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Maf 104 Assignment

① $x^2 \sin x \, dx$

$\int u \, dv = uv - \int v \, du \quad \text{--- (1)}$

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

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

$du = 2x \, dx$

$dv = \sin(x) dx$

$\int dv = \int \sin(x) \, dx$

$v = -\cos x$

Substitute into (1)

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

$\int x^2 \sin(x) \, dx = -x^2 \cos(x) + 2 \int x \cos(x) \, dx \quad \text{--- (2)}$

$u = x \rightarrow \frac{du}{dx} = 1 \therefore du = dx$

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

$v = \sin(x)$

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

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

$\int x \cos(x) \, dx = x \sin(x) + \cos x \quad \text{--- (3)}$

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

Substitute (3) into (2)

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

② $\int 3te^{2t}\,dt$

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

let $u = 3t$

$\frac{du}{dt} = 3$, $du = 3dt$

let $dv = e^{2t}\,dt$

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

$\int 3t(e^{2t})dt = 3t(\frac{1}{2})e^{2t} - \int \frac{1}{2}e^{2t}\,3\,dt$

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

③ $2x^2 \ln x\,dx$

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

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

$v = \ln(x)$

$dv = x^2\,dx$

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

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

$\int u\,dv = uv - \int v\,du$ $\quad (\ln x \times \frac{x^3}{3}) - \int \frac{x^3}{3} \times \frac{1}{x}\,du$

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

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

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

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

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

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

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

④ $\int \frac{2x-3x^2}{1-x}\,dx$

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

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

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

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

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

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