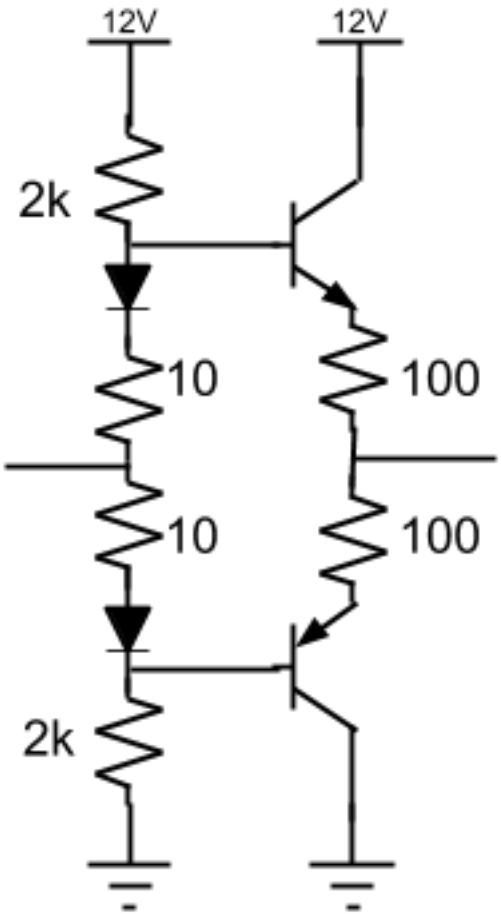

Figure 1: Schematic of a Class AB push-pull amplifier.

1 Warmup Problem

Find the r_{in} and r_{out} of the class AB amplifier in Figure 1 and the approximate bias current running in each branch. Assume the beta of all transistors is 100 and the V_{BEON} of all transistors is 0.7V. I recommend making liberal use of symmetry arguments.

2 Lab Introduction

In this lab you will build and characterize several output stages. The learning goals are listed below:

- Implement a class A, B and AB amplifiers, which requires considering their biasing.
- Observe differences in distortion, power output and efficiency between the amplifiers.

IMPORTANT NOTE: The class AB circuit you build here is the output stage of your operational amplifier. Please keep it on your breadboard for use in future labs.

3 Compare Class A and Class B amplifiers

In this section you will build and compare class A, class B, and class AB power amplifiers.

Please do the following for each amplifier for several different input amplitudes:

1. Measure the output impedance. Note that it's easy to measure this incorrectly in a class B amplifier: you need to add 0.7V to your output signal to account for the deadzone.
2. Save a trace containing the input and output waveforms overlaid at the maximum input amplitude you test.
3. Use your output voltage measurements to calculate the power driven into the load.
4. Measure the power pulled from the supply and calculate the efficiency of your amplifier. What is the maximum efficiency you can achieve?
5. Record the values of input amplitude at which there are significant changes in the shape of your output wave. Qualitatively compare the swing and non-linearit fo these stages.
6. Compare your output waveform to major sources of non-linearity in theory. Explain any significant distortion in your output waveform. You don't need to fix this distortion, just explain where it comes from.
7. Comment on the sound the amplifier makes when driving into a speaker.

Some design details of the amplifiers appear below:

1. All amplifiers may have capacitively coupled inputs.
2. All amplifiers must have capacitively coupled outputs. Don't overdo it on your output coupling cap because large capacitors at the output of an emitter follower can make the stage unstable.
3. All amplifier measurements (except output impedance) should be carried out with a speaker load attached. All measurements should be taken at 1kHz.
4. These amplifiers may require practical biasing circuits that were not pictured in lecture. These circuits will probably just be resistor dividers, but feel free to build current mirrors if you want to give it a shot.
5. The class A amplifier should be an emitter follower which is biased with 10mA of current. It should operate on a 12V supply.
6. The class B amplifier should be a push-pull operating off of a 12V supply.
7. The class AB amplifier should be built to the design in Figure 1.
8. Be careful of the power ratings of your resistors (usually 0.1W) and transistors (about 0.3W w/o heat sink)

Required Data: r_{out}, P_S, P_L, and η for each amplifier for several different amplitudes of v_{IN}. Overlaid input and output oscilloscope traces over 1-4 periods for each amplifier at max amplitude, discussion of non-linearity and comparisons between amplifiers.