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MATRIC NUMBER: 19/MHS01/308
SERIAL NUMBER: 129
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1) $\int 2x^2 \ln x \, dx$

Solution

$u = \ln x$

$\frac{du}{dx} = \frac{1}{x}$ $\quad du = \frac{1}{x} dx$

$dv = 2x^2 dx$

$\int dv = \int 2x^2 dx$

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

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

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

$= \frac{2}{3} x^3 \ln x - \frac{2}{3} \cdot \frac{x^3}{3} + c$

$= 2/3 \, x^3 \ln x - \frac{2}{9} \cdot x^3 + c$

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

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

Solution

$u = 3t$

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

$dv = e^{2t} dt$

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

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

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

$= 3t/2 \, (e^{2t}) - \frac{3}{2} \frac{e^{2t}}{2} + c$

$\int 3 + e^{2t} dt = \frac{3t(e^{2t})}{2} - \frac{3}{4} e^{2t} + c$

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

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

Solution

$u = x^2$

$du = 2x dx$

$dv = \sin x dx$

$v = -\cos x$

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

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

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

but $\int x \cos x dx = ?$

$\int x \cos x dx$

$u = x$

$du = dx$

$dv = \cos x dx$

$v = \sin x$

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

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

$= x \sin x + \cos x$

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

4) $\int \cos 5x \cos 6x \, dx$

solution

$\cos A \cos B = \frac{1}{2}\left[\cos(A+B) + \cos(A-B)\right]$

$A = 5x \quad B = 6x$

$\cos 5x \cos 6x = \frac{1}{2}\left[\cos(5x+6x) + \cos(5x-6x)\right]$

$= \frac{1}{2}(\cos 11x + \cos(-x))$

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

$= \frac{1}{2}(\cos 11x + \cos x)$

$\int \cos 5x \cos 6x \, dx = \frac{1}{2}\int (\cos 11x + \cos x)\, dx$

$= \frac{1}{2}\left(\frac{\sin 11x}{11} + \frac{\sin x}{1}\right) + c$

$\therefore \int \cos 5x \cos 6x \, dx = \frac{\sin 11x}{2\cancel{8}} + \frac{\sin x}{2} + c$

5) $\int \sin 7x \cos 2x \, dx$

solution

$\sin 7x \cos 2x = \frac{1}{2}(\sin 9x + \sin 5x)$

$\int \sin 7x \cos 2x \, dx = \frac{1}{2}\int (\sin 9x + \sin 5x)\, dx$

$= \frac{1}{2}\left[\frac{-\cos 9x}{9} - \frac{\cos 5x}{5}\right] + c$

$= \frac{-\cos 9x}{18} - \frac{\cos 5x}{10} + c$

$\therefore \int \sin 7x \cos 2x \, dx$

$= \frac{-\cos 9x}{18} - \frac{\cos 5x}{10} + C$