Ref. No.: EX/Met/Ph/T/2A/125/2018

B.E. METALLURGICAL AND MATERIAL ENGINEERING

FIRST YEAR, SECOND SEMESTER EXAM 2018

Subject: PHYSICS IIA Time: Three Hours Full Marks: 100

Answer any **five** questions.

1. (a) State and prove Gauss's law in electrostatics. Derive Coulomb's law from Gauss law in case of a single point charge.
   (b) Using Gauss law, find the electric field at a distance r from the centre of a uniformly charged sphere of radius R (for the cases $r < R$ and $r > R$). Plot the variation of the electric field with distance. [(2+4+4)+7+3]
2. (a) Starting from the assumption of Bohr atom model derive an expression for energy of hydrogen atom in the n^{th} orbit.
   (b) Explain why in the absorption spectrum of hydrogen, absorption lines of only Lyman series appear.
   (c) In the Bohr theory of the hydrogen atom, the electron is in constant motion. How is it possible for such an electron to have a negative amount of energy?
   (d) At what speed must the electron revolve round the nucleus of a hydrogen atom in order that it may not be pulled into the nucleus by electrostatic attraction? Take the radius of the orbit of the electron as 0.5×10^{-10} meter, m=9.1×10^{-31} kg and e= 1.6×10^{-19} coulomb. [8+3+3+6]
3. (a) Briefly discuss the absorption of X-rays by an absorber and draw the variation of transmitted intensity as a function of thickness of the absorber.
   (b) Sate and deduce Bragg's law of X-rays diffraction.
   (c) The K_α line from molybdenum has a wavelength of 0.7078 Å. Calculate the wavelength of K_α line of copper. Atomic number of molybdenum = 42 and Atomic number of copper = 29.
   (d) X-rays of wavelength 0.1 nm are scattered at such an angle that the recoil electron has the maximum kinetic energy. Calculate the wavelength of the scattered ray and the energy of the recoiled electrons.
   (e) Explain de-Broglie's matter wave. [5+6+3+4+2]
4. (a) State and explain Biot-Savart law in magnetostatics. Using this law calculate the axial magnetic field of a solenoid which carries a steady current I.
   (b) A small magnet of momentum $\vec{M}$ can move along the axis of a circular coil of radius c. Show that when the magnet is at distance z from the coil, the magnetic flux through the coil is

$$\frac{\mu_o}{2}\frac{c^2}{(z^2+c^2)^{3/2}}$$

   (c) State and deduce the differential form of Faradays law.
   (d) Define self and mutual inductances. [(2+5)+ 5+ 6+2]

[Turn over

5. (a) What do you mean by coherence of light? What are the different methods of obtaining two coherent sources? Discuss clearly the necessary conditions for the sustained interference of light.
   (b) Explain the interference of light using Fresnel's Biprism. Derive the expression for the fringe width. [(2+4)+4+10]

6. (a) Discuss with a clear diagram the Fraunhoffer diffraction due to a single slit and plot the corresponding intensity profile. What is the width of the central maxima?
   (b) A 10 μm transparent plate when placed in the path of one of the interfering beams of a double slit experiment [λ= 5800 Å], the central fringe shifts by a distance equal to ten fringes. Calculate refractive index, μ of the plate.
   (c) Find the half angular width of the central bright maximum in the Fraunhoffer diffraction when a slit of width 120 μm is illuminated by a light of wavelength 6000 Å.
   [(5+2+3)+5+5]

7. (a) Explain the interference in a thin transparent film of refractive index μ due to reflected light. Why an extended source of light is used in such experiment?
   (b) Newton's rings are observed in reflected light of wavelength 5900 Å. The diameter of the 10^{th} ring is 0.5 cm. Find the radius of curvature of the lens and the thickness of the air film.
   (c) Show that in a diffraction grating with grating element 1.5×10^{-6} m and light of wavelength 500 nm, the third and higher order principal maxima are not visible.
   [(8+2)+6+4]

8. (a) What do you mean by polarized and unpolarized light? Give examples.
   (b) Discuss the phenomenon of polarization by reflection and hence state the Brewster's law. Obtain the relation between the angle of incidence and angle of refraction when the light is incident at the polarizing angle.
   (c) What do you mean by polarization by double refraction? Discuss the properties of o-rays and e-rays. [4+10+6]