Roll No.:.....

National Institute of Technology, Delhi

Name of the Examination: End Sem Exam (Dec 2022)

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

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

Note : All questions are compulsory.

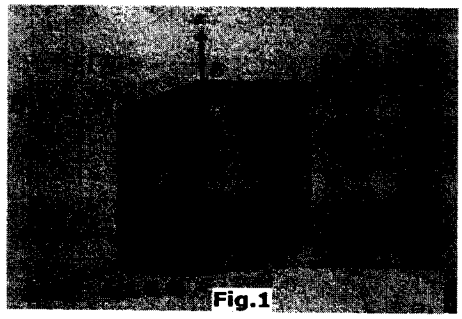
Section A (10 x 3 = 30 marks)

A1. Determine the Laplacian of a scalar field given as

$$V = \rho z \sin\emptyset + z^2 cos^2\emptyset + \rho^2$$

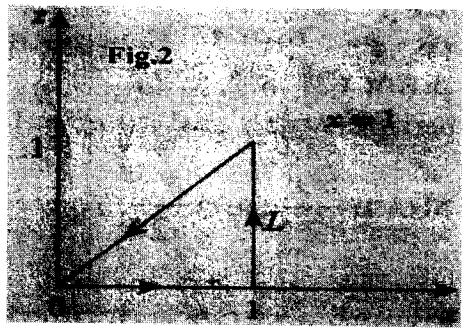
A2. Determine the divergence of $\overline{A} = yza_x + 4xya_y + ya_z$ at point **(1,-2,3).**

A3. Consider the Fig. 1 and Calculate
(a) Surface area *AOFD*
(b) Volume *ABDCFO*



A4. Two dipoles with dipole moments $-5a_z$ nC.m and $9a_z$ nC.m are located at points **(0, 0, -2)** and **(0, 0 ,3),** respectively. Calculate the potential at the origin.

A5. Evaluate the circulation of $\overline{B} = xya_x - yza_y + xza_z$ around the path L on the $x = 1$ plane, as shown in Fig.2.



A6. Two point charges **-4μC** and **5μC** are located at **(2, -1, 3)** and **(0, 4, -2),** respectively. Find the potential at **(1, 0, 1),** assuming zero potential at infinity.

A7. Find the current through the cylindrical surface ρ = **2, 1≤ z ≤ 5m.** for the current density $\bar{J} = 10z\, sin^2\emptyset\, a_\rho$ A/m^2

A8. A potential field is given as $V = 100e^{-5x} \sin 3y \cos 4z$ V. If point **P(0.1, π/12, π/24)** be located at a conductor free space boundary. Calculate the magnitude of tangential and normal component of electric field intensity at point P.

A9. Determine the work done in carrying a charge of **-5C** from **(2, 1, -1)** to **(4, 2, -1)** in the field $\bar{E} = x a_x$.

A10. For a lossy dielectric, **σ = 5 S/m** and $\epsilon_r = 1$. The electric field intensity is $\bar{E} = 100 \sin 10^{10} t$. Calculate the frequency at which $\bar{J}_C$ is 280 times of $\bar{J}_D$.

Section B (4 x 5 = 20 marks)

B.1 **(a)** Write down all the Maxwell's euations in point form as well as in integral form.

(b) State and prove the Maxwell,s equation derived from Ampere's circuital law in point and integral form.

B.2 **(a)** Derive the expression for electric field intensity at a point P located at a distance ***r*** from an Infinite line charge with uniform charge density of ρ_L C/m.

(b) If, a uniform line charge $\rho_L = 25$ **nC/m** lies on the line x = **-3m** and y = **4m** in free space. Then Find the electric field intensity at a point **(2, 3, 15)** m.

B.3 Derive the expression for magnetic field intensity due to a co-axial cable whose inner conductor is a solid with radius "***a***", carrying direct current "***I***". The outer conductor of this cable is in the form of concentric cylinder whose radius is "***b***" and outer radius is "***c***". Assume that the cable is placed along the z axis and the current "***I***" is uniformly distributed in the inner conductor while "***– I***" is uniformly distributed in the outer conductor.

B.4 Consider the Fig . 3. If Q_1 **is 2 nC,** Then determine the value of Q_2 such that the force on the test charge Q at point C has no **z** component.

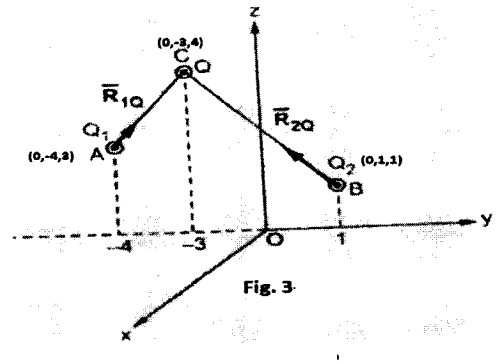


Fig. 3