NAME: Amadi Saarima Mildred
DEPARTMENT: Medicine and Surgery
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Integrate the following functions

1: $2x^2 \ln x$

$$\int \underset{dv}{2x^2} \underset{u}{\ln x}$$

$$\int u\,du = u - \int v\,du$$

$u = \ln x$ $\quad dv = 2x^2$

$du = \frac{1}{x}$ $\quad v = \int 2x^3$

$v = \frac{2x^3}{3} + C$

$$\int \ln x\, 2x^2 = \frac{2x^3 \ln x}{3} - \int \frac{2x^3}{3x}$$

$$\int \ln x\, 2x^2 = \ln x \times \frac{2x^3}{3} - \int \frac{2x^3}{3} \times \frac{1}{x}$$

$$\int \ln x\, 2x^2 = \frac{2x^3 \ln x}{3} - \int \frac{2x^3}{3x}$$

$$\int \ln x\, 2x^3 = \frac{2x^3 \ln x}{3} - \int \frac{2x^4}{2^4} \times \frac{1}{3x}$$

$$\int \ln x\, 2x^2 = \frac{2x^3 \ln x}{3} - \frac{x^4}{6x} + C$$

2 $3te^{2t}$

$$\int 3t\, e^{2t}$$

let $u = 3t$

$dv = e^{2t}$

$du = 3$

$dv = e^{2t}$

$$v = \int e^{2t}$$

$$\frac{d}{dx} = e^{2t}$$

let $u = 2t$

$y = e^e$

$$\frac{du}{dt} = 2$$

$$\frac{dt}{dy} = e^{2t}$$

$$\frac{du}{ex} = \frac{dy}{dg} \times \frac{du}{dy}$$

$$\frac{du}{dy} = 2e^u$$

Therefore $\int e^{2t} = e^{2t} + C$

$$\int u\,du = uv - \int du$$

$$\int 3te^{2t} = 3t \times e^{2t} - \int e^{2t} \times 3$$

$$\int 3te^{2t} = 3te^{2t} - \int 3e^{2t} + C$$

3. $\int x^2 \sin x$

$u \quad dv$

Let $u = x^2$ $\quad du = 2x$

$dv = \sin x$ $\quad dv = v \cdot \int \sin x$

$V = -\cos x + C$

$\int u\,dv = uv - \int v\,du$

$\int x^2 \sin x^2 - x^2 \cos x - \int -\cos x \sin x + C$

4. $\cos 5x \cos 6x$

$A = 5x \quad B = 6x$

Recall that

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

$= \frac{1}{2}\int \cos 11x + \cos x$

$\int \cos 5x \cos 6x\,dx = \frac{1}{2}\left[\frac{\sin 11x}{11} + \sin x\right] + C$

$\therefore \int \cos 5x \cos 6x\,dx = \frac{\sin 11x}{22} + \frac{\sin x}{2} + C$

5. $\sin 7x \cos 2x$

$A = 7x \quad B = 2x$

Recall that;

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

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

$\int \sin 7x \cos 2x\,dx = \frac{1}{2}\left[-\frac{\cos 9x}{9} - \frac{\cos 5x}{5}\right] + C$

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