Code : 031506

B.Tech 5th Semester Exam., 2013

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) Divergence of a curl of a vector is ——.

(b) Energy density in the electrostatic field is ——

(c) The value of relative permeability is slightly less than one for —— and slightly greater than one for ——.

(d) Tangential component of electric field is —— across the interface between two dielectric media.

(e) Surface impedance of good conductor is just equal to ——

(f) For uniform plane wave E field and H field has —— in the direction of propagation.

(g) VSWR varies from —— to ——.

(h) Short circuited quarter wave section and open end half-wave section is analogous to ——.

(i) If the standing wave of voltage slope is up towards the termination, then the reactance will be ——.

(j) The quality factor of a resonant section of transmission line is equal to the ratio of —— per unit length to —— per unit length.

2. *(a)* For a two-dimensional system $r = \sqrt{x^2 + y^2}$, determine $\nabla^2 V$, when $V = \ln \frac{1}{r}$.

(b) Find out the divergence of vector and interpret it by giving physical examples.

(c) State and prove divergence theorem. 4+8+2=14

3. *(a)* State and prove uniqueness theorem.

(b) Find the capacitance of two spheres, whose separation d is very much larger than their radii R. Hence show that the capacitance of sphere above an infinite ground plane is independent of the height h above the plane when $h >> R$. 4+(5+5)

4. (a) Describe magnetic vector potential.

(b) Explain Ampere force law.

(c) Find the magnetic field inside a solid conductor carrying a direct current I and hence obtain total magnetic flux per unit length within the conductor. 5+3+6

5. (a) Obtain continuity equation for time-varying field.

(b) Explain in consistency of Ampere circuital law.

(c) The electric vector $\vec{E}$ of a electromagnetic wave in free space is given by the expression

$$E_y = A\cos\omega\left(t - \frac{z}{c}\right)$$

Using Maxwell's equation for free space condition, determine magnetic vector $\vec{H}$. 5+5+4

5. (a) Find the component of $\vec{E}$ and $\vec{H}$ in the direction of the propagation for uniform plane wave.

(b) Establish the relation between $\vec{E}$ and $\vec{H}$ in a uniform plane wave.

(c) Show that the function

$$F = e^{-\alpha z}\sin\frac{\omega}{v}(x - vt)$$

satisfies the wave equation

$$\nabla^2 F = \frac{1}{c^2}\frac{\partial^2 F}{\partial t^2}$$

provided that the wave velocity is given by

$$v = c\left(1 + \frac{\alpha^2 c^2}{\omega^2}\right)^{-\frac{1}{2}}$$ 4+6+

7. (a) Find the reflection coefficient by perfect dielectric for parallel polarization and hence obtain Brewster angle.

(b) Discuss surface impedance. 11+

8. (a) State and prove Poynting theorem.

(b) Discuss Smith chart. (4+6)+

9. (a) Find the quality factor of a resonant transmission line section.

(b) Find the voltage step up in quarter wave line. 9+

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