(1)

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(1) $\sin^6 x$

Sol^n

$$\int \sin^6 x \, dx$$

$$\int \sin^2 x (\sin^2 x)^2 dx$$

$$\sin^2 x = \frac{1-\cos 2x}{2}$$

$$\int \left(1 - \frac{\cos 2x}{2}\right)\left(1 - \frac{\cos 2x}{2}\right)^2$$

$$\frac{1}{8}\int (1-\cos 2x)(1 - 2\cos 2x + \cos^2 2x)$$

$$\frac{1}{8}\int 1 - 2\cos 2x + \cos^2 2x - \cos 2x + 2\cos^2 2x - \cos^3 2x$$

$$\frac{1}{8}\int 1 - 3\cos 2x + 3\cos^2 2x - \cos^3 2x$$

$$\int \cos^3 2x \, dx = \int (\cos 2x \cos^2 2x \, dx$$

$$\int \cos^3 2x \, dx = \int (\cos 2x - \cos 2x \sin^2 2x) dx$$

Let $u = \sin 2x$, $du/dx = 2\cos 2x$, $dx = du / 2\cos 2x$

$$\frac{\sin 2x}{2} = \int \cos 2x \, u^2 \cdot du / 2\cos 2x$$

$$-\cos^3 2x \, dx = \frac{\sin 2x}{2} - \frac{u^3}{6} = \frac{\sin 2x}{2} - \frac{\sin^3 2x}{6}$$

$$\int \sin^6 x = \frac{1}{8}\int 1 - 3\cos 2x + 3\cos^2 2x - \cos^3 2x$$

$$\int \sin^6 x = \frac{1}{8}\int x - \frac{3\sin 2x}{2} + \left(\frac{3x}{2} + \frac{3\sin^2 x}{4} - \left(\frac{\sin 2x}{2} - \frac{\sin^3 2x}{6}\right)\right)$$

$$= \frac{1}{8}\left(\frac{5x}{2} - \frac{4\sin 2x}{2} + \frac{3\sin^2 x}{4} + \frac{\sin^3 2x}{6}\right)$$

(2)

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(2) $\cos^4 x \sin^3 x$

Soln

$\int \cos^4 x \sin^3 x \, dx$

$du/dx = -\sin x$

$dx = -du/\sin x$

$\int u^4 \cdot \sin^3 x \times -\frac{du}{\sin x}$

$-\int u^4 \cdot \sin^2 x \, du$

$-\int u^4 (1-\cos^2 x) \, du$

$-\int u^4 (1-u^2) du$

$-\int u^4 - u^6 \, du$

$-\left(\frac{u^5}{5} - \frac{u^7}{7}\right) + c$

$-\frac{\cos^5 x}{5} + \frac{\cos^7 x}{7} + c$

$\frac{\cos^7 x}{7} - \frac{\cos^5 x}{5} + c$

(3) $\cos x \sin^3 x$

Soln

$\int \cos x \sin^3 x \, dx$

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

$\sin^2 x = 1 - \cos^2 x$

$\int \cos x \cdot \sin x (1-\cos^2 x) dx$

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

$\sin x \cdot -\cos x + \cos^3 x / 3 + c$

$= -\sin x \cos x + \frac{\cos^3 x}{3} + c$