Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

APPLIED PHYSICS

GENMP402

Apply Mechanics and Properties of Matter

Competence

RQF Level: 4

Learning Hours 40

Credits: 4

Sector: All sectors except arts and crafts, hospitality and tourism

Trade: All trades except music and performing arts, fashion design, fine and plastic arts, agriculture, food processing, animal health, forestry, leather technology, food and beverages operations, front office and housekeeping operations, tourism

Module Type: General

CURRICULUM: GENMP402-TVET CERTIFICATE 4 – All sectors except arts and crafts, hospitality and tourism

Issue Date: May 2023

<table>
<tr><td>Purpose statement</td><td colspan="5">This module describes knowledge, skills and attitudes required to apply concepts of mechanics and properties of matter. At the end of the module, the leaner will be able to apply static equilibrium and elasticity, apply thermodynamics, analyze fluid mechanics, describe laws of motion and their applications, describe optical instrument and examine effects of electric current flow in DC electric circuit.</td></tr>
<tr><td rowspan="6">Delivery modality</td><td colspan="2">Training delivery</td><td>100%</td><td colspan="2">Assessment</td><td>Total 100%</td></tr>
<tr><td colspan="2">Theoretical content</td><td>30%</td><td rowspan="4">Formative assessment</td><td>30%</td><td rowspan="4">50%</td></tr>
<tr><td colspan="2">Practical work:</td><td rowspan="3">70%</td><td rowspan="3">70%</td></tr>
<tr><td>• Group project and presentation</td><td>20%</td></tr>
<tr><td>• Individual project /Work</td><td>50%</td></tr>
<tr><td colspan="2"></td><td colspan="2">Summative Assessment</td><td>50%</td></tr>
</table>

Elements of Competency and Performance Criteria

Elements of competency	Performance criteria
1. Describe laws of motion and their applications	1.1. The concept of a force is clearly interpreted based on types of forces
	1.2. Newton's laws of motion are clearly interpreted based on mathematical expressions
	1.3. Newton's laws are properly applied based on the free body diagram
2. Apply static equilibrium and elasticity	2.1. The equilibrium conditions are correctly explained for rigid bodies
	2.2. Static equilibrium is properly applied base on free body diagram
	2.3. Elastic properties are properly described based on the type of solid material
3. Analyze fluid mechanics	3.1. The concept of pressure is correctly described based on its variation with depth
	3.2. Archimedes' principle is properly applied based on buoyant forces
	3.3. Fluid dynamics are effectively analysed based on ideal fluid model
	4.1. Fundamental concepts of thermodynamics are clearly described based on system

4. Apply thermodynamics	4.2.	Thermodynamic laws are properly explained based on the system
	4.3.	Applications of thermodynamic laws are correctly discussed based on area of application.
5. Examine effects of electric current flow in DC electric circuit	5.1.	Simple electric circuit is properly described based on ohm's law
	5.2.	Electric current, resistances and voltages in DC electric circuits are accurately determined based on Kirchhoff's laws
	5.3.	Electric energy, work and power in DC electric circuit are correctly determined in accordance with the law of conservation of energy
6. Apply geometric instruments	6.1.	Optical instruments are effectively described based on its corresponding types
	6.2.	Magnification of optical instruments is correctly determined in accordance to the image location
	6.3.	Optical aberrations are effectively described based on their types

Course content

Learning outcomes	**At the end of the module the learner will be able to:** 1. Describe laws of motion and their applications 2. Apply static equilibrium and elasticity 3. Analyze fluid mechanics 4. Apply thermodynamics 5. Examine effects of electric current flow in DC electric circuit 6. Apply Geometric instruments
Learning outcome 1: Describe laws of motion and their applications	**Learning hours: 4**
Indicative content	
• **Interpretation of the concept of force** ✓ Contact force and field forces ✓ Fundamental forces and their characteristics ✓ Internal & external forces	

- **Interpretation of Newton's laws**
  - ✓ First law of Newton
  - ✓ Second law of Newton
  - ✓ Third law of Newton

- **Application of Newton's laws on a free body diagram**
  - ✓ Motion on a plane
    - Static friction
    - Dynamic friction
    - Free body diagram on a plane
  - ✓ Motion of suspended object
    - Weight of suspended object
    - Tension forces
    - Free body diagram on suspended objects
  - ✓ Rocket motion
    - Thrust
    - Air resistance
    - Free body diagram on a rocket

Resources required for the learning outcome	
Equipment	PPE, Whiteboard and chalkboard, Computer, Projector, Textbooks
Materials	Chalks, Markers, Flipchart
Tools	Various measuring instruments, Scientific calculator
Facilitation techniques	• Demonstration and simulation • Individual and group work • Practical exercise • Trainer guided • Group discussion
Formative assessment methods	• Written assessment • Oral presentation • Performance assessment • Product based assessment • Project based assessment

Learning outcome 2: Apply static equilibrium and elasticity	Learning hours: 8
Indicative content	

- **Explanation of equilibrium conditions**
  - ✓ Moment of the force
    - Torque associated with the force

- Rotational equilibrium and static equilibrium
- ✓ Necessary conditions for equilibrium of an object
  - First condition for equilibrium
  - Second condition for equilibrium
- ✓ Centre of gravity

- **Application of static equilibrium**
  - ✓ Standing on horizontal beam
    - Upward force
    - Downward force
  - ✓ Standing on a slope
    - Determination of horizontal and vertical components
    - Applying conditions for equilibrium in solving problems

- **Application of elastic properties**
  - ✓ Deformation of solids in terms of the concepts of stress and strain
    - Relation between stress and strain
    - Elastic modulus
  - ✓ Types of deformation and elastic modulus
    - Young's modulus (elasticity in length)
    - Shear modulus (elasticity of shape)
    - Bulk modulus (Volume elasticity)
  - ✓ Stress versus strain curve for an elastic solid.

Resources required for the indicative content	
Equipment	PPE, whiteboard and chalkboard, compute, projector, textbooks
Materials	Chalks, Markers
Tools	Scientific calculator, meter ruler, compass
Facilitation techniques	• Demonstration and simulation • Individual and group work • Practical exercise • Trainer guided • Group discussion • Search engine
Formative assessment methods	• Written assessment • Oral presentation • Performance assessment • Product based assessment • Project based assessment

Learning outcome 3: Analyze fluid mechanics	Learning hours: 6

Indicative content

- **Description of pressure and its variation with depth**
  - ✓ Pressure
    - Pressure in a fluid
    - Force and pressure
    - A simple device for measuring the pressure exerted by a fluid
  - ✓ Variation of pressure with depth
    - Variation of atmospheric pressure with altitude
    - Water pressure with depth
    - Pascal's principle
  - ✓ Pressure measurements
    - Measurements of atmospheric pressure
    - Barometric pressure
    - Absolute pressure and gauge pressure

- **Application of Archimedes' principle**
  - ✓ Buoyant forces
    - Meaning of Buoyant force
    - Relationship between magnitude of buoyant force and weight of the fluid displaced.
  - ✓ Archimedes' principle
    - Practical inventions of Archimedes 'principle
    - Archimedes' principle on totally submerged object
    - Archimedes' principle on floating object

- **Analysing fluid dynamics**
  - ✓ Viscosity
    - Equation of continuity for fluids
  - ✓ Bernoulli's principle and its application
    - Bernoulli's equation as applied to an ideal fluid
    - Application of Bernoulli's principle
  - ✓ Applications of fluid dynamics
    - Streamline flow around a moving airplane wing
    - Newton's third law about the airstream.

Resources required for the indicative content

Equipment	PPE, whiteboard and chalkboard, computer, projector, textbooks
Materials	Chalks, markers
Tools	Scientific calculator
Facilitation techniques	• Demonstration and simulation • Individual and group work

	• Practical exercise • Trainer guided • Group discussion • Research
Formative assessment methods	• Written assessment • Oral presentation • Performance assessment • Product based assessment • Project based assessment

Learning outcome 4: Apply thermodynamics	Learning hours: 9
Indicative content	

- **Description of fundamental concepts**
  - ✓ Key terms
    - System
    - Boundary
    - Surrounding
    - Extensive
    - intensive properties
  - ✓ Heat Transfer and Quantity of heat
    - Heat and temperature
    - Modes of heat transfer
    - Heat capacity
    - Specific heat capacity
    - Thermal expansions.

- **Analysing thermodynamic laws**
  - ✓ Zeroth law and temperature measurement
  - ✓ First Law of Thermodynamics
  - ✓ Second law of thermodynamics statements

- **Application of thermodynamic laws**
  - ✓ Refrigerators
  - ✓ Heat engines
  - ✓ Ventilators
  - ✓ Power plant

Resources required for the indicative content	
Equipment	PPE, computer, whiteboard, chalkboard, projector, textbooks
Materials	Chalks, markers, internet
Tools	scientific calculator, calorimeters, thermometers

Facilitation techniques	• Demonstration and simulation • Individual and group work • Practical exercise • Trainer guided • Group discussion • Research
Formative assessment methods	• Written assessment • Oral presentation • Performance assessment • Product based assessment • Project based assessment

Learning outcome 5: Examine effects of electric current flow in DC electric circuit	**Learning hours: 7**
Indicative content	

- **Description of a simple electric circuit**
  - ✓ DC electric circuit
    - Elements of DC electric circuit
    - Electric current
    - Electrical resistance
    - Voltage
  - ✓ Measuring instruments used in DC electric circuit
    - Ammeter
    - Voltmeter
    - Ohmmeter
    - Multimeter
  - ✓ Ohm's law
  - ✓ Combination of resistors
    - Series
    - Parallel
    - Mixed
  - ✓ Electric cells
    - E.M.F(Electromotive force) of a cell
    - Internal resistance
    - Cells network

- **Determination of electric current, resistances and voltages in DC electric circuits**
  - ✓ Key concepts
    - Path, junction, branch
    - Voltage supply
    - Voltage drop
    - Voltage gain

- ✓ Kirchhoff's laws
  - Conservation of charges
  - Current law
  - Voltage law

- **Determination of electric energy, work and power in DC electric circuit**
  - ✓ Calculations of energy and power in DC electric circuit
    - Electrical energy
    - Electrical work
    - Electrical power
  - ✓ Effects associated with electric current in a circuit
    - Joule's effect
    - Chemical effect
    - Magnetic effect

Resources required for the indicative content	
Equipment	PPE, whiteboard, chalkboard, optical bench, optical slides, computer, projector, textbooks
Materials	Chalks, Markers, Candles, Water
Tools	Scientific calculator
Facilitation techniques	• Demonstration and simulation • Individual and group work • Practical exercise • Trainer guided • Group discussion • Search engine
Formative assessment methods	• Written assessment • Oral presentation • Performance assessment • Product based assessment • Project based assessment

Learning outcome 6: Apply Geometric instruments	Learning hours: 6
Indicative content	

- **Description of optical instruments**
  - ✓ Single lens optical instruments
    - Human eye
    - Magnifying glass
    - Single lens camera
  - ✓ Multi-lens optical instruments

- Microscope
- Telescope
- Projector

- **Determination of the magnification of optical instruments**
  - ✓ Magnification of microscope
  - ✓ Magnification of telescope

- **Correction of optical aberrations**
  - ✓ Spherical aberration
  - ✓ Chromatic aberrations
  - ✓ Astigmatic aberration

Resources required for the indicative content	
Equipment	PPE, whiteboard, chalkboard, computer, projector, textbooks telescope, microscope
Materials	Chalks, markers
Tools	Scientific calculator, digital camera, magnifying glass
Facilitation techniques	• Simulation software • Individual and group work • Practical exercise • Trainer guided • Group discussion • Search engine
Formative assessment methods	• Written assessment • Oral presentation • Performance assessment • Product based assessment • Project based assessment

References:

1. Young, Hugh, D.; Freedman, Roger, A. (2012), Sears and Zeanmansky's University Physics: With modern physics, 13th edition. New York: Addison Wesley, Pearson
2. Arthur Beiser (2009) Schaum's Outline of Applied Physics 4th edition. New York: McGraw-Hill Companies, Inc
3. Giancoli, Douglas C. (2005). Physics Principles with applications 6th edition. Pearson Prentice Hall. New Jersey.
4. Meriam, James, L.; Kraige, L. G. (2012). Engineering Mechanics7th edition. John Wiley and Sons. Inc
5. Bansal, Rajeev (2006), Fundamentals of Engineering Electromagnetics. CRC Press
6. Halpen, Alvin (2009) Schaum's Outline of Beginning Physics II: Waves, electromagnetism, optics and modern Physics. New York: McGraw-Hill Companies, Inc.
7. Milton, Gussow (2009) Schaum's Outline of basic electricity 2nd Edition. New York: McGraw-Hill Companies, Inc.

8. Nathan, Ida (2015). Engineering Electromagnetics 3rd Edition. Springer International Publishing Switzerland
9. Purcell, Edward (2011). Electricity and Magnetism 2nd Edition. Cambridge University Press
10. Salazar, Félix B.; Rafael Medina F.; Bayón Ana R.; Gascón Francisco L. (2016). Solved Problems in Electromagnetics. Springer-Verlag Berlin Heidelberg
11. Sameir M.; Ali, Hamed (2017). Electromagnetics for Engineering Students. Bentham Science Publishers