NAME: Ogunlana Omolara Abiodun
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1. $\int x^2 \sin x \, dx$

using integration by parts

$u\int v\,dx - \int u' \int v\,dx$

$u = x^2$, $u' = 2x$, $V = \sin x$

$V = \sin x \quad \int v\,dx = -\cos x$

$x^2 x - \cos x - \int -2x \cos x$

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

integrating $x \cos x$

$u = x$, $u' = 1$

$\int v\,dx = \sin x$

$\therefore x \sin x - \int \sin x$

$= x \sin x - (-\cos x)$

$= x \sin x + \cos x$

$\int x^2 \sin x \, dx = -x^2 \cos x + 2(x \sin x + \cos x) + C$

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

2. $\int 3te^{2t}\,dt$

Integrating by part

$u\int v\,dx - \int u'\int v\,dx$

let $u=3t$, $u'=3$ $v=e^{2t}$

$\int v\,dx = \frac{1}{2}e^{2t}$

$= \frac{3t}{2}e^{2t} - \frac{3}{4}e^{2t} + C$

$= e^{2t}\left(\frac{3t}{2} - \frac{3}{4}\right) + C$

3. $\int 2x^2 \ln x\,dx$

let $u=\ln x$, $u'=\frac{1}{x}$, $v=2x^2$

$\int v\,dx = \frac{2x^3}{3}$

$\therefore \ln x \cdot \frac{2x^3}{3} - \int \frac{1}{x}\cdot\frac{2x^3}{3}$

$= \frac{2x^3}{3}\ln x - \int \frac{2x^2}{3} = \frac{2x^3}{3}\ln x - \frac{2}{9}x^3 + C$

4. $\int \frac{2x - 3x^2}{1-x}\, dx$

Dividing the numerator by the denominator

$$
\begin{array}{r|l}
 & +3x+1 \\
\hline
1-x & 2x - 3x^2 \\
 & -(3x - 3x^2) \\
\hline
 & -x + 0 \\
 & -(-x + 1) \\
\hline
 & -1
\end{array}
$$

$+3x(1-x)$
$3x - 3x^2$
$1(1-x)$
$1 - x$

$$\therefore \int 3x + 1 + \left(\frac{-1}{1-x}\right) dx$$

$$= \int 3x\, dx + \int dx + \int \frac{-1}{1-x} dx$$

$$= 3\left[\frac{x^2}{2}\right] + x + \ln(1-x) + C$$

$$= \frac{3x^2}{2} + x + \ln(1-x) + C$$