PHY201

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M S RAMAIAH INSTITUTE OF TECHNOLOGY

(AUTONOMOUS INSTITUTE, AFFILIATED TO VTU)

BANGALORE – 560 054

SEMESTER END EXAMINATIONS – MAY / JUNE 2014

Course & Branch	:	**B.E:- Common to All Branches**	**Semester**	:	**II**
Subject	:	**Engineering Physics**	**Max. Marks**	:	**100**
Subject Code	:	**PHY201**	**Duration**	:	**3 Hrs**

Instructions to the Candidates:

- Answer one full question from each unit.
- $h=6.6\times10^{-34}$ J.s; $k=1.38\times10^{-23}$ J/K; $c=3\times10^{8}$m/s; $e=1.6\times10^{-19}$ C; $m_0=9.1\times10^{-31}$kg

UNIT – I

1. a) What is Moment of Inertia? Obtain the expression for moment of inertia of a circular disc about an axis perpendicular to the plane and passing through the center. (07)

   b) The ratio of masses of two circular discs is 1:3 and the ratio of the diameters is 2:1. If two identical rigid wires are used for suspension and the circular discs are set into torsional oscillations about a diameter, find the ratio of time periods. (05)

   c) Define rigidity modulus. Derive the expression for couple per unit twist of a cylinder. (08)

2 a) What is a cantilever? Assume the expression for bending moment of a beam and derive the expression for Youngs modulus of the material of the cantilever. (08)

   b) What is Poisson's Ratio? What are its theoretical limits? A material has Poissons ratio of 0.3. If a uniform rod of it suffers a longitudinal strain 3×10^{-3}, calculate the percentage change in its volume. (05)

   c) State and prove parallel and perpendicular axes theorems. (07)

UNIT – II

3. a) Explain spontaneous and stimulated emission. Show that at Optical frequencies the ratio of spontaneous to stimulated emission is >>>1 (06)

   b) What are the different modes of vibration of a CO_2 laser? Describe the construction and working of the CO_2 laser with necessary diagrams. (09)

   c) Describe how temperature of a specimen can be measured by a fiber optic sensor. (05)

4. a) Distinguish between intermodal and intramodal dispersion. Explain with refractive index profile and modal propagation diagram, how intermodal dispersion can be minimized by a Graded Index Fiber (08)

   b) Define Numerical aperture. The velocity of light in the core of an optical fiber is 2.1×10^8 m/s and the critical angle at the core cladding interface is 80°. Calculate the angle of acceptance and the diameter of the fiber given the number of modes is 250 at an operating wavelength of 0.75μm. (06)

   c) Discuss how lasers can be used to cool and trap atoms. (06)

UNIT – III

5. a) For $0 \leq x \leq \infty$, identify which of the following will be a suitable wave function for the matter waves and give reasons. (05)

   (i) e^x (ii) e^{-x} (iii) e^{ikx} (iii) x sinx (iv) cosx

   b) Apply Schrodinger's wave equation for a particle in an infinite one dimensional potential well and find the energy eigen values and eigen functions. Calculate the probability of finding the particle between x=0 and x=0.3L in the ground state of a potential well of dimension L. (10)

   c) Distinguish between phase velocity and group velocity. Derive the relationship between them in a medium in which phase velocity varies with wavelength. (05)

6. a) Define a step potential. Apply Schrodinger's wave equation for the case of particles of energy E incident on a step potential of height V_0 such that $E > V_0$ and obtain Reflection and Transmission coefficients. Calculate the percentage of reflection when electrons of energy 4 eV are incident on a step potential of height 3 eV. (09)

b) What is the principle of Scanning Tunneling Microscope? Describe briefly how it can be used to image surfaces. (06)

c) Justify the intrinsic line width of the spectral lines from Heisenberg's uncertainty principle. The energy difference between the excited and ground states of an atom corresponds to a spectral line of wavelength 6000Å with an intrinsic line width of 10^{-14} m. Calculate the life time of the excited state. (05)

UNIT – IV

7. a) Derive the expression for conductivity of a metal based on classical free electron theory. Explain any two drawbacks? (07)

b) Write the main postulates of quantum free electron theory. The number of conduction electrons in silver is 5.5×10^{28} m^{-3}. What is the probability that a quantum state of energy 6 eV is occupied at 1000 K. (07)

c) What is the importance of Hall effect? Obtain the expression for Hall voltage in an n-type semiconductor. (06)

8. a) Define density of states in a metal and plot the variation of density of states with energy. Calculate the density of states in a copper cube of dimension 2 cm between 0 and 1 eV. (06)

b) Obtain the expression for electron concentration in the conduction band of a semiconductor. (08)

c) State the law of mass action. Obtain the expression for the position of Fermi level in an intrinsic semiconductor. Explain the effect of temperature on the position of Fermi level (06)

UNIT – V

9. a) Identify the types of unit cells and list the corresponding sub lattices for each unit cell from the following data: (05)

(i)a=5Å; b=8Å; c=12Å; $\alpha = \beta = 90°$; $\gamma = 60°$

(ii) a=4Å; b=7Å; c=15Å; $\alpha = \beta = \gamma = 90°$

b) Identify the types of bonding in CsCl and ZnS. Compare their properties based on the bonding. (06)

c) Outline the procedure for obtaining Miller indices of a Crystal plane. Derive the expression for interplanar spacing in terms of Miller indices. A plane makes an intercept of 1Å, 4Å, 4Å along x, y and z axes in a cubic lattice of lattice parameter 2Å. Calculate the Miller indices. (09)

10. a) Assume the expression for potential energy of a diatomic molecule and derive the expression for cohesive energy and equilibrium inter atomic spacing. Explain with a graph the variation of potential energy with inter atomic distance. (09)

b) Derive Bragg's law. Explain how X-ray Diffraction is used to determine the crystal structure of cubic crystals. (07)

c) The potential energy of a diatomic molecule is given in terms of the interatomic distance r by the expression $U(r) = -\frac{a}{r^2} + \frac{b}{r^{10}}$. Calculate the equilibrium spacing of the two atoms and the dissociation energy. (04)

($a = 1.44 \times 10^{-39}$ Jm^2 and $b = 2.19 \times 10^{-115}$ Jm^{10})

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