(17)

B.Sc. in EEE, 5th Semester

October 11, 2023 (Morning)
10:00 A.M. – 11:30 A.M.

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid Semester Examination
Course No.: EEE 4579
Course Title: Engineering Materials

Summer Semester, A. Y. 2022-2023
Time: 1.5 Hours
Full Marks: 75

There are 3 **(three)** questions. You have to answer option **(a)** of all the three questions but you can choose to answer any 2 out of the other 3 options. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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1. **Each of the questions carry 5 marks. Among the questions you must answer the question (a) and answer any two from the options (b), (c) and (d).** **3×5=15**

a) Discuss the potential uses for a superconducting material that can function at room temperature. **5** CO2, PO2, PO3

b) Describe the material type utilized in capacitors and provide evidence to support your position. **(5)** CO1 PO1

c) Illustrate the relationship between a material's dielectric constant and frequency through a graph. **(5)** CO2 PO2

d) Discuss about the atomic interpretation of Ohm's law. **(5)** CO1 PO1

2. **Each of the questions carry 10 marks. Among the questions you must answer the question (a) and answer any two from the options (b), (c) and (d).** **3×10=30**

a) Discuss how Langevin function is related to Orientational polarization. Determine the generalized form of orientational polarization in case of saturation is $P_o = N\mu_p$. **(10)** CO1 PO2

b) Demonstrate with proper mathematical notation how the heat generated in a current carrying conductor is related to the applied electric field. **(10)** CO1 PO2

c) Discuss the properties of superconductor and describe how Meissner effect can be applied in maglev trains. **(10)** CO1 PO2

d) Demonstrate how refractive index of any material can be represented as a frequency dependent function. **(10)** CO1 PO2

3. **Each of the questions carry 10 marks. Among the questions you must answer the question (a) and answer any two from the options (b), (c) and (d).** **3×10=30**

a) The dielectric constant of a dielectric material at 30° C is, $\epsilon_r = 1.006715$ and at 200° C is $\epsilon_r = 1.0056$. The number of molecules of this material per m^3 is 2.62×10^{25}. Determine the value of the dipole moment of molecules and the sum of electronic and ionic polarizabilities. **(10)** CO2 PO2

b) Calculate- (i) polarizability,
(ii) relative permittivity, and
(iii) The displacement of the Hydrogen atom when the atom is subjected to a field of 2.8×10^{8} V/cm.
[radius of H- atom is 0.53 Å, density of H atom 82 g/m^3 and atomic weight is 1.] **(10)** CO2 PO2

c) For a material, the critical fields are respectively 2.5×10^5 A m and 5×10^5 A/m for 12 K and 8 K respectively. Determine the transition temperature and critical field at 0 K and 4.5 K. **(10)** CO2 PO2

d) A conduction wire has a resistivity of 1.4×10^{-8} Ω-m at room temperature. The Fermi energy for such a conductor is 6.2 eV and conduction electron per m^3 is 5.5×10^{28}. Calculate-
(i) The mobility and relaxation time of electrons.
(ii) The average drift velocity of electrons when the electric field applied to the conductor is 1 V/cm.
(iii) The velocity of an electron with Fermi energy.
(iv) The mean free path of the electrons. **(10)** CO2 PO2

You may use these formulas if required.

$J = \sigma E$	$H_c = H_0[1 - \left(\frac{T}{T_c}\right)^2]$	$D = \epsilon_0 E + P$
$v_x = \frac{qE}{m}\tau$	$J_c = \frac{I_c}{\pi r^2}$	$D = \epsilon_0 \epsilon_r E$
$J_x = -nqv_x$	$I_c = 2\pi r H_c$	$P = \epsilon_0 \kappa E$
$\sigma = \frac{nq^2\tau}{m}$	$\lambda = v_f \tau$	$P = N\mu_p$
$\mu_e = \frac{q\tau}{m}$	$C = \frac{\epsilon A}{d}$	$\epsilon_r = 1 + 4\pi N R^3$
$P = \epsilon_0(\epsilon_r - 1)E$	$W_f = \frac{1}{2}m{v_f}^2$	$F = qE = \frac{q^2}{4\pi\epsilon_0 x^2}$