

Module 1 self-assessment

Advice: Do NOT use \cdot or \times for scalar multiplication.

Question 1

Compute the gradient and of the function $f(x, y, z) = z - xy$ and then the directional derivative of f in the direction $\mathbf{q} = \hat{\mathbf{i}} + \hat{\mathbf{j}}$. Evaluate the directional derivative at the point $(1, 1, 1)$.

Question 2

Dielectrophoresis is a phenomenon where forces are exerted on a particle that is subjected to a non-uniform electric field. In such a case, three force fields are acting simultaneously on a particle positioned at the origin. The forces fields can be described as:

- $\mathbf{F}_1 = (xy + 1, y - 2, yz^3 + 3)$
- \mathbf{F}_2 has constant magnitude 9 and acts in direction $(-2, 2, 1)$
- $\mathbf{F}_3 = 4\hat{\mathbf{i}} - 8\hat{\mathbf{j}}$,

Find the resultant force that acts on the particle. What additional force must be imposed to reduce the resultant to zero?