BIRLA INSTITUTE OF TECHNOLGY AND SCIENCE, PILANI (RAJASTHAN)
Second Semester 2016-2017

Mid Semester Test (Closed Book/Open Book)

PHY F341	**SOLID STATE PHYSICS**	**Weightage: 30%**
Date: 07/03/17	**Duration: 90 mins**	**Full Marks: 90**

PART A (Closed Book) **60 minutes**

1. Each question carries two marks. Answer all the ten questions in the first two or three pages of the answer sheet. **[2×10=20]**

i. What is the volume of a primitive cell of (i) bcc and (ii) fcc lattice structure ?
ii. Write down the expression for Lennard-Jones potential.
iii. What is Matthiessen's rule?
iv. Estimate the kinetic energy of 3 dimensional gas of N free electrons at 0K.
v. Write down the expression for cutoff frequency ω_D of Debye model.
vi. Estimate the ratio of the given inter-planar spacing: d_{111}: d_{110}: d_{100} in a simple cubic lattice.
vii. Write down the expression for heat capacity of metals as a function of temperature.
viii. Find out the Miller indices of a plane which intercepts at a, b/2, 3c in a simple cubic unit cell.
ix. Sketch NaCl crystal structure with proper labeling.
x. Obtain the reciprocal lattice vectors of the simple cubic lattice.

2. Using the drift velocity theory, derive an expression for the static current density in the matrix form. **[8]**

3. Using the Einstein model for density of states, write down the thermal energy *U* due to phonons for each polarization type. With the help of this value of *U*, obtain an expression for the heat capacity C_V. **[7]**

4. What is the value of density of orbitals of a free electron gas per unit area of specimen in two dimensions? Using this value, derive an expression for chemical potential of a Fermi gas in two dimensions for n electrons per unit area. [**2+5**]

5. Obtain the expression for Van der Waals- London interaction considering two identical inert gas atoms at a separation *R* which is large in comparison with the radii of atoms. **[8]**

-------All the Best-------

PART B (Open Book) **(30 minutes)**

---

1. Consider a cubic crystal in which atoms of mass M_1 and M_2 lie on different set of planes. Consider in the two-atom linear chain model, force constants between nearest neighbor atoms are alternately C_1 and C_2. Let the nearest neighbor separation be $a/2$. Write down the equations of motion. Find $\omega(k)$ for various values of k. Sketch the dispersion relation for the case $M_2 = M_1$ and $C_1 = 2C_2$. **[12]**

2. Sketch the crystal structures of (i) LiH (ii) Platinum. (The sketch must be labeled using the proper lattice constant values and the nearest neighbor distances.) **[3+3]**

3. Calculate the total lattice energy of KBr crystal. **[6]**

4. Calculate the structure factor for the hcp lattice. **[8]**

5. Use the Debye model to calculate the heat capacity of a mono-atomic lattice with lattice spacing a in one dimension at temperatures small compared to Debye temperature. (Numerical constants in the form of integrals need not be evaluated.) **[8]**

-----All the Best-------