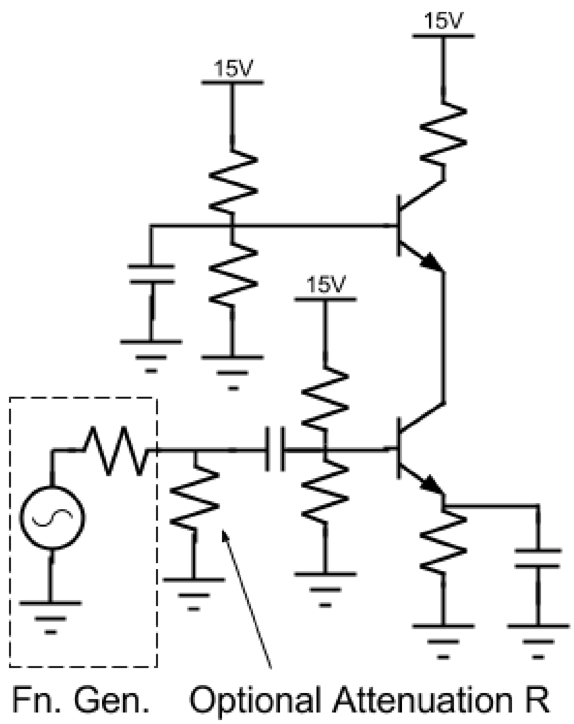

Figure 1: A sample design for a cascode amplifier.

In this lab you will build and characterize a cascode amplifier. In the design project, you will use a small number of transistors to design an amplifier to a specification that includes high frequency performance. The learning goals are listed below:

- Observe the improved performance of a cascode amplifier relative to a common emitter.
- Understand biasing techniques for cascode amplifiers by exploring them on your own.
- Use open circuit time constants as design aids to understand bandwidth limits in your design.
- Practice reconciling measured performance, simulations and analytical models.

1 Lab 6 – Design a Cascode Amplifier

In this lab you will design a cascode amplifier to meet a set of given specifications. You may use the reference design pictured in Figure 1 to do so. One explicit challenge of the lab is deciding what the bias voltage of the common base stage's base should be. Another challenge is applying open circuit time constants to the circuit in order to get a semi-accurate prediction of bandwidth.

You must begin your design by making hand calculations which help you pick your compnent values. These hand calculations should include calculations of open circuit time constants and short circuit time constants. After that you should simulate your design to make sure those component values work in simulation. Finally, you must build your design and experimentally show that it meets the design specifications.

Be sure to calculate, simulate and measure the power consumption of your design. Also be sure to measure your amplifier's Bode plot and step response and record them in your notebook. Explain features of the Bode plot and the step response and compare the measured 3dB bandwidth to a common emitter amplifier with the same gain.

The design specifications are as follows:

- $R_{in} > 1\text{k}\Omega$
- $R_{out} < 5\text{k}\Omega$
- $A_v = 200 \pm 10\%$.
- $V_{sw} > 3\text{V}$ as measured by absence of visible clipping, not by harmonic content.
- $f_{low} < 2\text{kHz}$
- Use only one 15 V power supply
- Your signal source has a source impedance of >10 Ω and may not have any DC offset
- Use two transistors, both 2N3904s

2 Design Project 2

Design an amplifier which meets the following specifications:

- $R_{in} > 20\text{k}\Omega$
- $R_{out} < 50\Omega$
- $A_v = 1000 \pm 5\%$
- $V_{sw} > 5\text{V}$ as measured by harmonic content which is at least 30dB below the fundamental.
- $f_{low} < 2\text{kHz}$
- $f_{high} > 4\text{MHz}$
- Use only one 15 V power supply.
- Input signal source has a source impedance of >5 Ω and may not have any DC offset.
- Use six or fewer transistors, up to three 2N3906s and up to three 2N3904s.
- Optimize for minimum power consumption and minimum component count.

As above, design the amplifier on paper, simulate it, build it, and experimentally verify its performance. Be sure to complete the following steps:

- Use open circuit time constants to estimate your amplifier's bandwidth and optimize its performance; include that analysis as part of your design process.
- Measure a Bode plot and a step response for your amplifier
- Reconcile your measurements with your simulations and analytical models. Prove you have done so by including a table in your report which compares measured, simulated and calculated amplifier parameters (including power).

You may need to build an attenuator to make your input signal small enough that your output does not exceed your output swing. You may use any supplies that you like to build your attenuator.