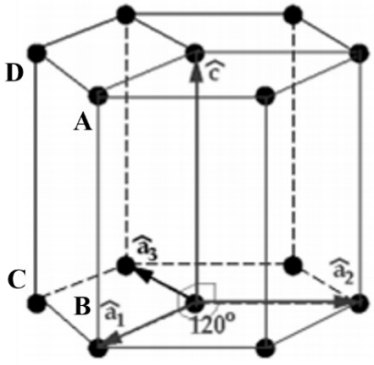
Name: Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

Course: Solid State Physics — **Semester: II**
Program: B.Sc. (Mathematics and Chemistry) — **Time 03 hrs.**
Course Code: PHYS 1019 — **Max. Marks: 100**

Instructions: Attempt all the questions. Sections B and C are having internal choices.
Scientific calculator is allowed.

SECTION A

S. No.		Marks	CO
Q 1	Define crystal lattice and translation vectors.	4	CO1
Q 2	Calculate the packing efficiency and density of sodium chloride from the following data: Radius of Na ion = 0.98 $\AA$; Radius of Cl ion = 1.81 $\AA$; Atomic mass of Na = 22.99 amu; Atomic mass of Cl = 35.45 amu.	4	CO2
Q 3	Establish the relation between dielectric constant and refractive index.	4	CO3
Q 4	Define polarization in dielectrics and write the relation between dielectric constant and atomic polarizability.	4	CO1
Q 5	Determine the Miller-Bravais indices for the ABCD plane. 	4	CO2

	SECTION B		
Q 6	An X-ray beam of wavelength 0.71 $\AA$ is diffracted by a cubic crystal KCl crystal of density 1.99×10^3 kgm^{-3}. Calculate the interplanar spacing for the (200) planes and the glancing angle for the second order reflection from these planes. The molecular weight of KCl is 74.6 amu and the Avogadro's number is 6.023×10^{26} $kg^{-1}mol^{-1}$.	**10**	**CO4**
Q 7	Derive the expression for Clausius Mosotti equation using internal field expression of polarized dielectrics.	**10**	**CO1**
Q 8	Explain classical Langevin theory of diamagnetic domains.	**10**	**CO3**
Q 9	Using the Kronig-Penney model, show that for $P \ll 1$, the energy of the lowest energy band is $E = \frac{\hbar^2 P}{m a^2}$ **OR** Describe the difference between Zener breakdown and Avalanche breakdown. What is the effect of temperature on breakdown voltage in each case?	**10**	**CO2**
	SECTION-C		
Q 10(a)	Explain Hall effect with suitable diagrams. Discuss this in conductors and semiconductors.	**10**	**CO1**
Q 10(b)	Explain the difference between Type I and Type II superconductors. The transition temperature of mercury with an average atomic mass of 200.59 amu is 4.153 K. Determine the transition temperature of one of its isotopes, $_{80}Hg^{204}$.	**10**	**CO3**
Q 11(a)	Determine the percentage of ionic polarizability in the sodium chloride crystal which has the optical index of refraction and the static dielectric constant as 1.5 and 5.6 respectively. **OR** Describe Weiss's theory of ferromagnetism with suitable diagrams.	**10**	**CO4**
Q 11(b)	Derive the expression of Debye theory of specific heat of solids for low temperature case and show that the vibrational energy is analogous to the Stephen's law of black body radiation. **OR** Describe the Einstein model of lattice heat capacity. Discuss the failures of this	**10**	**CO3**

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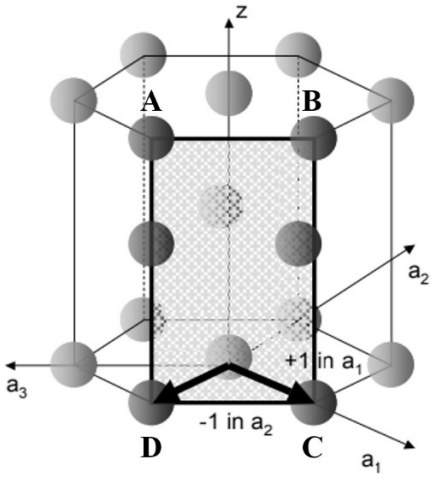
SECTION A

S. No.		Marks	CO
Q 1	Define normal dispersion and anomalous dispersion in dielectrics.	**4**	**CO1**
Q 2	Define primitive cell and unit cell.	**4**	**CO1**
Q 3	Calculate the Miller indices of a plane which intercepts at a, b/2, 3c in a simple cubic unit cell. Draw a neat diagram showing the plane.	**4**	**CO2**
Q 4	Define penetration depth in superconductors.	**4**	**CO1**
Q 5	Determine the Miller-Bravais indices for the ABCD plane. 	**4**	**CO2**

SECTION B			
Q 6	Show that the bcc lattice is reciprocal to fcc lattice.	**10**	**CO3**
Q 7	The atomic weight and density of Sulphur are 32.0 and 2.08 g/cm^3 respectively. The electronic polarizability of the atom is 3.28×10^{-40} F/m^2. If Sulphur solid has cubical symmetry, then estimate its relative dielectric constant.	**10**	**CO4**
Q 8	Derive the dispersion relation for vibrations of one-dimensional monoatomic lattice.	**10**	**CO1**
Q 9	Explain the Kronig-Penney model for insulators. **OR** The dielectric constant of helium having 2.7×10^{25}/m^3, measured at 0 ^{o}C and at one atmosphere is, 1.0000684. Calculate the atomic radius of helium.	**10**	**CO2**
SECTION-C			
Q 10(a)	The critical temperature of mercury is 4.153 K for its one isotope of mass 200.59 amu. Calculate the critical temperature of mercury for its one isotope of mass 204 amu.	**10**	**CO2**
Q 10(b)	The primitive translation vectors of a two-dimensional lattice are $\vec{a} = 2\hat{i} + \hat{j}, \vec{b} = 2\hat{j}$ Determine the primitive translation vectors of its reciprocal lattice.	**10**	**CO2**
Q 11(a)	Explain ionic polarization, electronic polarization and orientational polarization. **OR** Derive the expression of Debye theory of specific heat of solids for low temperature.	**10**	**CO3**
Q 11(b)	For ice, relaxation time is given as 18×10^{-6} s at 22 ^{o}C. Calculate the frequency when the real and imaginary parts of the complex dielectric constant will become equal. What will be the phase difference between the current and voltage at this frequency? **OR** Explain classical Langevin's theory of paramagnetism and determine the expression for paramagnetic susceptibility.	**10**	**CO4**