Lab 10: AM Radio

U.C. Davis Physics 116A

INTRODUCTION

The purpose of this lab is to demonstrate the ability to put together the various circuit pieces that we have studied over the course of the quarter into one larger, more complex, useful application – an AM radio.

1. Block Diagram

To build a complex circuit, you first break the circuit down into functional units. For the AM radio, the block diagram in figure 1 shows the various functional units for this circuit. Please note that we will not be building or testing the RLC tuner for lab this year; rather than tune AM radio signals using an antenna, we will use function generators to create an AM signal to test the circuits.

While you are building and testing the circuit elements from part 3, 4, and 5, please keep each part on a single breadboard.

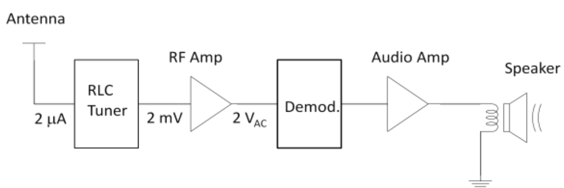

Figure 1: Block diagram of the complete circuit

2. RLC Tuner (Concept only)

Please note that this section is included for completeness, however we will not be building this part of the circuit.

- R = 1kΩ
- R_{pot} = 10kΩ
- L = 56μH
- C = 100pF
- D = 4001

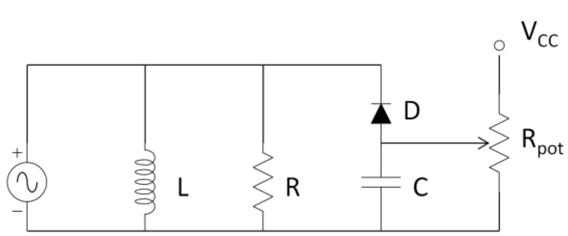

Figure 2: RLC tuning circuit

3. RF Amplifier

The design goal of this amplifier is to boost a small radio frequency signal by a voltage gain of 1000. The gain-bandwidth product of the 714 op-amp is such that we will need a three stage amplifier to achieve this gain.

Build the circuit as shown in figure 3 and test it with a 50 kHz sine wave from your function generator. Try to use a 10 mV signal from the function generator. If you are having trouble getting a low noise signal from the function generator, try using a higher amplitude signal, and then running it through a passive voltage divider to bring it down to the required input voltage. Measure the input voltage and the gain at each stage of the amplifier. Vary the input frequency to determine the corner frequency for this amplifier.

What is the purpose of the input capacitor. How do you determine the correct value for this capacitor?

- V_{CC} = +/-12V
- R_1 = 1kΩ
- R_2 = 10kΩ
- C_{in} = 0.1μF
- v_{in} = 50kHz, 10 mV_{pp}
- A_1 is a 741
- A_2 is a 741
- A_3 is a 741

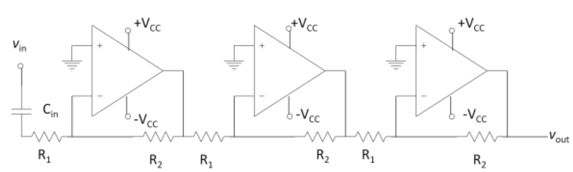

Figure 3: Radio frequency amplifier

4. Demodulation

For our demodulator, we will use an envelope detector circuit. You can also demodulate with a peak detecting circuit but this requires that you know the carrier frequency. The envelope detector is a simpler and more flexible circuit, but it introduces distortion, so it is not really the best demodulator for an audio application.

To test the performance of your demodulating circuit, you will need to work with another group, because you will need two function generators. Set one function generator at the carrier frequency of 50 kHz. The second function generator will be set to an audio frequency (use 5 kHz); its input will go into the AM modulation input in the back of the first function generator.

First verify that you have the correct input by sketching the input signal, be sure to show at least one full cycle of the audio frequency signal.

Next sketch the output of the demodulator. Explain how this circuit achieves the functionality of amplitude demodulation. What requirements are there on the resistors and capacitors in this circuit?

- D_1 = 4001
- R_1 = 1kΩ
- R_2 = 4.7kΩ
- C_1 = 0.01μF
- C_2 = 0.01μF
- C_{out} = 0.1μF
- v_{in} = 50kHz, 10 V_{pp}

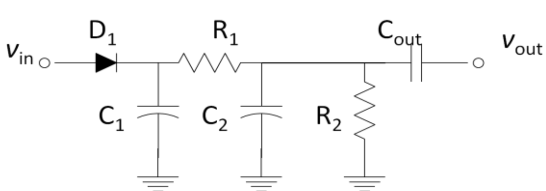

Figure 4: An envelope detector demodulator

5. Audio Frequency Power Amplifier

Make the amplifier shown in figure 5. Use the following components:

- V_{CC} = +/-12V
- R_C = 100Ω
- R_1 = 10kΩ
- R_2 = 1kΩ
- C_{in} = 0.01μF
- C_{out} = 0.01μF
- v_{in} = 20Hz to 20kHz, 2 V_{pp}
- Q_1 is a 3904 npn
- Q_2 is a 3904 npn
- Q_3 is a 3906 pnp
- Q_4 is a 3906 pnp

The purpose of this circuit block is to drive the speaker on the board. Test this element with an audio frequency sine wave from your function generator. Sketch the input and output waveforms and verify that your power amp can drive the speaker on the project board.

What are the limits on the capacitors in this circuit?

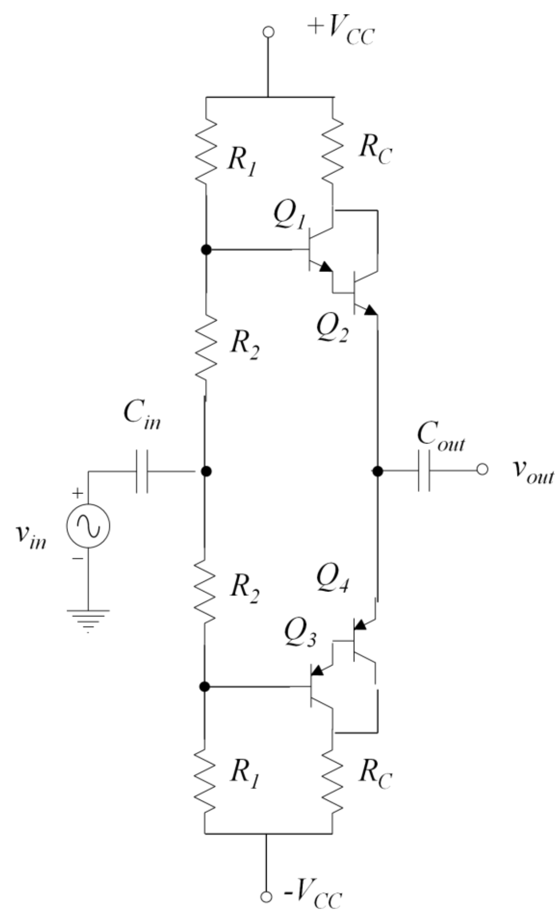

Figure 5: Audio frequency power amplifier

6. AM Radio

Now connect all the elements of the circuit together. Your lab TA will provide an audio input to the AM input of your function generator. Verify that you can get decent sound output from your speaker.