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Mechatronics Engineering

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Math 104 assignment

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

$$\boxed{\int u \frac{dv}{dx} dx = uv - \int v \frac{du}{dx} dx}$$

Let $u = e^x$ and $\frac{dv}{dx} = \sin x$

$\frac{du}{dx} = e^x$ $v = -\cos x$

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

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

$\int e^x \cos x \, dx$

let $u = e^x$ and $\frac{dv}{dx} = \cos x$

$\frac{du}{dx} = e^x$ $v = \sin x$

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

$$= e^x \sin x - \int e^x \sin x \, dx$$

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

adding $\int e^x \sin x \, dx$ to both sides

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

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

$\int e^x \sin x \, dx = \frac{e^x}{2}(\sin x - \cos x) + C$

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

$$\boxed{\int u\,dv = uv - \int v\,du}$$

Let $u = \ln x \longrightarrow du = \frac{1}{x}\,dx$

Let $dv = 2x^2 \longrightarrow v = \frac{2x^3}{3}$

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

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

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

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

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

$$\boxed{\int u\,dv = uv - \int v\,du}$$

Let $u = x^2$ and $dv = \sin x$

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

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

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

$\int x\cos dx$

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

$du = 1$ $\quad v = \sin x$

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

$$= x\sin x - -\cos x$$

$$= \boxed{x\sin x + \cos x}$$

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

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

(4) $\int x\cdot\cos(x)\,dx$

$$\boxed{\int u\,dx = uv - \int v\,du}$$

let $u = x$ and $dv = \cos(x)$

$du = dx$ $v = \sin(x)$

$$\therefore \int x\cos(x)\,dx = \int \cancel{\sin(x)\,dx}\; x\cdot\sin(x) - \int \sin(x)\,dx$$

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

$$= x\sin(x) + \cos(x) + C$$