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Course: MAT 104
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Solution:

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

let $u = \ln x$, $dv = 2x^2$

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

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

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

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

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

$$\int \ln x \, 2x^2 dx = \frac{2x^3}{3}\left[\ln x - \frac{1}{3}\right] + C$$

2. $\int 3t e^{2t} dt$.

let $u = 3t$, $dv = e^{2t}$

$du = 3dt$ $\quad v = \frac{1}{2} e^{2t}$

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

$$\int 3te^{2t}\,dt = 3t \cdot \tfrac{1}{2}e^{2t} - \int \tfrac{1}{2}e^{2t} \cdot 3\,dt$$

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

$$\int 3te^{2t}\,dt = \tfrac{3}{2}te^{2t} - \tfrac{3}{2}\left[\tfrac{1}{2}e^{2t}\right] + c$$

$$\int 3te^{2t}\,dt = \tfrac{3}{2}te^{2t} - \tfrac{3}{4}e^{2t} + c$$

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

let $u = x^2$, $dv = \sin x$

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

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

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

$u = 2x$, $dv = \cos x$

$dx = 2dx$ $\quad dv = \sin x$

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

$$\int 2x\cos x\,dx = 2x\sin x + 2\cos x + c$$

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

4. $\int \cos 5x \cos 6x\,dx$

$\cancel{let}$ $A = 5x$, $B = 6x$

$$\cos A \cos B = \tfrac{1}{2}[\cos A+B] + \cos[A-B]$$

$$\cos 5x \cos 6x = \tfrac{1}{2}[\cos 11x - \cos x]$$

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

$$\int \cos 5x \cos 6x\,dx = \tfrac{1}{2}\left[\frac{\sin 11x}{11} - \frac{\sin x}{1}\right] + c$$

$$\int \cos 5x \cos 6x\,dx = \frac{\sin 11x}{22} - \frac{\sin x}{2} + c$$

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5. $\int \sin 7x \cos 2x \, dx$

$A = 7x \qquad B = 2x$

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

$\sin 7x \cos 2x = \frac{1}{2}[\sin 9x + \sin 5x]$

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

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

$\int \sin 7x \cos 2x \, dx = -\frac{\cos 5x}{10} - \frac{\cos 9x}{18} + c$