1. (10 points) Compute the arc length of the curve 
\[ \vec{r}(t) = \left( t, \frac{4}{3} t^{\frac{5}{3}}, t^2 \right), \]
on the interval \(1 \leq t \leq 3\).

2. (10 points) Reparametrize the curve \( \vec{r}(t) = (e^t, e^t \sin t, e^t \cos t) \) with respect to arc length measured from the point \((1, 0, 1)\) in the increasing direction of \(t\).
3. (10 points) 
Find the tangent lines to the curves $\mathbf{r}_1(t) = \langle t, t^2, t^3 \rangle$ and $\mathbf{r}_2(u) = \langle 1, \sqrt{2}\sin(u), \sqrt{2}\cos(u) \rangle$ at the point $(1, 1, 1)$.

4. (10 points) Let $f(x, y) = \frac{\sqrt{x^2 - y}}{1 + x}$.
   
   a. (5 pts) Find the partial derivatives $\partial f / \partial x$ and $\partial f / \partial y$.

   b. (5 pts) Describe (using inequalities) and sketch the domain of $f(x, y)$.  

5. (10 points)
a. (5 pts) Find the limit

\[
\lim_{(x,y) \to (1,2)} \frac{x^2 + y^2}{xy}
\]

b. (5 pts) Prove that the following limit does not exist:

\[
\lim_{(x,y) \to (0,0)} \frac{3x^2 - y^2}{xye^x}
\]
6. (10 points)

a. (5 pts) Find all \((x, y)\) such that the first partial derivatives of \(f(x, y) = xye^y\) are zero.

b. (5 pts) Find all the second partial derivatives of \(f(x, y) = xye^y\)
7. (5 points)

a. (5 pts) Let \( z = \ln(u^3 + v^4) \), where \( u = t^4 \) and \( v = t^2 \). Compute \( \frac{dz}{dt} \).

8. (15 points) A curve in space is given by the vector function \( \mathbf{r}(t) = \langle 2 \sin(t), \sin(t), \sqrt{3} \cos(t) \rangle \). Compute unit tangent vectors to the curve.
9. (10 points) Answer the following questions. Give a brief explanation. Each question is worth 2 point.

Question 1: Can two different level curves of a function intersect?

Question 2: What are the level surfaces of the function \( f(x, y, z) = 5x + 4y + 3z \).

Question 3: Are the mixed partials \( \frac{\partial^2 f}{\partial x \partial y} \) and \( \frac{\partial^2 f}{\partial y \partial x} \) always equal?

Question 4: Define what it means for a function \( f(x, y) \) to be continuous at a point \((a, b)\).

Question 5: A space curve has a unique parameterization.