

**Q.1:** Reduce the equation and classify the surface,  $x^2 - y^2 + z^2 - 2x + 2y + 4z + 4 = 0$ .

**Sol:**  $x^2 - 2x - y^2 + 2y + z^2 + 4z = -4$   
 $x^2 - 2x + 1 - y^2 + 2y - 1 + z^2 + 4z + 4 = -4 + 4 - 1 + 1$   
 $(x - 1)^2 - (y - 1)^2 + (z + 2)^2 = 0$   
The surface is a cone.

**Q.2:** Identify the surface  $\rho^2 (\sin^2 \phi - 4 \cos^2 \phi) = 4$ .

**Sol:**  $\rho^2 \sin^2 \phi - 4\rho^2 \cos^2 \phi = 4$   
 $r^2 - 4z^2 = 4$   
 $x^2 + y^2 - 4z^2 = 4$   
The surface is hyperboloid of one sheet.

**Q.3:** Find the limit  $\lim_{(x,y) \rightarrow (0,0)} \frac{xy \cos y}{3x^2 + 2y^2}$  if exist, or show that limit does not exist.

**Sol:** Let  $x = 0$  and  $y \rightarrow 0$ , then  $\lim_{y \rightarrow 0} \frac{0y \cos y}{0 + 2y^2} = 0$ .

Let  $y = 0$  and  $x \rightarrow 0$ , then  $\lim_{x \rightarrow 0} \frac{x^2 0 \sin^2 0}{3x^2} = 0$ .

Let  $y = x$ , then  $\lim_{y \rightarrow 0} \frac{y^2 \cos y}{5y^2} = \frac{1}{5}$ .

Thus limit does not exist.