1. (a) Find the equation of the plane containing the points (1, 2, 2), (1, 1, −1) and 
(−1, 2, 1).
(b) Let \( \mathbf{r}(t) = (4t^{1/4}, e^{t^2-1}, 2t) \). Find the unit tangent vector at the point on the 
curve corresponding to \( t = 1 \).
2. (a) Let $f(x, y) = x \cos(y) - x^2 y$. Find the second partial derivative $f_{xy}$.
(b) Let $f = x^2 z$ and $\mathbf{F} = (xz, y, z^2 y)$. Find $\nabla f$ (the gradient of $f$), $\text{div} \mathbf{F}$ (the divergence of $\mathbf{F}$), and $\text{curl} \mathbf{F}$ (the curl of $\mathbf{F}$).
3. (a) Find the directional derivative of the function \( f(x, y, z) = xz - y \) in the direction of the vector \( \mathbf{v} = \mathbf{i} - 2\mathbf{j} + 2\mathbf{k} = \langle 1, -2, 2 \rangle \) at the point \((1, 2, 0)\).
(b) Find the maximum rate of change of \( f(x, y) = xy + 2\sqrt{y} \) at the point \((2, 1)\). In which direction does it occur?
4. (a) Let \( z = x^3y^2 - x \). Find the equation of the tangent plane at the point \((2, 1)\).
(b) Find equation of the tangent plane to the surface \( x^2 + 2y^2 - 2z^2 = 4 \) at the point \((2, -1, 1)\).
5. Find the local maximum, minimum and saddle points (if any) of the function
\[ f(x, y) = 2x^2 + 4xy - y^2 + 6x - 3. \]
6. (a) Find the linear approximation for the function
\[ f(x, y) = 2x^2 + y^2 + yx \]
near the point \((1, -2)\).

(b) Let \( f(x, y) = xy - 2x^2y \) and \( x = s - t, \ y = s^2t \). Find the partial derivatives \( \partial f/\partial s \) and \( \partial f/\partial t \).
7. Find the absolute maximum and absolute minimum points of the function

\[ f(x, y) = 2x^2 + 3y^2 - 4x - 3 \]

on the region \( 0 \leq x \leq 2, \quad -1 \leq y \leq 1 \). Be sure to provide the coordinates of the points and the values of absolute maximum and minimum.
8. Evaluate, by making an appropriate change of variables, the integral

\[ \int \int_D (x + y) \sin(x - y) \, dA \]

where \( D \) is the rectangle enclosed by the lines \( x - y = 0, \ x - y = 4, \ x + y = 1, \) and \( x + y = 2. \)
9. An agricultural sprinkler distributes water in a circular pattern over a maize field. Each hour, it supplies water to a depth of $e^{-r}/r$ feet at a distance of $r > 0$ feet from the sprinkler. Find the total amount of water supplied per hour to the region between the circles of radius 5 and 10 feet centered at the sprinkler.
10. (a) Switch the order of integration in the iterated integral
\[ \int_0^2 \left[ \int_0^{x^3} f(x, y) \, dy \right] \, dx. \]

(b) Using a double integral, find the area of the triangle with vertices (0, 0), (1, 1), (1, 2).
11. Use cylindrical coordinates to find the mass of the solid that lies within both the cylinder $x^2 + y^2 = 16$ and the sphere $x^2 + y^2 + z^2 = 36$ and above the plane $z = 0$, if the material in the solid has density (mass per unit volume) given by $\rho(x, y, z) = 2$. 