

15.2.0 ELECTRICAL PRINCIPLES II

15.2.01 INTRODUCTION

This module unit is designed to equip the trainee with knowledge, skills and attitudes necessary to understand principles of generating alternating current and appreciate correct usage of electrical measuring instruments.

15.2.02 GENERAL OBJECTIVES

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

- a) appreciate the value of electrical principles in electrical engineering trade
- b) apply acquired knowledge to repair electrical equipment and machinery.
- c) observe safety in electronic and electrical engineering work places

15.2.03 MODULE UNIT SUMMARY AND TIME ALLOCATION

ELECTRICAL PRINCIPLES II

Code	Sub Module Unit	Content	Time Hours
15.2.1	Instruments And Measurement	<ul style="list-style-type: none"> • Essential features of indicating instruments • Construction and operation of indicating instruments • Methods of range extension • Principles of Wheatstone bridge and DC potentiometer • Current, voltage and resistance measurement • Digital meters 	28
15.2.2	Principles Of Ac Generation	<ul style="list-style-type: none"> • Definition of AC terms • Basic principles of AC generation • Types of waveforms 	15
15.2.3	Alternating	<ul style="list-style-type: none"> • Effect of passive 	18

	Current(Ac) Circuits	<p>elements on current and voltage</p> <ul style="list-style-type: none"> • Perform calculations series and parallel circuits • Calculate power in AC circuits 	
15.2.4	Direct Current (Dc) Transients	<ul style="list-style-type: none"> • Effect of inductance on current voltage • growth and decay curves in inductive circuits • time constants in inductive circuits • Effect of capacitance on current and voltage • growth and decay curves in capacitive circuits • time constants in capacitive circuits • calculations on DC transients • application of time constant in an electric circuit 	20
15.2.5	Principles Of Three Phase Alternating Current (Ac) Generation And Transmission	<ul style="list-style-type: none"> • Principles of three-phase generation • Three phase connections • Advantages of three phase system over single-phase system • Calculations on three phase balanced system • Methods of power measurement • Transmission systems 	18
Total Time			99

15.2.1 INSTRUMENTS AND MEASUREMENTS

Theory

15.2.1T0 *Specific Objectives*

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

- a) describe the essential features of indicating instruments
- b) describe the construction and operation of indicating instruments
- c) explain methods of range extension
- d) explain the principles of the wheat-stone bridge and d.c Potentiometer
- e) explain current, voltage and resistance measurement
- f) describe digital meters.

Content

- 15.2.1T1 Essential features of indicating instruments
 - i) deflection device
 - ii) control device
 - iii) damping device
- 15.2.1T2 Construction and operation of indicating instruments
 - i) moving coil

- ii) moving iron
- iii) ohmmeter
- iv) thermocouple

15.2.1T3 Extension of range

- i) shunts
- ii) multipliers
- iii) instrument transformers
- iv) simple calculations

15.2.1T4 Principle of Wheatstone Bridge and d.c Potentiometer

- i) balancing
- ii) standardization

15.2.1T5 Measurement of:

- i) Current
- ii) Voltage
- iii) Resistance
- iv) Ohmmeter
- v) Wheatstone bridge method
- vi) Substitution method
- vii) using voltmeter/ammeter method

15.2.1T6 Digital meters

- i) construction
- ii) principle of operation
- iii) application

Practice

15.2.1P0 *Specific Objectives*

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

- a) identify parts of an indicating instrument
- b) safely operate an electrical indicating instrument

- c) demonstrate various methods of instruments range extension
- d) measure resistance using various methods
- e) measure electric quantities using digital meters.

Content

- 15.2.1P1 Identification of parts of an indicating instrument
- 15.2.1P2 Operation of an indicating instrument
- 15.2.1P3 Methods of range extension
 - i) shunts
 - ii) multipliers
 - iii) instrument transformers
- 15.2.1P4 Resistance measurement
 - i) Ohmmeter
 - ii) Ammeter/Voltmeter methods
 - iii) substitution method
 - iv) Wheatstone bridge
- 15.2.1P5 Measurement of electrical quantities using digital meters.
 - i) Voltage
 - ii) Current
 - iii) Resistance
 - iv) Capacitance
 - v) Transistor verification

15.2.2 PRINCIPLES OF ALTERNATING CURRENT (A.C.) GENERATION

Theory

- 15.2.2T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
 - a) define the various terms applied to a.c generation
 - b) explain the basic principles of a.c. generations
 - c) explain different types of wave forms.

Competence

- The trainee should have the ability to:
- i) Safely take measurements of electrical quantities
 - ii) Extend instrument range

Content

- 15.2.2T1 Definition of Terms
 - i) Alternating quantity
 - ii) Waveform
 - iii) Cycle
 - iv) Frequency
 - v) Period
 - vi) Amplitude
 - vii) Instantaneous value
 - viii) R.m.s value
 - ix) Average value

- x) Form factor
- 15.2.2T2 Basic principles of a.c. generation
 - i) Components of a.c generator
 - ii) Principle of operation
 - iii) E.m.f equation
- 15.2.2T3 Types of waveforms
 - i) types
 - ii) sketching and interpretation of waveforms
 - iii) addition and subtraction
 - iv) solution of problems
 - v) applications

Practice

- 15.2.2P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
 - a) identify components of an a.c. generator
 - b) operate an A.C. generator
 - c) verify the features of an a.c. quantity.

Content

- 15.2.2P1 Identification of components of a.c. generator
- 15.2.2P2 Operation of a.c generator
- 15.2.2P3 Features of an a.c waveform
 - i) Cycle
 - ii) Frequency
 - iii) Period
 - iv) Amplitude.

Suggested Learning Resources

- i) A.c generator trainer kit
- ii) C.R.O
- iii) Multi-meter
- iv) A.c generator
- v) Educational trip
- vi) Report writing.

15.2.3 ALTERNATING CURRENT CIRCUITS (A.C.) CIRCUITS

Theory

- 15.2.3T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
 - a) explain the effect of passive elements on current and voltage in a.c. circuits
 - b) perform calculations on series and parallel circuits
 - c) calculate power in a.c. circuits.

Content

- 15.2.3T1 Effects of passive elements on current and voltage
 - i) Resistance
 - ii) Inductance
 - iii) Capacitance
 - iv) Waveforms and phasor diagrams
- 15.2.3T2 Calculations on series and parallel circuits

- i) Impedance of Resistor-Capacitor (R-C) circuits
- ii) Impedance of Resistor- Inductor-capacitor (R-L-C) circuits
- iii) Impedance of Resistor-Inductor (R-L) circuits
- iv) Power factor and phase angle
- v) Resonance
- vi) Q-factor

15.2.3T3 Power in a.c circuit

- i) Active power
- ii) Reactive power
- iii) Apparent power

Practice

15.2.3P0 *Specific Objectives*

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

- a) verify the effects of passive elements on circuit parameters
- b) perform experiment to show the effect of power factor.

Content

15.2.3P1 Effects of R – L – C on voltage and current in a.c. circuit

- i) Series circuits
- ii) Parallel circuits

15.2.3P2 Experiment on power factor

Suggested Learning Resources

- i) capacitors, resistors, inductors
- ii) measuring instruments
- iii) Cathode Ray Oscilloscope (C.R.O)
- iv) AC trainer circuit kit

15.2.4 DIRECT CURRENT (D.C.) TRANSIENTS

Theory

15.2.4T0 *Specific Objectives*

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

- a) explain the effect of inductance on current and voltage
- b) sketch growth and decay curves in inductive circuits
- c) describe time constant in inductive circuits
- d) explain effect of capacitance on current and voltage
- e) sketch growth and decay curves in capacitive circuits
- f) describe time constant in capacitive circuits
- g) perform simple calculations on d.c Transients
- h) state the application of time constant in an electrical circuit.

Competence

- i) The trainee should have the ability to:
- ii) Attain resonance
- iii) Perform power factor correction

Content

- 15.2.4T1 Effect of inductance on current and voltage
 - i) steady state
 - ii) transient state
- 15.2.4T 2 Time constant in inductive circuits
 - i) definition
- 15.2.4T 3 Growth and decay curves in inductive circuits
- 15.2.4T 4 Effects of capacitance on current and voltage
 - i) steady state
- 15.2.4T 5 Growth and decay curves in capacitive circuits
- 15.2.4T 6 Time constant in capacitive circuits
 - Definition
- 15.2.4T 7 Simple calculations on d.c transient
 - i) steady state currents
 - ii) transient currents
- 15.2.4T8 Applications of time constant

Practice

- 15.2.4P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to plot the growth and decay

curves for inductive and capacitive circuits to determine the time constants.

- 15.2.4P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to plot the growth and decay curves for inductive and capacitive circuits to determine the time constants.

Content

- 15.2.4P 1 Growth and decay curves
 - i) R-C circuit
 - ii) R-L circuit

Competence

The trainee should have the ability to plot growth and decay curves for R-L and R-C circuits

Suggested Learning Resources

- i) drawing instruments
- ii) graph paper
- iii) CRO
- iv) Electronic components

15.2.5 PRINCIPLES OF THREE PHASE ALTERNATING CURRENT (A.C.) GENERATION AND TRANSMISSION

Theory

15.2.5T0 *Specific Objectives*

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

- a) explain the principles of three-phase generation
- b) describe various methods of three phase connections
- c) state advantages of three phase over single phase generation
- d) perform simple calculations on three phase balanced systems
- e) describe methods of power measurement in three phase balanced systems
- f) describe various transmission systems.

Competence

The trainee should have the ability to:

- i) Connect star and delta arrangements
- ii) Measure line and phase values in star and delta connections
- iii) Measure power in three phase circuits

Content

15.2.5T 1 Principle of three phase generation

- i) Three phase windings
- ii) Rotating field
- iii) Electromagnetic induction
- iv) Waveforms

15.2.5T2 Three phase connections

- i) Star
- ii) Delta
- iii) Line and phase values

15.2.5T3 Advantages of three phase over single phase systems

15.2.5T 4 Calculations on three phase balanced systems

15.2.5T5 Methods of power measurement

- i) One wattmeter method
- ii) Two wattmeter method
- iii) Three wattmeter method

15.2.5T6 Description of various transmission systems

- i) Single phase two-wire
- ii) Three phase 3 – wire
- iii) Three phase 4 – wire
- iv) Transmission voltages

Practice

15.2.5P0 *Specific Objectives*

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

- a) connect three phase circuits
- b) measure line and phase values
- c) measure power in three phase circuits.

Content

- 15.2.5P1 Connection of star and delta circuits
- 15.2.5P2 Measurement of line and phase values in star and delta connections
- 15.2.5P3 Measurement of power in three phase circuits
 - i) one wattmeter
 - ii) two wattmeter
 - iii) three wattmeter

Suggested Learning

Resources

- i) measuring instruments
- ii) charts
- iii) A.C. generation trainer kits