1. Find both first partial derivatives.
   (a) $f(x,y) = x^2 - 3y^2 + 7$ (b) $z = 2y^2\sqrt{x}$ (c) $f(x,y) = \ln(x^2 + y^2)$
   (d) $z = \sin(3x)\cos(3y)$ (e) $z = \cos(x^2 + y^2)$

2. Evaluate f_x and f_y at the given point.
   (a) $f(x,y) = \arccos(xy), (0, \sqrt{5})$ (b) $f(x,y) = \frac{6xy}{\sqrt{4x^2+5y^2}}, (1,1)$

3. For $f(x,y)$, find all values of x and y such that $f_x(x,y) = 0$ and $f_y(x,y) = 0$ simultaneously.
   (a) $f(x,y) = 3x^3 - 12xy + y^3$ (b) $f(x,y) = \ln(x^2 + y^2 + 1)$

4. Find w_s and w_t using the appropriate chain rule, and evaluate each partial derivative at the given values of s and t.
   (a) $w = y^3 - 3x^2y; x = e^s, y = e^t$, at the point $s = 0$ and $t = 1$
   (b) $w = \sin(2x + 3y); x = s + t, y = s - t$, at the point $s = 0$ and $t = \frac{\pi}{2}$

5. If $w = xy^2$ and $x = 2s - t$, $y = t^2$, using the Chain Rule to find w_t at the point (-1,2) in the $st-$plane.

6. Suppose w is a function of r and s where $r = xy + yz^2$, $s = \sin(y) + e^{xz}$. Use the information given below to compute $w_y(-1, 0, 0)$:
   $w_r(0,1) = 2$, $w_s(0,1) = 5$

7. If p is a differentiable function of u,v and w, and if $u = x - y$, $v = y - z$, and $w = z - x$, show that $p_x + p_y + p_z = 0$.

8. Find the directional derivative of the function at P in the direction of $\mathbf{v}$.
   (a) $g(x,y) = arccos(xy)$, $P(1,0)$, $\mathbf{v} = \hat{\imath} + 5\hat{\jmath}$ (b) $h(x,y) = e^{-(x^2+y^2)}$, $P(0,0)$, $\mathbf{v} = \hat{\imath} + \hat{\jmath}$
   (c) $h(x,y,z) = xyz$, $P(2,1,1)$, $\mathbf{v} = 2\hat{\imath} + \hat{\jmath} + 2\hat{k}$

9. Find the directional derivative of the function at P in the direction of Q.
   (a) $f(x,y) = \cos(x+y)$, $P(0,\pi)$, $Q(\frac{\pi}{2}, 0)$ (b) $g(x,y,z) = xy\,e^z$, $P(2,4,0)$, $Q(0,0,0)$

10. Find the direction of maximum increase of the function at the given point.
    (a) $g(x,y) = y\,e^{-x^2}, (0,5)$ (b) $w = xy^2z^2$, $(2,1,1)$

11. The surface of a mountain is modeled by the equation $h(x,y) = 5000 - 0.001x^2 - 0.004y^2$. A mountain climber is at the point (500,300,4390). In what direction should the climber move in order to ascend at the greatest rate?

12. A ground-dwelling cold hairy spider wants to get warm. The temperature at the point (x,y) is given by $T(x,y) = x^2 - xy + 2y^2$(degrees Fahrenheit). If the spider is at the point $(2,3)$, in which direction should it move to increase its temperature the fastest?

13. At time $t = 0$ (seconds), a particle is ejected from the surface $x^2 + y^2 - z^2 = -1$ at the point $(1, 1, \sqrt{3})$ in a direction normal to the surface at a speed of 10 units per second. When and where does the particle cross the $xy-$plane?

14. Find the directional derivative of the function $f(x,y,z) = 3xz - 2xy^2$ at the point (-1,1,2) in the direction from (-1,1,2) to (1,3,3).

15. Find the gradient and the direction of maximum decrease at the given point.
    (a) $z = e^{-x}\cos(y)$, $(0, \frac{\pi}{4})$ (b) $z = \frac{x^2}{x-y}$, $(2,1)$

16. Find an equation of the tangent plane at the given point.
    (a) $z = x^2 - 2xy + y^2$, $(1,2,1)$ (b) $x = y(2z-3)4$, $(4,4,2)$

17. Find an equation of the tangent plane and parametric equations of the line normal to the surface at the given point.
    (a) $z = -9 + 4x - 6y - x^2 - y^2$, $(2,-3,4)$ (b) $z = \sqrt{9 - x^2 - y^2}$, $(1,2,2)$