

<b>Name:</b>	
<b>Enrolment No:</b>	

**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**  
**Online End Semester Examination, December 2020**

**Course: Solid State Physics**  
**Program: B.Sc Physics (H)**  
**Course Code: PHYS 3002**

**Semester: V**  
**Time: 3 Hrs**  
**Max. Marks: 100**

**Section A**  
**All questions are compulsory. Each question carries 5 marks.**

S.No.	Question	CO
Q1	(i) The ferroelectric Curie temperature ( $\theta_c$ ) of a ferroelectric material is the temperature above which the ..... polarization vanishes. (2) (ii) ..... is the property of all electrical non-conductors that causes them to change their shape under the application of an electric field. (2) (iii) Pyroelectrics must be centrosymmetric crystals. (True/False) (1)	CO1
Q2	What is Piezoelectric effect?	CO1
Q3	(i) The coordination number of the central atom on the hexagonal face (HCP lattice) is (2) (a) 8 (b) 12 (c) 6 (d) 4 (ii) The Miller indices of the plane parallel to the x and y-axes are (2) (a) (1 0 0) (b) (0 1 0) (c) (0 0 1) (d) (1 1 1) (iii) How many crystal systems are there? (1) (a) 5 (b) 6 (c) 7 (d) 8	CO1
Q4	State the law of mass action.	CO2
Q5	Explain why the conductivity of a pure semiconductor increases with temperature while that of a metal decreases.	CO4
Q6	What is Meissner effect?	CO2

**Section B**  
**All questions are compulsory. Each question carries 10 marks.**

Q7	A beam of X-rays of wavelength $1.54 \text{ \AA}$ is incident on a cubic crystal at $13^\circ 40'$ when the first order Bragg's reflection occurs from (1 1 2) planes. Calculate the interatomic spacing.	CO3
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Q8	Show that for the Einstein's model of a solid, the molar specific heat at constant volume $C_v$ is given by $C_v = 3Nk \left( \frac{\hbar\omega}{kT} \right)^2 \frac{e^{\hbar\omega/kT}}{(e^{\hbar\omega/kT} - 1)^2}$ where the symbols have their usual meanings.	CO3
Q9	What is Hall effect? Derive an expression for the Hall voltage.	CO2
Q10	The London penetration depths for Pb at 3 K and 7.1 K are respectively 39.6 nm and 173 nm. Calculate its transition temperature as well as penetration depth at 0 K.	CO4
Q11	A paramagnetic material has a BCC structure with a unit cell edge of 2.8 Å. If the saturation value of the magnetization is $1.5 \times 10^6$ A/m, calculate the average magnetization contribution per atom in Bohr magnetron.	CO3

**Section C**

**Attempt any one question. Each question carries 20 marks.**

Q12	What do you mean by local field in a solid dielectric? Deduce an expression for the local field for structures possessing cubic symmetry. <p style="text-align: center;">OR</p> What do you mean by the term dielectric strength? Deduce the Clausius-Mosotti equation relating the macroscopic dielectric constant with microscopic polarization.	CO2
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**Values of some physical constants:**

Planck's constant,  $h = 6.6 \times 10^{-34}$  J.s

Boltzmann's constant,  $k = 1.38 \times 10^{-23}$  J/K

Mass of electron,  $m_e = 9.1 \times 10^{-31}$  Kg

Mass of proton,  $m_p = 1.67 \times 10^{-27}$  Kg

Velocity of light,  $c = 3 \times 10^8$  m/s

Rydberg Constant,  $R = 1.097 \times 10^7$  m<sup>-1</sup>

Avogadro's number =  $6.023 \times 10^{23}$

Permittivity of free space,  $\epsilon_0 = 8.85 \times 10^{-12}$  F/m

Permeability of free space,  $\mu_0 = 4\pi \times 10^{-7}$  H/m