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Find the integral of the following

1. $\int x^2 \sin x dx$

Solution

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

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

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

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

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

$$\cancel{-x^2\cos x + \sin x\,\frac{2x^2}{2} + C}$$

$$-x^2(\cos x) - \int -2x\cos x\,dx$$

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

$$-x^2\cos x - \left[-2x(\sin x) - \int \sin x(-2)dx\right.$$

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

$$2x\sin x + (2 - x^2)\cos x + C$$

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

solution

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

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

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

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

$$\frac{3e^{2t}}{4}(2t - 1) + C$$

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

solution

$\cancel{u = 2x^2}$ $\quad \cancel{dv = \ln x}$ $\quad u = \ln x$ $\quad dv = 2x^2$

$\cancel{\frac{du}{dx} = 4x}$ $\quad \cancel{v =}$ $\quad \frac{du}{dx} = 1/x$ $\quad v = \frac{2x^3}{3}$

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

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

$$\frac{2x^3}{3}\left(\ln x - \frac{1}{3}\right) + C$$

4 $\displaystyle\int \frac{2x-3x^2}{1-x}\,dx$

$$\begin{array}{r} 3x + 1 \\ -x+1 \overline{\big)\; -3x^2 + 2x} \\ \underline{-3x^2 + 3x} \\ -x \\ \underline{-x + 1} \\ -1 \end{array}$$

$$\int (3x+1)\,dx \int \frac{-1}{(-x+1)}\,dx = \int (3x+1)\,dx \int \frac{-1}{-(x-1)}\,dx$$

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

$$\frac{3x^2}{2} + x + \ln(x-1) + c$$

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