B Sc Eng.IPE/ME/1st Sem. Date: January 14, 2026

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF NATURAL SCIENCES

Course Number: PHY 4113
Course Title: Structure of Matter, Electricity, Magnetism and Modern Physics
Semester: Midterm Examination

Winter Semester: 2024 - 2025
Full Marks: 120
Time: 2 Hours

Answer all the **4 (Four)** questions. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in the brackets.

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1. a) Define amorphous solids. State the properties and reasons responsible for the formation of amorphous solids. (6) (CO1) (PO1)

b) List the differences among ionic, covalent and metallic bonding. (6) (CO1) (PO1)

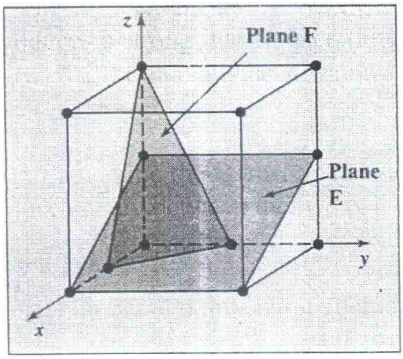
c) Describe two types of line defects (edge and screw) observed in crystals. (6) (CO1) (PO1)

2. a) i) Discuss seven crystal systems based on their types and lattice parameters with appropriate sketch. (6+14) (CO2) (PO2)
ii) For one component crystals estimate the fraction of volume in a simple cubic, body-centered cubic and face centered cubic crystal structure that is occupied by atoms.

b) i) Explain the term "bond length" from the graph of interatomic forces vs interatomic separation. Why might the bond length of a material change? (5+15) (CO2) (PO2)
ii) Explain the Born-Landé equation to calculate the lattice energy of ionic crystals. Discuss the significance of Madelung constant.

c) i) Discuss Gauss's theorem. (5+15) (CO2) (PO2)
ii) Demonstrate that Gauss's theorem can be proved from Coulomb's law and vise versa.

3. a) i) For NaCl crystal, density is given as 2180 kg/m^3. Atomic weight of Na and Cl are 23 and 35.5 kg/k.mol, respectively. Calculate the lattice constant and distance between adjacent atoms. (7) (CO3) (PO2)



ii) Determine the miller indices of the above planes E and F.

b) Demonstrate the expression of the Bragg's equation as $n\lambda = 2dsin\theta$ for X-ray diffraction. (7) (CO3) (PO2)

c) i) The edge length of the Ag FCC structure is 408.6 pm. An X-ray beam produces a strong interference (intense reflection) from the (111) planes at $2\theta = 38.2^0$. Calculate the X- ray wavelength. (7) (CO3) (PO2)

ii) Considering the Born-Landé equation determine which one have greater lattice energy between the two pairs ZnO vs. NaCl and LiF vs. MgO.

4. a) For n number of point charges demonstrate that the principle of superposition applies to electric fields as well as to electrostatic forces. (7) (CO3) (PO2)

b) Apply Gauss's theorem to find electric field intensity due to a thin and infinitely long straight wire (Cylindrical symmetry). (7) (CO3) (PO2)

c) i) A dipole is set up with a charge magnitude of $2x10^{-7}$ C for each charge (one is positive and the other is negative). The distance between the charges is 0.15 m. Determine the magnitude and direction of the E-field at the midpoint of the dipole. (Assume the positive charge is on the left.) Also determine the force magnitude and direction for an electron at that position in the field. (7) (CO3) (PO2)

ii) A circular plane, with a radius of 2.2 m, is immersed in an E-Field with a magnitude of 800 N/C. The field makes an angle of 20° with the plane. Calculate the magnitude of the flux through the plane.