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MECHATRONICS ENGINEERING

MAT 102

(2) 1) if $y = \frac{7x^2 \cos 8x}{e^{3x}} \therefore 7x^2 \cos 8x\, e^{-3x}$

$u = x^2 \quad v = \cos 8x \quad w = e^{-3x}$

$\frac{dy}{dx} = 7\left(\frac{du}{dx}(vw) + \frac{dv}{dx}(uw) + \frac{dw}{dx}(uv)\right]$

$= 7\left(2xe^{-3x}\cos 8x + x^2 e^{-3x}(-3)\cdot\cos 8x + x^2 e^{-3x}(-\sin(8x))\cdot 8\right]$

$= 7(2xe^{-3x}\cos 8x - 3x^2 e^{-3x}.\cos 8x - 8x^2 e^{-3x}.\sin 8x)$

$= 7(-8x^2 e^{-3x}\sin 8x - 3x^2 e^{-3x}\cos 8x + 2xe^{-3x}\cos 8x)$

$= -7xe^{-3x}(8x\sin 8x + (3x-2)\cos 8x.)$

(3) if $y = \cos(5x^2+6x) \quad u = 5x^2+6x$

$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$

$= -\sin(5x^2+6x) \times (10x+6)$

$= -(10x+6)(\sin(5x^2+6x))]$

4a) $\int \frac{3}{(4x+1)}dx = 3\int \frac{1}{4x+1}dx$

$u = 4x+1 \quad \frac{du}{dx} = 4 \quad dx = \frac{1}{4}du$

$\frac{3}{4}\int \frac{1}{u}du$

$\frac{3}{4} \frac{\ln u}{1}$

$\frac{3}{4}\ln(4x+1) + c$

(b) $\int \frac{1}{x^2+49}dx \quad u = \frac{x}{7} \quad \frac{du}{dx} = \frac{1}{7} \quad dx = 7du$

$= \int \frac{7}{49u^2+49}du$

$= \frac{1}{7}\int \frac{1}{u^2+1}du$

$= \frac{1}{7}\tan^{-1}u = \frac{1}{7}\tan^{-1}\left(\frac{x}{7}\right)$

(c) $\int e^{6x} + 9x^3 - \sin 7x + \cos 8x \, dx$

$\frac{e^{6x}}{6} + \frac{9x^4}{4} + \frac{\cos 7x}{7} - \frac{\sin 8x}{8} + c$

(d) $\int x\sqrt{x^2+7} \, dx$

$u = x^2 - 9$

$\frac{du}{dx} = 2x \qquad dx = \frac{1}{2x} du$

$\frac{1}{2} \int \sqrt{u} \, du$

$= \frac{1}{2} \left[\frac{2u^{\frac{3}{2}}}{3} \right] + 1$

$= \frac{u^{\frac{3}{2}}}{3}$

$= \frac{(x^2-9)^{\frac{3}{2}}}{3} + c$

(1) $\lim_{x \to 0} \frac{4x^2 - \sin x}{x^3}$

$= \lim_{x \to 0} \frac{8x - \cos x}{3x^2}$

$= \lim_{x \to 0} \frac{0 + \sin x}{6x}$

$= 0 + \lim_{x \to 0} \frac{1}{6} \left(\frac{\sin x}{x} \right)$

$= \frac{1}{6}$