1. Either evaluate the following limit, or show that it does not exist:
\[
\lim_{(x,y) \to (-2,4)} \frac{(x+2)^3 - (x+2)(y-4)}{(x+2)^2 + 2(y-4)^2}.
\]

2. Find all of the first partial derivatives of:
\[
u = \frac{x^2 - 2yz}{y + z^2}
\]

3. Find \( \frac{\partial^2 f}{\partial x \partial y} \) for \( f(x, y) = \int_x^{y^3} e^t \, dt \).
4. Show that \( u = e^{-9t} \cos(3x) \), satisfies the one-dimensional heat equation: \( u_{xx} = u_t \).

5. Find the linearization of \( f(x, y) = e^x - e^y \) at the point \((2, 0)\). Use it to estimate the value of \( f(2.1, 0.1) \).

6. Let \( z = F(x, y) \), \( x = g(s, t) \), \( y = h(s, t) \). Find \( z_t \) when \( s = -1, t = 3 \), given that \( F_x(4, 2) = 6 \), \( F_y(4, 2) = 2 \), \( g(-1, 3) = 4 \), \( h(-1, 3) = 2 \), \( g_t(-1, 3) = -1 \) and \( h_t(-1, 3) = 3 \).

7. Find \( D_u f \) for the function \( f(x, y) = \sqrt{x^2 + 3y^2} \) at the point \((1, 1)\) in the direction of \( v = 2i - 3j \).
8. Let $f(x, y) = x^2y - y + \frac{1}{x}$.

Show that the critical points are given by $(1, \frac{1}{2})$ and $(-1, -\frac{1}{2})$ and classify them using the Second Derivative Test.
9. Use Lagrange Multipliers to find the extrema of $x - 2y + 3z$ on the ellipsoid $x^2 + 2y^2 + z^2 = 1.$