1) a) Find the first partial derivatives to the function $F(x,y) = x^2y\int_{y^2}^{2x} \sin e^{-t}dt$.

b) Find $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$ if $yz + \cos x \ln y = yz^2$.

2) a) If $z = f(x, y)$ has continuous second-order partial derivatives and $x = r^2 + rs$ and $y = 3rs$, find $\frac{\partial z}{\partial r}$ and $\frac{\partial^2 z}{\partial r^2}$. Then, apply your result to evaluate $\frac{\partial^2 z}{\partial r^2}$ when $r = 1$ and $s = 0$ for the function $z = f(x, y) = xe^{xy}$.

b) Given that the function $g(x, y) = y^2 - 2y\ cosx$ has the critical points $A(0,1), B(\pi, -1), C(2\pi, 1), D\left(\frac{\pi}{2}, 0\right), E(\frac{3\pi}{2}, 0)$ on the interval $[-1,7]$, find the local maximum and minimum values and saddle point(s) of g if they exist.

3) Evaluate the double integrals:

a) $\int_0^1 \int_{-3}^3 \frac{xy^2}{x^2+1} dy\, dx$

b) $\int_0^1 \int_x^1 e^{x/y} dy\, dx$

c) $\int_{-2}^2 \int_0^{\sqrt{4-x^2}} \cos(x^2+y^2)\, dydx.$

4) a) Find the area of the part of the surface $z = xy$ that lies within the cylinder $x^2 + y^2 = 4$.

b) Evaluate the triple integral: $\int_0^{\pi} \int_0^{y} \int_0^{x} \sin(x + y + z)dzdxdy$.

5) a) Find the volume of the solid that is enclosed by the cone $z = \sqrt{x^2 + y^2}$ and the sphere $x^2 + y^2 + z^2 = 2$.

b) Evaluate $\iiint_E (x^2 + y^2 + z^2)^{\frac{3}{2}}\, dV$, where E lies between the spheres $x^2 + y^2 + z^2 = 1$ and $x^2 + y^2 + z^2 = 4$