(10 pts) 1) If \((x, y, z) = xe^y + z^2\) find

(a) the gradient, \(\nabla f\), at \((1, \ln 2, \frac{1}{2})\),

(b) the directional derivative of \(f\) in the direction of \(\vec{V} = \left( \frac{1}{\sqrt{2}} \right) i + \left( \frac{1}{\sqrt{2}} \right) k\) at \((1, \ln 2, \frac{1}{2})\).

(10 pts) 2) If \(z\) is defined as a function of \(x\) and \(y\) by

\[xy + z^3 x - 2yz = 0\]

find \(\frac{\partial z}{\partial x}\) at \((1, 1, 1)\).

(10 pts) 3) Find the tangent plane and normal line to \(z - x^2 - y^2 = 1\) at \((2, 2, 5)\).

(10 pts) 4) If \(f(x, y) = y(\sin x)\) find

(a) \(f_{xx}, f_{xy}, f_{yy}\) at \((0, 0)\)

(b) the quadratic approximation of \(f(x, y)\) at \((0, 0)\).
(15 pts) 5) If \( z = \sin(xy) + x(\sin y) \), \( x = u^2 + v^2 \), and \( y = uv \)

find \( \frac{\partial z}{\partial u} \) when \( u = 0 \) and \( v = 1 \).

(15 pts) 6) a) If \( f(x, y) = xy^2 + y(\cos x) \) find the linearization \( \ell(x, y) \) of \( f(x, y) \) at \((0, 1)\).

b) Estimate the error if \( |x| < \frac{1}{10} \) and \( |y - 1| < \frac{1}{10} \).

(15 pts) 7) Find the absolute maximum value and the absolute minimum value of the function \( f(x, y) = x^2 + xy + y^2 \) on the rectangular plots \( 0 \leq x \leq 5 \) and \( -1 \leq y \leq 1 \).

(15 pts) 8) Find the points on \( x + 2y + 3z = 13 \) closest to \((1, 1, 1)\).