Roll No.:.....

National Institute of Technology, Delhi

Name of the Examination: B. Tech. / M. Tech. / Ph.D.

Branch	**: B.Tech (ECE)**	**Semester**	**: III**
Title of the Course	**: ELECTROMAGNETIC THEORY**	**Course Code**	**: ECL 203**

Time: 3 Hours **Maximum Marks: 50**

Section A (10 x 1 = 10 marks)

All questions are compulsory.

A.1 What is spherical co-ordinate system?

A.2 Transform the Cartesian point (1,2,3) in spherical co-ordinate.

A.3 Find displacement current density if $\mathbf{E} = 250 \sin 10^{10} t$ V/m.

A.4 Find the curl of $\mathbf{A} = 2xy\hat{a}_x + x^2 z\,\hat{a}_y + z^3\hat{a}_z$

A.5 Find the laplacian of $W = e^{-z} \sin(2x) \cosh y$

A.6 Write down the formula for electric flux density for finite volume charge and finite surface charge.

A.7 What is Gaussian surface? Write down the properties of Gaussian surface.

A.8 Calculate the field intensity at a point on a sphere of readius 3 m, if a positive charge of 2 μC is placed at the original of sphere.

A.9 State and explain Ampere's circuital law.

A.10 Write down the Maxwell's euations in point form as well as in integral form.

Section B (4 x 5 = 20 marks)

Attempt any four questions.

B.1 Calculate the circulation of vector field $\mathbf{F} = r^2 \cos(\phi)\,\hat{a}_r + z \sin(\phi)\,\hat{a}_z$ around the path L defined by $0 \le r \le 3$, $0 \le \phi \le 60^\circ$ and $z = 0$.

B.2 A circular ring of charge with radius 5 m lies in $z = 0$ plane with centre at origin. If the $\rho_L = 10$ nC/m, find the point charge Q place at the origin which will produce same **E** at the point (0,0,5) m.

B.3 Three concentric spherical surfaces have radii r = 3, 5 and 7 cm respectively and have uniform charge densities of 200, -50 and ρ_X μC/m^2 respectively. Find

(a) **D** and **E** at r = 2 cm, 4 cm and 6 cm

(b) Find ρ_X if **D** = 0 at r = 7.32 cm.

B.4 In the region $0 \le r \le 0.5$ m, in cylindrical co-ordinates, the current density is $\mathbf{J} = 4.5\, e^{-2r}\,\hat{a}_z$ A/m^2 and **J** = 0 elsewhere. Use Amperes circuital law to find **H**.

B.5 Find the amplitude of the displacement current density,

(a) In the air near car antenna where the field strength of FM signal is $\mathbf{E} = 80 \cos(6.277 \times 10^8 t - 2.092y)\,\hat{a}_z$ V/m.

(b) Inside a capacitor where $\varepsilon_r = 600$ and $D = 3 \times 10^{-6} \sin(6 \times 10^6 t - 0.3464x)\,\hat{a}_z$ C/m2.

Section C (2 x 10 = 20 marks)

Attempt any two questions.

C.1 **(a)** Derive the Maxwell,s equation from Ampere's circuital law in point and integral form.

(b) A dipole having moment $P = 3\hat{a}_x - 5\hat{a}_y + 10\hat{a}_z$ nCm is located at Q(1,2,-4) in free space. Find V at (P,3,4).

C.2 **(a)** Find electric boundary conditions between two perfect dielctrics.

(b) A potential field is given as $V = 100\ e^{-5x} \sin(3y)\cos(4z)$ V. If point P $(0.1, \pi/12, \pi/24)$ is located at a conductor free space boundary. At point P, find V, E, E_T, E_N, **D**, D_N, ρ_s.

C.3 **(a)** If V = 2 V at x = 1 mm and V = 0 at x = 0 and volume charge density is $-10^6\varepsilon_0$ c/m^{3}constant throughout the region between x = 0 t0 x = 1 mm, calculate V at x = 0.5 mm and E_x at x = 1 mm in free space.

(b) Given $\mathbf{E} = E_0 z^2 e^{-5t} \hat{a}_x$ in free space. Determine if there exists a magnetic field such that both Faraday's law and Ampere's circuital law are satisfied simultaneously.