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Date: 23rd May 2020
Matric no: 19/mhs01/092.
Dept: Medicine and Surgery
Card no: No 177.

(1) $\int 2x^2 \ln x$

soln

$\int 2x^2 \ln x \, dx = [$

$u = \ln x, \quad \frac{du}{dx} = \frac{1}{x} = du = \frac{dx}{x}, \quad dv = 2x^2 dx$

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

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

$= \ln x \cdot \frac{2x^3}{3} - \int \frac{2x^3}{3} \times \frac{dx}{x}.$

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

$= \ln x \cdot \frac{2x^3}{3} - \frac{2}{3} \left[\frac{x^3}{3}\right] + c$

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

$\int u\,dv = \frac{2x^3}{3} \left[\ln x - \frac{1}{3}\right] + c.$

(2) $\int 3t\, e^{2t}$

soln

$\int 3t\, e^{2t}\, dt.$

$u = 3t$, $du = 3dt$, $dv = e^{2t}dt$, $v = \frac{1}{2}e^{2t}$

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

$$= 3t \cdot \frac{1}{2}e^{2t} - \int \frac{1}{2}e^{2t} \cdot 3dt$$

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

$$= \frac{3}{2}t \cdot e^{2t} - \frac{3}{2}\left[\frac{1}{2}e^{2t}\right] + c$$

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

$$= \frac{3}{2} \cdot e^{2t}\left[t - \frac{1}{2}\right] + c$$

(8) $x^2 \sin x$

soln

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

let $u = x^2$, $du = 2x\,dx$, $dv = \sin x\,dx$, $v = -\cos x$

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

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

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

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

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

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

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

④ $\cos 5x \cos 6x$

Soln.

$$\int \cos 5x \cos 6x \, dx.$$

$A = 5x$, $B = 6x$.

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

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

$$= \frac{1}{2}\left[\cos 11x + \cos (-x)\right]$$

$$\int \cos 5x \cos 6x \, dx = \frac{1}{2}\int \left[\cos 11x - \cos x\right]$$

$$= \frac{1}{2}\left[\frac{\sin 11x}{11} - \frac{\sin x}{1}\right]$$

$$= \frac{\sin 11x}{22} - \frac{\sin x}{2} + c.$$

$$= \frac{1}{22}\sin 11x - \frac{1}{2}\sin x + c.$$

⑤ $\int \sin 7x \cos 2x \, dx$

Soln.

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

$A = 7x$, $B = 2x$.

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

$$= \frac{1}{2}\left[\sin [7x+2x] + \sin [7x-2x]\right]$$

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

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

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

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

$$= -\frac{1}{18}\cos 9x - \frac{1}{10}\cos 5x \text{ //}$$