Code No: 155SE **RA**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year I Semester Examinations, February - 2022
ELECTROMAGNETIC FIELDS AND WAVES
(Electronics and Communication Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks

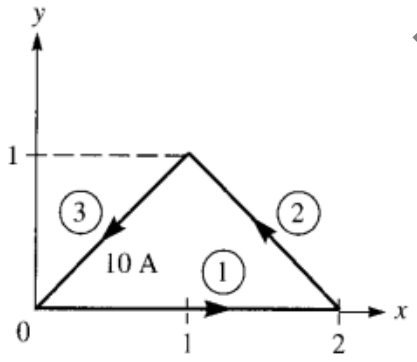
1.a) In a certain region, the electric field is given by
$$D = 2\rho(z+1)cos\emptyset a_\rho - \rho(z+1)sin\emptyset a_\emptyset + p^2 cos\emptyset a_z \mu C/m^2$$
i) Find the charge density.
ii) Calculate the total charge enclosed by the volume $0 < \rho < 2, 0 < \emptyset < \frac{\pi}{2}, 0 < z < 4$.

b) In free space $D = 2y^2 a_x + 4xya_y - a_z\, mC/m^2$. Find the total charge stored in the region 1 < x < 2, 1 < y < 2, -1 < z < 4. [8+7]

2.a) State Gauss's law. Deduce Coulomb's law from Gauss's law thereby affirming that Gauss's law is an alternative statement of Coulomb's law and that Coulomb's law is implicit in Maxwell's equation $\nabla . D = \rho_v$.

b) A cylindrical capacitor has radii a =1cm and b=2.5cm. If the space between the plates is filled with an inhomogeneous dielectric with $\varepsilon_r = (10 + \rho)/\rho$, where ρ is in centimeters, find the capacitance per meter of the capacitor? [10+5]

3.a) Find H at (0,0,5) due to side 3 of triangular loop shown in figure below.



b) Prove that the line integral of the tangential component of H around a closed path is the same as the net current enclosed by the path. [8+7]

4.a) For a current distribution in free space
$$A = (2x^2y + yz)a_x + (xy^2 - xz^3)a_y - (6xyz - 2x^2y^2)a_z Wb/m$$
i) Calculate B.
ii) Calculate H.
iii) Find the magnetic flux though a loop described by x=1, 0 < y, z < 2.
iv) Show that $\nabla . B = 0$
v) Show that $\nabla . A = 0$

b) State and prove Faraday's Law. [10+5]

5.a) Check whether the following field is satisfy Maxwell's equations:

$$\left(3\rho^2 cot\emptyset a_\rho + \frac{cos\emptyset}{\rho} a_\emptyset\right) sinwt$$

Assume that the fields exist in charge free regions.

b) Derive the boundary conditions for electric fields between dielectric to conductor surface. [9+6]

6.a) A plane wave propagating through a medium with $\varepsilon_r = 8, \mu_r = 2\ has\ E = 0.5e^{-z/3} \sin(10^8 t - \beta z)\ a_x V/m$. Determine β, loss tangent, wave impedance, wave velocity, and H field.

b) In free space $H = 0.2\cos(wt - \beta x) a_z$A/m. Find the total power passing through a circular disc of radius 5 cm on plane x=1. [10+5]

7.a) Derive the equation for reflection and transmission coefficients for the plane wave with oblique incidence with E perpendicular to the plane of incidence.

b) What are the advantages and limitations of microstrip lines? [10+5]

8.a) Derive the equation for cutoff frequency, wave impedance for rectangular waveguide in TE mode starting from Maxwell's equations.

b) A standard air-filled rectangular waveguide with dimensions a=8.636cm, b=4.318 cm is fed by a 4-GHz carrier from a coaxial cable. Determine if a TE_{10} mode will be propagated. If so, calculate the phase velocity and group velocity. [8+7]

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