Problem 1. (14 pts) Find the equation of the tangent plane to the surface
\( xy + yz + zx = 6 \) at the point \((2, 0, 3)\).

Problem 2. (14 pts) The temperature at a point in the plane is
\( T(x, y) = 100 - 3x^2 - 2y^3 \). A bug is at the point \((1, -1)\).
   (a) Compute \( \nabla T(1, -1) \).
   (b) Find the rate of change of temperature in the direction of \( \vec{v} = \langle 3, -4 \rangle \).
   (c) Find a direction in which the bug should move to NOT change its temperature.

Problem 3. (8 pts) Suppose the plane \( z = x - 2y - 3 \) is tangent to the graph of \( z = f(x, y) \) at \( P(1, -2) \).
   (a) Find \( f(1, -2), f_x(1, -2), f_y(1, -2) \).
   (b) Find the direction of maximum increase for the function \( f \) at the point \( P \).

Problem 4. (14 pts) A rectangular box has length, width and height, respectively, \( 20 \text{ cm} \times 10 \text{ cm} \times 10 \text{ cm} \). Use differentials to estimate the maximum error in measuring the volume of the box if the error in measuring each dimension is \( \pm 0.11 \text{ cm} \).

Problem 5. (14 pts) Let \( f(x, y, z) = x + y^2z \) and \( x = 3s^2 + 2t, \ y = 3s - 2t^2 \) and \( z = s^2 - t^2 \). Compute \( \frac{\partial f}{\partial s}(2, -2) \) and \( \frac{\partial f}{\partial t}(2, -2) \).

Problem 6. (22 pts) Let \( f(x, y) = 2x^2 + y^2 - 4y + 3 \).
   (a) Find critical points of \( f \) on the region \( x^2 + y^2 < 9 \).
   (b) Find the extreme values on the boundary \( x^2 + y^2 = 9 \) using Lagrange Multipliers.
   (c) Find the extreme values of \( f \) on \( x^2 + y^2 \leq 9 \) using the above information.

Problem 7. (14 pts) Find all the critical points of \( f(x, y) = x^3 + y^3 - 3xy + 4 \), and classify them using the Second Derivative Test.