ARYA COLLEGE OF ENGINEERING

GUESS PAPER

(1st B. Tech. I Semester DECEMBER., 2025)

(ENGINEERING PHYSICS)

UNIT I

PART A (WORD LIMIT: 25 WORDS)

Q1. Write Bragg's law. And X-ray diffraction.

Q2. What will be the effect on Newton's rings if a plane mirror is placed instead of the glass plate below the Plano convex lens? What will be the effect on Newton's rings if a medium of refractive index μ inserted between plano convex lens and plane glass plate.

Q3. What is the condition to get missing spectra in plane transmission grating? Why we uses two lenses in Fraunhofer's diffraction. Write differences between Fresnel and Fraunhofer's diffraction.

PART B (ANALYTICAL/ PROBLEM SOLVING QUESTIONS)

Q4. Light containing two wavelengths λ_1 and λ_2 falls normally on a plano-convex lens or radius of curvature R, resting on a glass plate. If the n^{th} dark ring due to λ_1 coincide with $(n+1)^{th}$ dar ring due to λ_2, prove that the radius of the n^{th} dark ring of λ_1 is

$$r_n = \sqrt{\frac{\lambda_1\lambda_2 R}{\lambda_1-\lambda_2}}$$

Q5. Newton's rings are observed between a spherical surface of radius of curvature 120 cm. and a plane plate. The diameters of 5th and 16th bright rings are 0.314 cm. and 0.583 cm. Calculate the diameter of 25th and 37th bright rings and also the wavelength of light used.

Q6. A diffraction grating has total ruled width 5 cm, for normal incidence. It is found that a line of wavelength 6000Å in a certain order superimpose on another line of wavelength 4500 Å of the next higher order. If the angle of diffraction is 30°, How many lines are there in the grating.

Q7. If a single slit is illuminated by light composed of two wavelengths λ_1 and λ_2. One observes that due to diffraction, the first minima obtained for λ_1 coincide with the second diffraction minima of λ_2. What will be the relation between λ_1 and λ_2.

Q8. Find the distance between two successive positions of a movable mirror of a Michelson interferometer giving distinct fringes in case of sodium having lines of wavelengths 5600 Å and 5610 Å.

Q9. A plane transmission grating produces an angular separation of 0.01 radian between two wavelengths observed at an angle of 30°. If the mean value of the wavelength is 5000 Å and the spectrum is observed in the second order, calculate the difference in the two wavelengths.

Q10. When a thin film of mica of refractive index 1.6 is interposed in the path of one of the interfering beams of the Michelson's interferometer, a shift of 50 fringes of sodium light is observed across the field of view. If the thickness of thin air film is 0.02 mm. Calculate the wavelength of the light used.

PART C (DESCRIPTIVE/ ANALYTICAL/ PROBLEM SOLVING/ DESIGN QUESTIONS)

Q11. Show that the relative intensities of successive maxima of Fraunhofer's diffraction at a single slit are $1 : \frac{4}{9\pi^2} : \frac{4}{25\pi^2} : \frac{4}{49\pi^2}$ … … …. . Distinguish between Fresnel's and Fraunhofer's diffraction.

Q12. Describe the construction, working and theory of Newton's ring. Show that diameter of nth dark ring is proportional to square root of natural no. How shall you measure wavelength of light and refractive index of liquid using Newton's ring experiment? Derive Formula used. What will happen to newton's ring if a plane mirror is used instead of plane glass plate. What will happen if a Plano convex lens of small radius of curvature is used?

Q13. Show that the intensity of light diffracted from a plane transmission grating is given by

$$\sin\alpha \quad ^2 \quad \sin N\beta \quad ^2$$

$I = I_0 \left(\alpha \right)$ $\left(\sin\beta \right)$ Also obtain the condition of absent spectra in a grating.

(b) A diffraction grating has a resolving power $\frac{\lambda}{\Delta\lambda} = N \times n$ Show that the corresponding frequency range $\Delta\upsilon$ that can be just resolved is given by $\Delta\upsilon = \frac{C}{N n \lambda}$.

Q14. Explain working of M.I.? What is the role of compensatory plate in Michelson's Interferometer? When will you observe circular fringes in Michelson's Interferometer? Show with necessary theory how it is used to measure the difference in wavelength between the lines of sodium light. Explain the shape of fringes. Write two differences between Haidinger fringes and Fizeau Fringes.

UNIT II

PART A (WORD LIMIT: 25 WORDS)

Q1. What do you understand by wave function. What are the necessary conditions of physically acceptable wave function. State Postulates of wavefunction and explain Normalized and orthogonalized wave function.

Q2. Write down Schrodinger's time dependent and time independent wave equation.

Q3. Show that the electron cannot exist inside the nucleus of an atom. And Explain Hamiltonian.

Q4. What do you mean by DEGENRATED STATES.

Q5. Define the term matter wave and wave particle duality.

PART B (ANALYTICAL/ PROBLEM SOLVING QUESTIONS)

Q6. A particle limited to the X-axis has the wave function $\psi = ax$ between $x = 0$and $x = 1$; $\psi = 0$ elsewhere

(a) Find the probability that the particle can be found between $x = 0.45$ and $x = 0.55$

Q7. Answer the following questions with respect to a particle in a cubical box of side 'a'.

(i) Is $n_x = n_y = n_z = 1$ State degenerate.

(ii) What is the order of degeneracy for $n_x + n_y + n_z = 4$

(iii) What shall happen to the degeneracies for $n_x + n_y + n_z = 4$ if the box is not cubical but rectangular parallelepiped with side a, b and c such that $a = b \neq c$?

Q8. Calculate first two energy levels of an electron in a rigid potential box of width 1Å.

Q9. Consider a particle moving in a 1D box of infinite height of $25 \times 10^{-10} m$. Width. Estimate the probability of finding the particle in an interval of $5 \times 10^{-10}\ m$. At the center of the box when it is in its state of least energy.

Q10. Monochromatic light of wavelength 623.8 nm is produced by a He-Ne Laser, the power emitted is 9.42 mW.

Q11. Find the energy and momentum of each photon in the light beam.

PART C (DESCRIPTIVE/ ANALYTICAL/ PROBLEM SOLVING/ DESIGN QUESTIONS)

Q12. Explain what you understand by the term potential barrier. Write down Schrodinger's equation for a free particle of mass m trapped in cubical box of sides 'a'.

Q13. Derive Schrodinger's **time independent** wave equation and give physical interpretation and essential requirements of wave function used in equation.

Q14. Derive **Eigen Energy operator and Eigen Momentum operator** for a particle trapped in one dimensional box hence derive Schrodinger's **time dependent** wave equation.

UNIT III

PART A (WORD LIMIT: 25 WORDS)

Q1. Define following:

(i) coherence and types of coherence
(ii) spectral purity
(iii) coherence length and coherence time
(iv) Mono mode optical fiber (with diagram)
(v) Multi-mode optical fiber (with diagram)

Q2. Define visibility and give its formulae.

Q3. Explain the following terms:

(i) Critical angle.
(ii) Acceptance angle & acceptance cone.
(iii) Numerical aperture
(iv) Advantages of optical fiber

Q4. Explain by using suitable diagram (i) Step index optical fiber (ii) Graded index optical fiber

PART B (ANALYTICAL/ PROBLEM SOLVING QUESTIONS)

Q5. A glass clad fiber is made with core glass of $\mu_{core} = 1.5$ and the cladding is dropped to give a fractional index difference of 0.005. Determine:

(i) Cladding index (ii) critical angle (iii) Numerical aperture.

Q6. Light of wavelength 4800 Å has a length of 25 waves. What is the coherence length and coherence time?

Q7. With He-Ne laser, Michelson interferometer fringes remain ed clearly visible when the path difference was increased up to 8 m. Deduce the lower limits for (i) the coherence length (ii) coherence time (iii) spectral half width (iv) Q of the line. Given $\lambda = 1.15 \times 10^{-5} cm$.

Q8. Calculate the refractive indices of the core and cladding material of a fiber from the following data N.A. = 0.22 and $\Delta\mu r = 0.012$.

PART C (DESCRIPTIVE/ ANALYTICAL/ PROBLEM SOLVING/ DESIGN QUESTIONS)

Q9. What is an optical fiber? What do you mean by numerical aperture of an optical fiber. Find an expression for the N.A. of a step index optical fiber. Explain clearly, the propagation of an electromagnetic wave inside an optical fiber. Also explain application of optical fiber.

UNIT IV

PART A (WORD LIMIT: 25 WORDS)

Q1. Explain following:

a) spontaneous emission
b) stimulated emission
c) absorption process
d) Population Inversion
e) Metastable state
f) Resonator
g) Active medium

PART B & C (DESCRIPTIVE/ ANALYTICAL/ PROBLEM SOLVING/ DESIGN QUESTIONS)

Q2. What are Einstein's Coefficients? Derive relation between them. Explain the essential requirement for production of LASER action. How could probability of stimulated emission be increased?

Q3. Explain construction and working of **He- Ne LASER.**

Q4. Explain the essential requirement for production of LASER.

Q5. What are the basic requirements of semi-conductor LASER? With the help of energy band diagram explain working of semi-conductor LASER.

UNIT V

PART A (WORD LIMIT: 25 WORDS)

Q1. Why a semiconductor behaves like an insulator at 0K temperature?

Q2. Explain following with examples:

a. ionic bonds.
b. Covalent bonds
c. Metallic Bonds
d. Valence Band
e. Forbidden Energy Band
f. Conduction Band
g. Fermi Dirac distribution and Fermi Energy.

PART B (ANALYTICAL/ PROBLEM SOLVING QUESTIONS)

Q3. For intrinsic silicon, at room temperature the electrical conductivity is $\mathbf{4 \times 10^{-4}\ \Omega^{-1}\ m^{-1}}$. The electron and hole mobilities are $\mathbf{0.14\ m^2\ V^{-1}\ s^{-1}}$ and $\mathbf{0.040\ m^2\ V^{-1}\ s^{-1}}$ respectively. Compute the intrinsic charge carrier density at room temperature.

Q4. A n-type semiconductor has hall coefficient $4.16 \times 10^{-4}\ m^3 c^{-1}$, The conductivity is $180\ \Omega^{-1}\ m^{-1}$. Calculate its charge carrier density and electron mobility at room temp.

Q5. Calculate the conductivity of intrinsic semiconductor at 300 K. Given by $n = 2.4 \times 10^{19}/\mathbf{m^3}$ $\boldsymbol{\mu_e} = \mathbf{0.39\ m^2\ V^{-1}\ s^{-1}}$ **and** $\boldsymbol{\mu_h} = \mathbf{0.19\ m^2\ V^{-1}\ s^{-1}}$

PART C (DESCRIPTIVE/ ANALYTICAL/ PROBLEM SOLVING/ DESIGN QUESTIONS)

Q5. Explain Hall Effect. Obtain the expression for Hall coefficient, Hall voltage, Hall angle and Hall mobility.

Q6. Obtain Bragg's equation for X-ray. Apply the necessary correction for this equation

Q7. Derive the expression for conductivity in an intrinsic and extrinsic semiconductor and Describe the formation of energy band in solids and hence explain how it helps to classify the materials into conductors and insulators.

UNIT VI

PART A (WORD LIMIT: 25 WORDS)

Q1. What do you mean by Poynting Vector

Q2. Write the characteristics of EM waves. And define Matter waves.

Q3. Define following:

(i) Gradient of scalar field (ii) Curl of vector quantity

Q4. What do you mean by scalar and vector field. Write expression for Bio- Savart's law in vector form.

Q5. State following:

(i) Gauss's divergence theorem (ii) Curls theorem

PART B (ANALYTICAL/ PROBLEM SOLVING QUESTIONS)

Q6. Prove that for a position vector $\nabla \left(\frac{1}{r}\right) = -\frac{\vec{r}}{r^3}$

Q7. Show that ratio of pointing vector to energy density is $\leq 3 \times 10^8\ m./s$

Q8. **Explain displacement current.**

is also a irrotational vector.

PART C (DESCRIPTIVE/ ANALYTICAL/ PROBLEM SOLVING/ DESIGN QUESTIONS)

Q12. Derive all four Maxwell's equations. For electromagnetism.

Q13. State and prove pointing theorem for the rate of flow of energy in electromagnetic field.

Q14. Derive Laplace's and Poisson's equation.