UPES
End Semester Examination, May 2023

Course: Solid State Physics (General)   Semester: 2
Program: B.Sc. Chemistry, Mathematics, Geology   Time: 03 hrs.
Course Code: PHYS 1019G   Max. Marks: 100

Instructions:
- All questions are compulsory (**Q. No. 6** and **Q. No. 11** has an internal choice)
- Scientific calculators can be used for calculations.
- All **highlighted** representations are **vector quantities**.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Draw the crystal planes (1 0 0) and (0 1 0) in a simple cubic unit cell.	4	CO1
Q 2	Three crystallographic axes for a simple cubic structure are given as $\mathbf{a}$ = a $\mathbf{i}$, $\mathbf{b}$ = a $\mathbf{j}$ and $\mathbf{c}$ = a $\mathbf{k}$. Calculate unit cell volume.	4	CO1
Q 3	What are phonons? Discuss the characteristics of phonons.	4	CO2
Q 4	Draw M vs H and M vs T for diamagnetic and ferromagnetic materials.	4	CO3
Q 5	Discuss the origin of magnetism in atoms.	4	CO3

SECTION B
(4Qx10M= 40 Marks)

Q 6	(a) What do you understand by Miller indices for crystal planes? (b) d_{hkl} spacing for (111) plane for simple cubic structure is 4.52 Å. What will be the value of d_{hkl} spacing for (101) plane? **OR** (a) How will you distinguish polycrystalline, single crystalline and amorphous crystal structures? (b) Find the value of atomic packing fraction for simple body centered cubic crystal structure (a=b=c).	5 5 4 6	CO1
Q 7	What is specific heat for solids? Derive Dulong and Petits law for specific heat in the case of solids, and mention its limitations.	10	CO2
Q 8	(a) What are the differences between conductors, semi-conductors and insulators? (b) The superconducting critical temperature of H_3S superconductor is 205 K with mass 35.09 u. Determine the superconducting critical temperature for its isotope D_3S with mass 38.1u.	6 4	CO4

| Q 9 | (a) What do you understand by mobility of a conductor? | 4 | |
| | (b) Assuming that there are 6.32×10^{28} atoms/m^3 in copper, find the Hall coefficient. | 6 | CO4 |

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SECTION-C
(2Qx20M=40 Marks)

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Q 10	(a) Why are some substances diamagnetic while others paramagnetic?	4	
	(b) Derive Langevin's equation for paramagnetic susceptibility.	10	
	(c) A bar magnet has a coercivity of 2.5×10^3 A /m. It is desired to demagnetise it by inserting it inside a 10 cm long solenoid having 50 turns. What current should be sent through the solenoid?	6	CO3
Q 11	(a) What is superconductivity? Discuss main characteristics of a superconductor.	6	
	(b) Explain the difference between type-I (soft) and type-II (hard) superconductors using phase diagrams.	8	
	(c) The critical temperature of mercury is 4.2 K and the penetration depth is 57 nm at 2.9 K. Determine the penetration depth in mercury at 0 K.	6	
	OR		CO4
	(a) What is polarisation and depolarisation field?	6	
	(b) Discuss different mechanism for polarisation with relevant discussion. Show the temperature variation of dipolar polarisibility.	8	
	(c) Two parallel plates of capacitor having equal and opposite charges are separated by 6.0 mm thick dielectric material of dielectric constant 2.8. If the electric field strength inside be 10^5 V/m, determine polarisation vector, displacement vector and energy density in the dielectric.	6	

Constant	Standard Values
Planck's Constant (h)	6.63×10^{-34} Joule $-$ sec
Permittivity of free space (ε_0)	8.85×10^{-12} Farad/meter
Velocity of light (c)	3×10^8 m/sec
Boltzmann constant (k_B)	1.38×10^{-23} JK^{-1}
Rest mass of an Electron (m_o)	9.11×10^{-31} kg
Charge of an electron (e)	1.6×10^{-19} C
Free space permeability (μ_0)	$4\pi \times 10^{-7}$ H·m^{-1}