Equation of normal

$y - y_1 = \frac{-1}{m_1}(x - x_1)$ $\quad (x, y) = (1, 2)$

$m_1 m_2 = -1$

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

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

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

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

$8y - 16 = 7x - 7$

$8y - 7x - 9 = 0$ (gives equation of normal).

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Examine whether or not the pair of lines are perpendicular

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

For them to perpendicular to each other $m_1 m_2 = -1$

$y-3x-2=0 \longrightarrow$ equation 1

$y = 3x+2$

$y = mx+c$

$m_1 = 3$

$3y+x+9=0 \rightarrow$ equation 2

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

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

$m_2 = -\frac{1}{3}$

$\therefore m_1 m_2 = -1$

$3 \times -\frac{1}{3} = -1$

$\therefore$ The lines are perpendicular to each other.

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

$3y-4=2x+3 \rightarrow$ eqn 1

$3y=2x+3+4$

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

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

$m_1=\frac{2}{3}$

$y-5=x+6$

$y=x+6+5$

$y=x+11$

$m_2=1$

For lines to lines to perpendicular $m_1m_2=-1$

$m_1m_2=-1, \frac{2}{3}\times 1=\frac{2}{3}$

$\therefore \frac{2}{3}\times 1 \neq -1$

$\therefore$ The lines are not perpendicular to each other.

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

$$x^2 + y^2 + 3xy - 11 = 0$$

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

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

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

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

$(x, y) = (1, 2)$

$$\frac{dy}{dx} = \frac{-2(1) - 3(2)}{2(2) + 3(1)} = \frac{-2 - 6}{4 + 3} = \frac{-8}{7}$$

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

Equation of tangent

$y - y_1 = m(x - x_1)$ $(x, y) = (1, 2)$

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

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

$7y + 8x - 22 = 0$ (equation of tangent)