SPRING END SEMESTER EXAMINATION-2014

2nd Semester B.Tech

PHYSICS-II PH-201

(Back-2008 & Previous Admitted Batches)

Full Marks: 70 **Time: 3 Hours**

Answer any SIX questions including Question No.1 which is compulsory.

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable and all parts of a question should be answered at one place only.

1. Answer all questions. [2 × 10

a) With a neat labeled diagram, explain briefly the working principle of an optical detector.

b) State Gauss's divergence theorem. Evaluate $\oint \vec{r}.\overrightarrow{ds}$ using it.

c) Electrons are emitted with zero velocity from a certain metal surface when it is exposed to radiation of wavelength $\lambda = 4000\,\text{Å}$. Calculate the threshold frequency and work function of the metal.

d) Explain the term "ultraviolet catastrophe" in the context of black body radiation.

e) State and explain Heisenberg's uncertainty principle.

f) An electron in motion has de-Broglie wavelength 30Å. Calculate its group velocity.

g) Show the graph showing variation of stopping potential in photoelectric effect with frequency. How one can determine work function of the metal used from this graph?

h) Distinguish between conduction current and displacement current.

i) Show that $curl\left(grad\ \varnothing\right)=0$.

j) Write short notes on scalar potential and vector potential in electromagnetism.

2. a) Distinguish between step index and graded index optical fibres. Derive an expression for numerical aperture of a step index optical fibre. [3+5

b) The refractive indices of the core and cladding of a given optical fibre are 1.65 and 1.42 respectively. Calculate the numerical aperture and the angle of acceptance of the optical fiber. [2

3. A free particle of energy E and mass m encounters a one dimensional potential step of height U_0 (such that $E > U_0$). Using quantum mechanical procedure, derive the expressions for reflection coefficient and transmission coefficient. [10

4. a) Starting from Maxwell's equations in electromagnetism, derive electromagnetic wave equations for free space and get the speed of these waves. Write down the plane wave solutions. [7+1

b) A plane electromagnetic wave moving along positive direction of Z-axis has its electric field given by $\vec{E}=\hat{j}24\sin\left(\pi\times10^{7}t-0.5\pi z\right)V/m$. Find its velocity and the corresponding magnetic field. [2

5. Set up the time independent Schrodinger equation for a particle in a one dimensional infinite potential box. Obtain the expression for energy eigenvalues and normalized eigen functions. Show graphically the variation of probability density for 3rd excited state with position inside the box. [2+4+2+2

6. a) Establish Maxwell's electromagnetic equations in differential form. [8

b) Prove that, the vector field [2

$\vec{A} = 3y^4z^2\hat{i} + 4x^3z^2\hat{j} - 3x^2y^2\hat{k}$ is solenoidal.

7. What is Compton effect? Obtain the expression for Compton shift due to scattering of photons by electrons. Why cannot we observe Compton scattering of visible light with electron? [2+6+2

8. a) Define phase velocity of a wave. Obtain the expression for phase velocity of de-Broglie wave representing a particle. Hence show that the phase velocity and particle velocity for the same entity are different both in relativistic and non relativistic limit. [2+2+2+2

b) Calculate the de-Broglie wavelength of an electron accelerated through a potential difference of 54 Volts. [2

You may use the following quantities:

Rest mass of electron (m_e) =$9.1 \times 10^{-31} kg$.
Rest mass of proton (m_p) = $1.67 \times 10^{-27} kg$
Charge of electron (e) = $1.6 \times 10^{-19} C$
Plank's constant (h) = $6.63 \times 10^{-34} J.sec$
Velocity of light in free space (c) = $3.0 \times 10^8 m/sec$

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