggested Evaluation Methods*

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

## 16.1.6 MAINTENANCE

### Theory

16.1.6T0 *Specific Objectives*

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

- a) explain and carry out  
corrective maintenance
- b) describe and carry out  
preventive maintenance
- c) describe and carry out  
planned maintenance
- d) explain routine  
maintenance

*Content*

16.1.6T1 Corrective maintenance

- i) Definition
- ii) Work card
- iii) History card

16.1.6T2 Preventive maintenance

- i) Definition
- ii) Audio sensitive  
gauges
- iii) Optical tools
- iv) Pressure gauges
- v) Temperature gauges
- vi) Vibration analyzers

16.1.6T3 Planned maintenance

- i) Definition
- ii) Equipment registers
- iii) Code number giving  
location
- iv) Number of items in  
the location
- v) Costing the repairs
- vi) Computer storage
- vii) Register

16.1.6T4

- Routine maintenance
- i) Cleaning equipment
  - ii) Checking system  
performances

### Practice

16.1.6P0 *Specific Objectives*

By the end of the sub -  
module unit, the trainee  
should able to perform  
various types of maintenance

*Content*

16.1.6P1 Maintenance

- i) Corrective maintenance
- ii) Preventive maintenance
- iii) Routine maintenance
- iv) Planned maintenance

16.1.6C **Competence**

The trainee should have the  
ability to: maintain electrical



installations, circuits and machines

*Suggested teaching/Learning Activities*

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise

*Suggested teaching/Learning Resources*

- i) Electrical and electronic tool kits
- ii) Electrical and electronic circuits
- iii) Electrical and electronic devices
- iv) Electrical and electronic measuring instruments

*Suggested Evaluation Methods*

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project
- Project Report writing and presentation

## 16.1.7 RELIABILITY

### Theory

16.1.7T0 *Specific Objectives*

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

- a) Describe the design and development of equipment reliability.
- b) describe various types of failures
- c) describe various types of periods of failures

- d) carry out reliability assessment, inspection and testing
- e) analyse reliability of various equipment

### Content

16.1.7T1 Design and development

- i) Definitions of terms used
- ii) Choice of components
- iii) Tests, stress and failure analysis
- iv) Complexity
- v) Inaccessibility
- vi) Environmental conditions

16.1.7T2 Various types of failures

- i) Sudden
- ii) Gradual
- iii) Partial
- iv) Complete
- v) Catastrophic and degradation
- vi) Periods of failures
- vii) The bath tub diagram

16.1.7T3 Types of periods of failure

- i) Failures due to incorrect operation
- ii) Definition and assessment of maintainability
- iii) Availability of equipment.

16.1.7T4 Reliability analysis

- i) MTBF
- ii) MTTF
- iii) Reliability law

16.1.7C **Competence**

The trainee should have the ability to: carry out reliability assessment, inspection and

tests on electrical and electronic devices

- Visits to standards laboratory
- Industrial attachment

*Suggested teaching/Learning Activities*

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations

*Suggested teaching/Learning Resources*

- Calculator

*Suggested Evaluation Methods*

- Oral tests
- Timed written tests
- Assignments

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