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Roll No.:.....

# National Institute of Technology, Delhi

**Name of the Examination: B. Tech.**

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|---|---|---|---|
| **Branch** | **: Electrical & Electronics Engg.** | **Semester** | **: 3rd** |
| **Title of the Course** | **: Electromagnetic Field Theory** | **Course Code** | **: EEL 203** |

**Time: 2 Hours** **Maximum Marks: 25**

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**Note :** 1. Answer all the questions.

2. Do not write anything on the question paper except Roll number

3. Assume any data suitably if found missing

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**Q.1.** Find in cylindrical coordinates (a) a unit vector $P(\rho=5,\phi=53.13^o,z=-2)$ in the direction of $\bar{F}=\rho z\cos\phi\hat{a}_\rho-\rho z\sin\phi\hat{a}_\phi+a\rho\hat{a}_z$; (b) a unit vector at $P$ parallel to $\hat{a}_x$; (c) unit vector at $Q(\rho=5,\phi=-36.87,z=-2)$ parallel to $\hat{a}_x$; (d) $\bar{G}=2\hat{a}_x-4\hat{a}_y+4\hat{a}_z$ at $P$ **[4]**

**Q.2.** Determine the divergence and curl of the following vector fields: (a) $\bar{G}=yz\hat{a}_x+4xy\hat{a}_y+y\hat{a}_z$; (b) $\bar{A}=r^2z\hat{a}_r+r^3\hat{a}_\phi+3rz^2\hat{a}_z$; (c) $\bar{A}=\frac{1}{\rho^2}\cos\theta\hat{a}_\rho+\rho\sin\theta\cos\phi\hat{a}_\theta+\cos\theta\hat{a}_\phi$ **[6]**

**Q.3.** A sheet of charge $\rho_s=2nC/m^2$ is on the plane $x=2$ in free space and a line charge $\rho_l=20nC/m$ is located at $x=1,z=4$. Find (a) the electric field at $P(0,0,0)$; (b) $\bar{E}$ and direction of $\bar{E}$ at $(4,5,6)$; (c) What is the force per unit length on the line charge ? **[4]**

**Q.4.** Given the potential field $V=50xyz$ volts in free space, find the total energy stored within the cube $0<x,y,z<2$; (b) what value would be obtained by assuming a uniform energy density equal to the value at the centre of the cube? **[4]**

**Q.5.** A point charge of $6\mu C$ is located at the origin, a uniform line charge density of $180nC/m$ lies along the x-axis, and a uniform sheet charge of $25nC/m^2$ lies in the $z=0$ plane. (a) find $\bar{D}$ at $A(1,2,4)$; (b) calculate the total electric flux leaving the surface of sphere of $4m$ radius centered at the origin. **[4]**

**P.T.O**

**Q.6.** A field is given in spherical coordinated at $\boldsymbol{P(r=5,\theta=30^o,\phi=60^o)}$ as $\bar{\boldsymbol{E}}=\boldsymbol{20\hat{a}_r-30\hat{a}_\theta+60\hat{a}_\phi V/m}$. Find the incremental work done in moving a $10\mu\boldsymbol{C}$ charge a distance of $0.8\mu\boldsymbol{m}$ in the direction (a) $\hat{\boldsymbol{a}}_r$; (b) $\boldsymbol{G}=2\hat{\boldsymbol{a}}_x+4\hat{\boldsymbol{a}}_y-3\hat{\boldsymbol{a}}_z$ **[3]**