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ASSIGNMENT

1. $\lim_{x \rightarrow 0} \frac{4x^2 - \sin x}{x^3}$

Solution

Using L'Hopital rule, we have

$$= \lim_{x \rightarrow 0} \frac{8x - (\cos x)}{3x^2}$$

$$= \lim_{x \rightarrow 0} \frac{8 - (-\sin x)}{6x} = \lim_{x \rightarrow 0} \frac{8 + \sin x}{6x}$$

$$= \lim_{x \rightarrow 0} \frac{\cos x}{6} = \frac{\cos(0)}{6} = \frac{1}{6}$$

2. $y = \frac{7x^2 \cos 8x}{e^{3x}}$

Solution

Let $u = 7x^2$, $v = \cos 8x$, $w = e^{3x}$

$$\frac{du}{dx} = 14x, \quad \frac{dv}{dx} = -8\sin 8x \quad \text{and} \quad \frac{dw}{dx} = 3e^{3x}$$

$$\frac{dy}{dx} = y \left[\frac{1}{u} \frac{du}{dx} + \frac{1}{v} \frac{dv}{dx} - \frac{1}{w} \frac{dw}{dx} \right]$$

$$\frac{dy}{dx} = y \left[\frac{1}{7x^2} (14x) + \frac{1}{\cos 8x} (-8\sin 8x) - \frac{1}{e^{3x}} (3e^{3x}) \right]$$

$$\frac{dy}{dx} = y \left[\frac{14x}{7x^2} + \frac{-8\sin 8x}{\cos 8x} - \frac{3e^{3x}}{e^{3x}} \right]$$

$$\frac{dy}{dx} = y \left[\frac{2}{x} - 8\tan 8x - 3 \right]$$

$$\frac{dy}{dx} = 7x^2 \cos 8x \left[\frac{2}{x} - 8\tan 8x - 3 \right]$$

$$\frac{dy}{dx} = \frac{14x^2 \cos 8x}{x e^{3x}} - \frac{56x^2 \tan 8x \cos 8x}{e^{3x}} - \frac{21x^2 \cos 8x}{e^{3x}}$$

$$1a. \frac{dy}{dx} = \frac{19x \cos 8x - 56x^2 \sin 8x - 21x^3 \cos 8x}{e^{3x}}$$

$$3. \int \cos(5x^2 + 6x)$$

Solution

Using chain rule

$$u = 5x^2 + 6x$$

$$\frac{du}{dx} = 10x + 6$$

$$\frac{dy}{du} = \cos u$$

$$\frac{dy}{du} = -\sin u$$

$$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx} = -\sin u \times (10x + 6)$$

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

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

4.

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

Solution

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

$$u = 4x+1$$

$$\frac{du}{dx} = 4$$

$$\frac{du}{4} = \frac{4 dx}{4}$$

$$dx = \frac{1}{4} du$$

$$= \int \frac{3}{(4x+1)} dx = \int \frac{3 \cdot \frac{1}{4} du}{u} = \int \frac{3}{4u} du = \frac{3}{4} \int \frac{1}{u} du$$

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

$$45. \int \frac{dx}{x^2+49}$$

$$\text{Soln} \\ \int \frac{dx}{x^2+49} = \int \frac{dx}{49\left(\frac{x^2}{49}+1\right)} = \int \frac{dx}{49\left(\frac{x}{7}\right)^2+1} = \frac{1}{49} \int \frac{dx}{\left(\frac{x}{7}\right)^2+1}$$

$$u = \frac{x}{7}$$

$$\frac{du}{dx} = \frac{1}{7}$$

$$dx = 7du$$

$$= \frac{1}{49} \int \frac{dx}{u^2+1} = \frac{1}{49} \int \frac{1}{u^2+1} \cdot 7du = \frac{7}{49} \int \frac{1}{u^2+1} du$$

Recall, $\int \frac{1}{u^2+1} du$ is a standard integral, so it equates to $\arctan u$

$$= \frac{1}{7} \times \arctan u + C$$

$$= \frac{\arctan\left(\frac{x}{7}\right) + C}{7}$$

$$46. \int (e^{6x} + 9x^3 - \sin 7x + \cos 8x) dx$$

Solution

$$= \int e^{6x} dx + \int 9x^3 dx - \int \sin 7x dx + \int \cos 8x dx$$

$$= \frac{e^{6x}}{6} + \left[\frac{9x^4}{4} \right] - \frac{1}{7} (-\cos 7x) + \frac{1}{8} (\sin 8x) + C$$

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

$$41. \int 2x\sqrt{9+x^2} dx$$

$$\text{Soln}$$

$$\int 2x\sqrt{9+x^2} dx$$

$$u = 9+x^2$$

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

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

$$= \int 2x \sqrt{u} \cdot \frac{du}{2x}$$

$$= \int \sqrt{u} du$$

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

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

$$= \frac{1}{2} \frac{u^{3/2}}{3/2}$$

$$= \frac{1}{2} u^{3/2} \times \frac{2}{3}$$

$$= \frac{1}{3} u^{3/2}$$

$$= \frac{1}{3} u^{3/2} = \frac{1}{3} [9+x^2]^{3/2}$$

$$= \frac{(9+x^2)^{3 \times 1/2}}{3}$$

$$= \frac{(9+x^2)(\sqrt{9+x^2})^2}{3} + C //$$