Facts about Integration by Parts for Indefinite Integrals	**Explanation**
$$\int u\ dv = uv - \int v\ du$$	The common Integration by Parts Formula for Indefinite Integrals.
The LIATE Scale L - Logarithm Function I - Inverse Trigonometric Function $\uparrow u$ A - Algebraic Function (polynomials) T - Trigonometric Function $\downarrow dv$ E - Exponential Function (e^x or 10^x)	Use this LIATE scale to pick your u and dv. Pick your u to be something higher on this scale and dv to be something lower on this scale. This is just a guideline; there might be functions where you might not want to use the LIATE scale.
How to compute du where $u = f(x)$?	$$du = f'(x)\ dx$$
How to compute v where $dv = g'(x)\ dx$?	$$v = \int dv = \int g'(x)\ dx = g(x)$$

1. Evaluate $\int xe^x dx$ through the following parts.
   (a) Use the LIATE scale to assign your u and dv.

   Solution:
   $$u = x \qquad dv = e^x\ dx$$

   (b) Find du (the differential of u) and v (antiderivative of dv).

   Solution:
   $$du = dx \qquad v = \int e^x\ dx = e^x$$

   (c) Set up the integration by parts formula and find an antiderivative for the integral.

   Solution:
   $$\begin{aligned}\int xe^x\ dx &= xe^x - \int e^x\ dx \\ &= xe^x - e^x + C\end{aligned}$$

2. Evaluate $\int x^2 \ln(x)\ dx$ through the following parts.

   (a) Use the LIATE scale to assign your u and dv.

   Solution:

   $$u = ln(x) \qquad dv = x^2\ dx$$

   (b) Find du (the differential of u) and v (antiderivative of dv).

   Solution:

   $$du = \frac{1}{x}\ dx \qquad v = \frac{x^3}{3}$$

   (c) Set up the integration by parts formula and find an antiderivative for the integral.

   Solution:

   $$\begin{aligned}\int x^2 ln(x)\ dx &= \frac{x^3}{3} ln(x) - \int \frac{x^3}{3}\frac{1}{x}\ dx \\ &= \frac{x^3 ln(x)}{3} - \frac{x^3}{9} + C\end{aligned}$$

3. Evaluate $\int e^x sin(x)\ dx$ (You will have to use integration by parts twice).

Solution:
We first find

$$\begin{aligned} u &= \sin(x), & v &= e^x, \\ du &= \cos(x), & dv &= e^x\ dx. \end{aligned}$$

This leaves us with a new integral

$$\int e^x sin(x)\ dx = e^x sin(x) - \int e^x cos(x)\ dx.$$

Unfortunately, we still don't know how to solve the integral we've been left with, but let's just integrate by parts one more time. Let

$$\begin{aligned} u &= \cos(x), & v &= e^x, \\ du &= -\sin(x), & dv &= e^x\ dx, \end{aligned}$$

and we find

$$\int e^x sin(x)\ dx = e^x sin(x) - e^x cos(x) - \int e^x sin(x)\ dx.$$

But wait a minute. We can just add the last term over to find

$$2\int e^x sin(x)\ dx = e^x sin(x) - e^x cos(x).$$

This is just twice what we originally wanted to find! So, we have

$$\int e^x sin(x)\ dx = \frac{e^x sin(x) - e^x cos(x)}{2} + C.$$

4. Evaluate $\int_0^1 \arcsin(x)\ dx$.

Solution:

There is not much to go on here, but we can begin by choosing

$$u = \arcsin(x), \qquad v = x,$$
$$du = \frac{1}{\sqrt{1-x^2}}\,dx, \qquad dv = 1\,dx.$$

Now we integrate by parts to find

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

With this new integral, we can make the substitution $w = 1 - x^2$ to find

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

and so,

$$\int \arcsin(x)\,dx = x\arcsin(x) + \sqrt{1-x^2}.$$

The original problem was a definite integral from 0 to 1, so we evaluate as

$$\int_0^1 \arcsin(x)\,dx = x\arcsin(x) + \sqrt{1-x^2}\Big|_0^1 = \frac{\pi}{2} - 1.$$

5. Some additional practice.

    1. $\int 4x\cos(2-3x)\,dx$
    2. $\int_6^0 (2+5x)e^{x/3}\,dx$
    3. $\int x^2\cos(3x)\,dx$
    4. $\int t^7\sin\left(2t^4\right)\,dt$