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Computes Science
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$$1) \int x^2 \sin x \, dx$$

Solution

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

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

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

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

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

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

~~Solution~~

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

$$v = x \quad \frac{dv}{dx} = 1 \Rightarrow dv = dx$$

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

$$v = \sin(x)$$

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

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

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

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

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

$$2) \int 3t e^{2t} dt$$

Solution

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

$$\text{let } u = 3t$$

$$du/dt = 3 \quad \text{so } du = 3dt$$

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

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

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

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

$$3) \int 2x^2 \ln x dx$$

Solution

$$2 \times \int x^2 \ln x dx$$

$$2 \times \int \ln x \times x^2 dx$$

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

$$u = \ln x$$

$$dv = x^2 dx$$

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

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

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

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

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

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

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

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

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

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

$$4.) \int \frac{2x - 3x^2}{1-x} dx \text{ separate} = \int \frac{2x}{1-x} - \frac{3x^2}{1-x} dx$$

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

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

~~2-2x~~

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

$$-\frac{9-2x+3x^2}{2} + \ln(1-x)$$

$$\int \frac{2x-3x^2}{1-x} = -\frac{9-2x+3x^2}{2} + \ln(1-x)$$