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Date Submitted: 22nd May, 2020

Find the integral of the following

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

Soln:

$\sin A \cos B = \frac{1}{2}[\sin(A+B) + \sin(A-B)]$ where $A = 7x$, $B = 2x$

$\sin 7x \cos 2x \, dx = \frac{1}{2}[\sin(7x+2x) + \sin(7x-2x)]$

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

$= \frac{1}{2}\int [\sin 9x + \sin 5x] \, dx$

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

$\int \sin 7x \cos 2x \, dx = -\frac{1}{18}\cos 9x - \frac{1}{10}\cos 5x + c$

2. $\int \cos 3x \cos x \, dx =$

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

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

$= \frac{1}{2}[\cos 4x + \cos 2x]$

$\int \cos 3x \cos x \, dx = \frac{1}{2}\int [\cos 4x + \cos 2x]$

$= \frac{1}{2}\left[\frac{1}{4}\sin 4x + \frac{1}{2}\sin 2x\right]$

$= \frac{1}{8}\sin 4x + \frac{1}{4}\sin 2x$

3) $\int \frac{\cos x}{\sin^3 x}\, dx$

soln

$$\int \cos x \sin^{-2} x\, dx = \int \sin^{-2} x \cos x\, dx$$

let $u = \sin x$, $du/dx = \cos x$

$dx = du/\cos x$

$$\int \sin^{-2} \cos x\, dx = \int u^{-2} \cancel{\cos x} \left(du/\cancel{\cos x}\right)$$

$$= \int u^{-2}\, du$$

$$= \frac{u^{-1}}{-1} + c$$

$$= -u^{-1} + c$$ substitute the value of u

$$= -\sin^{-1} x + c$$

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

4) double integral with limits from 1 to 2, from 0 to 3
$9x^2 y \, dx \, dy$

Soln

$$\Rightarrow \int_1^2 \int_0^3 (9x^2 y) \, dx \, dy$$

$$= \int_1^2 \left[\int_0^3 (9x^2 y) \, dx \right] dy = \int_1^2 \left[3x^3 y \Big|_{x=0}^{x=3} \right] dy$$

$$= \int_1^2 \left[3(3)^3 y \right] dy = \int_1^2 \left[81y \right] dy$$

$$\int_1^2 \int_0^3 (9x^2 y) \, dx \, dy = \frac{81y^2}{2} \Big|_1^2$$

$$= \frac{81(2)^2}{2} - \frac{81(1)^2}{2}$$

$$= 162 - 40.5$$

$$= 121.5.$$