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B. TECH
THEORY EXAMINATION (SEM-IV) 2017-18
ELECTROMAGNETIC FIELD THEORY

Time: 3 Hours ***Max. Marks: 100***

Note: *Be precise in your answer. In case of numerical problem assume data wherever not provided*

SECTION – A

1. Attempt all parts of the following questions: 2×10=20

(a) Explain Faraday's law.
(b) State point form of ohms law & Gauss's law.
(c) Explain Biot-Savart's Law.
(d) Give the relation between Magnetic field and Magnetic flux density?
(e) Define Dot and Cross products of vectors. Given **A** = 2 **a**x + 4 **a**y and **B** = 6**a**y – 6 **a**z, find the smaller angle between them using the cross and dot product.
(f) Transform the point P (2,1,6) in spherical coordinate system.
(g) Write the Maxwell's equations in integral and differential form.
(h) State and prove divergence theorem for a vector field.
(i) Explain reflection and transmission coefficient of a plane wave at normal incidence.
(j) Explain the Method of Images for electrostatics.

SECTION B

2. Attempt any three parts of the following questions: 3×10=30

(a) Given the potential $V = \frac{10}{r^2}\ sin\theta\ cos\emptyset$. Find the electric flux density D at $\left(2, \frac{\pi}{2}, 0\right)$.

(b) State and derive ampere circuital law. A single turns circle coil of 50 meters in diameter carries current 28×10^4 Amp. Determine the magnetic field intensity H at a point on the axis of coil and 100 meters from the coil. The relative permeability of free space surrounding the coil is unity.

(c) Explain Electric Dipole. Find the electric field intensity due to electric dipole. An electric field is given by **E** = 10 y **a**x + 10 x **a**y V/m. Find the potential function V. Assuming V = 0 at origin.

(d) Determine the magnetic flux density B at a distance d meter from an infinite straight wire carrying current I. Also find out when the length of the wire is semi-infinite.

(e) Three identical small spheres of mass m are suspended from a common point by threads of negligible masses and equal lengths l. A charge Q is divided equally among the spheres, and they come to equilibrium at the corners of a horizontal equilateral triangle whose sides are d. Show that

$$Q^2 = 12\,\pi\,\varepsilon_0\,mgd^3\,[\,l^2 - \frac{d^2}{3}]^{\frac{-1}{2}}.$$

Where g= acceleration due to gravity.

SECTION C

Attempt any one part of each of the following questions: 5×10=50

3. **(a)** State and prove divergence theorem. Determine the flux over the closed surface of cylinder $0 < z < 1, p = 4$ if $D = p^2 cos2(\varphi)\hat{a}_p + z \sin\varphi\, \hat{a}_\varphi$. Verify the divergence theorem for above mentioned case.
(b) Find the potential function and electric field intensity for the region between two concentric right circular cylinder where V=V_0 at r=a and V=0 at r=b (b>a)?

4. **(a)** Explain Skin effect. Derive the expression for α and β in a conducting medium.
(b) Define propagation constant and characteristic impedance. Derive the boundary conditions for electric field between two dielectrics having different permittivity interfaces.

5. **(a)** State Poynting theorem. Derive the mathematical expression for Poynting theorem.
(b) Point charges $Q_1 = 1nC, Q_2 = -2nC, Q_3 = 3nC\ and\ Q_4 = -4nC$ are positioned one at a time in that order at (0,0,0), (1,0,0), (0,0,-1) and (0,0,1) respectively. Calculate the energy in the system after each charge is positioned.

6. **(a)** A uniform plane wave propagating in good conductor. If the magnetic field intensity is given by $H = 0.1e^{-15}\cos(2\pi \times 10^8 l - 15z)\, i$ A/m, determine the conductivity and corresponding component of E field. Also calculate the average power loss in a block of unit area and thickness t.
(b) Define phase velocity, group velocity, propagation constant and phase-shift constant. For a lossy dielectric material having $\mu_r = 1,\ \varepsilon_r = 40,\ \sigma = 20$ S/m, calculate the attenuation constant, phase shift and intrinsic impedance at a frequency of 9 GHz.

7. **(a)** What do you mean by intrinsic impedance of a medium? Derive intrinsic impedance for plane waves in lossless dielectrics.
(b) A cable pair has the following primary coefficient at an angular velocity of 5000 rad/sec, R=30 ohm/km, G=1μv/km, L=1.1 mH/km and C=0.2 μp/km
Calculate (i) the characteristic impedance (ii) The attenuation coefficient (iii) the phase shift coefficient (iv) The attenuation is decibels over a length of 15 Km.