1. Let \( f(x, y) = \frac{x^2}{4} + \frac{y^2}{9} \). Write the equations for the level curve that passes through \((2, 3)\) and for the level curve that passes through \((0, 6)\). Draw these curves.

2. Let \( h(x, y) = \sin(xy^2) \). Compute \( h_{xx}(0, 1) \) and \( h_{xy}(0, 1) \) and \( h_{yy}(0, 1) \).

3. Find the equation for the tangent plane to the graph of \( z = e^x \sin y \) at \((1, \pi/2, e)\).

4. Suppose \( x = r \cos \theta \) and \( y = r \sin \theta \) and \( z = f(x, y) \). Find \( \frac{\partial z}{\partial r} \) and \( \frac{\partial z}{\partial \theta} \) in terms of \( r, \theta, \frac{\partial z}{\partial x} \) and \( \frac{\partial z}{\partial y} \).

5. a. Find the instantaneous rate of change of \( z = x + xy \) in the direction of the vector \((3/5, 4/5)\) at the point \((2, 5)\).
   
b. Find \( \frac{\partial z}{\partial n} \)|\((0,0)\), where \( u \) has the same direction as \((1, 2)\).

6. At the point \((1, 2)\), in what direction does the function \( f(x, y) = x^2 y - xy^2 \) increase most rapidly, and what is the rate of increase?

7. Find the equation of the plane tangent to the surface \( \frac{x}{2} + 1 = x + y - z + \sin(xyz) \) at \((1, \pi/2, 1)\).

8. Do each part of the following:
   
a) Let \( f(x, y) \) be a differentiable function on the plane. Suppose \( f(a, b) = c \). Write the equation for the tangent plane to the surface \( z = f(x, y) \) at the point \((a, b, c)\).
   
b) Let \( F(x, y, z) = f(x, y) - z \). What is the relationship between the level surface of \( F \) at \( 0 \) and the graph of \( f \)?
   
c) Compute \( \nabla F(a, b, c) \).
   
d) Recall from M1552 that if \( n \) and \( v_0 \) are vectors in space, then the plane that is normal to \( n \) and passes through \( v_0 \) is described by the equation in vector form \( n \cdot (v - v_0) = 0 \). Write in vector form from the equation for the plane that is normal to \( \nabla F(a, b, f(a, b)) \) and passes through \((a, b, c)\).
   
e) Convert the vector equation in part c) into algebraic form, i.e., let \( v = (x, y, z) \), and write out the vector equation in terms of \( x, y \) and \( z \).
   
f) Bonus problem. Observe that planes that the answers to a) and e) are the same. Explain why.

9. Find and classify the critical points of
   
a. \( f(x, y) = x^3 + x^2 - y^2 \)
   
b. \( h(x, y) = x^3 - 6xy + 8y^3 \)

10. Find the locations of the points where \( f(x, y, z) = z - x - y \) has maximum and minimum values and find those values, subject to the constraint \( g(x, y, z) = x^2 + y^2 + z^2 = 50 \).