

11.1.0 ELECTRONICS

11.1.01 Introduction

This module unit is designed to equip the trainee with the necessary knowledge, skills and attitude required to understand the concepts of electronic circuits and their application in related engineering fields.

11.1.02 General Objectives

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

- a) understand the theory of semiconductors
- b) discuss the components used in electronic circuits
- c) acquire knowledge in the operation of electronic circuits
- d) develop correct attitude towards career progression in the trade area
- e) appreciate changes in electronic technology
- f) apply the acquired knowledge in solving electronic and related problems

11.1.03 Module Summary and Time Allocation

Electronics

Code	Sub Module Unit	Content	Hrs
11.1.1	Semiconductor Theory	<ul style="list-style-type: none"> • Atomic theory • Classification of materials • Intrinsic semiconductors • Extrinsic semiconductors • The p-n junction diode 	4
11.1.2	Electronic Components	<ul style="list-style-type: none"> • Construction of components • Operation of components • Characteristics of components • Application of components 	12
11.1.3	Amplifiers	<ul style="list-style-type: none"> • Transistor configuration • Transistor characteristics • Biasing methods 	12

		<ul style="list-style-type: none"> • Coupling methods • Distortion and noise in amplifiers • Operational amplifiers 	
11.1.4	Power Supplies	<ul style="list-style-type: none"> • Rectification • Smoothing • Regulation • Voltage multipliers • Methods of protection 	12
11.1.5	Feedback	<ul style="list-style-type: none"> • Feedback principle • Positive and negative feedback • Types of negative feedback • Requirements for oscillation • Sinusoidal oscillator circuits 	12
11.1.6	Number System And Codes	<ul style="list-style-type: none"> • Translation of radix • Binary arithmetic • Coding systems • Code conversion • • Application of coding systems 	16
11.1.7	Boolean Algebra	<ul style="list-style-type: none"> • Boolean identities • De Morgan's rules • Simplification of Boolean equations using identities and Karnaugh map • (upto 4-variables) 	10
11.1.8	Logic Gates	<ul style="list-style-type: none"> • Symbols • Truth table • Logic families • Application of logic gates 	8
11.1.9	Flip Flops	<ul style="list-style-type: none"> • Definition of flip-flop • Description of various flip-flops 	5

11.1.10	Transducers	<ul style="list-style-type: none">• Definition• Construction• Operation• Application	5
11.1.11	Filters	<ul style="list-style-type: none">• Operation of filters• Response curves• Application	3
Total Time			99

11.1.1 SEMICONDUCTOR THEORY

Theory

11.1.1T0 *Specific Objectives*

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

- a) explain atomic theory
- b) classify materials using the energy band diagram
- c) describe extrinsic semiconductors
- d) describe the p-n junction

Competence

The trainee should have the ability to:

Connect a diode in a circuit

Contents

11.1.1T 1 Atomic theory

- i) Element
- ii) Compound
- iii) Periodic table
- iv) Protons
- v) Neutrons
- vi) Electrons
- vii) Orbit

11.1.1T 2 Classification of materials

- i) Conductor
- i) Semiconductors
- ii) Insulators

11.1.1T 3 Intrinsic semiconductors

- i) Silicon
- ii) Germanium

- iii) Covalent bonds
- iv) Electron hole pair generation/recombination
- v) Intrinsic conduction

11.1.1T4 Extrinsic

- semiconductors
- i) Doping
 - ii) N- type semiconductor
 - iii) P- type semiconductor
 - iv) Extrinsic conduction

11.1.1T 5 The P-N junctions

- i) Formation of the junction
- ii) Depletion layer
- iii) Forward bias

Practice

11.1.1P0 *Specific Objectives*

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

- a) identify the terminals of a p-n junction diode
- b) connect the P-N junction diode circuit
- c) determine the characteristics of the P-N junction diode

Content

11.1.1P1 Identification of the

- terminals of a P-N junction diode
- i) Anode
 - ii) Cathode

- 11.1.1T2 Connection of a diode in a circuit
- i) Polarity
 - ii) Voltage levels
 - iii) establish transistor configuration
- 11.1.1T3 Characteristics of p-n junction diode
- i) Forward
 - ii) Reverse

Suggested Learning Resources

- i) Junction diodes
- ii) Measuring instruments
- iii) Connecting leads
- iv) Power supply units
- v) Accessories
- vi) Electronic tool kit
- vii) Bread boards

11.1.2 ELECTRONIC COMPONENTS

Theory

11.1.2T0 *Specific Objectives*

- By the end of the sub-module unit, the trainee should be able to:
- a) describe the construction of various components
 - b) describe the operation of various electronic components
 - c) explain characteristics of various electronic components

- d) state the application of various electronic component

Competence

The trainee should have the ability to:

- i) identify electronic components
- ii) test electronic components
- iii) determine component value and rating

Content

- 11.1.2T1 Description of the construction of electronics components
- i) Resistors
 - ii) Capacitors
 - iii) Inductors
 - iv) Diodes
 - v) Bi polar Junction Transistor (BJT)
 - vi) Field effect transistors (FETS)
 - vii) Triacs
 - viii) Thyristors (SCR)
 - ix) Photo conductive cells
 - x) Photo diodes
 - xi) Photo transistors
 - xii) Light emitting diodes (LED)
 - xiii) Liquid crystal display (LCD)
 - xiv) Integrated circuits (ICS)

- 11.1.2T2 Operation of electronic components

- 11.1.2T3 Characteristics of electronic components
- 11.1.2T4 Applications of electronic components

- iv) various electronic tools
- v) connecting leads
- vi) data books and catalogues

Practice

- 11.1.2P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
 - a) identify various electronic components
 - b) determine values and ratings of electronic components
 - c) test various electronic components

Content

- 11.1.2P1 Identification of various electronic components
- 11.1.2P2 Values and rating
 - i) Component size
 - ii) Colour code
 - iii) Component Data
- 11.1.2P3 Testing of electronic component
 - i) Short circuit
 - ii) Open circuit
 - iii) Change in value
 - iv) leakage

Suggested Learning Resources

- i) various components
- ii) breadboard
- iii) measuring instruments

11.1.3 AMPLIFIERS

Theory

- 11.1.3T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
 - a) state the types of transistor configurations
 - b) explain the various characteristics of transistors
 - c) describe biasing methods of transistor
 - d) describe various coupling methods
 - e) explain different classes of amplifier operations
 - f) explain distortion and noise in amplifiers
 - g) describe the operation of operational amplifiers

Competence

- The trainee should have the ability to:
- i) Construct and test various amplifiers

- Content*
- 11.1.3T1 Transistor configuration
 - i) common base
 - ii) common emitter
 - iii) common collector
 - 11.1.3T2 Characteristics of transistors
 - i) Input characteristics
 - ii) Output characteristics
 - iii) transfer characteristics
 - 11.1.3T3 Biasing methods
 - i) Fixed bias
 - ii) Collector base bias
 - iii) Potential divider bias
 - iv) Emitter bias
 - 11.1.3T4 Coupling methods
 - i) R.C coupling
 - ii) Transformer coupling
 - iii) direct coupling
 - iv) matching
 - 11.1.3T5 Distortion and noise in amplifiers
 - i) Harmonic distortion
 - ii) Frequency distortion
 - iii) Inter modulation distortion
 - iv) Amplitude distortion
 - v) Transistor noise
 - 11.1.3T6 Classes of amplifiers
 - i) Class A
 - ii) Class B
 - iii) Class C

- iv) 11.1.3T7
Operational amplifiers
- v) definitions and terminology
- vi) Characteristics of op-amps
- vii) Applications of op-amps

Practice

11.1.3P0 Specific Objectives

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

- a) connect and operate various amplifier circuits
- b) perform various measurements and tests on an amplifier
- c) construct various amplifiers

Content

- 11.1.3P1 Connection and operation of amplifiers
 - i) Different biasing methods
 - ii) Different coupling methods
 - iii) Different classes of operation
- 11.1.3P2 Measurements and tests
 - i) Input signal levels
 - ii) Output signal levels
 - iii) Distortion
 - iv) Bias voltage
 - v) Bias current
 - vi) Waveforms

- vii) Power
 11.1.3P3 Construction of amplifiers

- e) explain the methods of power supply protection.

Suggested Learning Resources

- i) Transistors
- ii) Op-amps
- iii) Measuring instruments
- iv) Catalogue and data books
- v) Power supply units
- vi) Connecting leads
- vii) Electronic tool kit
- viii) Training kits
- ix) Bread boards

Competence

The trainee should have
 The trainee should have the ability to:

- i) Construct basic power supply circuits
- ii) Test and measure power supply parameters

11.1.4 POWER SUPPLIES

Theory

11.1.4T0 Specific Objectives

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

- a) describe the rectification processes
- b) describe different methods of smoothing
- c) explain the principles of power regulation and stabilization
- d) explain the operation of voltage multipliers and dividers

Content

- 11.1.4T1 Methods of power rectification
 - i) Half wave
 - ii) Full wave
 - iii) Methods of smoothing
 - iv) Full wave bridge
- 11.1.4T2 Smoothing
 - i) Reservoir capacitor
 - ii) R – C filter
 - iii) Pie filter
- 11.1.4T3 Regulation
 - i) Zener diode regulator
 - ii) Transistor regulator
 - iii) IC regulator
- 11.1.4T4 Voltage multipliers
 - i) Double
 - ii) Triplex
 - iii) quadruple
- 11.1.4T5 Methods of power supply protection
 - i) Fuses
 - ii) Current limiting

Practice

11.1.4P0 Specific Objectives

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

- a) construct half and full wave rectifier circuits
- b) construct filter network circuits
- c) build simple regulator circuit
- d) test and measure various supply parameters

Content

- 11.1.4P1 Construction of rectifier circuit
 - i) Half wave
 - ii) Full wave
 - iii) Full wave bridge
- 11.1.4P2 Construction of smoothing circuits
 - i) Reservoir capacitor
 - ii) R – C filter
 - iii) Pie filter
- 11.1.4P3 Construction of power supply regulators
 - i) Zener diode regulator
 - ii) Transistor regulator
 - iii) IC regulator
- 11.1.4P4 Tests and measurements
 - i) D.C .out put on no load

- ii) D.C. output on load
- iii) Load current
- iv) Ripple

Suggested Learning Resources

- i) Transformers
- ii) Rectifiers
- iii) Filters
- iv) Regulators
- v) Instruments
- vi) Charts

11.1.5 FEEDBACK

Theory

11.1.5T0 Specific Objectives

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

- a) explain the feedback principle
- b) differentiate between positive and negative feedback
- c) state types of feedback connection
- d) explain the effects of feedback connections
- e) state the requirements for oscillation
- f) explain the operation of various oscillator circuits

Competence

The trainee should have the ability to;

- i) connect and test various feedback circuits
- ii) Connect and test various sinusoidal oscillator circuits

Content

- 11.1.5T1 Explanation of feedback principle
- 11.1.5T2 Positive and negative feedback
 - i) Gain with positive feedback
 - ii) Gain with negative feedback
- 11.1.5T 3 Effects of negative feedback on
 - i) Gain
 - ii) Stability
 - iii) Noise and distortion
 - iv) Bandwidth and response
 - v) Input and output resistance
- 11.1.5T 4 Types of feedback connections
 - i) Voltage shunt
 - ii) Voltage series
 - iii) Current shunt
 - iv) Current series
- 11.1.5T 5 Explanation of requirements for oscillation
 - i) Feedback requirement
 - ii) Impedance requirement
- 11.1.5T 6 Explanation of operation of various

sinusoidal oscillation circuits

- i) LC oscillators
- ii) Colpit's
- iii) Hartley
- iv) Crystal
- v) Clapps

Practice

- 11.1.5P0 *Specific Objectives*
By the end of the sub-module unit, the trainees should be able to:
- a) connect and test simple negative and positive feedback circuits
 - b) connect and test various sinusoidal oscillator circuits

Content

- 11.1.5P1 Connection of positive and negative feedback circuit
 - i) Gain
 - ii) Noise
 - iii) Response
 - iv) Impedence
- 11.1.5P2 Connection and Testing various sinusoidal oscillator circuits
 - i) Frequency
 - ii) stability

Suggested Learning

Resources

- i) Manufacturers catalogue and data book

- ii) Breadboard
- iii) Connecting leads
- iv) CRO
- v) Components

11.1.6 NUMBER SYSTEMS AND CODES

11.1.6T0 *Specific Objectives*

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

- a) translate numbers from one radix(base) to another
- b) perform binary arithmetic
- c) describe various coding systems
- d) perform conversion of various coding systems
- e) state the applications of various coding systems

Contents

- 11.1.6T1 Translation of one radix to another
 - i) Binary to decimal and vice versa
 - ii) Binary to octal
 - iii) Octal to decimal
 - iv) Binary to hexadecimal
 - v) Hexadecimal to decimal
- 11.1.6T2 Binary arithmetic
 - i) Subtraction

- ii) Multiplication
- iii) Division as a form of subtraction

- 11.1.6T3 Coding systems
 - i) BCD (8421)
 - ii) Gray code
 - iii) ASCII
 - iv) Excess - 3

- 11.1.6T4 Code systems conversion
 - i) Binary to BCD
 - ii) Binary to gray code and vice versa

- 11.1.6T5 Applications of various coding systems

Suggested Learning Resources

- Number systems charts

11.1.7 BOOLEAN ALGEBRA

Theory

11.1.7T0 *Specific Objectives*

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

- a) state Boolean identities
- b) state De Morgan's laws
- c) simplify Boolean equations

Contents

- 11.1.7T1 Boolean identities
- 11.1.7T2 De Morgan's laws
- 11.1.7T3 Simplification using De Morgan's laws, Boolean

identities and Karnaugh map

Suggested Learning Resources

- Boolean identities charts

11.1.8 LOGIC GATES

11.1.8T0 Specific Objectives

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

- a) sketch the symbols of various logic gates
- b) indicate on a truth table the out put of various logic gates to given input
- c) state
- d) describe various logic families and their characteristics
- e) state the applications of logic gates

Competence

The trainee should have the ability to:

- i) Identify various logic gates
- ii) Connect and test various logic gates

Contents

- 11.1.8T1 logic gates
 - i) American symbols
 - ii) British symbols
 - iii) AND
 - iv) OR

- v) NOT
- vi) NAND
- vii) NOR
- viii) EX OR
- ix) EX- NOR

11.1.8T2 Truth table Content for various gates

11.1.8T3 Logic families and their characteristics

- i) TTL (Transistor– transistor logic)
- ii) DTL (Diode Transistor Logic)
- iii) RTL (Resistor Transistor Logic)
- iv) ECL (Emitter Coupled Logic)

11.1.8T4 Applications of logic gates

Practice

11.1.8P0 Specific Objectives

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

- a) identify various logic gates
- b) connect and test various logic gates

Contents

11.1.8P2 Identification of logic gates

11.1.8P1 Connection and testing of logic gates

- i) Pin out identification
- ii) Logic levels static tests
- iii) Dynamic tests

Suggested Learning Resources

- i) Digital logic trainer kit
- ii) Logic gates
- iii) Jumper wires
- iv) DC power supply source
- v) CRO

11.1.9 FLIP FLOPS

11.1.9T0 Specific Objectives

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

- a) define flip flops
- b) describe the operation of various flip – flops

Competence

The trainee should have the ability to:

- i) apply flip flops in electronic circuit
- ii) test flip flop circuits

Contents

11.1.9T1 Definition of flip flops

11.1.9T2 Description of various types of flip flops

- i) SR
- ii) JK
- iii) T
- iv) D

Practice

11.1.9P0 Specific Objectives

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

- a) identify various flip flops
- b) carry out tests on flip flops circuits

Contents

11.1.9P1 identification of flip flops

11.1.9P2 tests on flip flop circuits

Suggested Learning Resources

- i) Digital logic trainer
- ii) Logic gates
- iii) Jumper wire
- iv) Bread board
- v) DC power supply
- vi) IC clips
- vii) Flip flop integrated circuits

11.1.10 TRANSDUCERS

Theory

11.1.10T0 Specific Objectives

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

- a) define the term transducers
- b) describe the construction of various types of transducers
- c) describe the operation of various types of transducers

- d) state the applications of transducers

Competence

The trainee should have the ability to:

- i) Identify various types of transducers
- ii) Construct an test simple transducer circuits

Content

11.1.10T1 Definition of transducer

11.1.10T2 Construction of various

types of transducers

- i) Thermal
- ii) Inductive
- iii) Capacitive
- iv) Photo electric
- v) Acoustic

11.1.10T3 Operation of the transducers

- i) Thermal
- ii) Inductive
- iii) Capacitive
- iv) Photo electric
- v) Acoustic

11.1.10T4 Application of the transducers

- i) Displacement
- ii) Pressure
- iii) Flow rate
- iv) Sound
- v) Alarm systems
- vi) Humidity
- vii) Temperature

Practice

11.1.10P0 *Specific Objectives*

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

- a) identify various types of transducers
- b) connect simple transducer circuits

Content

11.1.10P1 Transducer circuits

- i) Thermal
- ii) Inductive
- iii) Capacitive
- iv) Photo electric
- v) Acoustic

11.1.10P2 connection of

transducer circuits

Suggested Assessment Methods

- i) Assignment
- ii) Oral tests
- iii) Written tests
- iv) Practical tests

11.1.11 FILTERS

Theory

11.1.11T0 *Specific Objectives*

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

- a) describe the operation of the filter networks
- b) sketch response curves of various filter net works
- c) state the application of filters

Competence

The trainee should have the ability to:

- Construct and test basic filter circuits

Content

- 11.1.11T 1 Operation of different types of filter networks
 - i) R- C filters
 - ii) L – C filters
 - iii) Active filters
- 11.1.11T 2 Response curves
 - i) Low pass
 - ii) High pass
 - iii) Band pass
- 11.1.11T 3 Application of filters

Practice

11.1.11P0 *Specific Objectives*

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

- a) construct basic filter circuits
- b) test various types of filter circuits

Content

11.1.11P 1 construction of filter circuits

- i) Low pass
- ii) High pass
- iii) Band pass

11.1.11P 2 Filter circuits tests

Suggested learning resource

- i) Components (discrete, ICs)
- ii) CRO
- iii) Signal generators