

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) : $2 \times 7 = 14$

- (a) Divergence of a curl of a vector is —.
- (b) Energy density in the electrostatic field is $\frac{1}{2} \epsilon_0 E^2$
- (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. $E_1 \sin \theta_1 = E_2 \sin \theta_2$
- (e) Surface impedance of good conductor is just equal to $\sqrt{\frac{\omega \mu_0}{2\sigma}}$
- (f) For uniform plane wave E field and H field has \perp 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 $h \gg R$.

 $4+(5+5)$

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

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

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+
