Negative Feedback & Op Amp Topologies

The classic formulation of the negative feedback problem looks like so:

\[ s_{\text{out}} = \frac{A}{1 + Af} s_{\text{in}} \approx \frac{1}{f} \text{ when } A \to \infty \]

Figure 1: Classic negative feedback block diagram

For the block diagram above, the output is related to the input by

\[ s_{\text{out}} = \frac{A}{1 + Af} s_{\text{in}} \approx \frac{1}{f} \text{ when } A \to \infty \]

In this class, the block for \( A \) often involves the use of an operational amplifier, or op amp (not to be confused with OMP!) for short. For these situations, the value of \( A \to \infty \), so we can make some assumptions known as the “Golden Rules”.

- Always true: \( i_- = i_+ = 0 \text{A} \)
- Negative feedback only: \( u_+ = u_- \)

When dealing with feedback topologies, we often want to know two things:

- Is it actually in negative feedback?
- What is the relationship of the output signal with respect to the input signal?
The way we show that a system is in negative feedback involves a bit of a gedankenexperiment\(^1\).

(a) Turn off all independent sources

(b) Perturb the output by pretending that it gets “kicked” up (or down)

(c) Go around the feedback loop to see how the inputs of the op amp \(u_+\) and \(u_-\) are affected (i.e. do they go up or down?)

(d) After determining how the inputs of the op amp responds to the initial stimulus, see how the output of the amp responds to the changing op amp inputs. If the system is in negative feedback, the output should be pushed in the opposite direction as the initial stimulus!

1. Amplifier Topologies

For the following amplifiers, assume that \(V_{REF}\) is constant.

i. Find \(v_{out}\) in terms of any given voltages/currents and passive components

ii. For topologies with \(v_{in}\), if \(v_{in}\) has an \(R_{Th} > 0\Omega\) in series, will \(v_{out}\) be different than if \(R_{Th} = 0\Omega\)? An alternative way of phrasing this question is, does the amplifier topology present a finite resistance at its input?

(a) 

(b) 

\(^1\text{https://en.wikipedia.org/wiki/Thought_experiment}\)
(c) Assume you know $v_{out}(t_0)$.
(f)