

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination

Winter Semester, A.Y. 2022-2023

Course No.: EEE 4501

Full Marks: 75

Course Title: Electromagnetic Fields and Waves

Time: 90 Minutes

There are 05 (five) questions. Answer all 05 (five) questions. Marks for parts of the questions and corresponding CO and PO are indicated in the right margin. Programmable calculators are not allowed. Do not write on this question paper. Symbols carry their usual meanings.

1. Define gradient and Laplacian of a scalar field. Classify vector fields in terms of their divergence and curl. Classify DC current density J mentioning reason. State Helmholtz's theorem with equation. (4+4+3
+4)
(CO1)
(PO1)

2. Calculate the total outward flux of vector $A = 2y a_x - z^2 a_y + 3xy a_z$ through the surface defined by $\rho = 3, 0 < \phi < \pi/2, 0 < z < 1$. State, with reason, whether divergence theorem can be applied in this case or not. (12+3)
(CO2)
(PO2)

3. i) A cube carrying charge density $\rho_v = 12xz \text{ mC/m}^3$ is defined by $1 < x < 3, 2 < y < 4, 3 < z < 5$. Find the total outward flux from the cube. (7)
(CO3)
(PO2)
 ii) An infinite sheet of charge with density $\rho_s = 20 \text{ nC/m}^2$ occupies the $x = 0$ plane. Determine the work done in moving a $20 \mu\text{C}$ charge from point $A(3, 4, -1)$ to point $B(5, 2, 6)$. (8)
(CO3)
(PO2)

4. A thin disk of radius a (m) is defined as $0 < \rho < a, 0 < \phi < 2\pi, z = 0$. The disk is in air and carries a uniform surface charge density ρ_s .
 i) Derive an expression for the electric potential V at a point $(0, 0, z)$ on the positive z axis. The general expression of V for surface charge is (10)
(CO3)
(PO2)

$$V(r) = \frac{1}{4\pi\epsilon_0} \int_S \frac{\rho_s(r') dS'}{|r - r'|}$$
 ii) Find the corresponding electric field E . (5)
(CO3)
(PO2)

5. i) A solid conducting sphere of 5 cm radius centered at the origin is placed in free space. The electric field at the surface of the sphere is $E = 150 a_r \text{ V/m}$. Find the total charge on the surface of the sphere. (7)
(CO3)
(PO2)
 ii) Consider a parallel plate capacitor with plates parallel to yz plane. One plate is placed at $x = 0$ with $V = 0\text{V}$. The other plate is at $x = d$ m with $V = 0\text{V}$. The dielectric between the plates with permittivity $\epsilon_0\epsilon_r \text{ F/m}$ has a uniform charge density $\rho_v \text{ C/m}^3$. Determine the potential and electric field inside the capacitor. (8)
(CO3)
(PO2)