

## **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**

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

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

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

## 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
- Polarity
  - Voltage levels
  - establish transistor configuration
- 11.1.1T3 Characteristics of p-n junction diode
- Forward
  - Reverse

*Suggested Learning Resources*

- Junction diodes
- Measuring instruments
- Connecting leads
- Power supply units
- Accessories
- Electronic tool kit
- 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:

- describe the construction of various components
- describe the operation of various electronic components
- explain characteristics of various electronic components

- state the application of various electronic component

### *Competence*

The trainee should have the ability to:

- identify electronic components
- test electronic components
- determine component value and rating

### *Content*

- 11.1.2T1 Description of the construction of electronics components
- Resistors
  - Capacitors
  - Inductors
  - Diodes
  - Bi polar Junction Transistor (BJT)
  - Field effect transistors ( FETS)
  - Triacs
  - Thyristors ( SCR)
  - Photo conductive cells
  - Photo diodes
  - Photo transistors
  - Light emitting diodes (LED)
  - Liquid crystal display ( LCD)
  - 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

#### *Content*

### **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

#### 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. output 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