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

(An Autonomous Institution affiliated to VTU, Belgaum)

Third Semester, B.E. – Electronics and Communications Engineering

Semester End Examination; Dec. - 2014

Engineering Electromagnetics

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each Unit.*
ii) Assume suitable missing data if any.

Unit - I

1 a. Four point charges, each 20 μC are on the x and y axis at ± 4 m. Find the force on a 200 μC point charge at (0, 0, 3) m. 6

b. Derive an equation for the Electric field intensity at a point along the axis at a distance of 'X' from the center of circular line of charge. 6

c. State Guass divergence theorem. Given that $D = \frac{10x^3}{3}\hat{a}x\, C/m^2$. 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. 8

2 a. Q_1 and Q_2 are the point charges located at (0, -4, 3) and (0, 1, 1). If Q_1 is 2 nC, find Q_2 such that the force on a test charge at (0, -3, 4) has no Z component. 6

b. Derive the equation for electric field intensity due to infinite line of charge at a point P which is located at a normal distance of 'r' from the center of infinite line of charge. 8

c. The flux density $\vec{D} = \frac{r}{3}\hat{a}_r\, nC/m^2$ is in the free space find; (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 of r = 0.3 m. 6

Unit - II

3a. A potential field is given by V = 100 e^{-5x} sin 3y cos 4z volt let point $P\left(0.1, \pi/12, \pi/24\right)$ be located at a conductor free space boundary. At point P, find the magnitude of 8

i) E ii) E_t iii) E_n iv) $\vec{D}$ v) D_n vi) ρs

b. Explain the conservative nature of electric field and shown that E = -∇V 6

c. Derive continuity equation of current both in integral form and differential form. 6

4 a. Starting from Gauss law in point form obtain Laplace's and Poisson's equation. 4

b. Derive boundary conditions between two perfect dielectrics. 8

c. In spherical coordinates V = 0 at r = 0.1m and V = 100 volt at r = 2m. Assuming free space between these concentric shells, find $\vec{E}$ and $\vec{D}$. 8

Unit - III

5 a. State and prove Ampere's Law. A radial field $\vec{H} = \frac{2.39\times10^6}{r}\cos\phi\hat{a}_r\, A/m$ exist in free space. 8

Find the magnetic flux crossing the surface defined by $0 \le \phi \le \frac{\pi}{}$ and $0 \le z \le 1\ m$.

b. Explain the concept of magnetic scalar and vector potential. 6

c. State and prove Stoke's theorem. 6

6 a. Derive an expression for force on differential current element moving in a steady magnetic field. 6

b. Obtain 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

c. A current element $I_1\overrightarrow{\Delta l_1} = 10^5 \hat{a}_z Am$ is located at P_1(1, 0, 0) while a second element at P_2(-1, 0, 0). Is $I_2\overrightarrow{\Delta L_2} = 10^{-5}\left(0.6\hat{a}_x - 2\hat{a}_y + 3\hat{a}_z\right) Am$ both in free space. Find vector force on $I_2\overrightarrow{\Delta L_2}$ by $I_1\overrightarrow{\Delta L_1}$. 6

Unit - IV

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

b. Region 1 has μr_1= 1.5, region 2 has $\mu r2$ = 1. The flux density $\vec{B} = 1.2\hat{a}x + 0.8\hat{a}y + 0.4\hat{a}zT$ is incident at boundary from region 1. Calculate i) $\vec{B}_2$ ii) angle of incidence iii) angle of reflection. The boundary is at z = 0 and normal to z – axis. 8

c. Derive equation for inductance of co-axial cable. Calculate the inductance of a 10m length of co – axial cable filled with a material for which μ_r = 80 and radii of inner and outer conductors are 1 mm and 4 mm respectively. 6

8 a. Explain the concept of conduction current density and displacement current density. If the applied voltage is sinusoidal what is the ratio of $\left|\frac{J_C}{J_D}\right|$. 8

b. List the Maxwell's equation both in integral form and differential form. 8

c. Write a note on Retarded potential. 4

Unit - V

9 a. Sate and prove Poynting theorem starting from Maxwell's equation. 8

b. For TEM ware define the terms; i) Propagation constant ii) Intrinsic impedance. A 300 MHz uniform plane wave propagates through fresh water for which σ = 0, μ_r = 1 and $\in_r$ = 78. Calculate; i) attenuation constant ii)Phase constant iii) Wave length iv) Intrinsic impedance 8

c. Find the skin depth and propagation constant at a frequency of 1.6 MHz in aluminium where σ = 38.2 M℧/m and μ_r = 1. 4

10 a. Define the terms; i) Standing wave ratio iii) reflection Coefficient. What is the relationship between SWR and reflection co-efficient? 6

b. Explain reflection of uniform plane wave with normal incidence at a plane dielectric boundary. 8

c. Explain the following types of wave polarization,
i) Linear ii) Elliptical iii) Circular. 6

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