**B.E. (2nd Semester CE, ME, Met. & Min. and AE) End-semester Examination, 2013**

**PHYSICS (PH - 1201)**

Full Marks: 70 Time: 3 hrs.

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*Answer any five questions*:

1.a) Show that the scalar triple product $\vec{A}.(\vec{B}X\vec{C})$ in absolute value is equal to the volume of a parallelepiped with sides $\vec{A}$, $\vec{B}$ and $\vec{C}$.

b) Find a unit normal to the surface $x^2y + 2xz = 4$ at the point P (2, -2, 3).

c) Prove the following

i) $\vec{\nabla}.(\vec{\nabla} \times \vec{A}) = 0$ ii) $\vec{\nabla} \times (\emptyset\vec{A}) = \vec{\nabla}\emptyset \times \vec{A} + \emptyset(\vec{\nabla} \times \vec{A})$

d) Show that $\vec{F} = (2xy + z^3)\hat{i} + x^2\hat{j} + 3xz^2$ is a conservative force field. Find the scalar potential and the work done in moving an object in this field from (1,-2,1) to (3,1,4).

e) State Stoke's theorem for a vector $\vec{A}$.

[2+2+2+2+2+3+1]

2. a) Derive an expression for the intensity distribution of Fraunhoffer double slit diffraction. Give a plot of the intensity distribution. Hence define the missing orders.

b) What do you understand a diffraction grating? Show that the resolving power of a grating depends on order number and total number of slits in the grating.

c) Calculate the possible order of spectra with a plane transmission grating having 18000 lines/inch when light of wavelength 4500Å light is used.

d) What is polarization of light?

[6+4+2+2]

3. a) What do you mean by stimulated emission of radiation?

b) Obtain the ratio of the rate of stimulated emission to the rate of spontaneous emission at a given equilibrium temperature. Evaluate this ratio at 1000K if the wavelength of radiation is 5000 Å.

c) Describe the population inversion technique for three and four energy level lasers.

d) Draw the refractive index profiles of a step index and a graded index optical fibre. Give a sketch of the path followed by rays in these optical fibres.

[1+6+3+4]

4. a) Write down Faraday's law and Ampere's law in their integral form as well as in differential form. What was the inconsistency in Ampere's law? How it has been removed by Maxwell?

b) Obtain the following forms of wave equations corresponding to electric field and magnetic fields in free space. $\nabla^2\vec{E} = \mu_0\epsilon_0 \frac{\partial^2 E}{\partial t^2}$ and $\nabla^2\vec{H} = \mu_0\epsilon_0 \frac{\partial^2 H}{\partial t^2}$.

c) Show that the electric and magnetic field corresponding to an electromagnetic wave propagating in a particular direction are mutually perpendicular to each other.

[(4+1+2)+4+3]

5.a) Define crystal lattice, basis, unit cells and primitive cell. Draw the two dimensional representation whenever necessary. Write down the specification for triclinic and orthorhombic unit cell.

b) The primitives of a crystal are 1.2 Å, 1.8 Å and 2 Å along the three axes where the Miller indices (2, 3, 1) cut intercept 1.2 Å along x-axis. What will be the lengths of intercepts along y and z axis?

c) What are the different types of interactions found in ionic crystals? Determine the electrostatic interaction energy for the same.

[(4+2)+3+(2+3)]

6. a) Write down the Galilean transformation relations.

b) Describe Michelson-Morley experiment and discuss the results obtained there from.

c) What are the postulates of Einstein's special theory of relativity? Write down the Lorentz transformation relations. What is time dilation?

d) A rod of 8.0 m long is moving along its length with a velocity of 0.6c. Calculate the length as it appears to a stationary observer.

[2+4+2+2+1+3]

7. a) Write down Planck's distribution law of black-body radiation. Obtain Wein's displacement law from it.Show that in the appropriate limit it reduces to Rayleigh-Jeans and Wein's law of black body radiation.

b) State Heisenberg's uncertainty relation. Using this find Bohr radius and ground state energy (i.e. minimum energy) of hydrogen atom.

c) What is Compton effect? Find the change in wavelength of X-rays due to Compton process. Why X-rays are needed to observe such process?

*or*

Write down the time-dependent Schrödinger equation. State the condition under which one gets time independent Schrödinger equation?

State the physical interpretation of wave function. What do you mean by stationary state?

[(2+2+2)+(1+3)+4]

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