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(A-93) **No. of Printed Pages: 02**

SARDAR PATEL UNIVERSITY

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M. Sc. (Physics) 4th Semester Examination

Wednesday, 22nd April, 2015

Time: 02:30 pm to 05:30 pm

Subject: PS04CPHY02 [Theoretical Solid State Physics]

Total Marks: 70

Note: (1) Figures to the right indicate marks.
(2) Symbols have their traditional meaning.

Q:1 **Attempt all of the following Multiple choice type questions. [01 mark each]** [08]

(1) A plasma oscillation in a metal is which type of excitation of the conduction electrons
(a) transverse
(b) longitudinal
(c) collective transverse
(d) collective longitudinal

(2) Electromagnetic waves propagate without damping when dielectric function ε is
(a) positive and imaginary
(b) negative and imaginary
(c) positive and real
(d) negative and real

(3) A Bloch function $|\psi_k\rangle$ can be represented in terms of plane waves as
(a) $\sum_g a_g \langle \vec{k} - \vec{g} |$
(b) $\sum_g a_g | \vec{k} - \vec{g} \rangle$
(c) $\sum_g a_g | \vec{k} - \vec{g} \rangle \langle \vec{k} - \vec{g} |$
(d) $\sum_g a_g \langle | \vec{k} - \vec{g} \rangle |$

(4) $2\pi/a$ defines the boundary between
(a) second and third Brillouin zone
(b) none
(c) First and second Brillouin zone
(d) origin and first Brillouin zone

(5) de-Haas van-Alphen effect involves oscillations in M/H in a sample of Bismuth at
(a) 14.2 K
(b) 142 K
(c) 20K
(d) 1.42 K

(6) Difference in area of classical orbits at adjacent allowed energies is
(a) $\left(2\pi c H/\hbar H\right)$
(b) $\left(2\pi e H/\hbar c\right)$
(c) $\left(2\pi H/\hbar c\right)$
(d) $\left(2\pi e H/c\right)$

(7) For a superconducting material if M is isotopic mass and T_c transition temperature then $M^{1/2}T_C$ is
(a) Independent of mass
(b) Varies linearly
(c) constant
(d) zero

(8) Transition between normal and superconducting states is
(a) thermodynamically reversible X
(b) ferromagnetic
(c) non-reversible
(d) not possible

Q:2 **Answer any 7 of the following 9 questions briefly. [02 marks each]** [14]

1 Explain the concept of band effective mass.
2 Describe Umklapp scattering.
3 Give classification of solids into insulator, semi conductor and conductor based on band theory.
4 Show how Brillouin zones are constructed.
5 Draw a schematic diagram showing the formation of OPW.
6 What is anomalous skin effect?
7 What are Friedel oscillations?
8 Explain isotope effect.
9 What is cooper pair?

Q:3 (a) Explain longitudinal plasma oscillations. Derive an expression for static dielectric function $\varepsilon(\omega)=1-\frac{\omega_p^2}{\omega^2}$. What is a Plasmon? [6]

(b) Write a detailed note on screened Coulomb potential with necessary equations. [6]

OR

(b) Describe in detail the Kronig-Penney model. [6]

Q:4 (a) Explain the Plane Wave method of band structure calculation and obtain the expression for the secular determinant. [6]

(b) Using suitable diagrams explain the reduced, periodic and extended zone schemes. [6]

OR

(b) Explain the tight binding method of energy band calculation. [6]

Q:5 (a) Write a note on de Haas – van Alphen effect. [6]

(b) Define "Fermi surface". Give names of the experimental methods used to measure the Fermi surface. Explain free electron Landau levels. [6]

OR

(b) Obtain an expression for the Lindhard screening function. Determine its limiting values for $q\to 0$ and $q\to\infty$. [6]

Q:6 (a) Define the term "superconductivity". Explain how superconductors are classified into type-I and type-II superconductors. Give in brief the experimental survey. [6]

(b) Deduce the equations for London penetration depth and coherence length and draw the main inferences. [6]

OR

(b) Explain the Meissner effect. [6]

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