$y - 2 = 2$

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

Solution.

$y - 3x - 2 = 0$

$y = 3x + 2$

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

$m_1 = 3$

$3y + x + 9 = 0$

$3y = -x - 9$

$y = \frac{-x}{3} - \frac{9}{3}$

$dy/dx \quad y = -x/3 - 3$

$dy/dx = -1/3$

$m_2 = -1/3$

For perpendicularity $m_1 m_2 = -1$

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

$\therefore$ It is perpendicular as it satisfies the eqn

$m_1 m_2 = -1$

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

Solution.

$3y - 4 = 2x + 3$

$3y = 2x + 3 + 4$

$3y = 2x + 7$

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

$\frac{dy}{dx} = \frac{2}{3}$, $m = 2/3$

$y = x + 6 + 5$

$y = x + 11$

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

$m = 1$

for perpendicularity $m_1 m_2 = -1$

$2/3 (1) = 2/3$

$m_1 \neq m_2$

It is not perpendicular as $m_1 m_2 \neq -1$

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

Solution:

$x^2+y^2+3xy-11=0$ — bi-differentiate

$\frac{dy}{dx} = 2x + 2y\frac{dy}{dx} + 3\left(x\cdot\frac{dy}{dx} + y\cdot 1\right) = 0$

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

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

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

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

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

$\left.\frac{dy}{dx}\right|_{x=1,y=2} = \frac{-2(1)+3(2)}{2(2)+3(1)} = \frac{-2+6}{4+3} = -\frac{4}{7}$

$m = 4/7$

Eqn of tangent: $y - y_1 = m(x - x_1)$

$y - 2 = -\frac{4}{7}(x-1)$

$y - 2 = -\frac{4}{7}x + \frac{4}{7}$

$7y - 14 = -4x + 4$

$7y + 4x - 14 + 4 = 0$

$7y + 4x - 22 = 0$

Eqn of normal: $y - y_1 = \frac{-1}{m}(x - x_1)$

$y - 2 = \frac{-1}{-4/7}(x - 1)$

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

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

$$8y - 16 = -7x + 7$$

$$8y + 7x - 16 + 7 = 0$$

$$8y + 7x - 9 = 0$$