FS – 24 / 15-16

Physics

Paper – II

Time : 3 hours

Full Marks : 200

The figures in the right-hand margin indicate marks.

*Candidates should attempt Q. No. 1 from Section – A and Q. No. 5 from Section – B which are compulsory and any **three** of the remaining questions, selecting at least **one** from each Section.*

SECTION – A

1. Answer any **two** of the following questions : $20 \times 2 = 40$

   (a) Calculate the commutator bracket $[x^2, \sin p_x]$ using the fundamental bracket $[x, p_x] = i\hbar$. What is the physical significance of the fundamental commutator bracket ?

   (b) Describe the photo-electric effect. Why classical theory fails to explain it ? Justify.

Light of wavelength 400nm incident upon Lithium(Li). If the work function of Li is 2.13 eV, find the kinetic energy of the fastest photo-electron.

(c) Using the Russell-Saunders coupling, obtain the spectral terms for the ground-state of Nd^{3+}, Gd^{3+} and Ho^{3+} which have respectively 3, 7 and 10 electrons in the unfilled 4f shell. Calculate the g-values and effect magnetic moment of these 3 ions.

2. Consider the scattering due to a finite potential barrier of height V_0 and width 2a. Find the wave-function in all three-regions and hence calculate the transmission and reflection coefficient. Explain how these coefficients change with energy. 40

3. (a) Describe normal and anomalous Zeeman effect. Explain how it lifts the degeneracy in hydrogen atom. 30

(b) What is Lamb shift ? Discuss its significance. 10

4. (a) State the characteristic properties of rotational spectra of any diatomic molecule. Obtain the expression for rotational constant.

How rotational spectra differs from vibrational spectra ? 30

(b) Calculate the value of moment of inertia I and bond length r of CO. Given : the rotational constant B = 1.92118 cm^{-1}. 10

SECTION – B

5. Answer any **two** of the following : 20×2 = 40

(a) Plot the binding energy per nucleon versus the nucleon number. Describe any 5 salient features of the curve.

(b) Consider a superconducting sphere of radius 'a' placed in an uniform magnetic induction B_0. Derive an expression for the total magnetic induction outside the sphere.

(c) State and explain De Morgan's Theorem. Simplify each of the Boolean expressions given below :

(i) $A(A + \bar{A}) + B$

(ii) $(A + B)(\bar{A} + B)\bar{B}$

6. (a) What are the fundamental interactions in nature ? Explain with examples. Write the various conservation laws for different interactions. Discuss the unification of these interactions. 25

(b) What are quarks ? How do they differ from leptons ? Make a table and write down the strangeness, charge, baryon number, lepton number for each quark. Which of these quantities are not conserved in a weak force interaction ? 15

7. (a) Write down the semi-emperical mass formula and explain each term. What is meant by Mass parabola ? 30

(b) Explain the magic numbers using nuclear shell model. Calculate the spin and parity of the ground state of the following nuclei : $^{8}O_{17}$, and $^{26}Fe_{56}$. 10

8. (a) Explain the construction and working of MOSFET. How MOSFET differs from FET. 30

(b) Determine the value of source resistance R_s required to self-bias an *n*-channel JFET with shorted source drain current I_{DSS} = 25mA, cutoff gate-to-source voltage $V_{GS(off)}$ = –10V, gate source voltage V_{GS} = – 5V. Also determine its trans-conductance g_m. 10