Form B

1. $\vec{\nabla} f(x,y) = \langle 4x+3y-1,\ 3x+2y \rangle$

$$z = f(1,-2) + \frac{\partial f}{\partial x}(1,-2)(x-1) + \frac{\partial f}{\partial y}(1,-2)(y+2)$$

$$\boxed{z = -1 - 3(x-1) - 1(y+2) \quad \text{or} \quad 3x + y + z = 0}$$

2. $$\vec{u} = \frac{\langle 4-1,\ 2--2 \rangle}{\sqrt{3^2+4^2}} = \left\langle \frac{3}{5}, \frac{4}{5} \right\rangle$$

$$D_{\vec{u}} f(1,-2) = \vec{\nabla} f(1,-2) \circ \vec{u} = \langle -3, -1 \rangle \circ \left\langle \frac{3}{5}, \frac{4}{5} \right\rangle$$

$$= -\frac{9}{5} - \frac{4}{5} = \boxed{\frac{-13}{5}} = -2.6$$

3. Solve $\vec{\nabla} f(x,y) = 0 \iff$

$$\left.\begin{aligned} \frac{\partial f}{\partial x} &= 4x + 3y - 1 = 0 \\ \frac{\partial f}{\partial y} &= 3x + 2y = 0 \end{aligned}\right\} \Rightarrow \underbrace{x = -2,\ y = 3}_{\text{inside } R}$$

$f_{xx} = 4$, $f_{xy} = 3$, $f_{yy} = 2$, so at every point (x,y),

$$D(x,y) = \begin{vmatrix} 4 & 3 \\ 3 & 2 \end{vmatrix} = -1 < 0,$$ indicating the critical point is the location of a <u>saddle point</u>.