

PHYSICS (Paper II)

Time Allowed : Three Hours

Maximum Marks : 300

QUESTION PAPER SPECIFIC INSTRUCTIONS

(Please read each of the following instructions carefully before attempting questions)

There are EIGHT questions divided in two Sections.

Candidate has to attempt FIVE questions in all.

Question Nos. 1 and 5 are compulsory and out of the remaining, any THREE are to be attempted choosing at least ONE question from each Section.

All questions carry equal marks.

Wherever any assumptions are made for answering a question, they must be clearly indicated.

Word limit in questions, wherever specified, should be adhered to.

SECTION 'A'

1. Answer any three of the following:
 - (a) An electric dipole is placed in an external electric field. Find the interaction energy between the electric dipole and the field. And hence find the force and the torque acting on the dipole.
 - (b) Show that the Amperes circuital law fails for time varying currents. How has this difficulty been overcome by Maxwell by introducing the concept of displacement current density? How is the expression for $\nabla \times \mathbf{B}$ modified for magnetized material for magnetisation vector $\mathbf{M}$?
 - (c) How does a ferromagnetic material get magnetized? Why is the demagnetization process irreversible? What is the physical significance of the magnetic hysteresis loop for a ferromagnetic material? Under what conditions the ferromagnetic materials become paramagnetic?
 - (d) How does built in potential appear across a p-n junction? Explain under what biasing conditions drift and diffusion currents, respectively, dominate.
2.
 - (a) An alternating voltage is applied to CR circuit connected in series. Under what conditions it acts as an (i) integrator and (ii) a differentiator?
 - (b) An alternating voltage of varying frequency is applied across a two-branch parallel circuit of R_1 and L in series and R_2 and C in series as shown in Fig. below.
[Figure: An AC source connected across two parallel branches; the first branch is resistor R_1 in series with inductor L; the second branch is resistor R_2 in series with capacitor C. The two branches are joined at a common top node and a common bottom node, which connect to the two terminals of the source. No component values are given.]
Find its resonant frequency. If R_1 and R_2 are not zero, state the conditions when the resonant frequency is given by $f_0 = 1/2\pi\sqrt{LC}$.
3. Starting from maxwell equations obtain differential equations for scalar and vector potentials. Choosing the required gauge obtain identical differential equations for scalar and vector potentials. Solve the equation for scalar potential in a dielectric medium having a source of charge density ρ .
4.
 - (a) Establish the two Barkhausen conditions for sustained sinusoidal oscillations. Sketch the circuit of Wien's bridge oscillator and explain its working.
 - (b) Draw the block diagram of a superhetrodyne radio receiver and explain the function of local oscillator.

SECTION 'B'

5. Answer any three of the following:
- (a) What are the term symbols of 2 equivalent p electrons? Write down the term symbols in ascending order of energies.
 - (b) Using Heisenberg Uncertainty principle, calculate the mass of meson being exchanged between nucleons inside the nucleus, taking the range of nuclear force as $1.7 F$. Distinguish between pion and muon.
 - (c) Explain why even-even nuclei are more stable than odd-odd nuclei.
 - (d) Describe how Davisson-Germer electron diffraction experiment confirms the de Broglie hypothesis of matter wave.
6. (a) What is space quantisation? Discuss the Stern Gerlach experiment establishing the space quantisation.
- (b) Explain the origin of anti-Stokes lines in Raman spectra.
7. An electron is confined in a one dimensional box $1 \text{ \AA}$ width. Draw the energy level diagram upto three energy states of $[-]$ also draw the corresponding normalized eigen function. Derive the expressions for eigen functions and eigen values used in the calculations. Show that eigen functions are orthogonal.
8. (a) What is the synchronization condition in a cyclotron? Under identical magnetic flux density, show that the kinetic energy of an accelerated α -particle is equal to that of proton. What should be the frequencies of r.f. electric fields for α -particles and proton, respectively placed under the same magnetic flux density?
- (b) State conservation laws obeyed by strong and weak interactions.