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Examine whether or not these pairs of lines are perpendicular to each other.

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

$y = 3x + 2$; $3y = -x - 9$

$y = mx + c$; $y = -\frac{x}{3} - \frac{9}{3}$

$m_1 = 3$; $y = mx + c$

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

For two lines to be perpendicular,

$m_1 m_2 = -1$

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

∴ Since $m_1 m_2 = -1$, the lines are perpendicular to each other.

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

$3y = 2x + 7$; $y = x + 11$

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

$y = mx + c$; $m_2 = 1$

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

For 2 lines to be perpendicular to each other,

$m_1 m_2 = -1$

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

∴ since $m_1 m_2 \neq -1$, the lines are not perpendicular to each other.

3. Find the equations of the tangent and normal to the curve;

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

at the point $x=1, y=2$

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

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

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

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

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

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

$m=\dfrac{-2-6}{4+3}=\dfrac{-8}{7}$

(a) Equation of tangent: $m=\dfrac{y-y_1}{x-x_1}$

$-\dfrac{8}{7}=\dfrac{y-2}{x-1}$

$-8(x-1)=7(y-2)$

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

$7y+8x-22=0$

(b) Equation of normal:

$-\dfrac{1}{m}=\dfrac{y-y_1}{x-x_1}$

$m=-8/7$

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

$7/8=\dfrac{y-2}{x-1}$

$7(x-1)=8(y-2)$

$7x-7=8y-16$

$8y-7x-9=0$