Registration No.: | | | | | | | | | | |

Total Number of Pages: 02 **Course: B.Tech**

Sub_Code: RPH2A001

2nd Semester Back Examination: 2024-25

SUBJECT: PHYSICS

BRANCH(S): AEIE, BIOTECH, CIVIL, CSE, CSEAI, CSEAIML, CSEDS, CSIT, CST, ECE, EEE, ELECTRICAL, ELECTRICAL & C.E, ETC, MECH, MINING, MME, PLASTIC

Time: 3 Hours

Max Marks: 100

Q.Code: S403

Answer Question No.1 (Part-I) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 **Answer the following questions:** **(2 x 10)**

a) Define the time period, frequency, and amplitude of an oscillator.

b) What is the condition for resonance?

c) Write two uses of Newton's ring experiment.

d) What are Fresnel's half-period zones?

e) Calculate the interplanar spacing for a (321) plane in a simple cubic lattice whose lattice constant is 0.42 nm.

f) A silica glass optical fiber has a core refractive index of 1.5 and a cladding refractive index of 1.450. Calculate the numerical aperture (NA) of the fiber.

g) Define the gradient of a scalar field. Is it a vector or a scalar?

h) Distinguish between conduction current and displacement current.

i) The energy required to remove an electron from sodium is 3.1 eV. Does sodium show a photoelectric effect for orange light with λ = 680 nm? Justify.

j) Write down the time-independent Schrodinger's equation for a free particle of mass 'm' moving in Z – axis.

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

a) Derive the equation of motion for simple harmonic oscillation and prove that the total energy of the oscillator is constant with respect to time.

b) Two simple pendulums of mass 'm' and length 'l' each are coupled by a spring of force constant 'k'. Write the expression for the frequency of normal modes of vibration of the coupled system.

c) Show that the radii of Fresnel half-period zones are proportional to the square root of natural numbers.

d) What is a Bi-prism? How can the wavelength of monochromatic light be measured with the help of a Fresnel Bi-prism?

e) Draw the structure of an optical fiber. Distinguish between a single mode and a multimode optical fiber.

f) What do you mean by miller indices? Write down the procedure to find out the miller indices. A certain orthorhombic crystal has axial units a: b: c of 0.424: 1: 0.367. Find the miller indices of the crystal whose intercepts are 0.424: ∞: 0.123.

g) Show that the electromagnetic Waves are transverse in nature.

h) Define poynting vector. Deduce poynting theorem for the flow of energy in an electromagnetic field.

i) Define gradient, divergence, and curl. A vector field is given by $\vec{A}$ = 2xy $\hat{\imath}$ +x^{2}y $\hat{\jmath}$ +xyz $\hat{k}$, find the divergence and curl of the vector at the point (1, 1, -1).

j) What is uncertainty principle? Using uncertainty principle, show the non-existance of electron inside the nucleus.

k) Calculate the expectation value of x-component of momentum of a free particle in a box of length l

$$\psi = \sqrt{\frac{2}{l}}[sin\left(\frac{n\pi x}{l}\right)$$

l) What do you mean by photoelectric effect? Find out planck's constant from Einstein's photoelectric equation.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four) **(16 x 2)**

Q3 **a)** A damped oscillator is subjected to a damping force proportional to its velocity. Write the differential equation of motion of the oscillator and discuss the underdamped, overdamped, and critically damped motions with suitable examples. **(12)**

b) A 1-D sinusoidal wave is propagating along the positive x-direction. The displacement at two points x_1 = 0 and x_2 = 2.0 cm is given by the following expressions: **(4)**

Y (x_1, t) = (0.02 cm) sin [(3π s^{-1}) t]

Y (x_2, t) = (0.02 cm) sin[(3π s^{-1})t + π/2]

Determine the amplitude, frequency, wavelength, direction of propagation, and speed of the wave.

Q4 **a)** With a suitable diagram explain the construction and working of ruby laser. Draw the energy level diagram showing the operation of the ruby laser. Write the limitations of ruby laser. **(12)**

b) In Newton's Rings experiment, the diameter of the 15th ring was found to be 0.59 cm, and that of the 5th ring was 0.336 cm. If the radius of the plano-convex lens is 100 cm, calculate the wavelength of light used. What happens to ring diameter if air film is replaced with liquid of refractive index 1.5? **(4)**

Q5 **a)** Write Maxwell's electromagnetic equations in integral and differential form. From Maxwell's electromagnetic equations, obtain the electromagnetic wave equations for electric field and magnetic field in vaccum. **(12)**

b) Show diagrammatically and differentiate the valance and conduction bands for insulators, conductors, and semiconductors. **(4)**

Q6 **a)** Starting from the schrodinger's equation for a particle confined in a one dimensional box of length L, develop an expression for the normalized wavefunction. Show that it's energy is discrete and quantized. **(12)**

b) X-rays with λ = 1Å are scattered from a carbon block. The scattered radiation is viewed at 90° to the incident beam: (i) what is the Compton shift Δλ, (ii) How much kinetic is imparted to the recoiling electron? **(4)**