Ref. No.: Ex/Met/Ph/T/2A/125/2019(old)

B.E. METALLURGICAL AND MATERIAL ENGINEERING

FIRST YEAR, SECOND SEMESTER EXAM 2019 (Old)

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

Answer any **five** questions.

1. (a) What are the necessary conditions for sustained interference of light.
   (b) Show that the dark and bright fringes produced in Young's double slit experiment are equally spaced.
   (c) Deduce an expression for the displacement of the fringes after introducing a thin transparent sheet in one of the interfering beam's path.
   (d) A 10 μm transparent plate when placed in the path of one of the interfering beams of a double slit experiment [$\lambda = 6000$ Å], the central fringe shifts by a distance equal to ten fringes. Calculate refractive index, μ of the plate.

[4+6+6+4]

2. (a) Explain using 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) 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.
   (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.

[(5+2+3)+5+5]

3. (a) What do you mean by polarization of light. What are the different states of polarization?
   (b) State the Brewster's law of polarization. Obtain the relation between the angle of incidence and angle of refraction when the light is incident at the polarizing angle.
   (c) An unpolarized light falls on two polarized sheets placed one on top of the other. What must be the angle between the characteristic direction of the sheets if the intensity of the transmitted light is one-third the intensity of the incident light?

[6+(3+6)+5]

4. (a) State and prove Gauss's law in electrostatics. How Gauss' law is modified in presence of a dielectric?.
   (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]

[Turn over

5. (a) What do you mean by Continuous and Characteristics X-rays? Discuss.
   (b) State and deduce Bragg's law of X-ray diffraction.
   (c) Which element has a K_α X-ray line whose wavelength is 0.180 nm?.
   (d) A typical atomic nucleus is about 5.0×10^{-15} m in radius. Use the uncertainty principle to place a lower limit on the energy an electron must have if it is to be a part of a nucleus.

[6+5+4+5]

6. (a) Deduce an expression for the magnetic field at a point distant '*r*' from a long straight conductor carrying a current '*i*', using Biot Savart's law.
   (b) State Ampere's circuital law and show how it leads to the same result as obtained in the above case.
   (c) What are the laws of electromagnetic induction? Define co-efficient of self-inductance. Deduce an expression for the self-inductance of a circular coil of radius 'a' with 'n' number of turns.

[5+(2+3)+(3+2+5)]

7. (a) What do you mean by a wavefront and hence state and explain Huygen's principle.
   (b) Explain the formation of Newton's ring. Obtain the expressions for the diameter of the bright and dark rings of Newton's ring due to reflected light.
   (c) In a Newton's ring experiment, the diameter of the 10^{th} dark ring changes from 1.40 cm to 1.27 cm when a liquid is introduced between the lens and the plate. Calculate the refractive index of the liquid.

[(2+3)+10+5]

8. Write short notes (any two)
   (a) Compton effect
   (b) Matter Waves
   (c) Diffraction grating
   (d) Fresnel's biprism

[10+10]