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

For perpendicular lines, $m_1 m_2 = -1$

$y - 3x - 2 = 0$

$y = 3x + 2$

$\frac{dy}{dx} = 3$

$\therefore m_1 = 3$

$3y + x + 9 = 0$

$3y = -x - 9$

$y = \frac{-x}{3} - 3$

$\frac{dy}{dx} = \frac{-1}{3}$

$\therefore m_2 = -1/3$

$m_1 m_2 = 3 \times -1/3$

$= -1$

Therefore, $y - 3x - 2 > 0$ and $3y - x + 9 = 0$ are PERPENDICULAR

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

For perpendicular lines, $m_1 m_2 = -1$

$m_1 m_2 = -7$

$3y - 4 = 2x + 3$

$3y = 2x + 7$

$y = \frac{2}{3}x + \frac{7}{3}$

$\frac{dy}{dx} = \frac{2}{3}$ $\therefore m_1 = \frac{2}{3}$

$y - 5 = x + 6$

$y = x + 11$

$\frac{dy}{dx} = 1$ $\therefore m_2 = 1$

$m_1 m_2 = \frac{2}{3} \times 1 = \frac{2}{3}$

Therefore, the lines $3y - 4 = 2x + 3$ and $y - 5 = x + 6$ are NOT PERPENDICULAR

③ $x^2 + y^2 + 3xy - 11 = 0$ at pt $x = 1, y = 2$.

$\frac{dy}{dx} = 2x + 2y\frac{dy}{dx} + 3y + 3x\frac{dy}{dx} = 0$

$2x + 2y\frac{dy}{dx} + 3\left(y + x\frac{dy}{dx}\right) = 0$

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

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

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

$\left.\frac{dy}{dx}\right|_{(1,2)} = \frac{-2(1) - 3(2)}{2(2) + 3(1)}$

$= \frac{-2 - 6}{4 + 3}$

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

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$\therefore m = -8/7$

Equation of tangent

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

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

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

$7y + 8x - 22 = 0$

Equation of normal

$y - y_1 = \frac{-1}{-8/7}(x - x_1)$

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

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

$8y - 16 = 7x - 7$

$8y - 7x - 9 = 0$

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