RAJ KUMAR GOEL INSTITUTE OF TECHNOLOGY & MANAGEMENT, GZB

1st Sessional Examination 2017-18 (Odd Semester)

Roll No.: **Subject Name: FEMT**

Year/Branch: **III / Electrical & Electronics** **Subject Code: NEC508**

Max Time: 1Hours 30 Minute **Max Marks: 50**

SECTION-A

Q.1 Attempt all parts carry equal marks. Write answer of each part in short. (2x5=10)

(a) Given $\boldsymbol{A} = 2\hat{a}_x + \hat{a}_z$, $\mathbf{B} = 3\hat{a}_x + \hat{a}_y$ and $\mathbf{C} = -2\hat{a}_x + 6\hat{a}_y + 4\hat{a}_z$, show that **C** is perpendicular to both **A** and $\boldsymbol{B}$.

(b) If $\boldsymbol{r} = x\hat{a}_x + y\hat{a}_y + z\hat{a}_z$, then show that the $\nabla r = \boldsymbol{r}/r$, where $r = |\boldsymbol{r}|$.

(c) Given $W = x^2y^2 + xyz$, compute the directional derivative in the direction $3\hat{a}_x + 4\hat{a}_y + 12\hat{a}_z$ at (2, -1, 0).

(d) An electric field on a plane is described by its potential $V = 20(r^{-1} + r^{-2})$ where r is the distance from the source. This field is due to:

(i) a monopole (ii) a dipole (iii) both a monopole and a dipole (iv) a quadrupole

(e) Define the relaxation time. Calculate the value of relaxation time for Copper.

SECTION-B

Note: Attempt any five questions from this section. (5x5=25)

Q.2 Find the distance between $(5, 3\pi/2, 0)$ & $(5, \pi/2, 10)$ in cylindrical coordinates.

Q.3 (a) For a vector field **A**, show explicitly that the divergence of the curl of any vector field is zero.

(b) Prove that vector field $\bar{P} = yz\hat{a}_x + xz\hat{a}_y + xy\hat{a}_z$ is solenoidal.

Q.4 Find the angle at which line x = y =2z intersects the ellipsoid $x^2 + y^2 + 2z^2 = 10$.

Q.5 Point charges 1 mC and -2 mC 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 that point.

Q.6 Given that $\boldsymbol{D} = z\rho cos^2\varphi\ \hat{a}_z$ C/m^2, calculate the charge density at (1, π/4, 3) and the total charge enclosed by the cylinder of radius 1m with $-2 \le z \le 2$m.

Q.7 Derive the relationship between **E** and V.

Q.8 Derive continuity current equation.

Q.9 A lead $(\sigma = 5 \times 10^6 S/m)$ bar of square cross section (side = 3 cm) has a hole (d = 1 cm) bored along its length of 4 m. Find the resistance between the square ends.

SECTION-C

Note: Attempt any two questions from this section. (7.5x2=15)

Q.10 The finite sheet $0 \le x \le 1$, $0 \le y \le 1$ on the z = 0 plane has a charge density $\rho_s = xy(x^2 + y^2 + 25)^{3/2}$ nC/m^2. Find: **(a)** The total charge on the sheet

(b) The electric field at (0, 0, 5)

(c) The force experienced by a -1 mC charge located at (0, 0, 5).

Q.11 Analyze the dielectric-dielectric boundary condition and also narrate the law of refraction.

Q.12 (a) Two dipoles with dipole moment $-5\hat{a}_z nC/m$ and $9\hat{a}_z nC/m$ are located at points (0, 0, -2) and (0, 0, 3) respectively. Find the potential at the origin.

(b) If $\vec{J} = \frac{1}{r^3}(2\cos\theta\ \hat{a}_r + \sin\theta\hat{a}_\theta)\ A/m^2$, calculate the current passing through **(i)** a hemispherical shell of radius 20 cm, $0 < \theta < \frac{\pi}{2}, 0 < \varphi < 2\pi$; **(ii)** a spherical shell of radius 10 cm.