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matric no: 19/sci11/007

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MATH104 Assignment answers

2<sup>nd</sup> Apr 1, 2020

1  $\lim_{x \rightarrow 0} \frac{x - \cos x}{x}$

$$\frac{dy}{dx} = \lim_{x \rightarrow 0} \frac{1 + \sin x}{1}$$

$$\frac{dy}{dx} = 1 + \sin 0$$

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

2  $u = -3$

$$\frac{dy}{dx} = 0 \quad \frac{dy}{dx} = 7 \sec^2 7x$$

$$u = e^{3x} \quad \frac{dy}{dx} = 3e^{3x}$$

$$\frac{dy}{dx} = y \left( \frac{1}{x} + \frac{1}{\tan 7x} \right) + \frac{1}{x^2} (3e^{3x})$$
$$\frac{dy}{dx} = -3 \tan 7x e^{3x} \left[ \frac{7 \sec^2 7x}{\tan 7x} + 3 \right]$$

3  $y \cos x = \cos 3x$

$$y + \Delta y = \cos 3(x + \Delta x)$$

$$\Delta y = \cos(3x + 3\Delta x) - \cos 3x \rightarrow 0$$

Recall:

$$\cos A - \cos B = -2 \sin \frac{A+B}{2} \sin \frac{A-B}{2} \quad \text{--- (1)}$$

Compare equation (1) and (2)

$$A = 3x + 3\Delta x \quad B = 3x$$

$$A+B = \frac{3x + 3x + 3\Delta x + 3\Delta x}{2} = \frac{6x + 6\Delta x}{2} = 3x + 3\Delta x$$

$$\text{And } \frac{A-B}{2} = \frac{3x + 3\Delta x - 3x}{2} = \frac{3\Delta x}{2}$$

Hence

$$\Delta y = \cos(3x + 3\Delta x) - \cos 3x = -2 \sin \left( 3x + \frac{3\Delta x}{2} \right) \sin \frac{3\Delta x}{2}$$

19/sep/17/007 17

$$\Delta y = -2 \sin\left(3x + \frac{3\Delta x}{2}\right) \frac{\sin \frac{3\Delta x}{2}}{2}$$

Divide through by  $\Delta x$ 

$$\frac{\Delta y}{\Delta x} = \frac{-2 \sin\left(3x + \frac{3\Delta x}{2}\right) \frac{\sin \frac{3\Delta x}{2}}{2}}{\Delta x}$$

multiply the numerator & denominator with  $\frac{1}{2}$ 

$$\frac{\Delta y}{\Delta x} = \frac{-\cancel{2} \sin\left(3x + \frac{3\Delta x}{2}\right) \frac{\sin \frac{3\Delta x}{2}}{2} \times \frac{1}{2}}{\frac{\Delta x}{2}}$$

$$\frac{\Delta y}{\Delta x} \stackrel{\lim_{\Delta x \rightarrow 0}}{=} \leftarrow$$

$$\text{recall } \lim_{\Delta x \rightarrow 0} \frac{\sin\left(\frac{\Delta x}{2}\right)}{\frac{\Delta x}{2}} = 1$$

$$\text{So... } \frac{\Delta y}{\Delta x} \stackrel{\lim_{\Delta x \rightarrow 0}}{=} = -\sin 3x \cdot 3$$

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

$$(f-g)(x) = f(x) - g(x)$$

$$(f-g)(x) = (2x^3 - 7x) - (-3x)$$

$$(f-g)(s) = [2(s)^3 - 7(s)] - [-3(s)]$$

$$= [2(125) - 35] - [-15]$$

$$= [250 - 35] + 15$$

$$= 170 + 15$$

$$= 185,$$

19/Sci17/007

$$\begin{aligned}
 5 \text{ Fog}(x) &= 4(2x+3)^2 + 2 \\
 &= 4(2x+3)(2x+3) + 2 \\
 &= 4(4x^2 + 12x + 9) + 2 \\
 &= 16x^2 + 48x + 36 + 2 \\
 &= 16x^2 + 48x + 38
 \end{aligned}$$

$$6 \quad y - y_1 = m(x - x_1)$$

$$x^2 + 2xy + y^2 = 1020$$

$$2x \frac{dy}{dx} + 2 \left[ 1 \cdot y \frac{dy}{dy} + x \frac{dy}{dx} \right] + 2y \frac{dy}{dx} = 1020$$

$$2x + 2y + 2x \frac{dy}{dx} + 2y \frac{dy}{dx} = 1020$$

$$2x + 2y + \frac{dy}{dx} (2x + 2y) = 1020$$

$$\frac{dy}{dx} (2x + 2y) = 1020 - 2x - 2y$$

$$\frac{dy}{dx} = \frac{1020}{2x + 2y} - \frac{2x + 2y}{2x + 2y}$$

$$\frac{dy}{dx} = \frac{1020}{2x + 2y} - 1$$

$$7 \quad y = x^2 \cos x$$

$$u = x^2$$

$$v = \cos x$$

$$\frac{du}{dx} = 2x$$

$$\frac{dv}{dx} = -\sin x$$

$$\frac{dy}{dx} = u \frac{dv}{dx} + v \frac{du}{dx}$$

$$= x^2 (-\sin x) + (\cos x)(2x)$$

$$= 2x \cos x - x^2 \sin x$$