1. For each of the following, state a definition equivalent to that given in the text.

   (a) *the derivative of a vector-output function* \( \vec{F}(t) \)  
       (6 points)

   (b) *the partial derivative with respect to y of the function* \( f(x, y, z) \)  
       (6 points)

2. A wire is wrapped around a circular cylinder of radius 4 cm and length 20 cm so that there are 10 complete wraps of the wire. Give a vector-output function that parametrizes the shape of this wire. Include a domain for the function.  
   (12 points)

3. Compute the derivative of the vector-output function \( \vec{F}(t) = e^{3t} \hat{i} + 2t^3 \hat{j} + t \cos t \hat{k} \).  
   (9 points)

4. Consider the output curve for the vector-output function \( \vec{F}(t) = (t^2 - 3) \hat{i} + (t + 1) \hat{j} + (6t - 7) \hat{k} \). 
   and the plane with equation \( 4x + 2y - z = 5 \).

   (a) Show that the output curve intersects the plane for \( t = 2 \).  
       (5 points)

   (b) Find the acute angle between a normal to the plane and the curve at the point of intersection.  
       (7 points)

5. Show that \( \lim_{(x,y) \to (0,0)} \frac{x^2y}{x^3 + y^2} \) does not exist.  
   (10 points)

6. Compute all first and second partial derivatives of the function \( f(x, y) = x^2 \sin(3xy^2) \).  
   (15 points)

7. Compute all first partial derivatives of the function \( G(p, q, r) = pqe^{pr^2} \).  
   (9 points)

8. Find the equation of the tangent plane for the function \( f(x, y) = 4x^2y^3 - 7xy^2 \) for \((x, y) = (1, 2)\).  
   (12 points)

9. For an ideal gas, the temperature \( T \) is related to the pressure \( P \) and volume \( V \) by \( T = \alpha PV \) where \( \alpha \) is a constant. The quantity \( \frac{\Delta T}{T} \) represents a percentage change in the temperature. Show that this percentage change \( \frac{\Delta T}{T} \) is approximately equal to the sum of the percentage changes in the pressure and volume.  
   (9 points)