U.G. 4th Semester Examination - 2020

PHYSICS

[PROGRAMME]

Course Code : PHY(G)CC-P-4

[PRACTICAL]

Full Marks : 20

The figures in the right-hand margin indicate marks.

Answer any **two** questions: 10×2=20

1. a) Write down the expression of Hamiltonian of a Hydrogen atom in spherical polar coordinate.

   b) Derive the expression of energy Eigen value of the ground state of a Hydrogen atom. Plot the corresponding wave function.

   c) What is quantum an-harmonic oscillator?

                                        2+(4+2)+2

2. a) What is quantum tunnelling?

   b) Explain with optical analogy.

   c) What is the basic principle of a tunnelling diode?

   d) Draw the I-V characteristics of a tunnel diode.

                                        2+2+4+2

3. a) What is Zeeman Effect?

   b) Derive the expression of atomic energy level splitting of when the atom is subjected to an external magnetic field of field strength $\vec{B}$. State the selection rule for such transition. Sketch the allowable transition for Sodium D1 line.

   c) What is hyperfine structure?   2+(3+1+2)+2

4. a) What is paramagnetic substance?

   b) Show that for paramagnetic substance the magnetic moment and angular momentum of the orbital electron is oppositely oriented.

   c) Show that for paramagnetic substance the average value of magnetic moment is $\mu L\left(\dfrac{\mu H}{KT}\right)$.

   d) Hence derive Curie's Law of magnetism. State the drawback of this law.   1+3+3+(2+1)

5. a) What is Hall Effect?

   b) Show that the density of electron in the conduction band of an N-type semiconductor varies with band gap E_g according to the formula

   $$2\left(\frac{2\pi KT}{h^2}\right)^{\frac{3}{2}} \left(m_h^* m_e^*\right)^{\frac{3}{4}} e^{\left(\frac{-E_g}{2KT}\right)}.$$

   c) Hence derive how the resistivity of the semiconductor varies with temperature. Draw the

curve showing the variation of resistivity with temperature. $\quad$ 2+4+(3+1)

6. a) What is piezoelectric effect?

   b) Explain why quartz can be used as a piezoelectric material.

   c) What is magnetization? Why a uniformly magnetized shell is equivalent to a current carrying loop?

   d) Show and briefly explain the variation of **B** with respect to **H** when a ferromagnetic substance undergoes a complete cycle of magnetization.

   $\hspace{6cm}$ 2+2+(1+2)+3

7. a) State Faraday's law of electromagnetic induction. What is Eddy Currents? What is mutual inductance?

   b) If two inductor of inductance L_1 and L_2 are connected in series show that the equivalent inductance will be $L_{eq} = (L_1 + L_2 \pm 2M)$. M is the mutual inductance between these two coils.

   c) How does the dielectric constant of a dielectric change with frequency? $\quad$ (2+2+2)+3+1

8. a) What is double refraction? How a Nicol prism can act as a polariser?

   b) State and explain Malus's Law. What is Polaroid?

c) What is polarimeter? State the basic principle of a Laurent half-shade polarimeter with a neat diagram. $\quad$ (1+2)+(2+1)+(1+3)

9. a) State Stefan's law of radiation. Briefly explain the basic theory of determination of Stefan's constant.

   b) Draw a neat diagram and explain the basic construction of a Gaussian eye piece.

   c) State and explain Brewster's Law. Discuss how can you determine the Boltzmann constant from PN junction V-I curve. $\quad$ (1+3)+2+(2+2)

10. a) Write down the Planck's law of Blackbody radiation. Explain how this law explains both Wine's displacement law and Rayleigh-Jeans law.

    b) What are the drawbacks of Dulong-Petit's law? State how Einstein has solved the underlying problem of Dulong-Petit's law.

    c) For indistinguishable particle obeying Bose-Einstein statistics show that the occupation number at any energy level E is $\langle n_E \rangle = \dfrac{1}{e^{\beta(E-\mu)} + 1}$.

    What is the significance of μ ? Draw the curve showing variation of $\langle n_E \rangle$ with temperatute.

    $\hspace{6cm}$ (1+2)+(1+2)+(2+1+1)

$\rule{3cm}{0.4pt}$