1 Lab Introduction

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

- Implement 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.

2 Compare Class A and Class B amplifiers

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

Some design details of the amplifiers appear below:

- All amplifier measurements (except output impedance) should be carried out with a speaker load (or an 8Ω proxy resistor) attached.
- Be mindful of the frequency you use to test the amplifiers. You don’t need AC coupling in this lab, which changes our consideration of what frequencies to use. Beware of stray capacitance at high frequencies.
- Be careful not to hook test equipment, particularly signal generators, to DC offsets or large AC outputs. Think about the DC voltage of any node that you DC couple to.
- The class A amplifier should be an emitter follower which is biased with a 10mA current mirror attached to the emitter. It should operate on a ±6V supply.
- The class B push-pull amplifier should be a push-pull operating off of a ±6V supply.
- The class AB push-pull amplifier should be built to the design in Figure 1.
- Be careful of the power ratings of your resistors (usually 0.1W) and transistors (about 0.3W w/o heat sink)

Do the following for each amplifier. Where appropriate, take measurements at two or three different input amplitudes that demonstrate different linearity behaviors:

1. Measure a transfer characteristic.
2. Save a trace showing the input and output 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-linearity of 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.
8. 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.

**Required Data:** $r_{out}$, $P_S$, $P_L$, and $\eta$ for each amplifier for several different amplitudes of $v_{IN}$. Transfer characteristics for each amplifier. Overlaid input and output oscilloscope traces over 1-4 periods for each amplifier at max amplitude, discussion of non-linearity and comparisons between amplifiers.
Figure 1: Schematic of a Class AB push-pull amplifier.