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B.TECH
PEI3I001

3rd Semester Regular Examination 2016-17
ELECTROMAGNETIC FIELD THEORY
BRANCH: AEIE,EIE,IEE
Time: 3 Hours
Max Marks: 100
Q.CODE: Y533

Answer Part-A which is compulsory and any four from Part-B.
The figures in the right hand margin indicate marks.

Part – A (Answer all the questions)

Q1 Answer the following questions: *multiple type or dash fill up type* **(2 x 10)**

a) $\hat{a}_x . \hat{a}_\theta = \cdots ?$ and $\hat{a}_x . \hat{a}_\rho = \cdots ?$

b) If a vector field $\vec{G}$ can be written in terms of gradient of a scalar field (h), then the vector field $\vec{G}$ is ……..in nature?

c) Let $\vec{S} = \rho^2 sin\varphi \hat{a}_\rho + 3\rho^2 z cos\varphi \hat{a}_\varphi + z^2 cos\varphi \hat{a}_z$ then $\nabla . \vec{S}$= ……?

d) The potential at point P located at distance r due to a dipole is ……..? And the potential at any point in the plane bisecting the dipole is ……?

e) Electric Field intensity $\vec{E} = 80cos(6.277 \times 10^8 t - 2.092y)\hat{a}_z$ V/m. So, the amplitude of displacement current density in air is ……..?

f) The curl of a vector field $\vec{F} = 2x\hat{a}_x + 3y\hat{a}_y + 4z\hat{a}_z$ is ……..?

g) Let relaxation time of a material X is very much less than material Y. So ……. is a good conductor (X or Y)?

h) Magnetic Reluctance ($\Re$) and magnetic flux (Φ) are related as ……..

i) When a plane wave propagates in a dielectric medium, the average electric energy density is……the average magnetic energy density. (greater than or equals with or smaller than) and the value of average electric energy density is ……..?

j) The depth of penetration of a wave in a lossy dielectric increases with increasing ……? (conductivity or wavelength or permittivity)

Q2 Answer the following questions: *Short answer type* **(2 x 10)**

a) Find the distance between two points given in spherical coordinates as $P(10, \pi/3, \pi/4,) and\ Q(5, \pi/6, \pi/5)$. What is the distance vector from P to Q.

b) Pictorially represent the three different differential elements of surfaces $(\overline{dS})$ in a spherical coordinate system. What is differential volume of a sphere?

c) What is dominant mode and evanescent mode?

d) The electric field intensity(E) in polystyrene ($\epsilon_r = 2.5$) filling the space of a capacitor is 10 KV/m. Determine flux density (D) and polarization(P)?

e) Let for a medium $\mu_r = 1.5;\ \epsilon_r = 2.0$. What is intrinsic impedance η of medium?

f) Write Integral and Differential form of Maxwell's equation derived from Faraday's law of induction?

g) Magnetic vector potential is given as $\vec{A} = (10^{-3} y cos\, 3 \times 10^8 t cosz)\hat{a}_z$ Wb/m. Determine magnetic field intensity $\vec{H}$ if $\mu_r = 1$?

h) Let a conducting loop is moving in a time varying magnetic field.What is the total emf ?

i) How can we differentiate between good dielectric and good conductor according to

the concept of loss tangent?

j) What is a uniform medium? How a medium could be non uniform?

Part – B (Answer any four questions)

Q3 a) Express the vector $\vec{H} = {}^{5}/_{r}\hat{a}_r + 3r\cos\theta\hat{a}_\theta + 2\hat{a}_\varphi$ in Cartesian system at (3,4,0). (10)

b) Define these vector identities (5)

(i) $\nabla.(\nabla \times \vec{H})$= …… (ii) $\nabla \times \nabla \times \vec{E}$= ……..;

(iii) V($\nabla.\vec{D}$)= …… (iv) $\nabla.(f\vec{G})$=……..…..(v) $\nabla\left(\frac{1}{R}\right) \times \vec{F}$ = ……

Q4 a) A charged ring of radius 2.5cm carries a uniform line charge distribution of $\rho_l = 5\ C/cm$.Determine the potential (V) and the electric field intensity ($\vec{E}$) at (0,0,0) and at (0,0,10)? What is the value of $\vec{D}$ at (0,0,10)? (10)

b) Prove that the energy stored in electrostatic system is W = $\frac{1}{2}\int_v \vec{D}.\vec{E}$, where $\vec{D}$ and $\vec{E}$ are electric flux density and electric field respectively. (5)

Q5 a) A rectangular wave guide with dimensions a = 2.55cm, b= 1.1cm is to operate below 15GHz.Howmany TE and TM modes can the waveguide transmit if the guide is filled with a medium with μ_r =1 and ε_r =3.8, σ =0. Calculate cutoff frequencies of the modes. (10)

b) A 200 m long transmission line has a total inductance and capacitance of 37.75μH and 20nF, respectively. Determine (i) velocity of propagation (ii) the phase constant (iii) the characteristic impedance of the transmission line? Operating frequency is 200 KHz. (5)

Q6 a) Derive Maxwell's equation constituted from Ampere's current law. Which inconsistencies led Maxwell to add displacement current to validate Ampere's law for time varying case? (10)

b) What is plane wave? Write short note on TEM, TE and TM wave? (5)

Q7 a) Define Poynting's theorem? Explain the significance of each term present in the integral form of Poynting's equation. What is the angle between Poynting vector and magnetic field intensity? (10)

b) In a nonmagnetic medium $\vec{E} = 8\sin(2\pi \times 10^6 t - 0.75x)\hat{a}_z$ V/m. Find (i) ϵ_r and η (ii) time average power carried by the wave ? (5)

Q8 a) Derive time dependent wave equation for lossless medium with proper assumptions and conditions. What is the name of this equation? Write these equations in frequency domain. (10)

b) Differentiate between forward travelling wave and backward travelling wave? Draw both the waves for a conducting medium at time t = constant. (5)

Q9 a) The electric field intensity of a uniform plane wave in a medium characterized by $\mu_r = 1;\ \epsilon_r = 2.0$ is given by $\vec{E} = 64.35\cos(\omega t - 6z)\hat{a}_x$ V/m. Determine (i) velocity of propagation (ii) wave frequency (iii) phase constant(iv) magnetic field intensity and (v) average power density in the medium. (10)

b) Calculate the skin depth of aluminum at 60 KHz and 60MHz. Assume that $\sigma = 3.5 \times 10^7$S/m, $\mu_r = 1;\ \epsilon_r = 1$. Also determine surface resistance of aluminum at each frequency? (5)