1) Find and classify the critical points of the function

$$f(x, y) = y^2 - 2y\,cosx, \qquad 0 \leq x \leq 2\pi.$$

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

b) If $z = f(x, y),\ \ x = r\cos\theta\ ,\ \ and\ \ y = r\sin\theta$, find $\frac{\partial z}{\partial r}$ and $\frac{\partial z}{\partial \theta}$ and then show that $\left(\frac{\partial z}{\partial x}\right)^2 + \left(\frac{\partial z}{\partial y}\right)^2 = \left(\frac{\partial z}{\partial r}\right)^2 + \frac{1}{r^2}\left(\frac{\partial z}{\partial \theta}\right)^2$.

3) a) Find the surface area of the part of the surface $z = x^2 + 3y$ that lies above the triangular region in the $xy - plane$ with vertices $(0,0), (1,0),$ and $(1,1)$.

b) Evaluate the double integrals:

(i) $\int_{-3}^{3} \int_{0}^{\sqrt{9-y^2}} \cos(x^2 + y^2)\, dxdy$ (ii) $\int_{0}^{8} \int_{\sqrt[3]{y}}^{2} e^{x^4} dx\, dy.$

4) a) Evaluate the triple integral $\iiint_E (x^2 + y^2 + z^2)\, dV$, where E lies between the spheres $x^2 + y^2 + z^2 = 1$ and $x^2 + y^2 + z^2 = 4$.

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