SC217: Electromagnetic Theory, **AUTUMN'19 MIDSEM 1**

DA-IICT, B.Tech, Sem III 8:30-10:00 AM 7^{th}Sep.2019 **25 marks**

1. If $\vec{A}$ and $\vec{B}$ are vectors prove that $\vec{A}\cdot\vec{B}$ transforms as a scalar under rotation. **(5)**
   (*You may use two dimensional case.*)

2. Find $\vec{\nabla}(\sin(\vec{n}\cdot\vec{r}))$ and $\vec{\nabla}\times(\vec{n}\times\vec{r})$ where $\vec{n}$ is a constant vector. **(5)**

3. For any scalar field F

   (a) Prove that $\vec{\nabla}\times(\vec{\nabla}F) = 0$. **(2)**

   (b) Using part (a) prove that the line integral $\int_a^b \vec{\nabla}F\cdot\vec{dl}$ is independent of the path taken from point a to point b. **(3)**

4. You are given that the volume of a sphere of radius a is $\frac{4}{3}\pi a^3$. Using divergence theorem on the vector field $\vec{A} = \vec{r}$ prove that the surface area of the sphere is $4\pi a^2$ **(5)**

5. In the spherical polar coordinate system the relation between x, y, z and r, θ, ϕ is given as $x = r\sin\theta\cos\phi;\;\; y = r\sin\theta\sin\phi :\;\; z = r\cos\theta$.
   Using these find the unit vectors $\hat{r}, \hat{\theta}$ and $\hat{\phi}$ in terms of $\hat{i}, \hat{j}, \hat{k}$. **(5)**

Gradient, divergence and curl

$\vec{\nabla}F = \hat{i}\frac{\partial F}{\partial x} + \hat{j}\frac{\partial F}{\partial y} + \hat{k}\frac{\partial F}{\partial z} \qquad \vec{\nabla}\cdot\vec{A} = \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$

$\vec{\nabla}\times\vec{A} = \hat{i}\left(\frac{\partial A_z}{\partial y} - \frac{\partial A_y}{\partial z}\right) + \hat{j}\left(\frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x}\right) + \hat{k}\left(\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y}\right)$

$\nabla^2 F = \frac{\partial^2 F}{\partial x^2} + \frac{\partial^2 F}{\partial y^2} + \frac{\partial^2 F}{\partial z^2}$