PES University, Bengaluru

(Established under Karnataka Act 16 of 2013)

END SEMESTER ASSESSMENT (ESA) - May 2023

UE19EC252 - Electromagnetic Field Theory

Total Marks : 100.0

1.a. Write expressions for
1) transforming a point from cartesian (x,y,z) to cylindrical (ρ,ϕ,z) coordinate system and from cylindrical to cartesian
2) transforming a point from cartesian (x,y,z) to spherical (r,θ,ϕ) coordinate system and from spherical to cartesian (6.0 Marks)

1.b. Determine curl of the vector field $\boldsymbol{A} = \rho z \sin\phi \; a_\rho + 3\rho z^2 \cos\phi \; a_\phi$ at $(5, \pi/2, 1)$ (6.0 Marks)

1.c. Derive the expression for electric field intensity at any point (ρ, ϕ, z) of an infinite line charge with ρ_L charge density along z-axis. (8.0 Marks)

2.a. If $\boldsymbol{D} = (2y^2 + z)\, a_x + 4xy\, a_y + x\, a_z\ C/m^2$, find

1) Volume charge density at (-1, 0, 3) (2M)

2) Flux through the cube defined by $0 \le x \le 1, 0 \le y \le 1, 0 \le z \le 1$ (4M)

3) Total charge enclosed by the cube (2M) (8.0 Marks)

2.b. Given $\boldsymbol{D} = 50\, a_x + 80\, a_y - 30\, a_z\ nC/m^2$ in region $x > 0$ where $\varepsilon = 2.1\, \varepsilon_0$, find $\boldsymbol{D}$ In the region $x < 0$ where $\varepsilon = 7.6\, \varepsilon_0$ (6.0 Marks)

2.c. $V = 5x^3y^2z$ *and* $\varepsilon = 2.25\, \varepsilon_0$. Find **E** at a point P(-3, 1, 2) and ρ_v at point P (6.0 Marks)

3.a. Derive the expression for magnetic field intensity **H** , at a height h along z-axis for a circular loop on z=0 plane with its center at origin carrying a current of I amperes in ϕ direction. (8.0 Marks)

3.b. Given $\boldsymbol{H} = 10^3 \rho^2 \, a_\phi \, A/m$.

1) Find **J** (3M)

2) Calculate current through the surface $0 < \rho < 2 \, , 0 < \phi < 2\pi, z = 0$ (3M) (6.0 Marks)

3.c. Derive the expression for force between two current elements (6.0 Marks)

4.a. Derive the expression for displacement current (8.0 Marks)

4.b. Express the following time harmonic fields as phasors

1) $\boldsymbol{A} = 5 \sin\left(2t + \frac{\pi}{3}\right) a_x + 3 \cos(2t + 30^0) \, a_y$ (2M)

2) $\boldsymbol{B} = \frac{100}{\rho} \sin(\omega t - 2\pi z) \, a_\rho$ (2M) (4.0 Marks)

4.c. Write all Maxwell's equations in differential form and integral form (8.0 Marks)

5.a. A lossless transmission line is 80cm long and operates at a frequency of 600MHz. The line parameters are L = 0.25 μH/m and C = 100 pF/m. Find the characteristic impedance, phase constant and phase velocity (6.0 Marks)

5.b. Give the expressions for input impedance , reflection coefficient and standing wave ratio for a shorted line, open circuited line and matched line (8.0 Marks)

5.c. Derive the expression for input impedance of a quarter wave transformer (6.0 Marks)