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Course code:- Maths 104
Department:- MBBS

1. Integrate $\sin^6 x$

$\int \sin^6(x)\,dx = \int (\sin^2(x))^3\,dx$

Recall that $\sin^2(\theta) = \frac{1}{2}(1-\cos(2\theta))$

$\int \sin^2(x)^3)\,dx = \int \frac{1}{2}(1-\cos(2x))^3\,dx$

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

$= \int \frac{1}{8}((1-\cos(2x))^3\,dx$

$= \int \frac{1}{8}[1-3\cos(2x)+3\cos^2(2x)-\cos^3(2x)]\,dx$

$= \frac{1}{8}\int dx - \frac{3}{8}\int \cos(2x)\,dx + \frac{3}{8}\int \cos^2(2x)\,dx - \frac{1}{8}\int \cos^3(2x)\,dx$

$\frac{x}{8} - \frac{3\sin(2x)}{16} + \frac{3x}{16} + \frac{3\sin(4x)}{64} \frac{-\sin(2x)}{16} + \frac{\sin^3(2x)}{48} + C$

$= \frac{x}{8} + \frac{3x}{16} - \frac{3}{16}\sin(2x) + \frac{3}{64}\sin(4x) - \frac{1}{6}\sin(2x) + \frac{1}{48}\sin^3(2x) + C$

$= \frac{5(x)}{16} - \frac{3}{16}\sin(2x) + \frac{3}{64}\sin(4x) - \frac{1}{6}\sin(2x) + \frac{1}{48}\sin^3(2x) + C$

2. $\int \cos^4 x \sin^3 x\,dx = \int \sin(x)\cdot\sin^2(x)\cdot\cos^4(x)\,dx$

$= \int \sin(x)\cdot(1-\cos^2(x))\cdot\cos^4(x)\,dx$

Let $u = \cos(x)$

$du = -\sin(x)\,dx$

$-du = \sin(x)\,dx$

$= \int \sin(x)\cdot(1-u^2)u^4\,dx = \int (1-u^2)u^4\sin(x)\,dx$

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

$\int (u^6-u^4)\,du = \frac{u^7}{7} - \frac{u^5}{5} + C$

$= \frac{\cos^7(x)}{7} - \frac{\cos^5(x)}{5} + C$

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8. $\cos(x)\sin 3x - \int \sin(3x)\cos(x)\,dx$

Recall,

$\sin a \cdot \cos b = \frac{1}{2}(\sin(a+b) + \sin(a-b))$

$\sin(3x)\cos(x) = \frac{1}{2}(\sin(4x) + \sin(7x))$

$= \frac{1}{2}\int \sin(4x)\,dx + \frac{1}{2}\int \sin(2x)\,dx$

$= \frac{1}{2}\left(\frac{-\cos 4x}{4}\right) + \frac{1}{2}\left(\frac{-\cos 2x}{2}\right) + C$

$\cos(x)\sin(3x) = \frac{-\cos(4x)}{8} - \frac{\cos 2x}{4} + C$