1. Compute the total derivative of each function at an arbitrary point \((x, y)\) or \((x, y, z)\).

(a) \(2\)pts \( f(x, y) = (e^x, \sin xy) \)

(b) \(2\)pts \( f(x, y) = (x + y, x - y, xy) \)

(c) \(2\)pts \( f(x, y, z) = (x + z, y - 5z, x - y) \)

2. Find the planes tangent to the following surfaces at the indicated points.

(a) \(3\)pts \( x^2 + 2y^2 + 3xz = 10, \) at \((x, y, z) = (1, 2, 1/3)\)

(b) \(3\)pts \( xyz = 1, \) at \((x, y, z) = (1, 1, 1)\)

3. Compute the gradient \(\nabla f\) for the following functions, and find the directional derivative of \(f\) in the direction \(v\) at the point \(p\).

(a) \(3\)pts \( f(x, y, z) = \frac{1}{\sqrt{x^2 + y^2 + z^2}}, \ v = i + k = (1, 0, 1), \ p = (1, 1, 1).\)

(b) \(3\)pts \( f(x, y, z) = xy + yz + xz, \ v = i + j + k = (1, 1, 1), \ p = (1, 0, 2).\)

4. \(6\)pts Compute \(g \circ f, Df(x, y), Dg(u, v, w)\) and \(D(g \circ f)(0, 0),\) where

\[
 f(x, y) = \left( e^x, \cos(y - x), e^{-y} \right), \quad g(u, v, w) = \left( e^{u - v}, \cos(v + u) + \sin(u + v + w) \right)
\]

5. Let \( f(x, y) = x^4 y^3 - x^8 + y^8. \)

(a) \(3\)pts Compute \( \frac{\partial^2 f}{\partial x^2}, \ \frac{\partial^2 f}{\partial y^2}, \ \) and \( \frac{\partial^2 f}{\partial y \partial x}. \) Verify that \( \frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}. \)

(b) \(3\)pts Compute \( \frac{\partial^3 f}{\partial x \partial y \partial y}, \ \frac{\partial^3 f}{\partial x \partial y \partial x}, \) and \( \frac{\partial^3 f}{\partial y \partial x \partial x}. \)

6. \(6\)pts Find the second order Taylor approximation for

\[
 f(x, y) = e^{-x^2 - y^2} \cos(xy)
\]

at \((x_0, y_0) = (0, 0).\)