**EE1203: Vector Calculus**

**Assignment - 2**

**Handed out on : 14 - Jan - 2024** **Due on : 24 - Jan - 2024 (before 5 PM)**

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**Instructions :**

1. Please submit the solutions to the assignment problems to the course page (on the Google Classroom platform). Solutions submitted to the course page will only be evaluated.
2. Submissions received after the deadline will attract negative marking.
3. It is suggested that you attempt all the questions. However, submitting solutions for problems totaling at least 10 points is sufficient.
4. Note: Vectors are indicated using the bold interface.

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1. (5 Points) Let $P_1$ and $P_2$ denote the projection of the point $P(x, y, z)$ (denoted in Cartesian coorindates) on the planes $x = 0$ and $y = 0$ respectively. Represent the points $P_1$ and $P_2$ in cylindrical and spherical coordinate systems.
2. (5 Points) Consider a modified spherical coordinate system (purely hypothetical), where any point in the three-dimensional space is represented in the following form $P(r, \theta, \phi)$ where $r$ is the magnitude of the position vector to the point, $\theta$ is angle with respect to $y-$axis and $\phi$ is angle that the position vector to $P_1$ (projection of $P$ onto $zx$-plane) subtends with $x-$axis. Derive expressions for representing any point $P(x, y, z)$ in this hypothetical coordinate system.
3. (5 Points) Quadruple Product/s: Consider four vectors $\mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d} \in \mathcal{R}^3$. Prove the following vector identities
   (a) (2 Points) $(\mathbf{a} \times \mathbf{b}) \cdot (\mathbf{c} \times \mathbf{d}) = (\mathbf{a} \cdot \mathbf{c})(\mathbf{b} \cdot \mathbf{d}) - (\mathbf{a} \cdot \mathbf{d})(\mathbf{b} \cdot \mathbf{c})$
   (b) (3 Points) $(\mathbf{a} \times \mathbf{b}) \times (\mathbf{c} \times \mathbf{d}) = [(\mathbf{a} \times \mathbf{b}) \cdot \mathbf{d}]\,\mathbf{c} - [(\mathbf{a} \times \mathbf{b}) \cdot \mathbf{c}]\,\mathbf{d}$
4. Find the equation of a line y=mx+c in spherical coordinates. Now, find the equation of a plane ax+by+cz+d=0 in spherical coordinates.
5. Tune the parameters of the plane such that it reduces to the line. What corresponding changes are observed in the spherical coordinate vector?