Mahindra University Hyderabad

École Centrale School of Engineering
Minor-II

Program: B. Tech. **Branch: AI, CSE, ECM, ECE, CM, CE, ME, MT, NT Year: II Semester: I**
Subject: Physics II (PH2102)

Date: 10.11.2023 **Start Time: 10:00 AM**
Time Duration: 1.5 Hours **Max. Marks: 100**

Instructions:

1) **All questions are mandatory**
2)

Question 1 **Marks 15 + 15 = 30**

a) Find the potential, electric field and capacitance between spherical shells of radii a and b (a<b) with charges +Q on the inner shell and –Q on the outer shell.

b) Consider a vector field (F) given by $\vec{F} = Ayz\hat{i} + Bzx\hat{j} + xy\hat{k}$ in Cartesian coordinate system. For what values of A and B this field will represent an electrostatic field.

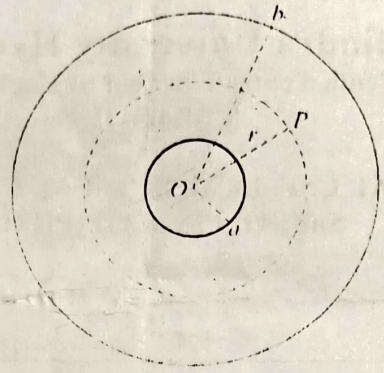
Question 2 **Marks 15 + 15 = 30**

a) Identify the polar and non-polar molecules from the following list, CH_4, NH_3, HCl, H_2 and N_2?

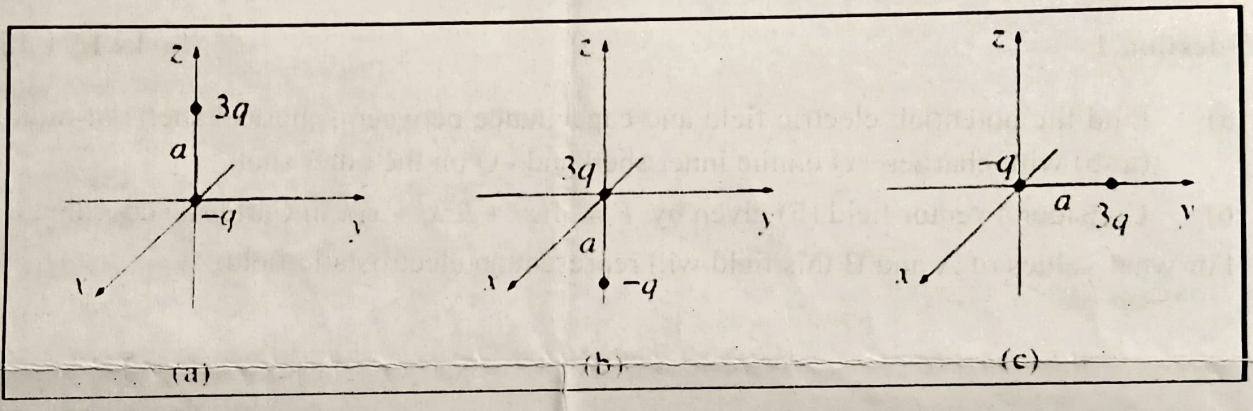
b) An infinite dielectric slab of thickness d is placed in a uniform electric field $\mathbf{E}_0$ pointing perpendicular to the surface. Calculate the electric field inside the dielectric and the bound surface charge densities.

Question 3 **Marks 25 + 15 = 40**

a) A hollow spherical shell of inner radius a and outer radius b carries a charge density $\rho = \alpha r$ ($a < r < b$); α being a constant. Find the field **E** at a point P which is at a distance r from the centre of the shell for three cases i) $r < a$, ii) $a < r < b$, iii) $r > b$.



b) Two-point charges 3q and –q is separated by a distance a. For each of the arrangements in figure below, find (i) the monopole moment, (ii) the dipole moment



Useful relations and constants:

i) $q_{e,P} = 1.6 \times 10^{-19}$ C, $m_P = 1.7 \times 10^{-27}$ kg and $m_e = 9.1 \times 10^{-31}$ kg]

ii) *Gradient in Spherical polar coordinates,* $\nabla t = \frac{\partial t}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial t}{\partial \theta}\hat{\theta}\frac{1}{rSin\theta}\frac{\partial t}{\partial \varphi}\hat{\varphi}$

iii) *Laplacian in cylindrical polar coordinates,* $\nabla^2 t = \frac{1}{s}\frac{\partial t}{\partial s}(s\frac{\partial t}{\partial s}) + \frac{1}{s^2}\frac{\partial^2 t}{\partial s^2} + \frac{\partial^2 t}{\partial z^2}$

iv) *Laplacian in cartesian coordinate system,* $\nabla^2 t = \frac{\partial^2 t}{\partial x^2} + \frac{\partial^2 t}{\partial y^2} + \frac{\partial^2 t}{\partial z^2}$