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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL UNIVERSITY, MANIPAL

SECOND SEMESTER B.Tech. END-SEMESTER EXAMINATION - MAY 2016

SUBJECT: ENGINEERING PHYSICS (PHY1001)

Time: 3 Hrs. **Max. Marks: 50**

Note:

Answer **ALL** the questions. Each question carries **10** marks
Answer all the sub questions of a main question in a continuous sequence.
Write specific and precise answers. Any missing data may suitably be assumed.
Write question number on the margin only. Draw neat sketches wherever necessary.

Physical Constants: Permittivity of free space = 8.854×10^{-12} F/m

Speed of light in vacuum	= 3.00×10^{8} m/s	Electron charge	= 1.60×10^{-19} C
Electron mass	= 9.11×10^{-31} kg	atomic mass unit (u)	= 1.66×10^{-27} kg
Boltzmann constant	= 1.38×10^{-23} J/ K	Planck's constant	= 6.63×10^{-34} J.s

1A. Obtain an expression for the width of the any principal maximum in diffraction pattern due to multiple slits. **[4]**

1B. Draw a schematic plot of the intensity of light in a double-slit interference against phase-difference (and path-difference). **[2]**

1C. In a double slit experiment, the distance of the screen from the slits is 52 cm, the wavelength is 480 nm, slit separation is 0.15 mm and the slit width a is 0.025 mm. What is the spacing between adjacent fringes? What is the distance from the central maximum to the first minimum of the fringe envelope? How many bright fringes are there in the central peak of the diffraction envelope? **[4]**

2A. What are the classical predictions about the photoelectric effect? **[3]**

2B. Lenses are often coated with thin films of transparent substances such as MgF_2 (n=1.38) to reduce the reflection from the glass surface. What is the minimum thickness of a coating required to produce a minimum reflection at the center of the visible spectrum? (wavelength = 550nm). **[2]**

2C. A He-Ne laser emits light at a wavelength of 632.8 nm and has an output power of 2.3 mW. How many photons are emitted each minute by this laser when operating ? **[2]**

2D. The wave-function of an electron is $\psi(x) = \sqrt{\frac{2}{L}}\sin\left(\frac{n\pi x}{L}\right)$. Obtain an expression for the probability of finding the electron between x = a and x = b. **[3]**

3A. Derive the compton shift equation. **[5]**

3B. Consider a freely moving quantum particle with mass m and speed u. Its energy is E= K= $mu^2/2$. Determine the phase speed of the quantum wave representing the particle and show that it is different from the speed at which the particle transports mass and energy. **[3]**

3C. Molybdenum has a work function of 4.2 eV. What is the stopping potential if the incident light has wavelength of 180 nm? **[2]**

4A. Assuming the Fermi-Dirac distribution function , obtain an expression for the density of free-electrons in a metal with Fermi energy E_F, at zero K and, hence obtain expression for Fermi energy E_F in a metal at zero K. [Given: density-of-states function: $g(E) = \frac{8\sqrt{2}\,\pi\, m^{3/2}\sqrt{E}}{h^3}$] **[5]**

4B. An electron is confined between two impenetrable walls 0.20 nm apart. Determine the frequency of the photon which can excite the electron from state n = 1 to state n = 2. **[3]**

4C. Light from a hydrogen discharge tube is incident on a CdS crystal (E_g= 2.42 eV). Which spectral line from the Balmer series [λ_α = 656 nm, λ_β = 486 nm, λ_γ = 434 nm, λ_δ = 410 nm] are absorbed and which are transmitted ? **[2]**

5A. What are superconductors? Draw a representative graph of Resistance versus Temperature for a superconductor. **[3]**

5B. The average kinetic energy of a conduction electron in a metal is given by:

$E_{AV} = \frac{\int_0^\infty E\,N(E)dE}{\int_0^\infty N(E)dE}$ where $N(E) = \frac{8\sqrt{2}\,\pi\, m^{3/2}}{h^3}\frac{\sqrt{E}}{\exp\left(\frac{E-E_F}{kT}\right)+1}$

E = kinetic energy of electron, E_F = Fermi energy, k = Boltzmann constant, T = absolute temperature, m = electron mass, h = Planck's constant.

Show that $E_{AV} = \frac{3}{5}E_F$ at T = zero K. **[4]**

5C. Positronium consists of an electron and a positron (a particle with charge (e) opposite to that of electron and mass (m) same as that of an electron), moving in a common circular orbit around their centre of mass. The quantized ground state energy of a positronium is given by $E_1 = -\frac{m\,e^4}{16\,\epsilon_0^2\,h^2}$ where h = Planck's constant, ϵ_o = permittivity of free space. Compute the wavelength of the photon emitted when this system undergoes transition from n = 3 state to n = 2 state. **[3]**

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