Now that we've reviewed Laplace transforms of signals, we can move on to systems, the transfer function, and system block diagrams using blocks which contain transfer functions.

Consider a circuit:

\[ H(s) = \frac{V_o(s)}{V_{in}(s)} = \frac{R + L_2s}{R + L_1s + L_2s} = \frac{R + L_2s}{R + (L_1 + L_2)s} \]

This could be represented in as a block operator:

\[ V_{in}(s) \rightarrow \frac{L_2s + R}{(L_1 + L_2)s + R} \rightarrow V_o(s) = V_{in}(s)H(s) \]

Transfer functions can be written for all kinds of devices and systems, not just electric circuits and the input and output do not have to be similar. For instance, the potentiometers used to measure angular position in the crude servo of lab 1 can be represented like this:

\[ \theta_{in}(s) \rightarrow K_p = 0.7 \frac{V}{\text{rad}} = 0.012 \frac{V}{\text{deg}} \rightarrow V_{out}(s) = K_p \theta_{in}(s) \]

In general:

\[ H(s) = \frac{\text{output}}{\text{input}} = \frac{Y(s)}{X(s)} \]

\[ X(s) \rightarrow H(s) \rightarrow Y(s) = X(s)H(s) \]

The output signal has the poles of both the input AND the transfer function.

**Serial - path systems** Two blocks with transfer functions \( A(s) \) and \( B(s) \) in a row would look like this:

\[ X(s) \rightarrow A(s) \rightarrow X(s)A(s) \rightarrow B(s) \rightarrow Y(s) = X(s)A(s)B(s) \]

The two blocks could be replaced by a single equivalent block:

\[ X(s) \rightarrow A(s)B(s) \rightarrow Y(s) = X(s)A(s)B(s) \]

The output signal has the poles of the input AND BOTH transfer functions.