Problem Quiz

$$I = \int \underset{dv}{x} \, \underset{u}{\ln(x)} \, dx$$

Sol^n

$$I = \frac{x^2}{2}\ln(x) - \int \frac{x^2}{2} \cdot \frac{1}{x} \, dx$$

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

$$= \frac{x^2}{2}\ln(x) - \frac{x^2}{4} + C$$

Notation

Fact:

$$\int k f(x) \, dx = k \int f(x) \, dx$$

for any constant k

$$\sin^2(x) = \sin(x) \sin(x)$$

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

So $\left(\sin(x)\right)^3 = \sin^3(x)$

Recall: $\cos^2(x) + \sin^2(x) = 1$

Problem Prove that

$$I_n = \int \sin^n(x)\,dx =$$

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

for integers $n \geq 2$.

Sol^n

$$I_n = \int \underbrace{\sin(x)}_{dv} \underbrace{\sin^{n-1}(x)}_{u}\,dx$$

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

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

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

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

In summary:

$$I_n = -\cos(x)\sin^{n-1}(x) + (n-1)\int \sin^{n-2}(x)\,dx$$

$$- (n-1) I_n$$

$$I_n + (n-1) I_n = -\cos(x)\sin^{n-1}(x) + (n-1)\int \sin^{n-2}(x)\,dx$$

$$I_n = -\frac{1}{n}\cos(x)\sin^{n-1}(x) + \frac{(n-1)}{n}\int \sin^{n-2}(x)\,dx.$$

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