10.1.0   ELECTRICAL PRINCIPLES I

10.1.01   Introduction
This module unit is intended to equip the trainee with knowledge, skills and attitudes to enhance the trainee's understanding of other aspects of electrical and electronic technology. Trainees undertaking this module unit require prior knowledge of basic mathematics.

10.1.02   General Objectives
By the end of the module unit, the trainee should be able;
a) understand the principles of direct current circuits.
b) acquire knowledge in the care and maintenance of chemical cells.
c) apply concepts of electrostatics in electrical circuits
d) understand the theory of magnetism and electromagnetism.
e) apply the principles of transformers in electric machines.

10.1.023   Module Summary and Time Allocation

Electrical Principles I

Code	Sub-Module Unit	Content	Time Hrs
10.1.1	Direct Current Circuits	• Basic electrical quantities and their units • Simple circuit diagrams. • Ohm's law • Determination of resistance of metal conductors • Kirchhoff's laws • Effects of temperature on resistance • Kirchhoff's law	22

10.1.2	Chemical Cells	• Faraday's laws of electrolysis • Construction of cells and their characteristics • Cell connections • Charging methods • Care and maintenance of cells • Effects of internal resistance on terminal voltage	20
10.1.3	Electrostatics	• Electric fields • Construction of capacitors • Definitions of electrostatic quantities and units • Determination of total capacitance • Energy stored in a capacitor	14
10.1.4	Magnetism and Electomagnetism	• Magnetic and non-magnetic materials • Magnetic field patterns • Force on current carrying conductor • Magnetism curve and hysteresis loop • Electromagnetic induction • Inductance in materials	14

10.1.5	Transformers	• Principle of operation of transformers • Types of transformers and their applications • Construction of different types of transformers • Simple calculations on single phase transformers • Transformer impedance matching • Reasons for RF shielding	18
Total Time			**88**

10.1.1 DIRECT CURRENT CIRCUITS

Theory

10.1.1T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) explain the basic electrical quantities and their units
b) draw and interpret simple circuit diagrams
c) state Ohm's law to solve given electrical circuit problems
d) determine the resistance of metal conductors.
e) explain the effects of temperature on resistance
f) apply Kirchhoff's laws to solve given electrical circuit problems

Competence
The trainee should have the ability to:
i) Measure electrical quantities

Content
10.1.1T1 Basic electrical quantities and their units
i) E.m.f in volts
ii) Current in amperes
iii) Resistance in ohms

iv) Power in watts
v) Energy in joules
10.1.1T2 Simple circuit diagrams.
i) The simple electric circuit
ii) Resistor in parallel
iii) Series – parallel connection
iv) Resistors in series
10.1.1T3 Ohm's law
i) Statement
ii) Verification
iii) Resistance circuit calculations
iv) Power and energy calculations
10.1.1T4 Determination of resistance of metal conductors
i) Resistivity
ii) Conductivity
iii) Length
iv) Cross – sectional area
10.1.1T5 Effects of temperature on resistance
i) Definition of temperature coefficient of resistance
ii) Positive and negative temperature coefficient
iii) Simple calculations to any base temperature
10.1.1T6 Kirchhoff's laws
i) Current law
ii) Voltage law
iii) Calculations

Practice

10.1.1P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
  a) connect simple electrical circuits and measure various electrical quantities
  b) verify Ohm's law
  c) demonstrate that the resistance of material depends on area, length and resistivity
  d) verify Kirchhoff's law

Content
10.1.1P 1 Measurement of electrical quantities
  i) Current
  ii) Voltage
  iii) Resistance
  iv) Power
10.1.1P 2 Verification of Ohm's law
10.1.1P 3 Determination of conductor resistance
  i) Resistance
  ii) Resistivity
  iii) length
  iv) Area
10.1.1P 4 Verification of Kirchhoff's laws
  i) current law
  ii) voltage law

Suggested Learning Resources
  i) Dc power source
  ii) Assorted resistance

  iii) Measuring instruments
  iv) Bread boards

10.1.2 CHEMICAL CELLS

Theory

10.1.2T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
  a) State Faraday's laws of electrolysis
  b) Describe the construction of cells and their characteristics
  c) state methods of cell connections
  d) describe charging methods of batteries
  e) describe the care and maintenance of batteries
  f) explain the effects of internal resistance on terminal voltage

Competence
The trainee should have the ability to:
  i) Charge cells
  ii) Maintain cells

Content
10.1.2T1 Faraday's laws of electrolysis
  i) 1st law
  ii) 2nd law
10.1.2T2 Construction of cells and their characteristics

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i) Primary – Lec lanche cell
ii) Secondary – lead Acid cell
iii) Alkaline cell

10.1.2T3 Cell connections
i) series connection
ii) parallel connection
iii) series – parallel connections
iv) simple calculations

10.1.2T4 Charging methods
i) constant current
ii) constant voltage
iii) trickle charge
iv) booster charge
v) battery ratings
vi) simple calculations

10.1.2T5 Care and maintenance of cells
i) specific gravity
ii) electrolyte level
iii) terminal voltage
iv) safety precautions
v) storage

10.1.2T6 Effects of internal resistance on terminal voltage – simple calculations

Practice

10.1.2P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) measure total voltage and current of cells connected in series and parallel
b) demonstrate various charging methods

c) determine the internal resistance of cells and show its effect on terminal voltage
d) carry out light maintenance on a battery

Content
10.1.2P1 Measurements of total voltage and current in series and parallel connected cells
10.1.2P 2 Demonstration of various charging methods
10.1.2P 3 Effects of internal resistance on terminal voltage of cell
10.1.2P 4 Maintenance of cells

Suggested Learning Resources
i) Various batteries
ii) Sulphuric acid
iii) Distilled water
iv) Battery chargers
v) Test instruments

10.1.3 ELECTROSTATICS

Theory

10.1.3T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) explain the concept of electric fields
b) describe the construction of

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capacitors and their applications

c) define the electrostatic quantities

d) determine the total capacitance for various capacitor connections

e) derive and apply the formula for energy stored in a capacitor

Competence
The trainee should have the ability to:
i) Test a capacitance
ii) Apply capacitors in electrical circuits

Content

10.1.3T1 Electric fields
i) Electric flux
ii) Charge
iii) Potential gradient

10.1.3T2 Construction of capacitors and applications
i) Paper capacitors
ii) Electrolytic capacitors
iii) Ceramic capacitors
iv) Alluminium foil capacitor
v) Polyester capacitor
vi) Tantalum capacitor
vii) Multiplate capacitor
viii) Variable capacitor
ix) Applications

10.1.3T3 Definitions of electrostatic quantities and units

i) Electric flux
ii) Electric flux density
iii) Electric field intensity
iv) Permittivity
v) Capacitance
vi) Charge
vii) Derivation of formula

$$C = \frac{\mathcal{E}A}{d} = \frac{\mathcal{E}r\,\mathcal{E}o\,A}{d}$$

10.1.3T4 Determination of total capacitance
i) Series connection
ii) Parallel
iii) Series-parallel connection
iv) Calculations

10.1.3T5 Energy stored in a capacitor
i) $E = \frac{1}{2}\,CV2$ joules
ii) calculations

Practice

10.1.3P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) identify various types of capacitors
b) measure capacitance in various connections
c) test a capacitor

Content
10.1.3P0 Identification of capacitors

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10.1.3P1 Measurement of capacitance

10.1.3P2 Testing of capacitance

Suggested Learning Resources
  i)   Assorted capacitors
  ii) Test instruments
  iii) Bread boards

10.1.4 MAGNETISM AND ELECTROMAGNETISM

Theory

10.1.4T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
  a) distinguish between magnetic and non-magnetic materials
  b) explain the concepts of magnetic field
  c) explain the concept of force on a current carrying conductor in a magnetic field and its applications
  d) define the magnetic circuit quantities and their electric circuit equivalents
  e) describe the magnetization curve and hysteresis loop
  f) explain the concept of electromagnetic induction
  g) explain inductance in materials

  h) determine total inductance

Competence
The trainee should have the ability to:
  i)   Construct an electromagnet
  ii) Apply magnets in the engineering field

Content
10.1.4T1 Magnetic and non-magnetic materials
  i)   Molecular arrangements
  ii) Field patterns
10.1.4T 2 Magnetic field patterns
  i)   Permanent magnets
  ii)   Electromagnets
  iii) Single wire
  iv)   Loop of wire
  v)   Solenoid
10.1.4T3 Force on current carrying conductor
  i) $F = BIL$
  ii) Practical applications
10.1.4T4 Magnetic circuit quantities and their electrical equivalents
  i)   Magnetic flux
  ii)   Magneto motive force (m.m.f)
  iii) Reluctance
  iv)   Permeability
  v)   Series
  vi)   Parallel
10.1.4T5 Magnetization curve and hysteresis loop
  i)   B –H curve
  ii) Hysteresis loop

iii) Remnant flux
iv) Coercive force
v) Saturation
vi) Energy

10.1.4T6 Electromagnetic induction
i) Self induction
ii) Mutual induction
iii) Faraday's Laws
iv) Lenz's Laws
v) Direction of induced e.m.f

10.1.4T7 Inductance in materials
i) Definition
ii) Unit of inductance
iii) Inductors in series aiding
iv) Energy stored in inductance
v) Calculations

10.1.4T8 Total inductance
i) Aiding
ii) Opposing

Practice

10.1.4P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) Construct electromagnets and verify electromagnetic induction
b) Use magnets in engineering applications
c) Plot B-H curve

Content

10.1.4P1 Construction of electromagnets
i) Ferrous materials
ii) Wire
iii) Power source

10.1.4P2 Use of magnets
i) Bells
ii) Speakers
iii) Solenoids

10.1.4P 3 Plotting of B-H curve

Suggested Learning Resources
i) Permanent magnets
ii) Electromagnets
iii) Power
iv) Wires
v) Bells

10.1.5 TRANSFORMERS

Theory

10.1.5T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) explain the principle of operation of a transformer
b) describe the various types of transformers
c) describe the construction of different types of transformers
d) explain applications of transformers

Competence

The trainee should have the ability to:
i)   Test transformers
ii) Construct a single phase transformer

Content

10.1.5T1 Principle of operation of a transformer
  i)   Electromagnetic induction
  ii)   Magnetic circuit
  iii) Inductance
  iv)   Coupling efficiency
  v)   Losses

10.1.5T2 Types of transformers and their applications
  i)   Single – Phase transformers
  ii)   Power transformers
  iii) Audio transformers
  iv)   Radio Frequency (R.F) transformers
  v)   Auto transformers
  vi)   Three phase transformers
  vii) Isolating transformers

10.1.5T3 Construction of different types of transformers
  i)   Core type
  ii)   Shell type
  iii) Windings

10.1.5T4 Simple calculations on single phase transformers
  i)   Transformers ratios

ii) Efficiency
iii) Applications of transforms

Practice

10.1.5P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
  a) Carry out transformer tests
  b) Construct a ingle phase transformer

Content

10.1.5P1 Transformer tests
10.1.5P2 Transformer construction

Suggested teaching/learning resources

  i)   Various types of transformers
  ii)   Wires
  iii) Electrical measuring instruments
  iv)   Electrical tools