1. Determine the largest set on which the function $f(x, y) = \cot \frac{y}{x}$ is continuous.  
10 points

2. Find all the second partial derivatives of $f(x, y) = x^5 - x^3 y^3 + y^5$.  
10 points
3. Find the differential of the function $w = \ln(x + y - z)$.

4. Let $u = xy + yz + zx$, $x = st$, $y = e^{st}$, $z = t^2$. Use the chain rule to find $\partial u / \partial s$ and $\partial u / \partial t$ when $s = 0$, $t = 1$. 

10 points
5. Find all points \((x, y)\) on the plane where the function \(f(x, y) = x^3y^3\) has a nonzero gradient and the direction of the fastest increase is \(\vec{i} + 2\vec{j}\). 

10 points

6. Find the absolute minimum and maximum values of \(f(x, y) = x^2y\) on the domain

\[
D = \{(x, y) | x \geq 0, \ y \geq 0, \ x^2 + y^2 \leq 1\}.
\]

10 points
7. Use Lagrange multipliers to find the maximum and minimum values of the function \( f(x, y, z) = x^4 + y^4 + z^4 \) subject to the constraint \( x^2 + y^2 + z^2 = 1 \).

10 points

8. Find the absolute extreme values of \( f(x, y) = x^2 + 4y^2 - 3x \) on the disk \( x^2 + y^2 \leq 1 \).

10 points
9. Calculate the integral
\[ \int_0^2 \int_0^1 \sqrt{x+y} \, dx \, dy. \]

10 points

10. Calculate
\[ \iint_R \frac{xy^2}{x^2 + 1} \, dA \]
over the rectangle \([-1, 1] \times [0, 3] \). 

10 points