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① $\int 2x^2 \ln x$.

solution

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

By re-arranging, $\int \ln x \cdot 2x^2 dx$

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

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

$dv = 2x^2 dx$

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

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

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

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

$du = 2x\,dx$

$dv = \sin x\,dx$

$v = \int \sin x\,dx = -\cos x$

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

picking $\int 2x\cos x\,dx$

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

$dv = \cos x\,dx$

$v = \int \cos x\,dx = \sin x$

$\int 2x\cos x\,dx = 2x\sin x - \int 2\sin x\,dx$

$= 2x\sin x + 2\cos x + C$

$\therefore \int x^2 \sin x\,dx = -x^2\cos + 2x\sin x +$
$2\cos x + C$

4 Note that $\cos a \cos b = \frac{1}{2}[\cos(a+b) + \cos(a-b)]$

$\cos 5x \cos 6x = \cos 6x \cos 5x$

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

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

$\int \cos 5x \cos 6x \, dx = \frac{1}{2}\int (\cos 11x + \cos x)$

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

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

5 Note that $\sin a \cos b = \frac{1}{2}[\sin\langle a+b\rangle + \sin\langle a-b\rangle]$

$\sin 7x \cos 2x =$

$\frac{1}{2}[\sin\langle 7x+2x\rangle + \sin\langle 7x-2x\rangle]$

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

$\int \sin 7x \cos 2x \, dx = \frac{1}{2}\int (\sin 9x + \sin 5x)$

$= \frac{1}{2}\int (\sin 9x + \sin 5x)\, dx$

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

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

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

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

2. $\int 3te^{2t}\, dt$

$u = 3t$, $\frac{du}{dt} = 3 \Rightarrow du = 3dt$

$dv = e^{2t} dt$, $v = \int e^{2t} dt = \frac{e^{2t}}{2}$

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

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

$= \frac{3}{2} te^{2t} - \frac{3}{2} \times \frac{1}{2} e^{2t} + c$

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

3 $\int x^2 \sin x\, dx$

Going by integration by part.

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

$u = x^2$, $\frac{du}{dx} = 2x$