PG/IIS/PHS-202/13

M.Sc. 2nd Semester Examination, 2013

PHYSICS

PAPER—PHS- 202(A & B)

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

Illustrate the answers wherever necessary

PHS – 202A

[*Marks* : 20]

1. Answer any *two* of the following : 2 × 2

   (*a*) Show that, if Lagrangian function does not contain the co-ordinate q_k explicitly, then the generalized momentum p_k is a constant of motion.

(*b*) If the Hàmiltonian H is independent of time *t* explicitly, then prove that it is equal to the total energy of the system.

(*c*) Write down Hamilton's canonical equation in terms of poisson's Bracket.

2. Answer any *two* of the following : 3 × 2

(*a*) Prove that for a conservative system Hamilton's principal function *S* and Hamilton's characteristic function *W* are related as

$$S(q_k, t) = W(q_k) - Et.$$

(*b*) Derive the equation of motion of a charge particle which is moving in an electro-magnetic field and the Hamiltonian is given by

$$H = \frac{1}{2m}[(p_x - qA_x)^2 + (p_y - qA_y)^2 + (p_z - qA_z)^2 + q\varphi]$$

(*c*) Derive Lagrange's equation of motion from Hamilton's principle.

3. Answer any *one* of the following : 10×1

(*a*) What is gauge transformation ? What arbitrariness does it introduce ? Show that the transformation $Q = \sqrt{2q}\, e^{\alpha} \cos p$ and $P = \sqrt{2q}\, e^{-\alpha} \sin p$ is a canonical transformation and find out the generating function. Evaluate the Poisson brackets.

$[L_x, x]$ and $[L_x, p_x]$ $2 + 2 + 3 + 3$

(*b*) Obtain the Euler-Lagrange differential equation by variational method. What is Δ-variation ? Discuss how it differs from δ-variation. State and prove the principle of least action. $\left(3 + 1\frac{1}{2} + 1\frac{1}{2} + 4\right)$

PHS – 202B

[*Marks* : 20]

Answer **Q No. 1 & 2** and any *one* from the rest

1. Answer any *two* bits : 2×2

(*a*) Find the distribution function of hole over the donor level in a semiconductor.

(*b*) Find the expression for Fermi energy in two dimensional Fermi gas assuming periodic boundary condition.

(*c*) What is meant by effective mass ? What is also meant by negative effective mass ?

2. Answer any *two* bits : 3 × 2

(*a*) Calculate the energy difference between conduction band bottom and Fermi Energy in an intrinsic Si Sample at 300°K. Where, $m_e^* = 1{\cdot}1$ m, $m_h^* = 0{\cdot}59$ m.

(*b*) Estimate the relative contribution of electron and lattice specific heat of Na at 20K. The Fermi temperature of Na is $3{\cdot}8 \times 10^4$ K and its Debye temperature is 150 K.

(*c*) Briefly explain the physical origin of energy gap.

3. (*a*) Describe in details the origin of Pauli's spin paramagnetism in metals and hence find an expression of magnetic susceptibility at T = 0 K.

(*b*) Explain what is meant by Boltzmann's Tail.

(*c*) Clearly indicate what is meant by extended zone scheme. 7 + 2 + 1

4. (*a*) Find the expression of electron concentration in *n* type nondegenerate semiconductor at extremely low temperature region.

(*b*) Find also the Position of Fermi level in *n* type nondegenerate semiconductor at moderately high temperature region. 8 + 2
