BACHELOR OF ENGINEERING 1ST YEAR 2ND SEMESTER EXAM., 2018(OLD)

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

Answer any five questions

1. (a) Explain the differential form of Gauss law. Calculate the electric field due to a uniformly charged sphere.
(b) What do you mean by electrostatic potential and equipotential surface?
(c) The total charge within a sphere of radius r in a cloud is given by

$$q \frac{r^2}{a^2} (e^{-r/a} - e^{-2r/a})$$

Determine the corresponding electric potential, the electric field and the charge density.

[(2+8)+(2+2)+6 = 20]

2. (a) Define the capacitance of a capacitor. Find the expression of capacitance of a parallel plate capacitor when the space is filled up with a dielectric medium with a relative permittivity K.
(b) State and explain Biot-Savart's law. Find magnetic field due to the current in a straight wire of finite length.
(c) An electron moves in a circular orbit of radius 0.51Å around a nucleus at a frequency of 6.8×10^{15} Hz. Find the magnetic induction at the nucleus and the equivalent magnetic moment.

[(2+9)+(2+4)+3 =20]

3. (a) State and explain Lenz's law of electromagnetic induction. What is mutual inductance? Calculate the mutual inductance for two co-axial solenoids.
(b) Derive an expression for equivalent inductance for two parallel connected inductances carrying the total current I.
(c) A DC voltage of 80V is switched on to a circuit containing a resistance of 5Ω in series with an inductance of 20H. Calculate the rate of growth of current at the instant when the current is (i) 6A and (ii) 16 A.

[(2+1+ 8)+6+3=20]

4. (a) What do you understand by interference of light? Write down the essential and sufficient conditions for sustained interference of light?
(b) How do you determine the wavelength of light using Young's double slit experiment?
(c) Why the extended source is necessary for Newton's ring experiment?

(d) The distances from a Fresnel biprism to a narrow slit and a screen are equal to a = 25 cm and b = 100 cm respectively. The refracting angle of the glass biprism is equal to θ = 20°. Find the wavelength of light if the width of the fringe on the screen is Δx = 0.55 mm.

[(2+2)+8+2+6 =20]

5. (a) Explain the interference in thin films due to reflected light?
   (b) What do you mean by coherence? Briefly explain the temporal and spatial coherence.
   (c) What is Brewster's law of Polarization? A glass plate (μ=1.5) is used as a polarizer. Obtain the polarizing angle of incidence. What is the angle of refraction when the reflected light is plane polarized?

[6+(2+4)+(4+4) = 20]

6. (a) Explain the Huygen's principle of light.
   (b) Distinguish between Fresnel and Fraunhoffer type of the diffraction of light.
   (c) Obtain an expression for the intensity distribution of a plane diffraction grating.
   (d) A parallel beam of light of wavelength 5460 Å is incident at an angle of 30° on a plane transmission grating which has 6000 lines/cm. Find the highest order spectrum that can be observed.

[3+2+10+5 = 20]

7. (a) Staring from the assumptions of Bohr atomic model derive an expression for the Energy of the electron in n^{th} orbit of hydrogen atom.
   (b) 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 energy?
   (c) How many revolutions does an electron in the n = 2 state of a hydrogen atom make before dropping to the n = 1 state? (The average lifetime of an excited state is about 10^8 sec)
   (d) Show that the velocity of the electron in the first Bohr orbit is $(1/137)c$ where c is the velocity of light.

[10+3+4+3 =20]

8. (a) Explain why Compoton effect is experimentally not observed for visible light rays. Also explain why Compton shift is independent of scattering materials.
   (b) NaCl has its principal planes spaced at 2.820 Å. The first order of Bragg reflection is located at 10°. Calculate (i) the wavelength of X-rays and (ii) the angle of second order Bragg diffraction.
   (c) What is de-Broglie's matter wave? Derive an expression for the wavelength of the de-Broglie's matter wave.
   (d) A proton is confined to nucleus of radius 5×10^{-15} m. Calculate the minimum uncertainty on its momentum. Also calculate the minimum kinetic energy of the proton should have. The proton mass is 1.67×10^{-27} kg.

[(2+2)+4+(1+8)+3 = 20]