Faculty of Engineering & Technology
Fourth Semester B.E. (Electronics Engineering) ET/EC
(C.B.S.) Examination
ELECTROMAGNETIC FIELD

Time—Three Hours] [Maximum Marks—80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.
(2) Assume suitable data wherever necessary.
(3) Illustrate your answers wherever necessary with the help of neat sketches.

1. (a) Express in cylindrical component :
(i) The vector from C(3, 2, –7) to D(–1, –4, 2).
(ii) A unit vector at D directed towards C.
(iii) A unit vector at D directed towards the origin. 9

(b) State and explain Gauss' Law. 5

OR

2. (a) An infinite uniform line charge $\rho_L = 2nC/m$, lies along x axis in free space, while point charges of 8 nC/m are located at (0, 0, 1) and (0, 0, –1) :
(i) Find $\bar{E}$ at (2, 3, –4)
(ii) To what value should ρ_c be charged to cause $\bar{E}$ to be zero at (0, 0, 3). 7

(b) Find the numerical value for the divergence of $\vec{D}$ at the point :

(i) $P_A(0.3, 0.4, 0.5)$ if :

$$\vec{D} = 20xy^2(z+1)\vec{a}_x + 20x^2y(z+1)\vec{a}_y + 10x^2y^2\vec{a}_z \, c/m^2$$

(ii) $P_B\left(1, \frac{\pi}{2}, 2\right)$ if :

$$\vec{D} = 4\rho z \sin\phi \vec{a}_\rho + 2\rho z \cos\phi \vec{a}_\phi + 2\rho^2 \sin\phi \vec{a}_z.$$

7

3. (a) State and explain Biot Savart's Law. 6

(b) Given points A(1, 2, 4), B(–2, –1, 3) and C(3, 1, –2), let differential current element with I = 6 Amp. and $|d\bar{L}| = 10^{-4}$ m be located at A. The direction of $d\bar{L}$ is from A to B. Find $d\bar{H}$ at C. 7

OR

4. (a) Let $\bar{H} = -y(x^2 + y^2)\bar{a}_x + x(x^2 + y^2)\bar{a}_y$ A/m in $z = 0$ plane for plane for $-5 \le x \le 5$ m and $-5 \le y \le 5$ m. Find the total current passing through the $z = 0$ plane in the $\bar{a}z$ direction inside the rectangle $-1 < x < 1$ and $-2 < y < 2$. 7

(b) What is Ampere Circuit Law ? Also explain Stoke's theorem. 6

5. Obtain Maxwell's equation in point form and in their integral form for time varying fields. 13

OR

6. (a) Assume a homogeneous material of infinite extent with $\sigma = 0$, $\epsilon = 2 \times 10^{-10}$ F/m and $\mu = 1.25 \times 10^{-5}$ H/m. Let $\bar{E} = 400\cos(10^9 t - kz)\, a_{\bar{x}}$ V/m. Use Maxwell's equation to find $\bar{D}, \bar{B}, \bar{H}$ and K. 8

(b) State and prove continuity equation for time varying fields. 5

7. (a) State and prove Poynting Vector. 7

(b) The electric field intensity associated with a plane e.m.f. wave travelling in perfect dielectric medium is given by :

$E_x(z, t) = 10 \cos (3\pi \times 10^8 t - 2\pi z)$ V/m

Calculate value of :

(i) Frequency

(ii) Wavelength

(iii) Velocity of propagation

(iv) Magnetic field intensity $\bar{H}$ if $\mu = \mu_0$ 6

OR

8. (a) A plane electromagnetic wave is incident obliquely on boundary between perfect dielectrics. Find a relation between reflection and transmission coefficients. 7

(b) A plane wave of 200 MHz, travelling in free space, impinges normally on a large block of material having $E_P = 9$, $M_P = 9$, $\sigma = 0$. Determine η_1, η_2, β_1, β_2, R and T. 6

9. (a) Define the following characteristics associated with waveguide :

(i) Cutoff frequency

(ii) Cutoff wavelength

(iii) Phase velocity. 6

(b) Find the wave impedance for the dominant mode in air filled rectangular guide of dimensions 7 cm × 4 cm operating at frequency of 4 GHz. 4

(c) Why TEM waves cannot be propagated in rectangular waveguides ? 4

OR

10. (a) Derive the expression for group velocity and phase velocity in rectangular waveguide. 8

(b) A hollow rectangular waveguide has inner dimensions of 7 cms × 4 cms. Find cutoff frequencies in TE_{01}, TE_{10} and TM_{11} modes. Why is TE_{10} mode usually preferred. 6

11. (a) Explain the term 'Retarded Potential'. 4

(b) Show that the radiation resistance of current element is given by :

$$R_{rad} = 80\pi^2\left(\frac{dl}{\lambda}\right)^2 \text{ ohms.}$$ 9

OR

12. (a) A monopole antenna of height 10 cms operate at a frequency of 300 MHz and is situated above ground. Find its radiation resistance. 6

(b) Define the following :

(i) Radiation Intensity

(ii) Directive Gain

(iii) Power gain

(iv) Front to back ratio. 7