In your tutorial, your tutor will work through the unstarred problems, and you will be expected to work on the starred problems yourself. The participation mark will be awarded only if you make a serious attempt at the starred problems.

*1. Find $\mathbf{u} \cdot \mathbf{v}$ and $\mathbf{u} \times \mathbf{v}$ if $\mathbf{u} = 2\mathbf{i} - 2\mathbf{j} + \mathbf{k}$ and $\mathbf{v} = \mathbf{i} + 3\mathbf{j} - \mathbf{k}$.

2. Calculate the work done by the force field $\mathbf{F} = 3xy \mathbf{i} - 2 \mathbf{j}$ along the piece of the hyperbola $x^2 - y^2 = 1, z = 0$ from $(1, 0, 0)$ to $(2, \sqrt{3}, 0)$.

*3. Calculate the work done by the force field $\mathbf{F} = x^3 \mathbf{i} - z \mathbf{j} + 2xy \mathbf{k}$ along the curve $C$, where $C$ is the straight line segment from $(0, 1, -1)$ to $(-2, 1, 2)$.

4. (i) Given that $\mathbf{F} = 2xy \mathbf{i} + (x^2 + z^2) \mathbf{j} + (2yz + 2z) \mathbf{k}$ is conservative, find a scalar function $\phi$ such that $\mathbf{F} = \nabla \phi$.

(ii) Find the work done by $\mathbf{F}$ along any path $C$ from the point $P(1, 1, 1)$ to the point $Q(1, 2, 3)$.

*5. (i) Given that $\mathbf{F} = 3x^2 \mathbf{i} + 4yz \mathbf{j} + (2y^2 - 5) \mathbf{k}$ is conservative, find a scalar function $\phi$ such that $\mathbf{F} = \nabla \phi$.

(ii) Find the work done by $\mathbf{F}$ along any path $C$ from the point $P(0, 0, 0)$ to the point $Q(2, 1, 1)$.

6. Find a unit vector normal to the cone $z = \sqrt{x^2 + y^2}$ at the point $(3, 4, 5)$. Sketch the surface, and the normal you have found.

*7. Find a unit vector normal to the sphere $x^2 + y^2 + z^2 = 4$ at the point $(1, 1, \sqrt{2})$. Sketch the surface, and the normal you have found.

8. Calculate Curl $\mathbf{F}$ if

(i) $\mathbf{F} = x^2z \mathbf{i} - y \mathbf{j} + z^3 \mathbf{k}$.

(ii) $\mathbf{F} = (\sinh x) \mathbf{i} + (\cosh y) \mathbf{j} - xyz \mathbf{k}$. 