Q.1: Identify the quadratic surface \( 4x^2 + 6y^2 - 3z^2 - 24x + 12y + 18z = 17 \). Find its intersections with the coordinate planes (10 pts)

Q.2: Find the directional derivative of the function \( f(x, y, z) = \frac{1}{x - 2y + 3z} \) at the point \((1, 2, 3)\) in the direction \( v = (1, 2, 3) \). (10 pts)
Q.3: Find \( \frac{\partial z}{\partial x} \) and \( \frac{\partial z}{\partial y} \) for the function \( \tan(xyz) - 2x^2y + y^2z = 8 \). (10 pts)

Q.4: (a) Write equation of the hyperboloid \( x^2 - y^2 - z^2 = 1 \) in spherical and cylindrical coordinates (3+3 pts)

(b) Find spherical and cylindrical coordinates of the point whose rectangular coordinates are \( (0, 2\sqrt{3}, -2) \) (2+2 pts)
Q.5: Find the limit \( \lim_{(x,y) \to (0,0)} \frac{x^2 + \sin^2 y}{3x^2 + 2y^2} \) if exist or show that limit does not exist. \((10 \text{ pts})\)

Q.6: Explain why \( f(x, y) = \tan^{-1}(2x + 3y) \) is differentiable at the point \( P \left( 0, \frac{1}{3} \right) \). Also find the linearization \( L(x, y) \) of \( f(x, y) \) at the point \( P \). \((10 \text{ pts})\)
Q.7: The length \( l \), width \( w \) and height \( h \) of a box are changing with time. If \( l \) is increasing at a rate of \( 3 \, \text{m/s} \), \( w \) is decreasing at a rate of \( 2 \, \text{m/s} \), and \( h \) is increasing at a rate of \( 1 \, \text{m/s} \). Find the rate of change of the volume of the box when \( l = 10 \), \( w = 8 \), and \( h = 5 \). (10 pts)

Q.8: If \( z = f(x, y) \), where \( x = r \cos \theta \) and \( y = r \sin \theta \). Find \( \frac{\partial z}{\partial r} \) and \( \frac{\partial z}{\partial \theta} \) and show that

\[
\left( \frac{\partial z}{\partial x} \right)^2 + \left( \frac{\partial z}{\partial y} \right)^2 = \left( \frac{\partial z}{\partial r} \right)^2 + \frac{1}{r^2} \left( \frac{\partial z}{\partial \theta} \right)^2
\]

(10 pts)
Q.9: Find equation of tangent plane and normal line to the surface \( x - z = 4 \tan^{-1}(yz) \) at the point \( (3 + \pi, \frac{1}{3}, -3) \). (10 pts)

Q.10: Find local minimum and local maximum values and saddle points of the function \( f(x, y) = xy (1 - x - y) \). (10 pts)