

II B.Tech I Semester Supplementary Examinations, May 2005
ELECTROMAGNETIC THEORY
 (Common to Electronics & Instrumentation Engineering and Electronics & Control Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
 All Questions carry equal marks

1. (a) State and explain Coulomb's law of electrostatic field in vector form.
 (b) It is required to hold four equal point charges to each in equilibrium at the corners of a square. Find the point charge, which will do this if placed at the center of the square.
2. Obtain an expression for the capacitance of a co-axial cylinder of diameters d_1 and d_2 and length l . In a concentric cable condenser, the diameter of the inner and outer cylinders are 3mm and 10mm, respectively. If relative permittivity of the insulator is 3, find its capacity per meter.
3. (a) State and explain Biot-Savart law and relate it to Amperes law. Show that the divergence magnetic induction is always zero.
 (b) If $\mathbf{H} = x^2 \mathbf{a}_x + 0.1x \mathbf{a}_z$ A/m, find the current density.
4. (a) A circular loop of 10cm radius is located in free space adjacent to a straight conductor which carries a sinusoidal current of 0.5 A at 5 KHz. the straight conductor is in the plane of the circular loop. If a small gap is introduced into the loop, determine the induced voltage across the gap and its proper polarity. The centre of the loop is 15cm away from the conductor.
 (b) A medium characterized by $\sigma = 0$, $\mu = 2\mu_0$, $\varepsilon = 5\varepsilon_0$. If $\mathbf{H} = 2\cos(\omega t - 3y) \mathbf{a}_z$ A/m, calculate ω and \mathbf{E} using Maxwell's equations.
5. (a) Starting from the Maxwell's curl equations, derive the wave equation in Magnetic field for free space.
 (b) A plane wave with frequency $f = 16$ GHz travels in a distilled water with $\mu_r = 1$, $\varepsilon_r = 50$, $\sigma = 20$ mhos/m. Calculate the propagation constant, attenuation, phase factor and intrinsic impedance.
6. (a) Distilled water has constants $\mu_r = 1$, $\varepsilon_r = 81$, power factor = 0.05 at 1 GHz, Calculate
 - i. The $1/e$ depth penetration and
 - ii. The 1 percent depth of penetration at this frequency.
- (b) A plane wave is travelling wave has a peak electric field $E_0 = 5$ V/m. if the medium is loss less $\mu_r = 1$, $\varepsilon_r = 3.5$, find the phase velocity, impedance of the medium, wavelength and peak value of \mathbf{H} field.

7. (a) A plane wave is normally incident from air to the surface of dielectric medium. Show that a partial standing wave is formed in air.
- (b) Reflection of an incident plane wave from the surface of a certain dielectric material of effectively infinite depth is seen produce a standing wave ratio of 2 in air. The face of the dielectric is an electric field minimum. Find the dielectric constant of the material.
8. (a) A uniform plane wave is normally incident from air on to a perfect dielectric with $\epsilon_r = 3$. If $\epsilon_i = 10 \cos(\omega t - z) \mathbf{a}_y$ y(S)m is the incident field, find the time average power in both regions.
- (b) In free space, $\mathbf{H} = 0.2 \cos(\omega t - \beta z) \mathbf{a}_z$ A/m. Find the total power passing through: a circular disc of radius 5 cm on plane $x = 1$
