1.

a)

$f_1(x) = w_1 x + b_1$

$f_2(f_1(x)) = w_2(w_1 x + b_1) + b_2 =$

$= w_1 w_2 x + w_2 b_1 + b_2$

$f_3(f_2(f_1(x))) = w_3(w_1 w_2 x + w_2 b_1 + b_2) b_3$

$= w_1 w_2 w_3 x + w_2 w_3 b_1 + w_3 b_2 + b_3$

$\frac{d}{dx} f_3(f_2(f_1(x))) =$

$= \underline{\underline{w_1 w_2 w_3}}$

2.

a) $f(x,y) = x^2y + 3y$

$\frac{d}{dx} f(x,y) = 2xy$

$\frac{d}{dy} f(x,y) = x^2 + 3$

$X_0 = (2, -1)$

$\nabla f(x,y) = \begin{bmatrix} 2xy \\ x^2+3 \end{bmatrix}$

$X_1 = X_0 - 2 \begin{bmatrix} -4 \\ 7 \end{bmatrix}$

$X_1 = (2, -1) - \begin{bmatrix} -8 \\ 14 \end{bmatrix}$

$\underline{\underline{X_1 = (10, -15)}}$

$X_2 = X_1 - 2 \begin{bmatrix} -300 \\ 103 \end{bmatrix}$

$X_2 = (10, -15) - \begin{bmatrix} -600 \\ 206 \end{bmatrix}$

$\underline{\underline{X_2 = (610, -221)}}$

5)

$$f(x,y) = 3x^2 + xy + y^2 - 4y$$

$$\frac{d}{dx} f(x,y) = 6x + y$$

$$\frac{d}{dy} f(x,y) = x + 2y - 4$$

$$\nabla f(x,y) = \begin{bmatrix} 6x+y \\ x+2y-4 \end{bmatrix}$$

$$X_0 = (2, -1)$$

$$\nabla f(X_0) = \begin{bmatrix} 11 \\ -4 \end{bmatrix}$$

$$X_1 = (2,-1) - \begin{bmatrix} 22 \\ -8 \end{bmatrix}$$

$$\underline{X_1 = [\quad] \; (-20, 7)}$$

$$\nabla f(X_1) = \begin{bmatrix} -113 \\ -10 \end{bmatrix}$$

$$X_2 = (-20, 7) - \begin{bmatrix} -226 \\ -20 \end{bmatrix}$$

$$\underline{X_2 = (206, 27)}$$