SC217: Electromagnetic Theory, **AUTUMN'17 MIDSEM 2**

DA-IICT, B.Tech, Sem III 08:30-10:30 AM 10^{th}Oct.2017 **25 marks**

1. Find the charge distribution that would cause the following electric fields: **(6)**

$$\textbf{(a)} \quad \vec{E}(\vec{r}) = \frac{A\sin\theta\hat{r} + B\hat{\phi}}{r\sin\theta} \qquad\qquad \textbf{(b)} \quad \vec{E}(\vec{r}) = \frac{A\hat{r} + B\sin\theta\cos\theta\hat{\phi}}{r}$$

2. Two concentric thin spherical shells of radii a and b, ($a < b$) are maintained at potentials V_a and V_b respectively. By solving the Laplace's equation in the three regions, $r < a$, $a < r < b$, $r > b$, and applying appropriate boundary conditions at the interfaces of the three regions, determine the potential due to this configuration everywhere. **(6)**

3. When an amount of charge Q is placed on a conductor it attains a potential V. Find the electrostatic energy stored in the conductor by evaluating the integral

$$\frac{\epsilon_0}{2}\int_{\text{all space}} |E|^2 d\tau$$

where $\vec{E}$ is the electric field created in the region surrounding the conductor due to the charge Q on it. **(6)**

4. A point charge q is situated at $z = 2$ on the z axis.
   (a) Find the average potential over the surface of a sphere $x^2 + y^2 + z^2 = 1$. **(2)**
   (b) Find the average potential over the surface of a sphere $x^2 + y^2 + z^2 = 9$. **(5)**

Gradient, divergence and curl

Spherical polar system

$$\vec{\nabla}F = \frac{\partial F}{\partial r}\hat{\text{r}} + \frac{1}{r}\frac{\partial F}{\partial\theta}\hat{\theta} + \frac{1}{r\sin\theta}\frac{\partial F}{\partial\phi}\hat{\phi} \qquad \vec{\nabla}\cdot\vec{\text{A}} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2A_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\sin\theta A_\theta) + \frac{1}{r\sin\theta}\frac{\partial A_\phi}{\partial\phi}$$

$$\vec{\nabla}\times\vec{\text{A}} = \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial\theta}(\sin\theta A_\phi) - \frac{\partial A_\theta}{\partial\phi}\right]\hat{\text{r}} + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial A_r}{\partial\phi} - \frac{\partial}{\partial r}(rA_\phi)\right]\hat{\theta} + \frac{1}{r}\left[\frac{\partial}{\partial r}(rA_\theta) - \frac{\partial A_r}{\partial\theta}\right]\hat{\phi}$$

Cylindrical System

$$\vec{\nabla}F = \frac{\partial F}{\partial s}\hat{\text{s}} + \frac{1}{s}\frac{\partial F}{\partial\phi}\hat{\phi} + \frac{\partial F}{\partial z}\hat{\text{z}} \qquad \vec{\nabla}\cdot\vec{\text{A}} = \frac{1}{s}\frac{\partial}{\partial s}(sA_s) + \frac{1}{s}\frac{\partial A_\phi}{\partial\phi} + \frac{\partial A_z}{\partial z}$$

$$\vec{\nabla}\times\vec{\text{A}} = \left[\frac{1}{s}\frac{\partial A_z}{\partial\phi} - \frac{\partial A_\phi}{\partial z}\right]\hat{\text{s}} + \left[\frac{\partial A_s}{\partial z} - \frac{\partial A_z}{\partial s}\right]\hat{\phi} + \frac{1}{s}\left[\frac{\partial}{\partial s}(sA_\phi) - \frac{\partial A_s}{\partial\phi}\right]\hat{\text{z}}$$