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(1) $\int x^2 \sin x \, dx$

$\int u \, dv = uv - \int v \, du$ —— (1)

for $\int u \, dv = \int x^2 \sin(x) \, dx$

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

$du = 2x \, dx$

$dv = \sin(x) dx$

$v = -\cos x$

Substitute into —— (1)

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

$\int x^2 \sin(x) \, dx = -x^2 \cos(x) + 2 \int x \cos(x) \, dx$ —— (2)

$v = x \Rightarrow \frac{du}{dx} = 1 \Rightarrow du = dx$

$du = \cos(2) \, dx \Rightarrow \int dv = \int \cos(x) \, dx$

$v = \sin(x)$

$\int x \cos(x) \, dx = x \sin(x) - \int \sin(x) \, dx$

Since $\int \sin(x) \, dx = -\cos(x)$, This becomes

$\int x \cos(x) \, dx = x \sin(x) + \cos(x)$ —— (3)

Recall

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

Substitute (3) into (2)

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

$\int x^2 \sin(x)\,dx = -x^2\cos(x) + 2x\sin(x) + 2\cos(x) + C$ //

(2) $\int 3z e^{2z}\,dz$

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

let $u = 3z$

$\frac{du}{dz} = 3 \quad du = 3dz$

let $dv = e^{2z}dz$

$v = \frac{1}{2}e^{2z}$

$\int 3z(e^{2z})dz = 3z(\frac{1}{2})e^{2z} - \int \frac{1}{2}e^{2z} \cdot 3dz$

$= \frac{3}{2}ze^{2z} - \frac{3}{4}e^{2z}$ //

(3) $\int 2x^2 \cdot \ln x\,dx$

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

$2x \ln(x) \times x^2 dx$

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

$u = \ln(x)$

$dv = x^2 dx$

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

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

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

$$\int 2x^2 \ln x \, dx = 2\left(\ln x \times x^3/_3\right) - \int x^3/_3 \times 1/_x \, dx$$

$$2x^2 \ln x \, dx = 2(\ln x \times x^3/_3 - \int x^3/_3 \, dx$$

$$2(\ln x \times x^3/_3 - 1/_3{}^x \int x^2 dx)$$

$$\int x^2 dx = \frac{x^{n+1}}{n+1}$$

$$\int x^2 dx = \frac{x^{2+1}}{2+1} = x^3/_3$$

$$= 2\left(\ln(x) \times \frac{x^3}{3} - \frac{1}{3} \times \frac{x^3}{3}\right.$$

$$= \frac{2x^3 \times \ln(x)}{3} - \frac{2x^3}{9}$$

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

(4) $\int \frac{2x - 3x^2}{1-x} dx$, Separate $= \int \frac{2x}{1-x} - \frac{3x^2}{1-x} dx$

$$\int f(x) = g(x)\,dx = \int f(x)\,dx = \int g(x)\,dx$$

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

Calculate undefinite Integral

$$2 - 2x = 2\ln(|1-x|) + 9 + \underline{6x + 3} + 3\ln(|1-x|)$$

$$\therefore \cancel{-5 + 2x + 3x^2 + 1 - (1)} - 2$$

$$\therefore -5 + 2x + 3x^2 + 1 - (1) - x|)$$

$$\int \frac{2x - 3x^2}{1-x} = \frac{-5 + 2x + 3x^2}{2} + \ln(|1-x|)$$