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Solution.

(1) $y - 3x - 2 = 0$ and $3y + x + 9 = 0$

$y - 3x - 2 = 0$

$y = 3x + 2$

$m_1 = 3$

$3y + x + 9 = 0$

$3y = -x - 9$

$y = -x/3 - 3$

$m_2 = -1/3$

$\therefore m_1 m_2 = -1$, it is perpendicular since their product is equal to -1.

(2) $3y - 4 = 2x + 3$ and $y - 5 = x + 6$

$3y - 4 = 2x + 3$

$3y = 2x + 3 + 4$

$3y = 2x + 7$

$y = 2/3x + 7/3$

$m_1 = 2/3$

$y - 5 = x + 6$

$y = x + 6 + 5$

$y = x + 11$

$m_2 = 1$

It is not perpendicular since $m_1 m_2 \neq -1$.

(3) $x^2 + y^2 + 3xy - 11 = 0$ at the point $x = 1, y = 2$

$m_1 = dy/dx = \dfrac{-2x - y}{2y + 3x}$

Using implicit rule

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

$2x + 2y\dfrac{dy}{dx} + 3\left[x\dfrac{dy}{dx} + y\dfrac{dx}{dx}\right] = 0$

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

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

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

From the gradient at $x = 1$

$m_1 = \dfrac{-2(1)y}{2y + 3(1)} = \dfrac{-2y}{2y + 3} = -1/3$

$\therefore y - y_1 = m(x - x_1)$

$y - 2 = -\dfrac{1}{3}(x - 1)$

$3(y - 2) = -x + 1$

$3y - 6 = -x + 1$

$3y = -x + 1 + 6$ (Equation of tangent)

$3y = -x + 7$ OR $3y + x - 7 = 0$

Equation of the normal

$m_1 m_2 = -1$

$(-1/3)m_2 = -1$

$m_2 = -1/-1/3 = -1 \times 3/-1 = 3$

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

$y - 2 = 3(x - 1)$

$y - 2 = 3x - 3$

~~$y - 2 = 3x$~~ $y = 3x - 3 + 2$

$y = 3x - 1$ OR $y - 3x + 1 = 0$