Mahindra University Hyderabad

École Centrale School of Engineering/ School of Management/School of Law

Minor-I

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

Subject: Physics II (PH2102)

Date: 15.09.2023 **Start Time: 2:00 PM**

Time Duration: 1.5 Hours **Max. Marks: 100**

Instructions:

1) All questions are mandatory

2) Calculators allowed

Question 1

a) Calculate $\int_0^4 \delta(x-6)dx$.

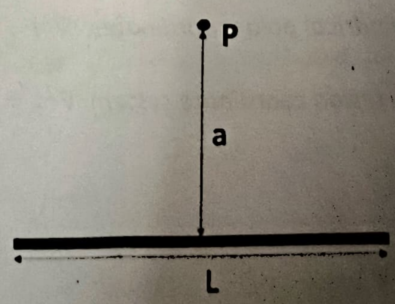
b) Find the Laplacian for $U = x^3y^2z^2$ at (1, -1, 1).

c) In a Hydrogen atom the electric field exerted by the proton on the electron is said to be ≈ 10^{39} times greater than the gravitational force exerted by the proton on the electron when they are 0.50×10^{-10} m apart. Verify the statement. [G =6.7 x 10^{-11} N.m^2/kg^2, the proportionality constant that appear in Coulomb's law is 9.0 x 10^9 N. m^2/ C^2.

Marks 5 + 10 + 15 = 30

Question 2

a) A charge Q is uniformly distributed over a thin wire of length *L*. Find the electric field components at a point P, whose perpendicular distance from the center of the wire is *a*. What will be the field when *a*>>*L*.



b) If the charge distribution inside the nucleus of $_{92}U^{238}$ is given by $\rho(r) = \alpha r$, $0<r<R$ and its radius (R) of $_{92}U^{238}$ nucleus is 6.63 x 10^{-15} m, Calculate the value of α.

Marks 25 + 15 = 40

Question 3

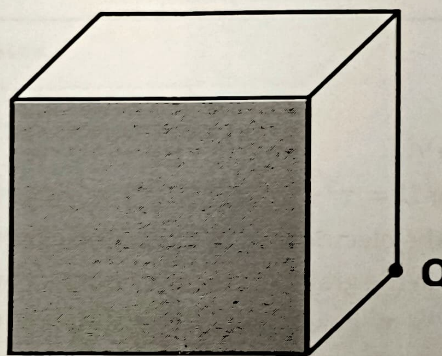
a) The temperature variation inside the earth can be assumed to be spherically symmetric and approximately describable by the following equation

$$T(r) = T_0 - \alpha r^2$$

Calculate gradient of T and indicate constant temperature surfaces.

c) A charge **Q** sits at the back corner of a cube, as shown in the figure. What will be the flux of **E** through the shaded side shown in the figure?

Marks 15 + 15 = 30



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,* $\nabla t = \frac{\partial t}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial t}{\partial \theta}\hat{\theta} \frac{1}{r Sin\theta}\frac{\partial t}{\partial \varphi}\hat{\varphi}$

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,* $\nabla^2 t = \frac{\partial^2 t}{\partial x^2} + \frac{\partial^2 t}{\partial y^2} + \frac{\partial^2 t}{\partial z^2}$