B.Sc. in EEE, 8th Semester

February 20, 2023 (Afternoon)
2:00 pm – 03:30 pm

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

Mid Semester Examination
Course No.: EEE 4803
Course Title: Engineering Materials

Summer Semester, A. Y. 2021-2022
Time: 1.5 Hours
Full Marks: 75

Please Read the Instructions Carefully.
There are **3 (three)** questions. Inside each of these questions, you have options to choose from. But you must answer all **3 (three)** questions. The symbols have their usual meanings. If any value is missing, you are allowed to assume any suitable value. If you are found writing unnecessary and irrelevant information other than the information asked in the question, you will be penalized. Marks of each question and corresponding COs and POs are written in the brackets. You will be judged by the quality of our answers, not by the quantity of the pages you have written.

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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) Imagine in an ideal world, an ideal conductor has been invented which can carry current through it without any resistance in any given temperature and we have our conventional Type I superconductor there as well. As an electrical engineer, determine the type of conductor you will choose for engineering application and justify your claim. **(5)** CO2 PO2, PO3

b) Will it be accurate if it is said that "**All Dielectrics are Insulators, but not all Insulators are Dielectrics**", Explain your view on the statement. **(5)** CO1 PO1

c) Discuss the areas where Clausius-Mossotti Relation is applied. **(5)** CO1 PO1

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

2. **Each of the questions carry 10 marks. Answer any 3 from the given options.**

3×10=30

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

b) Explain how we can get the value of thermal conductivity of a conductor , $K = \frac{1}{3}\frac{n\pi^2k^2T\tau}{m}$. **(10)** CO1 PO2

c) 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

d) Demonstrate the effect of alternating electric field on the permittivity of a dielectric material. **(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, ϵ_r=1.007615 and at 200° C is ϵ_r=1.006. The number of molecules of this material per m^3 is 2.6×10^{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, **(10)** CO2 PO2
(ii) relative permittivity, and
(iii) The displacement of the Hydrogen atom when the atom is subjected to a field of 2.5×10^{8} V/cm.
[radius of H- atom is 0.53 Å, density of H atom 82 g/m^3 and atomic weight is 1.]

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 3.5 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- **(10)** CO2 PO2
(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.

You may use these formulas if required.

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