PreLab 4 – Emitter Follower (Week of May 4th)

• GOAL

The overall goal of PreLab4 is to simulate the emitter follower circuits you will build/test in lab.

• GENERAL GUIDELINES

1) Each student must turn in his/her own PreLab assignment (include both schematics and waveforms).
2) Students are allowed (even encouraged) to work together. However, you must turn in your own work!
3) SAVE ALL SCHEMATIC AND WAVEFORM FILES – you will need them for your lab report.

• PART 1: DC FOLLOWER

Emitter followers have many DC applications, particularly for power supplies. Suppose we want to drive a DC motor with 5V. The motor requires about 60 mA of current, which is enough to cause a zener to drop out. ☹

One way to avoid zener drop out is to use an emitter follower! Although the motor is driven with 60 mA, the transistor base current is only a few hundred uA and barely affects the zener.

TASK 1a: Simulate the emitter follower in Fig. 1.

- Use the "2N2222" transistor (the data sheet is on the WEB.
- Use the 1N4734A zener (this is a 5.6 V zener).

NOTE: The 16 ohm resistor is not needed for the emitter follower to work properly. You will use it in lab to measure the collector voltage and therefore determine the collector current.

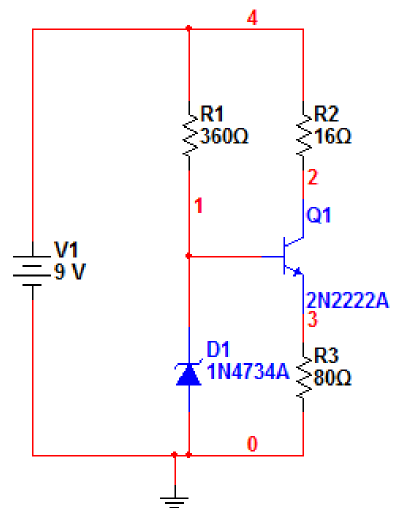

Figure 1: Driving a DC motor with an emitter follower.

- Use a DC operating point simulation: Simulate | Analysis | DC operating point.
- Select the following outputs: zener diode current I(D1[ID]), transistor collector current I(Q1[IC]), transistor base current I(Q1[IB]), transistor emitter current I(Q1[IE]), zener diode power dissipation P(D1), and transistor power dissipation P(Q1).
- Run your simulation and copy the output table and save it for your lab report.
- Copy the schematic an save it for your lab report.
- Calculate the transistor current gain and save the result for your lab report.

PART 2: DRIVING A SPEAKER

It is a bad idea to connect an audio speaker to a common emitter amplifier, because the speaker impedance (e.g. 16 ohm) is much much lower than the amplifier's output impedance (e.g. 1 kohm). You will end up with almost no signal at all! ☹

TASK 2: Simulate the circuit shown in Figure 2.

- The signal source is a 500 mV_{PEAK} sine wave (880 Hz). Label the wires Vi and Vout.
- The source impedance is RS = 50 + 1000 = 1050 ohm.
- Simulate about 2 cycles of the input/output wave form. Display the input signal on the left Y axis and the outpour on the right Y axis. Label the left axis Vin and the right axis Vout and change the title. Use the cursers to measure and label the maximum and minimum values for Vin and Vout. Your simulation should be similar to the one in Figure 3 below.
- Measure the peak-to-peak voltages and compute the voltage "gain" V_{OUT}/V_{IN} (should be ≈ 0.015).
- Save the schematic, waveforms, peak-to-peak voltages, and voltage gain for the lab report.

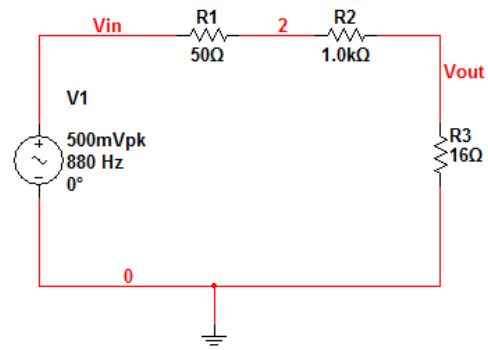

Figure 2: Direct connection of a speaker to a high impedance source.

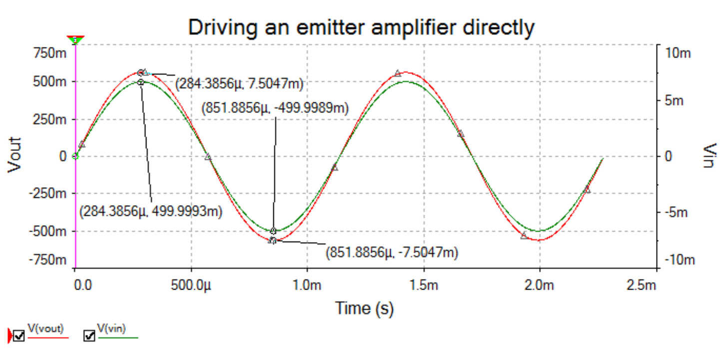

Figure 3: Simulation output

PART3: DARLINGTON-BASED AC FOLLOWER

Emitter follower to the rescue! We will use a Darlington connection to get extra high current gain (e.g. 10,000). This allows the input impedance of the follower to be over 10 kohm, even though the speaker impedance is only 16 ohm. Nice!

TASK 3: Simulate the emitter follower shown in Figure 4.

- The Darlington connection is made with a 2N3904 transistor and TIP31A transistor. Use an electrolytic capacitor: Basic | Cap_Electrolit. You will notice that this capacitor has polarity.

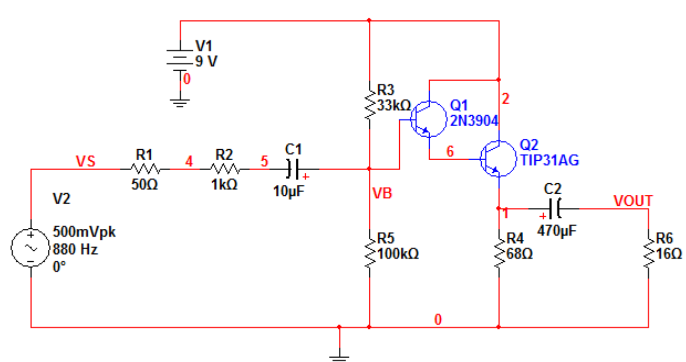

Figure 4: Emitter follower using Darlington-connected transistors.

- The signal source is a 500 mV_{PEAK} sine wave (880 Hz).
- Name the wires VS, VB, and Vout.
- Run a simulation that will display two cycles of the signals.
- Run your simulation for each of the voltages individually and copy and paste graphs into one graph. Your graph should look similar to the one in figure 5 at the bottom of page 3.
- Use Alt PrtScn to copy the graph of all three voltages and save for it use in your final report.
- Measure the peak-to-peak values of all three voltages.
- Compute the gain V_{OUT}/V_{IN} and V_{OUT}/V_S. NOTE: V_{IN} is the peak-to-peak value of V_B!
- Based on your two voltage gains, compute the input impedance of your voltage buffer. NOTE: R_S = 1050 ohm!
- Submit the schematic, waveforms, peak-to-peak voltages, voltage gains, and input impedance.

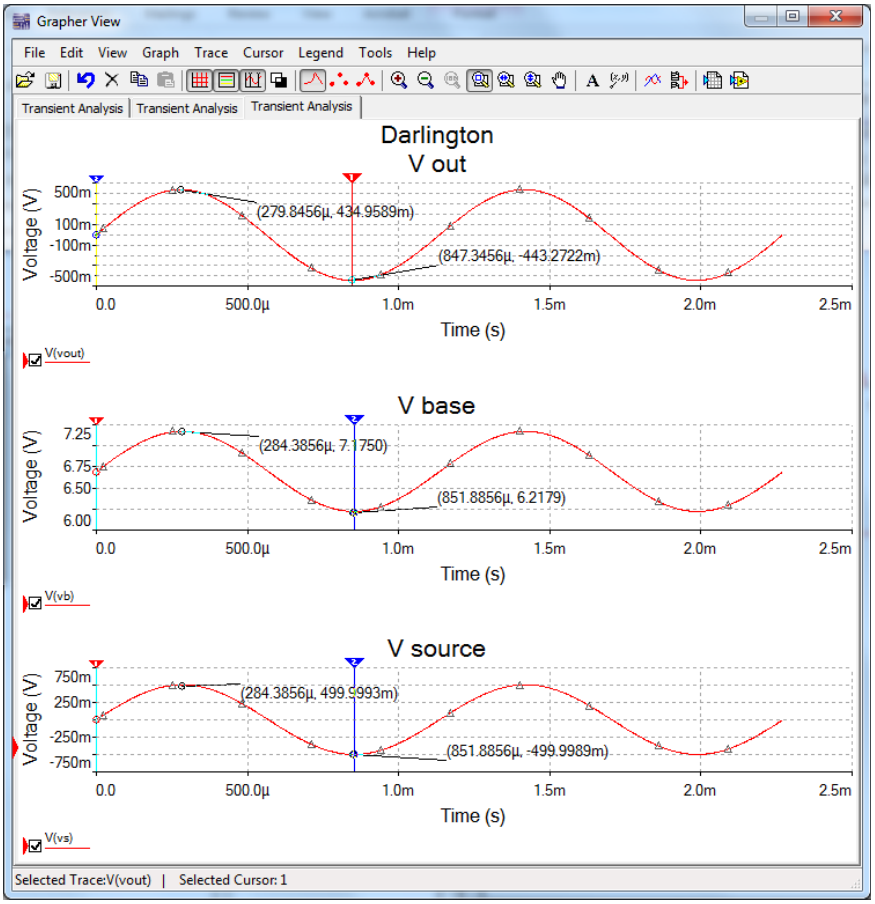

Figure 5: Graphs of Vs, VB, and Vout

(End of PreLab4)