Question Paper

Exam Date & Time: 18-Nov-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
END SEMESTER THEORY EXAMINATIONS NOVEMBER2019
III SEMESTER B.sc. (Applied Sciences) in Engg.
ELECTROMAGNETIC THEORY [IEC 233]

Marks: 100 **Duration: 180 mins.**

Answer 5 out of 8 questions.
Missing data, if any, may be suitably assumed.

1) A) A plane electromagnetic wave is propagating in z-direction in a dielectric medium of relative permittivity, $\varepsilon_r = 5$. The electric field is in x-direction and has an rms value of 0.1 V/m. What is the direction and magnitude of the magnetic field? Calculate the frequency of the wave, if wavelength is $\lambda = 5m$. (7)

B) Derive an expression for self and mutual inductance of a Toroid. (7)

C) A charge Q_A =-20μC is located at A (-6, 4, 7) and another charge Q_B=50μC is located at B (5, 8,-2) in free space. Determine (6)

(i) $\overline{R}_{AB}$

(ii) $|R_{AB}|$

Determine the force exerted on Q_A by Q_B if $\varepsilon_0 = 8.854X10^{-12} F/m$

2) A) The electric potential at 20 cm from a point charge is 9kV. What is the value of the charge? Find the radius of the equipotential surface at which the potential is (i) 18kV (ii) 3kV (7)

B) A steel pipe is constructed of a material for which $\mu_r = 180$ & $\sigma = 4x10^6 S/m$. The inner and outer radii are 6 & 8 m respectively and length is 80m. If the total current carried by the pipe is $2\cos 10^4 \pi t$ A. Determine (i) Skin depth (ii) effective resistance (iii) The DC resistance. (7)

C) Define and explain (i) SWR (ii) Intrinsic Impedance (iii) Displacement Current (6)

3) A) Consider two points A (-3, 2, 1) and B ($5,20^0,-70^0$) find (i) the spherical coordinates of A (ii) the rectangular coordinates of B(iii) the distance between A and B (7)

B) Write notes on (i) Phase Velocity (ii) Wave polarization (iii) Reflection coefficient (7)

C) Derive an expression for Electric Field for an infinite sheet charge placed in XY Plane using Gauss Law. (6)

4) (7)

Given the following values for P_1, P_2 and $I_1\Delta_1$ respectively, calculate ΔH_2

A)

(i) $P_1(0, 0, 2), P_2(4, 2, 0), 2\pi\overline{a_z}\ \mu Am$

(ii) $P_1(0, 2, 0), P_2(4, 2,0), 2\pi\overline{a_z}\ \mu Am$

B) Determine the capacitance of a cone by using Laplace's equation. (7)

C) (6)

if $\chi_m = 3.1$ for a material within which $\overline{B} = 0.4y\overline{a_y}$ T find (i) $\overline{H}$ (ii) μ (iii) μ_r (iv) $\overline{M}$ (v) $\overline{J}$ (vi) $\overline{J_b}$

5) Derive the boundary relations for Dielectric-Dielectric &Dielectric - conductor interfaces for static electric field. (7)

A)

B) (7)

A 10 V/m, 0.1 GHz uniform plane wave is propagating in free space and is incident normal to the surface of a material having $\varepsilon = 9\varepsilon_0$ & $\mu = 4\mu_0$. Write the complete time-domain expressions for the incident, reflected and transmitted electric and magnetic fields.

C) (6)

If $\mu_r = 24, \varepsilon_r = 13.55$ and $\overline{H} = 2\cos(10^{10}t - \beta x)\overline{a_z}$ A/m, using Maxwell's equation, find $\overline{B}$, $\overline{D}$, $\overline{E}$ and β.

6) (7)

A) Find the equation of streamline that passes through the point P(-2,7,10) in the field $\overline{E} = 2(y-1)\overline{a_x} + 2x\overline{a_y}$

B) Determine the expression of an electric field at the point P (0, 0, z) due to the sheet of charge placed in Z=0 plane. (7)

C) Determine the magnetic field intensity and magnetic flux density produced at any point P in air at a distance R from an infinite linear conductor carrying current 'I'. (6)

7) Derive an expression for energy stored in an electrostatic. Write an expression for stored energy due to a uniform line charge distribution. (7)

A)

B) (7)

Determine the magnetic field intensity inside a magnetic material, for the following conditions (i) M=100 A/m & $\mu = 1.5x10^{-5} H/m$ (ii) B=200 μT, $\xi_m = 15$ (iii) There are $8x10^{28}$ atoms/m^3, each atom has a dipole moment of $2.5x10^{-27}$ A -m^2 and $\mu_r = 30$

C) What is Brewster angle? Starting with plane wave incidence at dielectric interfaces, derive an expression for the Brewster angle. (6)

8) Given charge density 5r C/m^3 (spherical coordinates), determine the electric flux density in all regions . For this electric flux density, evaluate both sides of the divergence theorem for the volume enclosed between r=1 and r=2. (7)

A)

B) Derive all Maxwell's equations from the fundamentals and express them in time varying fields. (7)

C) Explain the Biot-Savart law and the Ampere's law. With the help of these, derive an (6)

c) Explain the Biot-Savart law and the Ampere's law. With the help of these, derive an expression for the magnetic field due to an infinite sheet of uniform current density. (6)

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