1. $y - 3x - 2 = 0 \cdots ①$

$3y + x + 9 = 0 \cdots ②$

$y - 3x = 2 \cdots ①$

$\therefore y = 3x + 2 \cdots ①$

$y = -x/3 + 3 \cdots ②$

$y = mx + c$

$m_1 = 3, \quad m_2 = -1/3$

If these lines are perpendicular, $m_1 \cdot m_2 = -1$

$3 \times -1/3 = -1$

$\therefore$ The two lines are perpendicular.

2. $3y - 4 = 2x + 3 \cdots ①$

$y - 5 = x + 6 \cdots ②$

$y = 2/3x + 7/3 \cdots 1$

$y = x + 11$

$y = mx + c$

$m_1 = 2/3 \quad m_2 = 1$

If these lines are perpendicular, $m_1 \cdot m_2 = -1$

$2/3 \times 1 = 2/3$

$\therefore$ The two lines are NOT perpendicular.

$y = \frac{-8x + 22}{7}$ → equation of the tangent

$m_1 \cdot m_2 = -1$

$-\frac{8}{7} \cdot m_2 = -1$

$m_2 = 7/8$

$y - y_1 = m_2 (x - x_1)$

$y - 2 = \frac{7}{8}(x - 1)$

$8y - 16 = 7x - 7$

$8y = 7x + 9$

$y = \frac{7x + 9}{8}$ → equation of the normal.

3. $x^2 + y^2 + 3xy - 11 = 0$ at the point $x = 1$ and $y = 2$.

$$x^2 + 3xy + y^2 = 11$$

$$d/dx(x^2 + 3xy + y^2) = d/dx(11)$$

$$2x + 3(x\,dy/dx + y\,dx/dx) + 2y\,dy/dx = 0$$

$$2x + 3(x\,dy/dx + y) + 2y\,dy/dx = 0$$

$$2x + 3x\,dy/dx + 3y + 2y\,dy/dx = 0$$

$$3x\,dy/dx + 2y\,dy/dx + 2x + 3y = 0$$

$$dy/dx(3x + 2y) = -2x - 3y$$

$$\frac{dy}{dx} = \frac{-2x - 3y}{3x + 2y}$$

Gradient $(m_1) = -\frac{(2x + 3y)}{3x + 2y}$

$$= -\frac{(2(1) + 3(2))}{3(1) + 2(2)}$$

$$= \frac{-8}{7}$$

~~Equat~~ $y - y_1 = m_1(x - x_1)$

$$y - 2 = \frac{-8}{7}(x - 1)$$

$$y - 2 = \frac{-8x}{7} + \frac{8}{7}$$

$$7y - 14 = -8x + 8$$

$$7y = -8x + 22$$