Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

APPLIED PHYSICS

GENDW502

Apply Dynamics and Waves

Competence

RQF Level: 5

Learning Hours
40

Credits: 4

Sector: MANUFACTURING AND MINING, ICT AND MULTIMEDIA, ARTS AND CRAFTS, TECHNICAL SERVICES

Trade: Manufacturing Technology, Mining Technology, Computer Systems and Architecture, Multimedia Production, Software Development, Networking and Internet Technologies, Music and Performing Arts, Electronics and Telecommunication

Type: General

Issue Date: May 2023

2024/25

<table>
<tr><td>Purpose statement</td><td colspan="5">This module describes knowledge, skills, and attitudes required to apply concepts of dynamics and waves. At the end of this module, the leaner will be able to describe motion in orbits, describe vibrations and waves, describe semiconductor materials, examine effects of magnetism, and apply the concept of electromagnetic field.</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="3"></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 motion in orbits**	1.1. Universal gravitation motion in orbits is clearly described based on celestial objects
	1.2. Kepler's laws are properly explained based on celestial objects
	1.3. Rockets and satellites are clearly described based on a planetary motion
2. **Examine effects of magnetism**	2.1. The concept of magnetism is clearly described based on its fundamental laws
	2.2. The magnetic field created by electric current is clearly explained according to the Ampere's law
	2.3. The magnetic force is clearly determined based on the Lorentz law
3. Describe vibrations and waves	3.1. The concept of waves is clearly explained according to the vibrations
	3.2. Sound is clearly described based on the wave nature
	3.3. The light is clearly described based on the wave nature
4. Apply the concept of electromagnetic field	4.1. Induced electromotive force in a circuit is correctly determined based on Faraday's law
	4.2. The equation of propagation of electromagnetic waves is effectively applied based on mechanical waves
	4.3. Mobile phone and radio communication are efficiently categorized in line with telecommunication systems
5. **Describe semiconductor materials**	5.1. Fundamental properties of semiconductor materials are clearly described based on electron mobility
	5.2. Principles of semiconductor devices are clearly explained according to PN-junction

	5.3. The principles of operational amplifiers are properly described referring to semiconductor devices

Course content

Learning outcomes	At the end of the module the learner will be able to:
	1. **Describe motion in orbits** 2. **Examine effects of magnetism** 3. **Describe vibrations and waves** 4. **Apply the concept of electromagnetic field** 5. **Describe semiconductor materials**

Learning outcome 1: Describe motion in orbits	**Learning hours: 6**

Indicative content

- **Description of universal Gravitation motion in orbits**
  - ✓ Universal Gravitation
    - Definition of orbital motion and universal gravitation
    - State of Newton's law of universal Gravitation.
    - Determination of Gravitational force of bodies moving in orbits
  - ✓ Free-fall acceleration and the Gravitational force
    - Variation of g with altitude,
    - The density of the earth
- **Explanation of Kepler's laws**
  - ✓ Kepler's laws
    - Kepler's first law
    - Kepler's second law
    - Kepler's third law
    - Application of Kepler 's laws.
  - ✓ The motion of celestial objects in orbits
    - Definition of Planetary motion
    - Movement of the planets, stars and other celestial objects
    - Kepler's conclusion about Brahe's data.
- **Description of Rockets and satellites motion**
  - ✓ **Planetary motion**
    - Gravitational field
    - Mathematical treatment of gravitational field
  - ✓ Motion of rocket, satellite and space crafts

- Classification of satellites orbits and space crafts
- Movement of satellites in orbits
- Escape speed of a rocket and satellite

✓ Description of three Cosmic velocities
- First cosmic velocity
- Second cosmic velocity
- Third cosmic velocity.

Resources required for the indicative content	
Equipment	PPE, whiteboard, 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 • Search engine
Formative assessment methods	• Written assessment • Oral presentation • Performance assessment • Product based assessment • Project based assessment

Learning outcome 2: Examine effects of magnetism	**Learning hours: 10**

Indicative content

- **Description of the concepts of magnetism**

✓ Concept of a magnet
- Definition of magnet
- Types of magnets

✓ Magnetization
- Magnetization process
- Magnetization Methods
- Magnetizing field

✓ Classification of magnetic materials
- Ferromagnetic materials
- Paramagnetic materials
- Diamagnetic materials

- Ferrimagnetic materials
- Anti-Ferromagnetic materials

✓ Fundamental laws of magnetism
- Law of attraction
- Law of repulsion
- Law of distance

- **Explanation of the magnetic field created by electric current**
  - Ampere's law

✓ Electromagnets
- Application

✓ Measuring instruments of magnetic field
- Magnetic needle
- Tesla meter
- Magnetometer

- **Determination of magnetic force**
  - Lorentz force law
  - Fleming's left-hand rule

✓ **Ampere's force two current-carrying conductors**
- Attraction
- Repulsion

✓ Application of magnetic forces
- Electric motor
- Loudspeaker
- Moving-coil meters
- Charge deflecting systems

Resources required for the indicative content	
Equipment	PPE, whiteboard, chalkboard computer, projector, textbooks
Materials	Chalks, Markers
Tools	Scientific calculator, magnets, compass
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 3: **Describe vibrations and waves**	**Learning hours: 8**

Indicative content

- **Explanation of the concept of waves**
  - ✓ Wave terminologies
    - Sine wave
    - Crests and trough
    - Wavelength
    - Amplitude
    - Period
    - Frequency
    - Wave speed
  - ✓ Waves classifications
    - Mechanical waves versus electromagnetic waves
    - Transverse versus longitudinal waves
  - ✓ Electromagnetic waves
    - Electromagnetic spectrum
    - Electromagnetic velocity
  - ✓ Properties of waves
- **Description of the Nature of Sound**
  - ✓ Sound characteristics
  - ✓ Sound waves interference
  - ✓ Sound Instruments
    - Musical instruments
- **Description of the Nature of Light**
  - ✓ Nature of color
    - Dispersion and prisms
    - Selective reflection
    - Selective transmission

Resources required for the indicative content

Equipment	PPE, whiteboard, 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 the concept of electromagnetic field	**Learning hours: 10**

Indicative content

- **Determination of the induced emf in a circuit**
  - ✓ Concept of electromagnetic induction (EMI)
    - Faraday's law
    - Lenz's law of EMI
    - Fleming's right-hand rule
  - ✓ Induced emf and induced current
    - EMI in a coil
    - EMI in a transformer
    - Motional induced emf
  - ✓ Applications of EMI
    - Transformers
    - Generators
    - Induction motors
- **Application of the equation of propagation of electromagnetic waves**
  - ✓ Properties of electromagnetic waves
    - Speed of EM waves in free space
    - EM waves wavelength
    - EM waves frequency
    - EM waves amplitude
    - Electromagnetic spectrum
- **Categorization of mobile phone and radio communication**
  - ✓ Interpretation of concepts in transmission
    - Transmission system.
    - Terms used in transmission system: (Transmitter, Channel, Receiver, Digital communication, Analog communication)
  - ✓ Principle of cellular radio and Structure of cellular network.
  - ✓ Types of modulations (AM, FM, and PM).
  - ✓ Description of post, telegraph and telephone (PTT)

Resources required for the indicative content

Equipment	PPE, whiteboard, chalkboard, computer, projector, textbooks

Materials	Chalks, markers
Tools	Scientific calculator, magnets
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: Describe semiconductor materials	**Learning hours: 6**

Indicative content

- **Description of fundamental properties of semiconductor materials**
  - ✓ Conductivity
    - Conductor materials
    - Insulator materials
    - Semiconductors materials
  - ✓ Basics of semiconductors
    - Valence electrons
    - Free electrons
    - Holes
    - Electron mobility
    - Holes mobility
  - ✓ Current in semiconductors
    - Intrinsic semiconductors
    - Extrinsic semiconductors
    - PN junction
- **Explanation of the principles of semiconductor devices**
  - ✓ N-type and P-type materials
  - ✓ Diode
    - Types of diodes
  - ✓ Transistor
    - Types of transistors
    - Current flow in a transistor
- **Description of the principles of operational amplifiers**
  - ✓ Introduction on integrated circuit

- integrated circuits types
- ✓ The operational amplifier
  - Feedback
  - The operational amplifier as amplifier
- ✓ The operational amplifier applications
  - Flame sensor
  - Heat sensor
  - Ramp generator
  - The summing amplifier
  - Oscillator

Resources required for the indicative content	
Equipment	PPE, whiteboard, 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

References:

1. E school today. (2008-2018). Retrieved February 19, 2018, from natural disasters: http
2. Avison, J. (1989). The world of PHYSICS. Cheltenham: Thomas Nelson and Sons Ltd.
3. Chand, S., & S.N., G. S. (2003). Atomic Physics (Modern Physics) (1 ed.). India.
4. CPMD. (2015). Advanced Level Physics Syllabus. Kigali: REB.
5. Cunningham, & William, P. (2000). Environmental science (6 ed.). Mc Graw-Hill.
6. Cutnell, J. D., & Johnson, K. W. (2006). Essentials of Physics. USA: John Wlley &Sons, Inc.
7. Cutnell, J. D., & Johnson, K. W. (2007). Physics. (7 ed.). USA: John Wiley; Sons, Inc
8. Cuttnell, J. D., & kennety, W. J. (2007). Physics (7 ed.). United State of America: John Willey & Sons. Inc
9. Douglass, C. G. (2014). PHYSICS, Principles with applications. (7 ed.). Pearson Education
10. Douglass, C. G. (2014). PHYSICS, Principles with applications. (8 ed.). Pearson Education.
11. Duncan, T., & Kennett, H. (2000). Advanced Physics (5 ed.). London, UK: Holder Education.

12. Giancoli, D. (2005). PHYSICS: Principles with applications. New Jersey: Pearson Education, Inc.
13. Giancoli, D. C. (2005). Physics principals with application. Upper Saddle River, NJ 07458: Pearson Education, Inc.
14. Giancoli, D. C. (2005). Physics: principals with application. Upper Saddle River, NJ 07458: Pearson Education, Inc.
15. MIDIMAR. (2012). Disaster High Risk Zones on Floods and Landslide. Kigali: MIDMAR
16. Office, U. M. (2011). Warming: A guide to climate change. U.K.: Met Office Hadley Centre.
17. Randall, D., & Knight. (2004). Physics for scientists and engineers: Strategic approach (Vol. 2). San Francisco: Pearson Education.
18. Randall, D., & Knight. (2004). Physics for scientists and engineers: Strategic approach. (Vol. 3). San Fransisco: Pearson Education, Inc.
19. Randall, D., & Knight. (2008). Physics for scientists and engineers: Strategic approach. (2 ed., Vol. 3). San Francisco: Pearson Education, Inc.
20. REMA. (n.d.). Rwanda Second National Communication under the UNFCCC. KIGALI: MINISTRY OF NATURAL RESOURCES, RWANDA
21. Science, G. (2006). Florida Physical Science with Earth Science. USA: Mc Graw Hill Glencoe Companies, Inc.
22. Serway, R. A. (1986). Physics for Scientists and Engineers (2 ed.). Saunders College Publishing.
23. IPCC. (1996). Economics of Greenhouse Gas limitation, Main report “Methodological Guidelines.
24. John, M. (2009). Optical Fiber Communications, Principals and Practice (3rd Ed.). London: Pearsnon Prentice Hall.
25. Tipler, P. A. (1991). Physics for Scientists and Engineers. (3 ed., Vol. 1). USA: Worth Publishers, Inc