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1. $2x^2 \ln x$

$u = \ln x \qquad dv = 2x^2$

$du = \frac{1}{x} \qquad v = \frac{2x^3}{3}$

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

$\int u\,dv = \ln x \times \frac{2x^3}{3} - \int \frac{2x^3}{3} \times \frac{1}{x} \times dx$

$\int u\,dv = \frac{2}{3}x^3 \ln x - \int \frac{2x^2}{3}$

$\int u\,dv = \frac{2}{3}x^3 \ln x - \frac{2}{3} \times \frac{x^3}{3}$

$\int u\,dv = \frac{2}{3}x^3\left(\ln x - \frac{1}{3}\right) + C$

2. $3te^{2t}$

$u = 3t \qquad v = e^{2t}$

$du = 3 \qquad v = e^{2t}/2$

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

$\int u\,dv = 3t \times \frac{e^{2t}}{2} - \int \frac{e^{2t}}{2} \times 3$

$\int u\,dv = \frac{3}{2}te^{2t} - \frac{e^{2t}}{2} \times \frac{1}{2} \times 3$

$\int u\,dv = \frac{3}{2}te^{2t} - \frac{3}{4}e^{2t}$

$\therefore \int u\,dv = \frac{3}{2}te^{2t} - \frac{3}{4}e^{2t} + C$

3. $x^2 \sin x$

$u = x^2 \quad dv = \sin x$

$du = 2x\,dx \quad v = -\cos x$

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

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

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

$= -x^2 \cos x + 2\int \cos x \times x \times dx \quad \cdots equ(i)$

Let $u = x \quad dv = \cos x$

$du = dx \quad v = \sin x$

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

$= x \times \sin x - \int \sin x \times dx \quad \cdots equ(ii)$

Sub equ (ii) into equ (i)

$\int u\,dv = -x^2 \cos x + 2(x \times \sin x - \int \sin x\,dx)$

$\int u\,dv = -x^2 \cos x + 2x \sin x - 2(-\cos x) + C$

$\int u\,dv = -x^2 \cos x + 2x \sin x + 2\cos x + C$

4. $\cos 5x \cos 6x =$

$= \frac{1}{2}[\cos(A+B) + \cos(A-B)]$

$= \frac{1}{2}[\cos(5x+6x) + \cos(5x-6x)]$

$= \frac{1}{2}[\cos 11x - \cos x]$

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

$= \frac{1}{2} + \frac{\sin 11x}{22} - \frac{\sin x}{2}$

$\cos 5x \cos 6x = + \frac{\sin 11x}{22} - \frac{\sin x}{1} \therefore \frac{\sin 11x}{22} - \frac{\sin x}{1} + C$

5. $\sin 7x \cos 2x$

$= \frac{1}{2}[2\sin(A+B) + \sin(A-B)]$

$= \frac{1}{2}[(\sin(7x+2x) + \sin(7x-2x)]$

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

$= \frac{1}{2}\left(\frac{-\cos 9x}{9} - \frac{\cos 5x}{5}\right)$

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

$\sin 7x \cos 2x = \frac{-\cos 9x}{18} - \frac{\cos 5x}{10} + C$