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1) $\int 2x^2 \ln x \, dx$

let $u = \ln x$, $du = \frac{1}{x}$

$dv = 2x^2 dx$, $v = \frac{2}{3}x^3$

$$\int u\,dv = uv - \int v\,du$$

$$= \ln x \times \frac{2x^3}{3} - \int \frac{2x^3}{3} \cdot \frac{1}{x}$$

$$= \ln x \times \frac{2x^3}{3} - \int \frac{2x^3}{3x} = \frac{2x^3}{3} \ln x - 2\int \frac{x^2}{3} dx$$

$$= \frac{2x^3}{3} \ln x - \frac{2x^3}{4}, \quad \frac{2(\ln x)^3}{3}$$

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

2) $\int 3te^{2t} dx$

let $u = 3t$, $du = 3$

$dv = e^{2t} dx$, $v = \frac{1}{2}e^{2t}$

$$\int u\,dv = uv - \int v\,du$$

$$= 3t \times \frac{1}{2}e^{2t} - \int \frac{1}{2}e^{2t} \times 3$$

$$= \frac{3t}{2}e^{2t} - \int \frac{3e^{2t}}{2}$$

$$= \frac{3te^{2t}}{2} - \frac{3}{2}\int e^{2t}$$

$$= \frac{3te^{2t}}{2} - \frac{3}{4}e^{2t} + C$$

$\int x^2 \sin x$ $\quad u = x^2 \quad du = 2x$
$dv = \sin x\,dx \quad v = -\cos x$

$\int u\,dv = uv - \int v\,du$

$= x^2 \times -\cos x - \int -\cos x \times 2x\,dx$

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

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

Integrate by parts

$\rightarrow x^2\cos x - -2x \times \sin x - \int \sin x \cdot -2$ let $u = -2x$

$dv = \cos x\,dx$

$du = -2$

$v = \sin x$

$-x^2\cos x + 2x\sin x - \int \sin x \times -2$

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

$-x^2\cos x + 2x\sin x + 2\cos x + C_4$

4) $\cos 5x \cos 6x$

Recall: $\cos A \cos B = \frac{1}{2}\left[\sin(A+B) - \sin(A-B)\right]$

$A = 5x,\ B = 6x$ $= \frac{1}{2}\left[\sin(5x+6x) - \sin(5x-6x)\right]$

$= \frac{1}{2}\left[\sin 11x + \sin x\right]$

$= \frac{1}{2}\left[\sin 11x + \sin x\right]$

$= \frac{\cancel{1/2}}{2}\left[\frac{-\cos 11x}{11} - \cos x\right]$

$= \frac{-\cos 11x}{22} - \frac{\cos x}{2} + C_4$

5 $\sin 7x \cos 2x$

Recall: $\cos A \cos B = \frac{1}{2}\left[\sin(A+B) + \sin(A-B)\right]$

$A = 7x,\ B = 2x$ $= \frac{1}{2}\left[\sin(7x + 2x) + \sin(7x - 2x)\right]$

$-\sin(-x)$

$+\sin x$

$= \frac{1}{2}\left[\cancel{\sin 9x + \sin 5x}\right]$

$= \frac{1}{2}\left[\sin 9x + \sin 5x\right]$

$= \frac{1}{2}\left[\frac{-\cos 9x}{9} + \frac{-\cos 5x}{5}\right]$

$= \frac{1}{2}\left[\frac{-\cos 9x}{9} - \frac{\cos 5x}{5}\right]$

$= -\frac{\cos 9x}{9} - \frac{\cos 5x}{5} + C_u$

OR

$= \frac{-\cos 9x}{18} - \frac{\cos 5x}{10} + C_u$

$\frac{1}{2} \times$ c