PES University, Bengaluru

(Established under Karnataka Act 16 of 2013)

END SEMESTER ASSESSMENT (ESA) - DEC 2023

UE21EC341A - Electromagnetic Field Theory

Total Marks : 100.0

1.a. Find the electric field intensity at a height 'h' from the centre of a circular disk of radius 'a' uniformly charged with $\rho_s\ C/m^2$. The disk lies on z=0 plane with its axis along the z-axis (8.0 Marks)

1.b. Given that $\overline{D} = \left(\frac{10x^3}{3}\right) a_x\ C/m^2$, evaluate both sides of the divergence theorem for the volume of cube, 2m on an edge, centered at the origin and with edges parallel to the axes (6.0 Marks)

1.c. Find the work done in moving a point charge Q=5μC from the origin to $(2m, \pi/4, \pi/2)$ in the field $\overline{E} = 5e^{(-r/4)}a_r + \frac{10}{r\sin\theta}a_\phi\ V/m$ (5.0 Marks)

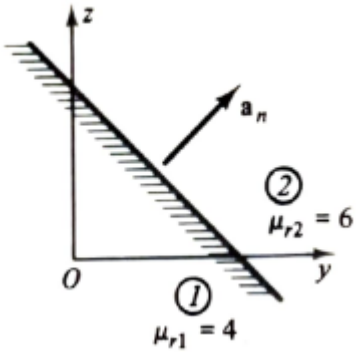
1.d. Region 1 defined by x<0 is free space, while region 2, x>0, is a dielectric material for which $\varepsilon_{2r} = 2.4$Given $\overline{D_1} = 3a_x - 4a_y + 6a_z\ C/m^2$. Find $\overline{E_2}$ and the angles θ_1 and θ_2 made with the normal to the interface(6.0 Marks)

2.a. A radial field $\overline{H} = \frac{2.39 \times 10^6}{\rho} \cos\phi\ a_\rho A/m$ exists in free space. Find the magnetic flux crossing the surface defined by $-\pi/4 \leq \phi \leq \pi/4, 0 \leq z \leq 1\ m$. (4.0 Marks)

2.b. A conductor of length 2.5m located at z=0, x=4m carries a current of 12A in the -ve y direction. Find the uniform magnetic flux density in the region if the force on the conductor is $1.2 \times 10^{-2}\ N$ in the direction $\frac{(-a_x + a_z)}{\sqrt{2}}$ (6.0 Marks)

2.c. Region 1 where $\mu_{1r}=4$, is the side of the plane $y+z=1$ containing the origin as shown in figure. In region 2, $\mu_{2r}=6$. $\overline{B_1}=2a_x+a_y$Wb/m^2, find $\overline{B_2}$ and $\overline{H_2}$.

(8.0 Marks)



2.d. Determine magnetic field at a point 'P' due to a straight current carrying filamentary conductor of finite length , that is along z-axis with upper and lower ends subtending angles α_2 and α_1 at this point P.

(7.0 Marks)

3.a. Derive Helmholt'z equations starting with Maxwell's equations. Also derive the expression for attenuation and phase shift constants

(10.0 Marks)

3.b. The magnetic field intensity of a uniform plane wave with $\varepsilon_r = 1, \mu_r = 1$ is $\overline{H} = 20e^{-12z}cos(2\pi \times 10^6 t + 12z)a_y m\ A/m$. Find the conductivity and the corresponding electric field (6.0 Marks)

3.c. The electric field intensity of a plane wave is represented by $\overline{E} = 10cos(10^9 t + 30z)a_y V/m$. Determine (1) magnetic field intensity (2) Phase velocity and (3) dielectric constant of the medium where $\mu = \mu_0$ (6.0 Marks)

3.d. Determine the polarization of the wave $\overline{E}_s = 40\, e^{j10z}\, a_x + 60\ e^{j10z}\, a_y\ V/m$ (3.0 Marks)

4.a. A lossless transmission line with characteristic impedance 500Ω is excited by a signal of voltage $10\angle 0^0 V$ at 1.2Mhz. If the line is terminated by Z_L at a distance 1km, calculate (1) input impedance of the line for $Z_L = \infty$ *and* 0 (2) voltage at the midpoint of the line for $Z_L = Z_0$ (6.0 Marks)

4.b. Derive the expressions for input impedance, reflection coefficient, standing wave ratio for an open circuited load of a lossless transmission line. Sketch standing wave pattern and variation of input impedance with path length. (5.0 Marks)

4.c. Derive the expression for the average input power at a distance *l* from the load, for a lossless transmission line. (6.0 Marks)

4.d. Find the shortest distance from the load and the length (both in meters) of a shorted stub connected in parallel to a 300 Ω lossless air-dielectric line to match a load $Z_L = 600 + j\,300\ \Omega$ at 600 MHz. The matching stub is the same type of line as the main line. Also briefly write the steps in finding these values from Smith chart (8.0 Marks)