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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Electronics and Communication Engineering

Semester End Examination; June - 2017

Electromagnetics and Antennas

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each Unit.*

UNIT - I

1 a. Derive an expression for Electric field intensity at a point due to sheet of charge. 7

b. A charge $Q_1 = 3x10^{-4}$ C is at point P(1, 2, 3) and charge $Q_2 = -10^{-4}$ C at a point Q(2, 0, 5) in a vacuum. Calculate force on Q_2 in vector form. State and explain Coulomb's law of force in vector form. 7

c. A uniform line charge $\int_l$ = 25 nC/m lies on the line x = -3 m, z = 4 m in free space. Compute the electric field intensity at a point (2,15,3) m. 6

2 a. State and prove Gauss divergence theorem. Given that $\overrightarrow{D} = \frac{10x^3}{3}\hat{a}_x \; C/m^2$, evaluate both sides of the divergence theorem for the volume of a cube 2 m on the edge centered at the origin and with edges parallel to the axes. 10

b. The flux density $\overrightarrow{D} = \frac{r}{3}\hat{a}_r \quad nC/m^2$ is in the free space. Calculate; (i) $\vec{E}$ at r = 0.2 m (ii) total electric flux leaving the sphere of r = 0.2 m (iii) Total charge within the sphere at r = 0.3 m. 6

c. Let $\overrightarrow{D} = 5r^2\hat{a}_r \quad mC/m^2$ for r < 0.08 m and $\overrightarrow{D} = \frac{0.1}{r^2}\hat{a}_r \; mC/m^2$ for r > 0.08 m. Calculate charge density for r = 0.06 m 4

UNIT - II

3 a. Explain the conservative nature of electric field and show that $E = -\nabla v$ 6

b. Calculate the stored energy in a system of four identical point charges Q = 4 nC at the corners of a square point 1 m on a side. What is the stored energy in the system when only two charges at opposite corners are in place? 8

c. Compute the potential difference between the points A and B where A is $\left(2, \pi/2, 0\right)$ and B is $\left(4, \pi, 5\right)$ due to line charge with $\rho_\ell = \frac{10^{-9}}{2} \quad C/m$ 6

4 a. Two parallel conducting planes are separated by distance 5 mm at Z = 0 and Z = 5 mm. If V = 0 at Z = 0 and V = 100 V at Z = 5 mm. Calculate the charge densities on the plates. 8

b. Compute the magnetic flux density at the centre of a square wire loop 2 m on a side carrying a current of 3 A. 6

c. Discuss the concept of magnetic scalar and vector potential. 6

UNIT - III

5 a. A current element $I_1\overrightarrow{\Delta l_1} = 10^5\hat{a}_z Am$ is located at $P_1(0,0,0)$ while a second element at $P_2(-1,0,0)$ is $I_2\overrightarrow{\Delta l_2} = 10^{-5}\left(0.6\hat{a}x - 2\hat{a}y + 3\hat{a}y\right)Am$ both in free space compute the vector force on $I_2\overrightarrow{\Delta l_2}$ by $I_1\overrightarrow{\Delta l_1}$. 6

b. Derive the boundary condition at the interface between two different magnetic materials. 6

c. Derive an expression for magnetic torque and magnetic dipole moment for a rectangular planar coil carrying current I placed in XY plane and parallel to the magnetic field. 8

6. a Write the Maxwell's equation both in integral and differential form for harmonically varying fields. 8

b. A loosy dielectric has $\mu = 4\pi x 10^{-9}$ H/m and $\in = \frac{10^{-8}}{36\pi} f/m$, $\sigma = 2\times10^{-8}$ ℧$/m$ The electric field $\vec{E} = 200\sin wt\,\hat{a}_z\ v/m$ exists in the dielectric (i) At what frequency will the conduction current density and displacement current densities have equal magnitudes (ii) At this frequency calculate the instantaneous displacement current density. 6

c. Give that $E = E_m \sin(\omega t - \beta z)\hat{a}y$ in free space compute (i) D and B (ii) H. 6

UNIT - IV

7 a. What is the uniform plane wave? Derive the equation for the wave in free space with electric field along X-direction and magnetic field along Y-direction. 8

b. State the Poynting theorem and prove it starting from Maxwell's equation. 8

c. Aluminium with $\sigma = 38.2m$ ℧ m, $\mu_r = 1$ and frequency 1.6 MHz. Calculate:
i) skin depth ii) Propagation constant. 4

8 a. Define the term transmission coefficient and reflection coefficient. Calculate the amplitude of reflected and transmitted electric field at the interface of two regions if $E_i = 1.5\ mV/m$ in region 1 for which $\in_n = 85, \mu_r = 1$ and $\sigma = 0$, regions 2 is a free space. 8

b. Derive the equation for effective aperture in terms of effective height of an antenna. 6

c. Calculate the maximum power received at distance 0.5 km over a free space 1 GHz circuit consisting of a transmitting antenna with 25 dB and a receiving antenna of gain 20 dB. The gain is with respect to isotropic source. The transmitting antenna input is 150 W. 6

UNIT-V

9 a. Discuss the wave propagation by means of space and surface wave with related figure and equations. 8

b. Starting from vector magnetic potential derive equation for $\in_r$ *and* $\in_\theta$ due to an alternating current element. 7

c. Explain Earth's behaviour at different frequencies. 5

10a. Discuss the effects of curved nature of earth. 6

b. Derive equation for skip distance in terms of maximum usable frequency, if the wave is reflected from a height of 300 km, N_{max} is $23.45x10^{10}$ and MUF is 10 MHz. Calculate the skip distance for flat earth. 8

c. Explain the mechanism of wave reflection from ionosphere. 6

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