B.E. / B.Tech. Electrical (Electronics & Power) Engineering (Model Curriculum) Semester-III

005 / SE105 - Electromagnetic Fields

P. Pages : 3 **GUG/W/24/13851**

Time : Three Hours * 5 4 8 9 * Max. Marks : 80

Notes :
1. All questions carry equal marks..
2. Answer **any five** questions as per internal given choice.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.
5. Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.
6. Use of non programmable calculator is permitted.

1. a) Given **8**

$A = 5\,a_x + 3a_y + 4a_z$ and

$B = 3a_x + 4a_y - 6a_z$

Find

1) The scalar component of A indirection of B
2) The vector component of A in direction B
3) Find $\frac{(6A - 7B)}{|2A|}$
4) Find A.B

b) Given two points find **8**

A(2, 1, 6) and B(6, 4, 5)

Find

i) R_{AB} ii) $|r_A|$

iii) Autovector directed from point B to A

iv) Find $|5A - 3B|$

OR

2. a) Transform each of the following into cylindrical co-ordinates at the points indicated. **8**

i) $5a_x$ at $(4, 120^o, 2)$ ii) $4a_x - 2a_y + 4a_z$ at $(2, 3, 5)$

iii) $3a_x + 4a_y$ at $(2, 4, 9)$

b) Two uniform vector field are given by **8**

$E = -5a_\rho + 10a_\phi + 3a_z$

$F = a_\rho + 2a_\phi - 6a_z$

i) $|E \times F|$

ii) The vector component of E at $P(5, \pi/2, 3)$ parallel to the line x = 2, z = 3

iii) The angle E makes with the surface z = 3 at P.

3. a) A charge of -1nC is located at the origin in free space. What charge must be located at (2, 0,0) to cause E_x to be zero at (3, 1, 1)? **8**

b) Eight 25nC point charges are located symmetrically on a circle of radius 0.2 m centered at Z = 0 plane. **8**

i) At what point on Z axis $|E|$ is maximum

ii) What is $|E|_{Max.}$?

OR

4. a) Point charges 1 mC and -2mC are located at (3, 2, -1) and (-1, -1, 4), respectively. Calculate the electric force on a 10 nC charge located at (0, 3, 1) and the electric field intensity at the point. **8**

b) State and derive expression for Coulomb's law. **8**

5. a) Derive the expression for electric potential and electric field intensity for electric dipole. **8**

b) An electric field is expressed in Cartesian coordinates by **8**

$E = 6x^2\ a_x + 6y\ a_y + 4a_z\ V/m$. Find

i) V_{MN} if points M and N are specified by
M (2, 6, -1)1 and N(-3, -3, 2)

ii) V_M if V = 0 at P(4, -2, -35)

iii) V_N if V = 2 V at P(1, 2, -4)

OR

6. a) Prove the uniqueness theorem for Laplace equations. **8**

b) Given the potential field in cylindricalco-ordinates. **8**

$V = \left(100/Z^2 - 1\right)\rho\cos\phi$ volts and point p at $\rho = 3m$.

$\phi = 60^o$ and $z = 2m$.

Find values at point p for

i) V
ii) E
iii) dv/dN
iv) a_N

7. a) Derive continuity equations for time varying field. **8**

b) The current density in a certain region is expressed as **8**

$J = 10\rho^2 z\ a_\rho - 4\rho\cos^2\phi a_\phi A/M^2$

Find

i) Current density at
$\rho = 3, \phi = 30^o$ and $z = 2$

ii) Determine total current flowing outward through the circular band
$\rho = 3,\ 0 \le \phi \le 2\pi, 2 < z < 2.8$

OR

8. a) Let $J = 400\sin\phi/\left(r^2+4\right) a_r A/m^2$. (a) Find the total current flowing through that portion of the spherical surface r = 0.8. bounded by $0.1\pi < \theta < 0.3\pi,\ 0 < \phi < 2\pi$. (b) Find the average value of J over the defined area. **8**

b) A point charge for which $Q = 2\times10^{-16}C$ and $m = 5\times10^{-26}$ kg is moving in the combined fields $E = 100a_x - 200a_y + 300a_z V/m$ and $B = -3a_x + 2a_y - a_z mT$. If the charge velocity at $t = 0$ is $v(0) = \left(2a_x - 3a_y - 4a_z\right)10^5 m/s$ (a) give the unit vector showing the direction in which the charge is accelerating at t = 0; (b) find the kinetic energy of the charger at t = 0. **8**

9. a) Write Maxwell's equation in differential and integral form for time varying field. **8**

b) Select the value of K such that each of the following pairs of fields satisfies Maxwell's equations. **8**

$E = (Kx - 100t)a_y V/m$

i) $H = (x + 20t\ a_z) A/m$
$\mu = 0.25H/m, \varepsilon = 0.01F/m$

ii) $D = 5x\ a_x - 2y\ a_y + kza_z\ \mu C/m^2$

OR

10. a) Write short notes on **any two**. **8**

i) Stokes theorem. ii) Biot Savart Law.

iii) Amperes Circuital Law.

b) A plane wave of 9375 MHz travelling in free space has an amplitude of 20 V/m **8**
Find i) Velocity of propagation.
ii) Wavelength
iii) Intrinsic impedance of medium
iv) Phase shift constant B

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