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COURSE; MAT 104
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1 $\sin^6 x = (\sin^2 x)^2 (\sin^2 x)$

$$\sin^6 x = \left(\frac{1-\cos 2x}{2}\right)^2 \left(\frac{1-\cos 2x}{2}\right)$$

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

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

$$\sin^6 x = \frac{1}{16}(2 - 4\cos 2x + 1 + \cos 4x)(1-\cos 2x)$$

$$\sin^6 x = \frac{1}{16}(3 - 4\cos 2x + \cos 4x)(1-\cos 2x)$$

$$\sin^6 x = \frac{1}{16}(3 - 4\cos 2x + \cos 4x - 3\cos 2x + 4\cos^2 2x - \cos 4x\cos 2x)$$

$$\sin^6 x = \frac{1}{16}\left[3 - 7\cos 2x + \cos 4x + 2(2\cos^2 2x) - \frac{1}{2}2\cos 4x\cos 2x\right]$$

$$\sin^6 x = \frac{1}{16}\left[3 - 7\cos 2x + \cos 4x + 2(1+\cos 4x) - \frac{1}{2}(\cos 6x + \cos 2x)\right]$$

$$\sin^6 x = \frac{1}{16}\left[3 - 7\cos 2x + \cos 4x + 2 + 2\cos 4x - \frac{1}{2}(\cos 6x + \cos 2x)\right]$$

$$\sin^6 x = \frac{1}{32}\left[6 - 14\cos 2x + 2\cos 4x + 4 + 4\cos 4x - \cos 6x - \cos 2x\right]$$

$$\sin^6 x = \frac{1}{32}\left[10 - 15\cos 2x + 6\cos 4x - \cos 6x\right]$$

let $\sin^6 x = R$

$$R = \frac{1}{32}\int (10 - 15\cos 2x + 6\cos 4x - \cos 6x)\,dx$$

$$R = \frac{1}{32}\left(10x - \frac{15\sin 2x}{2} + \frac{6\cos 4x}{4} - \frac{\cos 6x}{6}\right) + C$$

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$$\int \sin^6 x = \frac{10x}{32} - \frac{15\sin 2x}{64} + \frac{6\cos 4x}{128} - \frac{\cos 6x}{192} + C$$

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

$u = \cos x$

$du/dx = -\sin x$

$dx = -du/\sin x$

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

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

$$\int \cos^4 x \sin^3 x = \int \cancel{\sin x} \cdot \sin^2 x \quad u^4 \frac{-du}{\cancel{\sin x}}$$

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

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

$$= -\int \left[\frac{u^5}{5} - \frac{u^7}{7}\right] + C$$

$$= \frac{u^7}{7} - \frac{u^5}{5} + C$$

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

$$\int \cos^4 x \sin^3 x = \frac{(\cos x)^7}{7} - \left(\frac{\cos x}{5}\right)^5 + C$$

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

$u = \cos x$

$\frac{du}{dx} = -\sin x$

$du = -\sin x dx$

$-du = \sin x dx$

$dx = \frac{-du}{\sin x}$

$\cos x \sin^3 x = u \cdot \sin x \cdot \sin^2 x$

$$\int \cos x \sin^3 x dx = \int u \cdot \cancel{\sin x} \cdot \sin^2 x \cdot \frac{-du}{\cancel{\sin x}}$$

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$= -\int u \cdot \sin^2 x \cdot du$

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

$\therefore \sin^2 x = 1 - u^2$

$\int \cos^4 x \sin^3 x = -\int u \cdot (1 - u^2) \cdot du$

$\int \cos^4 x \sin^3 x = -\int u - u^3 \, du$

$\int \cos^4 x \sin^3 x = -\left(u^2/2 - u^4/4 \right) + C$

$\int \cos^4 x \sin^3 x = \frac{u^4}{4} - \frac{u^2}{2} + C$

$u = \cos x$

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