1 The lines $L_1$ and $L_2$ have parametric equations:

$L_1: x = 1 + 2t, \quad y = 2 - t, \quad z = 4 - 2t$

$L_2: x = 9 + t, \quad y = 5 + 3t, \quad z = -4 - t.$

(a) Verify that $(7, -1, -2)$ is the point of intersection of the lines $L_1$ and $L_2$.

(b) Find parametric equations for the line that is perpendicular to $L_1$ and $L_2$ and passes through their point of intersection. [5pts]

2 Show that the planes $4x - 2y + 6z = 3$ and $-6z + 3y - 9z = 4$ are parallel and then find the distance between them. [5pts]
3 Identify and sketch the surface $x^2 - y^2 + z^2 = 1$. [4pts]

4 Let $f(x, y) = \ln(3x - 3y) + \cos(x + y)$. Find $f_{xx} - f_{yy}$. What is $f_{xxy} - f_{yxy}$? [4pts]
5 Use partial derivatives to find $\frac{dy}{dx}$ if $y$ is an implicit function of $x$ satisfying $\cos(x - y) - xe^y = 1$. [2pts]

6 Let $f(x, y) = x^2y^3 - 4y$. (a) Find the directional derivative of $f$ at the point $P(2, -1)$, in the direction of $\vec{v} = \langle 8, -6 \rangle$. (b) Find also the maximum value of a directional derivative of $f$ at the point $P(2, -1)$ and the unit vector in the direction of which this maximum value occurs. [6pts]
7. Use polar coordinates to find the limit, if it exists: (a) \( \lim_{(x,y) \to (0,0)} \frac{x^3 - xy^2}{x^2 + y^2} \) (b) \( \lim_{(x,y) \to (0,0)} \frac{y^2}{x^2 + y^2} \) [4pts]