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

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

Recall $\cos A - \cos B = -2\sin\frac{A+B}{2}\sin\frac{A-B}{2}$

$\Delta y = -2\sin\left(\frac{6x+3\Delta x}{2}\right) \times \sin\left(\frac{3\Delta x}{2}\right)$

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

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

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

$\lim_{\Delta x \to 0} -3\sin\left(\frac{x+\Delta x}{2}\right) \times \frac{\sin\frac{\Delta x}{2}}{\frac{\Delta x}{2}}$

recall $\lim_{\theta \to 0} \sin\theta = 1$

$\frac{dy}{dx} = -3\sin 3x$

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

$g(x) = -3x$

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

$2x^3 - 7x + 3x$

$2x^3 - 4x$

Course Code: MAT 304

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(i) $\lim_{x \to 0} \frac{x - \cos x}{x}$

$-1 \leq \frac{\cos x}{x}$

$\lim_{x \to 0} (-1) = -1$

$\lim_{x \to 0} \frac{x - \cos x}{x}$ does not exist

(ii) $-3\tan 7x - e^{3x}$

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

$3\tan\frac{dy}{dx} = -21\sec^2 x \quad u = -3\tan 7x$

$dv/dx = 3e^{3x} \quad v = e^{3x}$

$dy/dx = -3\tan 7x(3e^{3x}) + e^{3x}(-21\sec^2 7x)$

$= -3\tan 7x(3e^{3x}) + e^{3x}(-21\sec^2 7x)$

(iii) $y = \cos 3x$

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

(vii) $y = x^2 \cos x$

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

$u = x^2 \qquad v = \cos x$

$\frac{dv}{dx} = -\sin x \qquad \frac{du}{dx} = 2x$

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

$-x \sin x + 2x \cos x$

(f-g)5 = 2(5) - 4(5)

250 - 20

= 230

(v) $f_{og}(x)$

if $f(x) = 4x^2 + 2$

$g(x) = 2x + 3$

$2x + 3 = 0$

$x = -3/2$

$f_{og} = 4\left(\frac{-3}{2}\right)^2 + 2$

$4\left(\frac{9}{4}\right) + 2$

$9 + 2 = 11$

(vi) $x^2 + 2xy + y^2$

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

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

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

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