1) a) Show that $lim_{(x,y)\to(0,0)} \frac{xy\, e^y}{5x^2+y^2}$ does not exist.

b) For the function $z = f(x, y) = \sqrt{9 - x^2 - y^2}$, find $\frac{\partial z}{\partial x \partial y}$ at the point $(2,1)$.

c) If $w = f(x, y, z)$ and $x = 2st, y = s^2 \sin t, \ \ z = \cos(3st)$, find $\frac{\partial w}{\partial s}$ using the partial derivatives of f.

2) a) For the function $f(x, y) = y^3 + 3x^2y - 6x^2 - 6y^2 + 2$, find the local maximum and minimum values and saddle points.

b) Find the equation of the tangent plane to the graph of $f(x, y) = \sqrt{2x + 5e^{4y}}$ at the point $P(2,0)$. Then, find the linear approximation to $f(2.1,0.1)$.

3) a) Find the surface area of the part of the surface $z = x^2 + 2y$ that lies above the triangular region in the $xy - plane$ with vertices $(0,0), (2,0),$ and $(2,2)$.

b) Evaluate the double integrals:

(i) $\int_0^3 \int_0^{\sqrt{9-x^2}} \cos(x^2 + y^2) dydx$ (ii) $\int_0^8 \int_{\sqrt[3]{y}}^2 e^{x^4} dx\, dy$

4) a) Evaluate the triple integral $\iiint_E x^2 + y^2 \, dV$, where E lies between the spheres $x^2 + y^2 + z^2 = 4$ and $x^2 + y^2 + z^2 = 9$.

b) Evaluate the triple integral $\iiint_E x^2 dV$, where E is the solid lies within the cylinder $x^2 + y^2 = 1$, above the plane $z = 0$, and below the cone $z = 4x^2 + 4y^2$.