



VIT
Vellore Institute of Technology

Final Assessment Test – May 2024

Course: **PHY1005 - Modern Physics**

Class NBR(s): **1984 / 4909**

Time: **Three Hours**

Slot: **E2+TE2**

Max. Marks: **100**

- **KEEPING MOBILE PHONE/ELECTRONIC DEVICES EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE**
- **DON'T WRITE ANYTHING ON THE QUESTION PAPER**

Answer any TEN Questions

(10 X 10 = 100 Marks)

1. What is heat engine? Elaborate the construction and working mechanism of Carnot's engine with suitable figures and PV diagrams. Deduce the expression for work done in the Carnot's cycle.
2. a) Obtain expression for change in entropy in reversible and irreversible process. [5]
b) Calculate the increase in entropy when 1 gram of ice at -10°C is converted to steam at 100°C . [5]
Given: Specific heat of ice = 0.5, latent heat of ice and steam are 80 and 540 cal g^{-1} .
3. Consider a simple damped mass-spring system and deduce the equation of motion the system and its solution. Explain the behavior of the system when its over damped, critical damped and under damped with suitable diagrams and expressions.
4. a) Differentiate simple and damped electrical oscillators with suitable figures and equations. [5]
b) A simple harmonic motion of a simple mass-spring system can be represented as $(x, t) = 0.2 \sin(6.28x - 1.57t)$, where all physical quantities are in SI units. Then, calculate the amplitude of the oscillation, frequency, wavelength, time period, and speed of the wave [5]
5. Discuss and derive the conditions to form both dark and bright interference fringes on a screen due to a monochromatic light passing through two parallel slits on an opaque screen. Also deduce the expression for band width for the fringes.
6. State the physical significance of Maxwell's equations for electromagnetic waves in differential form. Prove that the accelerating electric field propagates in free space with the speed of light in vacuum by considering Maxwell's equation of electromagnetic waves in free space.
7. a) Explain the incompleteness of Ampere's Law in magnetostatics with appropriate example and discuss how Maxwell modified it to arrive at the general Ampere's law. [5]
b) Consider a scalar function $S = x^2y - 3yz + \sin x \cos y$. Prove that the $\vec{\nabla} \times (\vec{\nabla} S) = 0$ [5]
8. A free sub atomic particle of mass m and energy E is trapped in an infinite one-dimensional potential well of length L . Prove that the motion the particle has wider energy levels separation at higher quantum states. Draw the probability density for first three energy states.

9. a) Define wavefunction. Discuss about the significance and condition for well-behaved wavefunction. [5]
- b) A bullet of mass 0.03 kg is moving with a speed of 500 m s^{-1} . The speed is measured accurate to 0.02%. Calculate the certainty with which we can locate the position of the bullet. Give your comment. [5]
10. Classify solids in terms of their atomic arrangement with suitable examples. Draw and explain the types of crystal systems.
11. a) Explain the construction and working principle of PIN photodiode with neat schematic diagrams. [5]
- b) A step-index fibre has a core of refractive index 1.5, cladding of refractive index 1.46 and the diameter of the core of the fibre is $100 \mu\text{m}$, and the medium surrounding the fibre is air. Determine (a) numerical aperture, (b) acceptance angles and (c) critical angle.
12. Describe the various vibrational modes of CO_2 molecule. Describe the construction, working mechanism and energy level of CO_2 laser with necessary diagrams.

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