Section I
Feedback and Stability
(Chapter 11 of your text)

Section I1: Introduction & Goals

Although all of the topics we are going to discuss next are not strictly required material for this course, this section is extremely important and will provide the tools that will allow you to become a more effective and efficient designer. We have been dealing with feedback, specifically negative feedback, for a while now, but have not really dealt with what it means and why it is important.

Feedback, by definition, exists when the output of a circuit or system is connected to the input of the same circuit or system in such a way that the output signal affects the input signal. We have seen specific instances of this with the emitter resistor of BJT circuits and the feedback resistor in op-amp circuits. In each of these cases, gain may have been sacrificed, but the sensitivity to device and/or operational parameters was reduced. There are two different types of feedback:

- **negative feedback** (also called subtractive or degenerative) occurs when the portion of the output that appears at the input has the effect of reducing the magnitude of the input signal; or
- **positive feedback** (also called additive or regenerative) occurs when the portion of the output that appears at the input increases the magnitude of the input signal.

Positive feedback is used in the design of oscillators and involves intentionally introducing marginal stability into the circuit (this will be clearer in a little while). Under these conditions, the amplifier can produce a periodic output signal even in the absence of an input signal. However, we’re going to begin our discussion concentrating on the much more widely used technique of negative feedback. Specifically, negative feedback allows us to control one or more of the following amplifier properties:

- **Closed loop gain**: the amplifier gain, although usually lower than without negative feedback, is less sensitive to variations in device parameters and operational conditions (i.e., temperature, frequency, etc.).
- **Input and output impedances**: the input and/or output impedances of an amplifier may be increased or decreased by using an appropriate feedback technique.
- **Bandwidth**: the bandwidth of an amplifier may be increased through suitable feedback.
- **Nonlinearities and distortion**: using feedback, nonlinear distortion may be reduced and the gain may be made constant independent of signal level; i.e., keep the output proportional to the input.
- **Noise**: the effects of undesirable signals due to internally generated noise in the device and circuit components or external interference is minimized.

In this section, we will be introducing feedback techniques and developing the mathematical tools for analyzing the effects of feedback on electronic circuits and systems. When you have completed this section of our studies, the goals are for you to be familiar with:

- the different types of feedback; and
- how amplifier stability can be controlled.

The remainder of the chapter has some interesting material that has definite practical applications. I encourage you to review

- the use of unstable (actually, marginally stable) amplifiers as oscillators; and
- the effects of capacitive loading.