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.

(Turn Over)
(2)

(b) If the Hamiltonian $H$ 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: $3 \times 2$

(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 electromagnetic field and the Hamiltonian is given by

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

(c) Derive Lagrange's equation of motion from Hamilton's principle.
3. Answer any one of the following: 

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

\[
\begin{align*}
[L_x, x] & \text{ and } [L_x, p_x] \\
2 & + 2 + 3 + 3
\end{align*}
\]

(b) Obtain the Euler-Lagrange differential equation by variational method. What is \( \Delta \)-variation? Discuss how it differs from \( \delta \)-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: 

(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: \(3 \times 2\)

(a) Calculate the energy difference between conduction band bottom and Fermi Energy in an intrinsic Si Sample at 300°C. Where, \(m_e^* = 1.1 m, m_h^* = 0.59 m\).

(b) Estimate the relative contribution of electron and lattice specific heat of Na at 20K. The Fermi temperature of Na is \(3.8 \times 10^4 K\) 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.

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.