8.1.0 APPLIED SCIENCE

8.1.01 Introduction

The module unit is intended to equip the trainee with the knowledge, skills and attitudes to enable him/her apply engineering science relevant to electrical Engineering.

8.1.02 General Objectives

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

a) apply relevant principles of applied science in solving engineering problems
b) carry out experiments to verify scientific principles
c) demonstrate correct skills in data collection, analysis and interpretation.

8.1.03 Module Unit Summary and Time Allocation

Applied Science

Code	Sub Module Unit	Content	Total
8.1.1	Foundations of Chemistry	• Properties of matter • Properties and effects of acids and bases • Properties and uses of Salts • Atomic structure • Chemical bonding	14
8.1.2	Light and Sound	• Laws of reflection and refraction of light • Refraction of light through various media • Refractive indices of various media • Location of images formed by mirrors and lenses • Power magnification and magnification power of instruments • Principle of operation of optical instruments • Polarization of light and its applications	8

		• Propagation and properties of sound • Sound levels	
8.1.3	Heat	• Temperature and temperature scales and conversions • Types of thermometers • Forms of heat transfer • Determine heat capacities and latent heat • Terms used in calorimetry • Graphs of change of state • Applications of heat capacity and latent heat	8
8.1.4	Density and Pressure	• Terms used for solids, liquids and gases. • Determination of densities • Archimedes principle, law of floatation and buoyancy • Calculation of density from relative density • Problems involving Archimedes principle and Law of floatation • Pressure and types of pressure • Pressure in solids, liquids and gases • Calculation of pressure • Methods and instruments of measuring pressure • Practical applications of pressure	8
8.1.5	Work, Energy, Power and Machines	• Definitions of terms and units • Forms, sources and types of energy • Law of conservation of energy • Problems involving work, energy and power • Calculations of potential energy (PE) and Kinetic Energy (KE) and the law of conservation of energy • Simple machines • Calculations of Mechanical Advantage (MA), Velocity Ratio (VR) and efficiency • Determination of the law of the	14

		machine • Problems involving practical examples of simple machines	
8.1.7	Magnetism and Electro-Magnetism	• Terms used in magnetism • The compass • Lines of flux around a magnet • Electromagnetism • Electromagnetic induction • Laws and rules of electromagnetic induction • Self induction • Applications of electromagnetic induction	8
8.1.8	Electro-Statics	• Definition of electrostatics • Types of charge and methods of charging objects • Sources of electrostatic charges • Basic law of charge • Capacitors and capacitance	4
8.1.9	Electro Magnetic Radiation	• Definition of terms • Properties of electromagnetic waves • Methods of producing and detecting radiations • Cathode Ray Oscilloscope (CRO)	4
Total time			**68**

8.1.1 FOUNDATIONS OF CHEMISTRY

Theory

8.1.1T0 *Specific Objectives*

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

a) state the properties of matter.
b) describe the properties and effects of acids and bases
c) describe the properties and uses of salts
d) describe atomic structure of elements
e) explain chemical bonding of elements.

Competence

The trainee should have the ability to:

i) Prepare and work safely with chemicals
ii) Use the periodic table of elements
iii) Verify applied science principles and apply them to ship systems
iv) Use common optical instruments
v) Track and identify weather patterns
vi) Carry out tests on metals and alloys

Content

8.1.1T1 Properties of matter
- i) Elements
- ii) Compounds
- iii) Mixtures
- iv) Polarization
- v) Ionization energies

8.1.1T2 Properties and effects of acids and bases:
- i) Type of Indicators
- ii) pH
- iii) Oxides
- iv) Hydroxides

8.1.1T3 Properties and uses of Salts
- i) Solubility
- ii) Conductivity
- iii) Effect of heat
- iv) Preparation:
- v) Neutralization
- vi) Precipitation

8.1.1T4. Atomic structure of elements
- i) Structure of an atom
- ii) Electric configuration
- iii) Atomic Spectra
- iv) Bohr Theory
- v) Spectral Series
- vi) Atomic number
- vii) Periodicity

8.1.1T5 Chemical Bonding of Elements
- i) Types of bonding
- ii) Hydrogen
- iii) Covalent
- iv) Metallic
- v) Co-ordinate

vi) Van der Waal
vii) Simple Molecules
viii) Mole concept
ix) Chemical equations
x) Thermo chemical equations
xi) Acid /base equations
xii) Redox equations
xiii) Bonding in carbon compounds
xiv) Covalent bonding formation
xv) Hybridization.

Practice

8.1.1P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) identify and test acids and bases
b) perform neutralization experiments
c) prepare salts.

Content
8.1.1P1 Identification Of Acids And Bases
8.1.1P2 Neutralization
8.1.1P3 Salts

8.1.2 LIGHT AND SOUND

Theory

8.1.2T *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) state and explain laws of reflection and refraction of light
b) describe refraction of light through various media
c) determine refractive indices of various media
d) locate images formed by mirrors and lenses
e) determine power magnification of lenses and magnification power of instruments
f) explain the principle of operation of optical instruments
g) explain polarization of light and describe its applications
h) explain propagation of sound and its properties.
i) explain sound levels, their measurement, effects and application to noise and noise pollution.

Content
8.1.2T1 Laws of reflection and refraction of light
8.1.2T2 Refraction of light through various media
i) triangular prisms

ii) rectangular prisms
iii) fluids
iv) convex and concave prisms.

8.1.2T3 Refractive indices of various media
i) liquids
ii) solids (glass)
iii) gases (air)

8.1.2T4 Locating images formed by mirrors and lenses
i) plane mirrors
ii) curved mirrors
iii) lenses
iv) convex
v) concave

8.1.2T5 Power magnification of a lens and the magnification power of instruments
i) lenses
ii) microscopes
iii) projectors
iv) binoculars
v) periscopes
vi) telescope

8.1.2T6 Principle of operation of optical instruments
i) lens formula
ii) images formed by lenses and mirrors
iii) power magnification and magnification power of lenses
iv) microscopes
v) telescopes
vi) projectors
vii) periscopes
viii) binoculars

8.1.2T7 Polarization of light
i) Production
ii) Glare reduction
iii) Photo elasticity
iv) Application of polarized light
v) Projecting images
vi) Projecting light
vii) Safety in use of
viii) polarized light

8.1.2T8 Propagation and properties of sound
i) Media
ii) air
iii) solids
iv) liquids
v) Properties
vi) refraction
vii) diffraction
viii) absorption
ix) interference

8.1.2T9 Sound levels
i) Measurement
ii) sound intensity
iii) sound pressure levels
iv) Tolerable pressure levels
v) Sound pressure meter
vi) Effects
vii) media effects
viii) room design
ix) applications
x) noise pollution
xi) noise reduction
xii) mufflers
xiii) dampers
xiv) acoustics
xv) ship whistle

Practice

8.1.2P0 *Specific Objectives*

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

a) perform an experiment to calculate the velocity of sound
b) perform experiments to measure sound levels.

Content

8.1.2P1 Velocity of sound
- Echo method

8.1.2P2 Sound levels measurement

8.1.3 HEAT

Theory

8.1.3T0 *Specific Objectives*

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

a) describe various temperature scales and conventions
b) describe various types of thermometers
c) describe forms of heat transfer
d) solve problems involving heat capacities, specific heat capacities and latent heat
e) define terms used in calorimetry
f) describe methods of determining heat capacities and latent heat
g) plot and interpret graphs of change of state
h) explain applications of heat capacity and latent heat.

Content

8.1.3T1 Temperature and temperature scales
i) Absolute scale
ii) Celsius scale
iii) Fahrenheit scale
iv) Kelvin scale
v) Temperature scales conversions

8.1.3T2 Types of thermometers
i) Mercury in glass
ii) Pyrometers
iii) Constant volume gas

8.1.3T3 Forms of heat transfer:
i) Conduction
ii) Convection
iii) Radiation
iv) Black body radiation
v) Ultraviolet (u.v.) and infrared (i.r.) Radiation
vi) Transmission
vii) Absorption
viii) Reflection

8.1.3T4 Calculations for quantity of
i) heat
ii) Heat capacity
iii) Specific heat capacity

iv) Latent heat

8.1.3T5 Terms used in calorimetry
- i) Heat
- ii) Specific heat capacity
- iii) Heat capacity
- iv) Latent heat of:
- v) Fusion
- vi) Vaporization/condensation
- vii) Sublimation

8.1.3T6 Methods of determining heat capacities and latent heat
- i) Mixture method
- ii) Electrical method

8.1.3T7 Change of state graphs

8.1.3T8 Applications of heat capacity and latent heat
- i) Refrigeration
- ii) Heat exchangers

Practice

8.1.3P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to perform experiments involving heat transfer, heat capacities, specific heat capacities and latent heat.

Content

8.1.3P1 Heat transfer experiments:
- i) Heat transfer
- ii) Heat capacity
- iii) Specific heat capacity
- iv) Latent heat

8.1.4 DENSITY AND PRESSURE

Theory

8.1.4T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
- a) explain the terms applied to density and pressure
- b) determine densities of solids, liquids and gases
- c) explain Archimedes principle, law of floatation and buoyancy
- d) apply Archimedes principle and law of floatation to
- e) solve problems related to density and pressure
- f) calculate density from relative density
- g) describe various types of pressure.
- h) describe pressure in solids, liquids and gases
- i) perform calculations involving pressure.

j) describe instruments of measuring pressure
k) explain practical applications of pressure.

Content

8.1.4T1 Terms used for solids, liquids and gases
i) Density
ii) Relative density
iii) Specific gravity

8.1.4T2 Determination of densities:
i) Solids
ii) Liquids
iii) Gases Solids
iv) Liquids
v) Gases

8.1.4T3 Archimedes Principle, Law of Floatation and Buoyancy

8.1.4T4 Calculation of density from relative density

8.1.4T5 Application of Archimedes Principle and Law of Floatation to solve problems

8.1.4T6 Pressure and types of pressure:
i) Gauge pressure
ii) Absolute pressure
iii) Atmospheric pressure

8.1.4T7 Pressure in:
i) Solids
ii) Liquids
iii) variation with depth/ density (Pascal's Law)
iv) Transmission
v) Forces acting on body in a fluid
vi) Velocity head
vii) Gases

8.1.4T8 Calculations involving pressure:
i) Conversions.
ii) Pascal's Law
iii) Pressure measurements

8.1.4T9 Instruments for measuring pressure
i) Barometer
ii) Manometer

8.1.4T10 Practical applications of pressure
i) Vacuum pump
ii) Hydrometer
iii) Hydraulic pump
iv) Controlled Pitch Propeller(CPP)

8.1.5 WORK, ENERGY, POWER AND MACHINES

Theory

8.1.5T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:
a) define work, energy and power
b) describe energy
c) state the law of conservation of energy
d) solve problems involving work energy and power

e) perform calculation on potential energy, kinetic energy and
f) law of conservation of energy
g) define terms as used in simple machines.
h) explain practical applications of simple machines
i) perform calculations on mechanical advantage, velocity
j) ratio and efficiency
k) determine the law of the machine using graphical and
l) analytical methods
m) solve problems involving practical applications of simple machines

Content

8.1.5T1 Definitions
i) Work
ii) Power
iii) Energy

8.1.5T2 Forms, sources and types of energy

8.1.5T3 The law of conservation of energy

8.1.5T4 Work, energy and power problems
i) Input
ii) Output
iii) Uniform velocity
iv) Variable velocity

8.1.5T5 Calculations of different forms of energy
i) Potential Energy (PE)
ii) Kinetic Energy (KE) (linear and rotating bodies)
iii) law of conservation of energy

8.1.5T6 Terms used in simple machine
i) Mechanical Advantage (MA)
ii) Velocity Ratio (VR)
iii) Efficiency

8.1.5T7 Practical applications of simple machines
i) Pulleys
ii) Levers
iii) Inclined planes

8.1.5T8 Calculations involving:
i) MA
ii) VR
iii) Efficiency

8.1.5T9 Determination of the law of the machine
i) Graphical method
ii) Analytical method

8.1.5T10 Problems involving practical examples of simple machines
i) Pulleys
ii) Levers
iii) Inclined planes

Practice

8.1.5P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to perform experiments

to verify the law of machines using graphical and analytical methods

Content

8.1.5P1 Determination and verification of the law of the machine
- i) Graphical method
- ii) Analytical method

8.1.6 GAS LAWS Theory

8.1.6T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
- a) describe gas laws
- b) derive the ideal gas equation
- c) perform calculations using the gas law equations
- d) explain the index law of expansion of gases.
- e) derive and apply the index law of expansion
- f) plot and interpret graphs for gas laws

Content

8.1.6T1 Gas laws:
- i) Definition of gas
- ii) Gas laws
- iii) Boyle's law
- iv) Charles law

8.1.6T2 The ideal gas equation

8.1.6T3 Calculations using gas laws
- i) Boyle's Law
- ii) Charles' law
- iii) Gas equation and application

8.1.6T4 Index law of expansion
- i) Adiabatic
- ii) Isothermal
- iii) Polytropic
- iv) The characteristic equation of a gas

8.1.6T5 The index law of expansion
- i) derivation
- ii) applications

8.1.6T6 Gas Laws graphs

Practice

8.1.6P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to perform experiments to verify the index law of expansion of gases

Content

8.1.6P1 The index law of expansion of gases

8.1.7 MAGNETISM AND ELECTROMAGNETISM

Theory

8.1.7T0 *Specific Objectives*
By the end of the sub-module unit, the

trainee should be able to;

a) define terms used in magnetism
b) describe the compass
c) plot lines of flux around a magnet
d) define electromagnetism
e) describe electromagnetic induction
f) state laws and rules of electromagnetic induction
g) describe self-induction
h) describe common applications of electromagnetic induction.

Content

8.1.7T 1 Definition of terms used in magnetism
- i) Flux and lines of flux
- ii) Angle of inclination/dip
- iii) Magnetic induction
- iv) 8.1.7T2 The Compass
- v) Earths Magnetic field
- vi) Points of compass

8.1.7T 3 Lines of flux around a magnet

8.1.7T 4 Electromagnetism
- definitions

8.1.7T 5 Electromagnetic induction

8.1.7T 6 Laws and rules of electromagnetic induction
- i) Fleming's Law
- ii) Lenz's Law
- iii) Fleming's right hand rule
- iv) Maxwell's Screw rule

8.1.7T7. Self-induction

8.1.7T8. Common applications of electromagnetic induction
- i) Electric bell
- ii) Induction coil
- iii) Transformers
- iv) Telephones
- v) Speedometer
- vi) Ignition systems etc

Practice

8.1.7P.0 *Specific Objectives*

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

a) Plot lines of flux around a magnet
b) Use a compass

Content

8.1.7P.1 Lines of flux around a magnet

8.1.7P.2 Magnetic compass

8.1.8 ELECTROSTATICS

Theory

8.1.8T0 *Specific Objectives*

By the end of the sub-module unit, the

trainee should be able to:

a) define electrostatics
b) explain methods of charging of objects
c) describe the sources of electrostatic charges
d) explain the basic law of charge.
e) explain the principle of capacitors and capacitance

Content

8.1.8T1 Definition of electrostatics

8.1.8T2 Methods of charging objects

i) Types of charge
ii) Methods

8.1.8T3 Sources of electrostatic charge

i) Ebony
ii) Glass rod
iii) Silk
iv) Fur
v) Plastics

8.1.8T4 Basic Law of charge

8.1.8T5 Capacitors and capacitance

i) Storage of electrical charge
ii) Relationship between
iii) voltage and charge
iv) Capacitor connection
v) Charging and discharging of a capacitor
vi) Energy stored in a Capacitor
vii) Types of capacitors and their
viii) applications

8.1.9 ELECTROMAGNETIC RADIATION

Theory

8.1.9T0 *Specific Objectives*

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

a) explain the electromagnetic spectrum
b) explain the properties of electromagnetic waves
c) explain methods of producing and detecting electromagnetic radiation
d) Describe the operations and working of a Cathode Ray oscilloscope

Content

8.1.9T1 The electromagnetic spectrum

- Electromagnetic radiation

8.1.9T2 Properties of electromagnetic waves

8.1.9T3 Methods of producing and detecting electromagnetic radiations:
i) X-rays
ii) Gamma rays
iii) Cathode rays

8.1.9T4 The Cathode Ray Oscilloscope (C.R.O.).
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