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19/ENG07/016.
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Find the integral of the following:

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

let $u = x^2$ $\quad v = \sin x$

$du = 2x$ $\quad dv = -\cos x$

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

Using $uv - \int v \, du$

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

$= x^2(-\cos x) - \int -\cos x \, \cancel{dx} \, (2x \, dx)$

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

Let $u = -2x$ and $dv = \cos x$

$du/dx = -2x$ and $v = \sin x$

$\therefore (-2x)(\sin x) - \int (\sin x)(-2)\, dx$

$-2x \sin x - (-2) \int \sin x \, dx$.

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

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

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

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

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

$\dfrac{du}{dt} = 3$ $\qquad \int dv = \int e^{2t}$

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

Using: ~~uv - ∫~~

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

$= 3t\left[\dfrac{e^{2t}}{2}\right] - \int \dfrac{e^{2t}}{2} \times 3dt$

$3t\left[\dfrac{e^{2t}}{2}\right] - \dfrac{1}{2}\int 3e^{2t}\, dt$

$3t\left(\dfrac{e^{2t}}{2}\right) - \dfrac{1}{2} \times \dfrac{3e^{2t}}{2} + C$

$\therefore \left[\dfrac{3te^{2t}}{2} - \dfrac{3e^{2t}}{4}\right] + C$

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

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

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

$\ln x \cdot \frac{2x^3}{3} - \frac{2}{3}\int x^3 \quad \frac{1}{x}$

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

$\left(\ln x \cdot \frac{2x^3}{3}\right) - \frac{2}{9}x^3 + C$

4 $\quad \frac{(2x - 3x^2)}{(1-x)} dx$

$$\begin{array}{r|l} & 2x - x^2 \\ 1-x & 2x - 3x^2 \\ & -2x - 2x^2 \\ & \quad -x^2 \\ & \quad -x^2 + x^3 \\ & \quad\quad -x^3 \end{array}$$

$\therefore \int (2x - x^2) dx + \int \frac{x^3}{1-x} dx$

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

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