Code : 031506

B.Tech 5th Semester Exam., 2014

ELECTROMAGNETIC FIELD THEORY

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Fill in the blanks (any *seven*) : 2×7=14

(a) The curl of a gradient of a scalar quantity is ——.

(b) Energy density in the magnetic field is ——.

(c) Normal component of electric flux density is ——, across the interface between two dielectric media.

(d) The relation of depth of penetration in good conductor is given by ——.

(e) The direction of magnetic vector potential is same as the direction of ——.

(f) VSWR for a matched termination is ——.

(g) If the standing wave of voltage slopes down towards the termination, then the terminating reactance will be ——.

(h) Quarter wave section is an ——.

(i) Uniform plane waves are —— waves.

(j) Two conductors carrying current in opposite direction experience —— force.

2. *(a)* Derive an expression for potential due to a long pair of parallel wires.

(b) Deduce the equation for equipotential surfaces for parallel line charges.

(c) Find the capacitance of parallel cylindrical conductors having equal radii a and separation between their axes as b. 14

3. *(a)* Find the conductor properties and boundary conditions.

(b) A point charge q is located at a distance h above an infinite conducting plane. Using the method of images, find the displacement density normal to the plane and hence surface charge density. Also obtain total charge on the infinite conducting plane. 6+8=14

(Continued)

4. (a) Obtain curl of a vector and interpret it.

(b) Prove Stokes' theorem.

(c) Discuss ampere force law. 7+4+3=14

5. (a) Obtain two Maxwell's equations which deviate from steady-state condition.

(b) Using $\nabla \cdot \vec{D} = \rho$, Ohm's law and the equation of continuity, show that if at any instant a charge density ρ existed within a conductor, it would decrease to $\frac{1}{e}$ times this value in time $\frac{\varepsilon}{\sigma}$ seconds. 9+5=14

6. (a) Discuss the propagation in a conducting medium and hence obtain the expression for attenuation constant α and phase-shift constant β.

(b) Find the values of α and β for good conductor and good dielectric. 7+7=14

7. (a) Find out the reflection coefficient for perfect conductor in the case of normal incidence.

(b) The electric field of a uniform plane electromagnetic wave in free space is 1 volt/metre and frequency is 300 MHz.

If a very large thick flat copper plate is placed normal to the direction of wave propagation, determine—

(i) $\vec{E}$ and $\vec{H}$ at the surface of plate;

(ii) depth of penetration;

(iii) conduction current density at the surface;

(iv) conduction current density at a distance of 0·01 mm below the surface;

(v) linear current density, J_s;

(vi) surface impedance;

(vii) power loss per square metre of surface area.

[Take : $\sigma_{cu} = 5 \cdot 8 \times 10^7$ v/m.] 6+8=14

8. (a) Discuss instantaneous, average and complex Poynting vectors.

(b) Obtain power loss in a plane conductor.

(c) A short vertical transmitting antenna erected on the surface of a perfectly conducting earth produces an effective field strength, $E_{eff} = 100 \sin\theta$ mV/m at points a distance one mile from the antenna. Compute Poynting vector and total power radiated. 5+4+5=14

(Continued)

9. *(a)* Discuss UHF line as circuit element and obtain input-input resistance of the line for resonant length.

(b) Discuss quarter wave line as a transformer.

(c) A lossless transmission line has a characteristic impedance of 300 Ω and is one-quarter wavelength long. What will be the voltage at the open-circuited receiving end, if sending end is connected to a generator which has a 50-Ω internal impedance and generated voltage of 10 volts? 5+5+4=14

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