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

Solution

$u = \sin x \quad dv = e^x$

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

$du = \cos x \, dx$

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

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

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

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

$u = \cos x \quad dv = e^x$

$du/dx = -\sin x$

$v = e^x$

$du = -\sin x \, dx$

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

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

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

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

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

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

let $\underline{P = \int e^x \sin x\, dx}$

$P = e^x \sin x - e^x \cos x - P$

collect like terms

$2P = e^x \sin x - e^x \cos x$

$P = \underline{\dfrac{e^x \sin x - e^x \cos x}{2}}$

Therefore

$\int e^x \sin x\, dx = \underline{\dfrac{e^x \sin x\ e^x \cos x}{2}}$

$\int e^x \sin x\, dx = 1/2 (e^x \sin x - e^x \cos x) + c$

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

Solution

$\ln x = \log_e x$

$\int 2x^2 \log_e x\, dx$

$u = \log_e x,\ dv = 2x^2$

$v = \dfrac{2x^3}{3}$

$du/dx = 1/x\, dx$

$du = 1/x\, dx$

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

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

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

$$\frac{2x^3}{3} \log x - \frac{2x^3}{9} + c_4$$

~~(3) x^2~~

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

Solution

$u = x^3 \quad du = \sin x$

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

$du = 2x\,dx$

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

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

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

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

$u = 2x \quad du = \cos x$

$du/dx = 2 \quad v = \sin x$

$du = 2dx$

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

$= 2x \cdot \sin x - \int \sin x \cdot 2$

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

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

Hence

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

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

solution

$u = x$ $\quad dv = \cos x$

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

$du = dx$

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

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

$= x \sin x - (-\cos x)$

$= x \sin x + \cos x + c$