1. (14) Find the domain and range of the function $f(x)$ given below, and identify its level curves. Sketch one typical level curve. Is the domain open or closed? Is the domain bounded?

$$f(x, y) = \sqrt{y - x^2}.$$ 

2. (12) Find the first partial derivatives with respect to each variable of the functions in each case.

(a) $f(x, y) = \frac{x + y}{xy - 1}$. Simplify your answers.

(b) $f(x, y, z) = \ln(2x + 3y - 5z)$.

3. (12) Find all second order partial derivatives of the function given below.

$$g(x, y) = y \sin x - e^y.$$ 

4. (12) Find $\frac{\partial w}{\partial s}$ when $r = \pi$, $s = 0$, if $w = \sin(2x - y)$, $x = r + \sin s$, $y = rs$.

5. (12) Find $\frac{dy}{dx}$ at $P(0, 1)$ when the following equation defines $y$ implicitly as a function of $x$.

$$1 - x - y^2 - \sin xy = 0.$$ 

6. (14) Find the derivative of the function $f(x, y, z) = xyz$ in the direction of the velocity vector of the helix $r(t) = (\cos 3t)i + (\sin 3t)j + 3tk$. Recall that the velocity vector of the curve $r(t)$ is $dr/dt$.

7. (12) What is the largest value that the directional derivative of $f(x, yz) = 1/xyz$ can have at the point $(1, 1, 1)$?

8. (12) Decide whether each of the following statements is True or False. Justify your answer.

(a) If the domain of a function $f(x, y)$ is closed, then it cannot be unbounded.

(b) When we have a dependent variable that depends on three intermediate variables and two independent variables, we draw three branch diagrams, one for each intermediate variable.

(c) At the point $(x_0, y_0)$, the vector $\nabla f$ is normal to the curve $f(x, y) = f(x_0, y_0)$.

(d) The directional derivative of $f$ in any direction $u$ different from that of $\nabla f$ is strictly smaller than the derivative in the direction of $\nabla f$. 