NAME: Ogunlana Omolara Abiodun
DEPARTMENT: Aeronautical Engineering
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Answers

1. $\int e^x \sin x \, dx$

Using integration by Parts formula

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

$u = \sin x \quad dv = e^x \quad , \frac{du}{dx} = \cos x \quad \therefore du = \cos x \, dx$

$v = \int e^x = e^x$

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

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

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

$=$

$u = \cos x \quad dv = e^x \quad du/dx = -\sin x \quad \therefore du = -\sin x \, dx$

$v = \int e^x = e^x$

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

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

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

$$\therefore \int \sin x\, e^x\, dx = \sin x\, e^x - \left(\cos x\, e^x + \int \sin x\, e^x\, dx\right)$$

$$\int \sin x\, e^x\, dx = \sin x\, e^x - \cos x\, e^x - \int \sin x\, e^x\, dx + c_1$$

$$2\int \sin x\, e^x\, dx = \sin x\, e^x - \cos x\, e^x + c_1$$

Divide through by 2

$$\int \sin x\, e^x\, dx = \tfrac{1}{2} \sin x\, e^x - \tfrac{1}{2} \cos x\, e^x + \tfrac{c_1}{2}$$

$$\therefore \int \sin x\, e^x\, dx = \tfrac{1}{2} \sin x\, e^x - \tfrac{1}{2} \cos x\, e^x + C$$

where $C = \frac{c_1}{2}$

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

Using intergration by parts formula

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

$u = \ln x \quad dv = 2x^2 \quad du/dx = 1/x \quad \therefore du = 1/x\, dx$

$v = \int 2x^2 = 2x^3/3$

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

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

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

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

Using the integral formula

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

$\therefore u = x^2 \quad dv = \sin x \quad v = \int \sin x \, dx = -\cos x$

$du/dx = 2x \quad \therefore du = 2x \, dx$

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

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

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

$\int 2x \cos x \, dx$

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

$u = 2x, \quad dv = \cos x, v = \int \cos x \, dx = \sin x, du = 2dx$

$\therefore \int 2x \cos x \, dx = 2x \sin x - \int 2 \sin x \, dx$

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

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

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

4. $\int x \cos x \, dx$

Using the integration by parts formula

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

$u = x \quad dv = \cos x \quad \frac{du}{dx} = 1 \therefore du = dx, \; v = \int \cos x = \sin x$

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

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

$= \int x \cos x \, dx = x \sin x + \cos x + c$