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19/MHS06/011
MAT 101

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

The function is defined for all real numbers except $x=2$.
The domain is real no except $x=2$
The codomain is the set of real numbers except $y=0$

2) $K = \ln V$ $\frac{dK}{dV} = \frac{1}{V}$

3a) $2x-3y-2=0$
$3y = 2x-2$
$y = \frac{2x-2}{3}$

b) $x^2+y^2=4$
$y^2 = 4-x^2$
$y = \sqrt{4-x^2}$

4) $P = \sin^{-1}t$

5) $f(x) = 2x^2-5$ $g(x) = 4x-2$
a) $f\circ g(x) = f(g(x))$
$f(g(x)) = f(4x-2)$
$= 2(4x-2)^2-5$
$= 2(4x-2)(4x-2)-5$
$f\circ g(x) = 2(16x^2-16x+4)$
$= 32x^2-32x+8$

b) $g\circ f(x) = g(f(x))$
$g(f(x)) = g(2x^2-5)$
$= 4(2x^2-5)-2$
$= 8x^2-20-2$
$= 8x^2-22$

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6.) $f(x) = 3x^2 - 2x + 1 = 0$

$f_e(x) = \frac{f(x) + f(-x)}{2}$

$f(-x) = 3(-x)^2 - 2(-x) + 1$

$= 3x^2 + 2x + 1$

$f(x) = 3x^2 - 2x + 1$

$f_e(x) = \frac{3x^2 - 2x + 1 + 3x^2 + 2x + 1}{2}$

$f_e(x) = \frac{6x^2 + 2}{2} = \frac{2(3x^2 + 1)}{2}$

$= 3x^2 + 1$

$f_o(x) = \frac{f(x) - f(-x)}{2}$

$= \frac{3x^2 - 2x + 1 - (3x^2 + 2x + 1)}{2}$

$= \frac{3x^2 - 2x + 1 - 3x^2 - 2x - 1}{2}$

$= \frac{-4x}{2} = -2x$

$f(x) = f_e(x) + f_o(x) =$

$= 3x^2 + 1 + (-2x)$

$= 3x^2 - 2x + 1$

7.) $y = \cos x$

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

subtract y from both sides

$y + \delta y - y = \cos(x + \delta x) - y$

but $y = \cos x$

$\delta y = \cos(x + \delta x) - \cos x$ — (i)

Consider from trig

$\cos(A+B) = \cos A \cos B - \sin A \sin B$

$\cos(A-B) = \cos A \cos B + \sin A \sin B$

$\cos(A+B) - \cos(A-B) = -2 \sin A \sin B$ — (ii)

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compare (i) and (ii)

let

$A + B = x + \delta x$ — *

$A - B = x$ — 2*

$2A = 2x + \delta x$

$A = \frac{2x + \delta x}{2} = x + \delta x/2$ } (iii)

$B = \delta x/2$

compare (i) and (ii)

$\cos(x+\delta x) - \cos x = -2\sin A \sin B$

$\delta y = -2\sin(x + \delta x/2)\sin(\delta x/2)$

$\frac{\delta y}{\delta x} = \frac{-2\sin(x+\delta x/2)\sin(\delta x/2)}{\delta x}$

$\frac{\delta y}{\delta x} = \frac{-\sin(x+\delta x/2)\sin(\delta x/2)}{\delta x/2}$

$= -\sin(x + \delta x/2)\frac{\sin(\delta x/2)}{\delta x/2}$ — (iv)

A standard limit

$\lim \frac{\sin(\delta x/2)}{\delta x/2} = 1$

$\lim_{\delta x \to 0} \frac{\delta y}{\delta x} = \lim_{\delta x \to 0} -\sin(x+\delta x/2)\frac{\sin(\delta x/2)}{\delta x/2}$

$= -\sin(x+0)\,1$

$= -\sin x$

$\lim_{\delta x \to 0} \frac{\delta y}{\delta x} = \frac{dy}{dx} = -\sin x$

8) dy/dx if $y = 3t^2$ $x = 1/t^2$

$y = 3t^2$; $dy/dx = 6t$

$x = \frac{1}{t^2}$; $\frac{dx}{dt} = -2t^{-3}$

$\frac{dy}{dx} = \frac{dy/dt}{dx/dt} = \frac{6t}{-2/t^3} = \frac{\overset{3}{\cancel{6}}t}{1} \times \frac{t^3}{-\cancel{2}_1} = -3t^4$

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1) $y = x^2 \cos 2x e^{4x}$
find $\log_e$ of both sides
$\ln y = \ln(x^2 \cos 2x e^{4x})$
$\ln y = \ln x^2 + \ln \cos 2x + \ln e^{4x}$
differentiate both sides wrt x
$$\frac{d}{dx}(\ln y) = \frac{d}{dx}(\ln x^2) + \frac{d}{dx}(\ln \cos 2x) + \frac{d}{dx}(\ln e^{4x})$$
$$\frac{1}{y}\frac{dy}{dx} = \frac{1}{x^2}(2x) + \frac{1}{\cos 2x}(-2\sin 2x) + \frac{1}{e^{4x}}(4e^{4x})$$
$$\frac{1}{y}\frac{dy}{dx} = \frac{2}{x} - \frac{2\sin 2x}{\cos 2x} + \frac{4e^{4x}}{e^{4x}}$$
$$\frac{1}{y}\frac{dy}{dx} = \frac{2}{x} - 2\tan 2x + 4$$
multiply both sides by y
$$\frac{dy}{dx} = y\left(\frac{2}{x} - 2\tan 2x + 4\right)$$
$$\frac{dy}{dx} = x^2 \cos 2x e^{4x}\left(\frac{2}{4} - 2\tan 2x + 4\right)$$

10) $y = \sin(3x^2+5)$
$dy/dx = dy/dx \times dy/dy$
$u = 3x^2+5$ $\quad y = \sin u$
$= 6x$ $\quad y = \cos u$
$$\frac{dy}{dx} = 6x \times \cos u$$
$= 6x \cos u$
Since $u = 3x^2+5$
$dy/dx = 6x\cos(3x+5)$