Integration by parts:

Derivative of a product: $(uv)' = uv' + vu'$

$$uv' = (uv)' - vu'$$
$$\int uv' = \int (uv)' - \int vu'$$
$$\int uv' = (uv) - \int vu'$$

Example: $\int e^{2x} sin(3x)$

Let $u = sin(3x)$, $dv = e^{2x}$

then $du = 3cos(3x)$, $v = \frac{1}{2}e^{2x}$

then $d^2u = -9sin(3x)$, $\int v = \frac{1}{4}e^{2x}$

$\int e^{2x} sin(3x) = \frac{1}{2}sin(3x)e^{2x} - \int \frac{3}{2}e^{2x}cos(3x)$

$$= \frac{1}{2}sin(3x)e^{2x} - [\frac{3}{4}cos(3x)e^{2x} - \int \frac{-9}{4}sin(3x)e^{2x}$$

$\int e^{2x} sin(3x) = \frac{1}{2}sin(3x)e^{2x} - \frac{3}{4}cos(3x)e^{2x} - \frac{9}{4}\int sin(3x)e^{2x}$

$\frac{13}{4}\int e^{2x} sin(3x) = \frac{1}{2}sin(3x)e^{2x} - \frac{3}{4}cos(3x)e^{2x}$

$\int e^{2x} sin(3x) = \frac{4}{13}[\frac{1}{2}sin(3x)e^{2x} - \frac{3}{4}cos(3x)e^{2x}]$

Optional Exercise: Calculate $\int e^{x} cos(2x)$