POSSESSION OF MOBILES IN EXAM IS UFM PRACTICE

Name of student ____________________ **Enrollment No.**__________

BENNETT UNIVERSITY, GREATER NOIDA

B.TECH/ TEST – Mid Term: FALL SEMESTER A.Y. 2018-2019

COURSE CODE	**EPHY105L/EPHY103L**	MAX. TIME: **1 hour**
COURSE NAME :	**Electromagnetics**	
COURSE CREDIT:	**3**	MAX . MARKS: **25**

ALL QUESTIONS ARE COMPULSORY

1. Give brief answers with appropriate reasons to the following questions: **(4x2=8)**
   a) Giving reasons determine whether the following vector field could represent an electrostatic field
   $$\vec{F} = b[(12x^2 - y^2)\hat{x} - 2xy\hat{y}]$$
   b) A unit point charge with charge with q = 1μC is placed at a point with Cartesian coordinates (0, 0, 2); all distances in meters. Obtain the electric field vector at the point with coordinates (0, 2, 0). (You may assume $\frac{1}{4\pi\epsilon_0} \approx 9 \times 10^9\ \mathrm{N.m^2/C^2}$).
   c) In a region of space defined by $0 < r < R$ the electrostatic field in spherical polar coordinates is given by
   $$\vec{E} = \frac{A}{R}(-\hat{r}\cos\theta + \hat{\theta}\sin\theta)$$
   Determine if there are any charges in this region.
   d) A conducting plate of thickness d and with parallel surfaces is placed in a uniform electric field $\vec{E} = E_0\hat{z}$ such that the surfaces are parallel to the x-y plane. Giving reasons, obtain the surface charge density on the surface of the conductor.

2. Consider the following spherical charge distribution having charge density of $+\rho_0$ in the region $0 < r < R$ and $-\rho_0/7$ in the region $R < r < 2R$ and free space in the region $r > 2R$.
   a) Using Gauss's law obtain the electric field in the regions $0 < r < R$, $R < r < 2R$ and $r > 2R$. **(4)**
   b) What will be the value of $\nabla.\vec{E}$ and $\nabla \times \vec{E}$ at $r = 3R/2$? **(2)**

3. A spherical conductor of radius R carries a charge $+Q$.
   a) Starting from Gauss's law obtain an expression for the electrostatic potential of such a charge distribution in the regions $r < R$ and $r > R$. **(3)**
   b) What will be the work done in moving a unit positive charge from a point with spherical polar coordinates $r = 2R$, $\theta = 0$, $\phi = 0$ to another point with coordinates $r = 3R$, $\theta = \pi/2$, $\phi = 0$? **(2)**

4. Consider a parallel plate capacitor with plate spacing of d and with plate areas A. Between the plates a dielectric slab with parallel faces with dielectric constant K and thickness $d/2$ is placed with its faces parallel to the plates of the capacitor. The plates carry charges $+Q$ and $-Q$. Neglecting edge effects,
   a) Using Gauss's law obtain the electric fields within the dielectric and in the free space. **(3)**
   b) What is the value of $\vec{P}$ in the dielectric? What are the values of bound surface and volume charge densities in the dielectric? **(3)**

P.T.O

Some useful formulas

- In Cartesian coordinates:

$$\nabla f = \frac{\partial f}{\partial x}\hat{\imath} + \frac{\partial f}{\partial y}\hat{\jmath} + \frac{\partial f}{\partial z}\hat{k}$$

$$\nabla . \vec{F} = \frac{\partial F_x}{\partial x} + \frac{\partial F_y}{\partial y} + \frac{\partial F_z}{\partial z}$$

$$\nabla \times \vec{F} = \left[\frac{\partial F_z}{\partial y} - \frac{\partial F_y}{\partial z}\right]\hat{\imath} + \left[\frac{\partial F_x}{\partial z} - \frac{\partial F_z}{\partial x}\right]\hat{\jmath} + \left[\frac{\partial F_y}{\partial x} - \frac{\partial F_x}{\partial y}\right]\hat{k} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2}$$

- In spherical polar coordinates:

$$\nabla f = \frac{\partial f}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial f}{\partial \theta}\hat{\theta} + \frac{1}{r\sin\theta}\frac{\partial f}{\partial \phi}\hat{\phi}$$

$$\nabla . \vec{F} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 F_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(\sin\theta\, F_\theta) + \frac{1}{r\sin\theta}\frac{\partial F_\phi}{\partial \phi}$$

$$\nabla \times \vec{F} = \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial \theta}(\sin\theta\, F_\phi) - \frac{\partial F_\theta}{\partial \phi}\right]\hat{r} + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial F_r}{\partial \phi} - \frac{\partial}{\partial r}(rF_\phi)\right]\hat{\theta} + \frac{1}{r}\left[\frac{\partial}{\partial r}(rF_\theta) - \frac{\partial F_r}{\partial \theta}\right]\hat{\phi}$$

- In cylindrical coordinates:

$$\nabla f = \frac{\partial f}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial f}{\partial \phi}\hat{\phi} + \frac{\partial f}{\partial z}\hat{z}$$

$$\nabla . \vec{F} = \frac{1}{r}\frac{\partial}{\partial r}(rF_r) + \frac{1}{r}\frac{\partial F_\phi}{\partial \phi} + \frac{\partial F_z}{\partial z}$$

$$\nabla \times \vec{F} = \left[\frac{1}{r}\frac{\partial F_z}{\partial \phi} - \frac{\partial F_\phi}{\partial z}\right]\hat{r} + \left[\frac{\partial F_r}{\partial z} - \frac{\partial F_z}{\partial r}\right]\hat{\phi} + \frac{1}{r}\left[\frac{\partial}{\partial r}(rF_\phi) - \frac{\partial F_r}{\partial \phi}\right]\hat{z}$$

- $\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{C^2/N\text{-}m^2}$