

International Islamic University Chittagong
Department of Electrical and Electronic Engineering

B.Sc. Engineering in EEE

Midterm Examination, Autumn 2023

Course Code: **EEE 3515**

Course Title: **Electrical properties of Material**

Time: 1 hour 30 minutes

Full Marks: 30

(i) Answer all the questions. The figures in the right-hand margin indicate full marks.

(ii) Course Outcomes (COs) and Bloom's Levels (BL) are mentioned in additional Columns.

Course Outcomes (COs), Program Outcomes (POs) and Bloom's Levels (BL) of the Questions		
CO	CO Statements	PO
CO1	Reflect a basic understanding of crystal structure, lattice geometry, quantum mechanical behavior of electrons, molecular orbital theories.	POa
CO2	i) Determine Miller indices, Crystal directions and planner concentration of crystals. ii) Apply the concept of dielectric and magnetic material properties and their applications to determine various dielectric constants.	POb
CO3	Demonstrate the working principle of superconductors and their applications.	POa

Bloom's Levels (BL) of the Questions						
Letter Symbols	C1	C2	C3	C4	C5	C6
Meaning	Remember	Understand	Apply	Analyze	Evaluate	Create

- 1) a) Consider a BCC Fe crystal, CO2 C3 5
 i. Show that there are two atoms per unit cell.
 ii. If " R " is the radius of the Fe atom and " a " is the lattice parameter, then derive the relationship between " a " and " R "
 iii. Calculate the atomic packing factor (APF) of the Fe molecule, where APF is the ratio between volume of atoms per unit cell to volume of unit cell.
- 1) b) Explain the Frankel and Schottky defect of the ionic crystal using a suitable schematic diagram. CO1 C2 5

Or,

- 1) a) "All the parallel plans are not having the same Miller indices unless they are separated by the unit cell parameter"-justify the statement using a suitable example. CO2 C3 5
- 1) b) What do you understand about planner concentration? Determine the planner concentration of (011) for a Cu FCC crystal. CO1 C2 5
- 2) a) i. Define mean scattering time and drift mobility. CO1 C2 5
 ii. Show that mean scattering time is proportional to the drift mobility of a conductor.

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|----|----|--|-----|----|---|
| 2) | b) | Given that the mean speed of conduction electrons in copper is $1.6 \times 10^6 \text{ m s}^{-1}$ and the frequency of vibration of the copper atoms at room temperature is about $4 \times 10^{12} \text{ s}^{-1}$, estimate the drift mobility of electrons and the conductivity of copper. The density d of copper is 8.96 g cm^{-3} and the atomic mass M_{at} is 63.56 g mol^{-1} . | CO1 | C3 | 5 |
| 3) | a) | "Increasing the light intensity (for the same frequency) doesn't increase the kinetic energy but increases the number of electrons with the same kinetic energy"- Explain this statement using Einstein's interpretation for photoelectric effect with a suitable diagram. | CO2 | C4 | 5 |
| 3) | b) | Calculate the energy and momentum of an X-ray photon with the wavelength of about 0.6 angstrom ($1 \text{ \AA} = 10^{-10} \text{ m}$), and the velocity of a corresponding electron that has the same momentum. | CO1 | C3 | 5 |