Roll No.:.....

National Institute of Technology, Delhi

Name of the Examination: B. Tech.

Branch	**: ECE and EEE**	**Semester**	**:1st**
Title of the Course	**:Electromagnetics and Quantum Physics**	**Course Code**	**:PHL100**

Time: 3 Hours **Maximum Marks: 50**

Section A (10 MARKS): Attempt all questions

Q1. Draw a labeled ray-diagram of Michelson's interferometer. **(1)**

Q2. Green light has a wavelength of about 500 nm. Through what potential difference should an electron be accelerated to have this wavelength? **(1)**

Q3. Poynting vector **S** = **E** x **H** has the dimensions: **(1)**

(i) Watt-m **(ii)** Watt-m^2 **(iii)** Watt/m **(iv)** Watt/m^2

Q4. Calculate the shortest possible wavelength (in nm) of X-ray photon if the electron gun is operated at 22000 Volts. **(1)**

Q5. Statement: "*Radio waves can be diffracted by a point hole slit*". Provide answer (true/false) with a clear justification. **(1)**

Q6. Write down two postulates of special theory of relativity. **(1)**

Q7. Polarization can't occur in: **(1)**

(i) Gravitational waves **(ii)** Microwaves **(iii)** Sound waves **(iv)** X-rays

Q8. Electron with energy 1 eV is incident on a barrier 10 eV high and 0.5 nm wide. **(a)** Find out its transmission probability. **(b)** How is this affected if the barrier is doubled in width? **(1+1)**

Q9. An important property of the wavefunctions of a quantum system is that they are ***orthogonal*** to one another, which means that $\int_{-\infty}^{+\infty} \psi_n \psi_m d\tau = 0$. Verify the ***orthogonality*** of wavefunctions for a particle in a one-dimensional infinite potential box. **(1)**

Section B (20 MARKS): Attempt any four (04) questions.

Q10. (a) Discuss double refraction and corresponding crystals. Draw a ray diagram for extraordinary and ordinary rays before and after passing through a quarter wave plate. **(2)**

(b) What is diffraction of light? Distinguish between Fresnel and Fraunhofer diffractions. **(2)**

(c) If the angle between a polarizer and analyser is 60^0, what will be the intensity of light transmitted through analyzer if the original intensity of incident light is I_0? **(1)**

Q11. (a) Write down and interpret Einstein's mass energy equivalence. **(1)**

(b) A stationary body explodes into two fragments of rest mass 1.0 Kg each that move apart at the velocity of 0.6c (c is velocity of light). Find out the rest mass of the original body. **(2)**

(c) Find out the KE of an electron whose wavelength is the same as that of a 100 KeV x-ray. **(2)**

Q12. (a) Describe Newton's rings experiment to determine the wavelength of sodium light (draw ray diagram). **(3)**

(b) In a Newton's rings arrangements if the diameters of the 15th and 5th bright ring are 0.59 and 0.336 cm, respectively, what is the wavelength of light used? (Radius of curvature = 1 m). **(2)**

Q13. (a) Drawing a proper diagram, explain the concept of Photoelectric effect and its quantum explanation. **(3)**

(b) Ultraviolet light of wavelength 350 nm and intensity 1W/m^2 is incident at metal surface (Work function = 2.2 eV). Find out the maximum KE of the photoelectrons. If only 0.5% of the incident photons produce photoelectrons, how many are emitted per second by the 1 cm^2 area of metal surface? **(1+1)**

Q14. (a) Derive an expression for Compton shift with suitable diagram. **(3)**

(b) X-rays of wavelength 1.0 Å are scattered from a carbon block. Find the wavelength **(in Å)** of the scattered beam in a direction making an angle of 60^0 with the incident beam. **(2)**

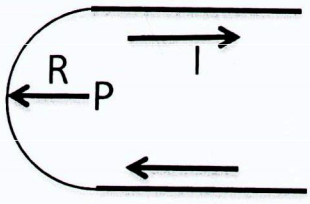
Section C (20 MARKS): Attempt any 02 questions.

Q15. (a) A cube of 4m edge is centered at the origin, the edges being parallel to the axes. Verify the divergence theorem for a vector **V (x,y,z)** = $2x^2\boldsymbol{i}$ C/m^2. **(2)**

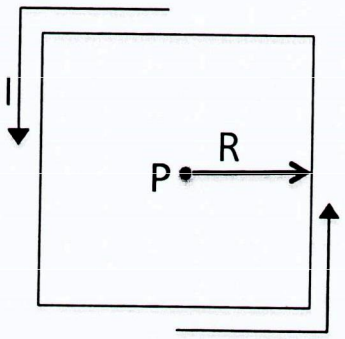
(b) A thin electric shell of metal has a radius of 0.25m. Calculate the electric intensity at a point **(i)** inside the shell, **(ii)** just outside the shell, and **(iii)** 3m from the Centre of the shell. Charge on the shell is 0.2 μC. Plot |**E**| as a function of radius. **(3)**

(c) Evaluate $\nabla \times \mathbf{A}$, and $\nabla.(\nabla \times \mathbf{A})$, where $\mathbf{A} = (\sin\phi/r^2)\boldsymbol{a}_r - (\cos\phi/r^2)\boldsymbol{a}_\phi$ **(2)**

(d) Find the magnetic field at point 'P' for each of the steady current configurations (i and ii): **(3)**



(i)



(ii)

Q16. (a) Perform a full derivation with diagram to get to the expressions for energy levels and wave-functions of a particle (of mass m) restricted to move in a one-dimensional box (of length L) with infinitely hard walls. **(5)**

(b) Draw and clearly interpret the probability density for first three energy states. **(2)**

(c) Compare the case of same particle in infinite potential well and a finite potential well (U_0). **(3)**

Q17. Write short notes on any **five** of the following: **(2x5)**

(a) Pair Production

(b) Spontaneous and stimulated emissions of radiation

(c) Losses in an optical fiber

(d) Heisenberg's uncertainty principle

(e) Tunnel Effect

(f) Band theory of solids

(g) Results of Davisson-Germer Experiment
