

- 1.) Compute the derivative of  $f(x, y) = x^2 + xy$  at the point  $P = (1, -1)$  in the direction of vector  $\vec{A} = \vec{i} - 2\vec{j}$ .
- 2.) Compute the derivative of  $f(x, y, z) = x - y^2 + z^3$  at the point  $P = (2, 0, -1)$  in the direction of vector  $\vec{A} = \vec{i} - \vec{j} + \vec{k}$ .
- 3.) Consider the function  $f(x, y) = xy^3$  and the point  $P = (2, 1)$ . Determine all unit vectors  $\vec{u}$  so that  $D_{\vec{u}}f(2, 1)$  is
  - a.) as large as possible.
  - b.) as small as possible.
  - c.) equal to zero.
  - d.) equal to 1.
- 4.) Consider the surface given by  $x^2 + 2y^2 + 3z^2 = 3$  and the point  $P = (1, -1, 0)$  on the surface. Find equations for
  - a.) the plane tangent to the surface at point  $P$ .
  - b.) the line normal (perpendicular) to the surface at point  $P$ .
- 5.) Consider the surface (hyperbolic paraboloid or saddle) given by  $f(x, y) = 3x^2 - 2y^2 + 5$  and the point  $P = (2, 3, -1)$  on the surface. Find equations for
  - a.) the plane tangent to the surface at point  $P$ .
  - b.) the line normal (perpendicular) to the surface at point  $P$ .
- 6.) Consider the function  $f(x, y) = xe^{xy}$  and the point  $P = (0, 1)$ . Use a differential to estimate the change in the values of  $f$  if
  - a.) point  $P$  moves a distance of  $ds = 0.15$  in the direction of vector  $\vec{A} = 3\vec{i} - 4\vec{j}$ .
  - b.) point  $P$  moves in a straight line to point  $Q = (1, 0)$ .
- 7.) Consider the function  $f(x, y, z) = xy^2 + yz - x^3z$  and the point  $P = (1, -1, 2)$ . Use a differential to estimate the change in the values of  $f$  if point  $P$  moves a distance of  $ds = 0.2$  in the direction of vector  $\vec{A} = -\vec{i} - 2\vec{j} + 2\vec{k}$ .
- 8.) Find and classify critical points as determining relative maximums, relative minimums, or saddle points.
  - a.)  $z = 3x^2 - 6xy + y^2 + 12x - 16y + 1$
  - b.)  $z = x^2y - x^2 - 2y^2$
  - c.)  $z = x^2 - 8\ln(xy) + y^2$
  - d.)  $z = 3x^2y - 6x^2 + y^3 - 6y^2$

“An education isn’t how much you have committed to memory, or even how much you know. It’s being able to differentiate between what you know and what you don’t.” – Anatole France