B. E. First Semester (All) / SoE – 2018 – 19 Examination

Course Code : GE 2105 **Course Name : Engineering Physics**

Time : 3 Hours] [Max. Marks : 60

Instructions to Candidates :—

(1) All questions are compulsory.
(2) All questions carry marks as indicated.
(3) Assume suitable data wherever necessary.
(4) Illustrate your answers wherever necessary with the help of neat sketches.
(5) Use of non programmable calculator is permitted.
(6) List of Constant :
Plank's constant $h = 6.625 \times 10^{-34}$ JS
Mass of electron $m_e = 9.1 \times 10^{-31}$ kg
Mass of Proton $m_p = 1.67 \times 10^{-27}$ kg
Charge of electron $e = 1.602 \times 10^{-19}$ C
Boltzmann constant $k = 1.38 \times 10^{-23}$ J / K
Velocity of light $c = 3 \times 10^{8}$ m / s.

1. (A) (A1) Discuss the phenomenon of Franhofer diffraction at a single slit. Obtain the condition for secondary maxima and minima.

(A2) Show that the fringes produced in wedge shaped thin film illuminated by a monochromatic light are of same width.

(A3) In Newton's rings experiment the diameter of the **10th** dark ring changes from **1.5 cm** to **1.27 cm** when a liquid is introduced between the lens and the glass plate. Calculate refractive index of liquid. 4+3+3(CO1)

OR

(B) (B1) Explain the formation of Newton's rings and show that radius of dark rings is proportional to under root of natural number.

(B2) The R. I. of a soap film is **1.33** and it is illuminated by white light. In the reflected light, the two consecutive dark fringes of wave lengths **550 nm** and **540 nm** are found overlapping. Calculate thickness of the film if angle of incidence is **45^0**.

(B3) What is plane transmission grating ? 4+4+2(CO1)

2. (A) (A1) Explain the terms :

(1) Phase velocity

(2) Group velocity, and

(3) Wave packet. Show that group velocity is equal to the velocity of particle.

(A2) Write down one dimensional Schrodinger equation for wave functions $\psi(x, t)$ and $\psi(x)$.

(A3) Find the de – Broglie wavelength of :

(i) An electron accelerated through a potential difference of **182 V**.

(ii) A **1 kg** object moving with speed of **1 m / s**.

Comparing these results, explain why the wave nature of matter is not apparent in our daily observations ? 5+2+3(CO2)

OR

(B) (B1) Consider a one dimensional potential well of macroscopic dimension say **$L = 10^{-2}$ m** and microscopic dimension say **$L = 10\ \mathring{A}$**.

Using relation $E_n = \dfrac{n^2h^2}{8\,mL^2}$ Compare the separation between the energy levels for macroscopic and microscopic well dimensions with thermal energy **kT** for **1 K and 300 K** respectively. What important inference can be drawn from these results ?

(B2) State the uncertainty principle in formal way for canonical conjugate pairs of variables position and momentum. Obtain the uncertainty relation for energy and time.

(B3) Explain why :

(i) ψ must be single valued and continuous function of Position. 5+3+2(CO2)

3. (A) (A1) Draw a well labelled diagram to explain Hall effect and hence obtain an expression for Hall coefficient, mobility and Hall angle.

(A2) Draw graph showing variation Fermi function with energy at different temperatures. In figure indicate an energy level above and below the Fermi level $\mathbf{E_F}$ by an increment δ_E. Show that the probability of occupancy of the energy level $\mathbf{(E_F + \delta_E)}$ is same as the probability of non occupancy of the level $\mathbf{(E_F - \delta_E)}$.

(A3) At what temperature will the fraction of electrons in the conduction band of silicon same as that of germanium at room temperature ? $\mathbf{E_G}$ for silicon is **1.1 eV** and for germanium is **0.72 eV**. 4+3+3(CO3)

OR

(B) (B1) In silicon atom, the highest 3p level is partially filled, still silicon solid is a semiconductor. Explain with diagram showing variation electron energy as function of their atomic separation.

(B2) In an intrinsic semiconductor $\mathbf{n \times p = n_i^2}$ because $\mathbf{n = p}$. Same is true for an extrinsic semiconductor even through $\mathbf{n \neq p}$. Explain your answer.

(B3) The resistivity of doped silicon crystal is $\mathbf{9.27 \times 10^{-3}}$ Ohm – m and the Hall coefficient is $\mathbf{3.84 \times 10^{-4}\ m^3 / C}$. Assuming the conduction is by a single type of charge carriers ; calculate the density and mobility of carriers. 4+3+3(CO3)

4. (A) (A1) Show that the deflection suffered by electron in uniform magnetic field acting normally over the limited region is given by

$D = LLB\sqrt{\frac{e}{2\,mVA}}$ where symbols have their usual meaning.

(A2) A proton accelerates from rest in a uniform electric field of **700 N / C**. At some time later its speed is **3×10^5 m / s**.

(i) Find the acceleration of the proton.

(ii) How long does it take the proton to reach the above velocity ?

(iii) How far has it moved in this time ?

(A3) When a charged particle of charge **q** Coulombs and mass **m kg** enters the field with velocity **v m / s** pass through uniform magnetic field, under what conditions, maximum force will act on it ? No force will act on it ? 5+3+2(CO4)

OR

(B) (B1) Discuss the motion of an electron projected into uniform electric field at an acute angle with the field direction. Obtain expressions for Range, time of flight and maximum height attained by the particle.

(B2) A proton, a deuteron and an alpha particle with same kinetic energy enter a region of uniform magnetic field moving at right angles to it. Compare radii of their circular paths in the field.

(B3) What do you mean by crossed field configuration ?

5+3+2(CO4)

5. (A) (A1) Describe construction, principle, and working of Bainbridge mass spectrograph using a well labelled diagram.

(A2) In a Bainbridge mass spectrograph, the magnetic field in the velocity selector is 1.0 T and the ions having the speed of **4×10^6 m / s** pass through it un – deflected :

(i) What should be the electric field between the plates ?

(ii) If the separation of the plates is 0.5 cm, what is the potential difference between the plates ?

(A3) What is synchronization ? Illustrate the answer with suitable diagram. 5+3+2(CO4)

OR

(B) (B1) Explain with well labelled diagram, the construction and working of Cyclotron, In the context. Obtain the expressions for :

(i) Resonance condition and

(ii) Maximum kinetic energy gain for a charge particle.

(B2) A cyclotron with its dees of radius of **2 m** has a magnetic field of $\mathbf{0.75\ wb / m^2}$ Calculate the maximum energies to which :

(i) Protons (ii) Deuterous can be accelerated.

(B3) What do you understand by blanking of trace during flyback time ? How is it achieved in CRO ? 5+3+2(CO4)

6. (A) (A1) Draw a neat labeled schematic and energy level diagram of Ruby laser with necessary details in both. Explain how lasing process will occur in it.

(A2) Explain the terms. Stimulated emission and Population inversion.

(A3) White light has a frequency range from $\mathbf{0.4 \times 10^{15}\ Hz}$ to $\mathbf{0.7 \times 10^{15}\ Hz}$. Find the coherence time and coherence length for it. 5+3+2(CO5)

OR

(B) (B1) Draw a neat labeled schematic and energy level diagram of Helium – Neon laser with necessary details in both. Explain the role of active centers in its working.

(B2) Find the relative populations of the two states in a Ruby laser that produces a light beam of wavelength $\mathbf{6943\ \mathring{A}}$. at **300 K** and **500 K**.

(B3) Explain how the intensity of beam can be increased and its directional selectivity can be achieved in lasing process. 5+3+2(CO5)