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1.) $2x^2 \ln x$.

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

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

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

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

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

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

$\therefore \int 2x^2 \ln x\,dx = \frac{2x^3}{3} \ln x - \frac{2x^3}{9} + C$

$= \frac{2x^3}{3} (\ln x - 1/3) + C.$

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2) $3te^{2t}$

$u = 3t$ $\quad\quad\quad\quad$ $dv = e^{2t}$

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

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

$\int 3te^{2t} = 3t \cdot \frac{1}{2} e^{t} - \int \frac{1}{2} e^{2t} \cdot 3dx$

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

$\therefore \int 3te^{2t}\,dt = \left[\frac{3te^{2t}}{2} - \frac{3}{4} e^{2t}\right] + c$

3) $x^2 \sin x$

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

$\frac{du}{dx} = 2x$ $\quad\quad\quad\quad$ $v = -\cos x$

$dx = 2x\,dx$

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

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

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

$= -x^2 \cos x + \left[\begin{array}{ll} u = 2x & dv = \cos x \\ du = 2dx & v = \sin x \end{array} \right.$

$= -x^2 \cos x + uv - \int v\,du$

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

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

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

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

$A = 5x,\ B = 6x.$

Recall that;

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

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

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

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

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

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

Recall that,

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

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

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

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