B.E. Fourth Semester (Electrical Engineering (Electronics & Power)) (C.B.S.)

# Elements of Electromagnetics Paper – II

P. Pages : 3 **KNT/KW/16/7279**

Time : Three Hours Max. Marks : 80

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Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.

**1.** a) Given points A (2, 5, -1), B (3, -2, 4) and C (-2, 3, 1) find : **8**

i) $\overline{R_{AB}} \cdot \overline{R_{AC}}$

ii) Angle between $\overline{R_{AB}}$ and $\overline{R_{AC}}$.

iii) The length of projection of $\overline{R_{AB}}$ on $\overline{R_{AC}}$

iv) The vector projection of $\overline{R_{AB}}$ on $\overline{R_{AC}}$.

b) The vector $\overline{R_{AB}}$ extends from A (1, 2, 3) to B. The length of vector is 10 unit and direction is given by $\hat{a} = 0.6a\hat{x} + 0.64a\hat{y} + 0.48a\hat{z}$. Find the coordinates of point B. **6**

**OR**

**2.** a) Two vectors are given by **6**

$\overline{A} = -4a\hat{x} + 2a\hat{y} + 3a\hat{z}$ and

$\overline{B} = 3a\hat{x} + 4a\hat{y} - a\hat{z}$ Find :

i) Vector component of $\overline{A}$ that is parallel to $\overline{B}$.

ii) A unit vector perpendicular to the plane in which vectors $\overline{A}$ and $\overline{B}$ lies.

b) Given the points $P(\rho = 5, \phi = 60^o, z = 2)$ and $Q(\rho = 2, \phi = 110^o, z = -1)$ **8**

Find :

i) Distance $|\overline{F}_{PQ}|$

ii) Give the unit vector in Cartesian coordinate at P that is directed towards Q.

iii) A unit vector in cylindrical coordinates at P that is directed towards Q.

**3.** a) In a free space, point charge $Q_1 = 10\,nC$ is located at A (0, -4, 0) and $Q_2 = 20\,nC$ is at B (0, 0, 4). Where should a 30nC point charge be located so that $\vec{E}$ is zero at the origin? **6**

b) State and explain Coulomb's Law. Derive an expression for electric field intensity for an infinite length uniform line charge having density $\rho_L \ {}^{C}/_{m}$. **7**

**OR**

**4.** a) Three uniform sheets of charge are located in free space as follows : **6**

$2 \ {}^{\mu c}/_{m^2}$ at $x = -3$;

$-5 \ {}^{\mu c}/_{m^2}$ at $x = 1$;

$4 \ {}^{\mu c}/_{m^2}$ at $x = 5$;

Find $\vec{E}$ at the points.

a) (0, 0, 0)
b) (2.5, -1.6, 4.7)
c) (8, -2, 5)

b) Eight 25nC point charges are located symmetrically on a circle of radius 0.2m centered at origin in Z = 0 plane. **7**

i) At what point on Z – axis is $|\overline{E}|$ maximum?

ii) What is value of $|\overline{E}|_{max}$ ?

**5.** a) State divergence theorem. Give physical significance of divergence. **4**

b) **9**

Given $D = \frac{5r^2}{4} a\hat{r} \ {}^{C}/_{m^2}$ in spherical coordinates. Evaluate both sides of divergence theorem for the volume of the sphere enclosed by r = 4m.

**OR**

**6.** a) **6**

If $\overline{E} = \frac{-10}{x^2} a\hat{x} + \frac{10}{x} a\hat{y} + 5 a\hat{z}, \ {}^{V}/_{m}$

Calculate :

i) $V_{PQ}$ given P (-10, 4, 2) and Q (5, 1, 1)

ii) $V_P$ if V = 0 at Q.

b) If $V = 60 \sin\theta$ volts, in free space and point P is located at $r = 3, \ \theta = 60^o, \ \phi = 25^o$, **7**

Find :

i) $V_P$ ii) $\overline{E}_P$

iii) $\frac{dV}{dN}$ at P iv) $\hat{a}_N$ at P

v) $\rho_V$ at P

**7.** a) Derive Laplace's equation. Express Laplace's equation for Cartesian, cylindrical and spherical coordinates. **7**

b) State and prove Uniqueness theorem. **7**

**OR**

**8.** a) Derive the boundary conditions for the boundary between two dielectric materials. **7**

b) Derive the expression for capacitance of a parallel plate capacitor with two dielectric medium. **7**

**9.** a) State and explain : **6**
i) Biot – Savart's Law
ii) Stoke's theorem.

b) Find the vector magnetic field intensity in Cartesian coordinate at P (1, -5, 3) due to a current filament of 24A in $a\hat{z}$ direction on the z-axis. **7**
extending from :
i) z = 0 to z = 6
ii) z = 6 to z = 0

**OR**

**10.** a) State and explain Ampere – circuital law. **6**

b) Evaluate both sides of Stoke's theorem for the field $\overline{H} = 6xy\,a\hat{x} - 3y^2 a\hat{y}$, $^{A}/_{m}$ and the rectangular path around the region $0 \le x \le 05,\ -1 \le y \le 1,\ z = 0$. Let the positive direction of $d\overline{s}$ be $a\hat{z}$. **7**

**11.** a) State Maxwell's equation in point form for time varying fields. **6**

b) A 150 MHz uniform plane wave in free space is travelling in the $a\hat{x}$ direction. The electric field intensity has a maximum amplitude of $200\,a\hat{y} + 400\,a\hat{z}$ V/m at P (10, 30, -40) at time t = 0. Find **7**
i) $\omega$ ii) $\beta$
iii) $\lambda$ iv) $\nu$
v) $\eta$ vi) $\overline{E}(x, y, z, t)$
vii) $\overline{H}(x, y, z, t)$

**OR**

**12.** a) State and derive Poynting vector equations. **7**

b) Explain the terms : **6**
i) Attenuation Constant.
ii) Phase Constant.
iii) Skin depth.

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