$$S_6 = -\frac{\sin^5 x \cos x}{6} + \frac{5}{6}\left(\frac{-\sin^3 x \cos x}{4} - \frac{3\sin x \cos x}{4}\right.$$

$$S_6 = -\frac{\sin^5 x \cos x}{6} - \frac{5\sin^3 x \cos x}{24} - \frac{5\sin x \cos x}{16} + \frac{5}{16}$$

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

$= \int \sin(x) (1 - \cos(x)] . \cos^4(x) \, dx$

Let $u = \cos(x)$

$du = \sin(x) dx$

$-du = \sin(x) dx$

$= \int \sin(x) (1-u^2) u^7 \, dx = \int (1-u^2) u^4 \sin(x) dx$

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

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

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

3. $\cos(x) \sin(3x) = \int \sin(3x) \cos(x) dx$

Recall;

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

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

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

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

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

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QUESTIONS

1. $\sin^6 x$

Using reduction formular

$$S_n = \frac{-\sin^{n-1}x \cos x}{n} + \frac{n-1}{n} S_{n-2}$$

$$S_6 = \frac{-\sin^{6-1}x \cos x}{6} + \frac{6-1}{6} S_{6-2}$$

$$S_6 = \frac{-\sin^5 x \cos x}{6} + 5/6\, S_4$$

Similarly, we obtain expression for S_4

$$S_4 = \frac{-\sin^3 x \cos x}{4} + \frac{3}{4} S_2$$

$$S_2 = \frac{-\sin x \cos x}{2} + 1/2\, S_0$$

$$S_0 = \int \sin^0 x \, dx = \int 1 \, dx = x$$

Substitute S_0 into S_2, then insert S_2 into S_4

$$S_4 = -\frac{\sin^3 x \cos x}{4} + \frac{3}{4}\left[\frac{-\sin x \cos x}{2} + 1/2\, x\right]$$

$$S_4 = \frac{-\sin^3 x \cos x}{4} - \frac{3 \sin x \cos x}{4} + \frac{3}{8} x$$

Substitute the above S_4 in S_6.