If $f(x,y)$ is diff. at (x_0,y_0)

$\Rightarrow$ $\not\Leftarrow$ $D_{\vec{u},(x_0,y_0)} f = \nabla f(x_0,y_0) \cdot \vec{u}$

$\vec{u} = (\cos\theta, \sin\theta)$

But $D_{\vec{u}(0,0)} f_3 = \cos^3\theta \neq \nabla f \cdot \vec{u} = \cos\theta$

$\therefore$ f_3 is not diff. at $(0,0)$

Eg 4. $f_4(x,y) = 1 + 2x + 3y + \underbrace{4x^2 + 5xy + 6y^2}_{\text{error}}$

Is $f_4(x,y)$ diff. at $(0,0)$?

Ans: Show $\lim_{(x,y)\to(0,0)} \frac{\text{error}}{\sqrt{x^2+y^2}} = 0$ (exercise)

or Show error $= \varepsilon_1 x + \varepsilon_2 y$, $\lim \varepsilon_1, \varepsilon_2 = 0,0$