ENSC 220 ELECTRIC CIRCUITS I – Fall 2004
Lab #5: Application Circuits: A Touch-Switch and an AM-Radio
(Due Dec. 6, 2004)
READ THIS HANDOUT THOROUGHLY BEFORE STARTING THE EXPERIMENT

The objective of this lab is to

- Construct two application oriented circuits
- Demonstrate its functionality
- Perform a series of measurements and
- Explain how the circuit works

1. Capacitor Touch Switch

The schematic shown in Circuit-1 is a touch switch. The touch switch capacitor is made of two pieces of copper-clad board with wires soldered on to them for contact. You can introduce a small piece of dielectric, for example thin dry piece of paper or thin plastic (plastic wrap etc) (folded in half), in between the plates to configure a touch sensitive variable capacitor. Whatever dielectric you use make certain that it can spring open and closed. Whenever you press the plates together, the distance between them changes and consequently the capacitance varies. For the 220 lab we have a copper-clad plates available from the engineering resource office. For those make certain that you solder wires to the inner copper side of the plates and assemble it such that the wires do not prevent the capacitor plates from coming as tightly as possible together. Alternatively, you can make your own touch sensitive capacitor using two metal foils and a paper or seran-wrap dielectric.

1.1 Circuit Assembly:

Construct the circuit. Component values shown in the circuit diagram are design-values. The circuit should function even if you choose the resistor values close to the design-value. For example the resistors R1 and R2 doesn't necessarily have to be 12K and 1K2. So long as the ratio between R1 and R2 is 10:1 the circuit will work. Choose the resistors in K-Ohm range. Same argument applies to R5 and R6. R3 and R4 can be between 8K and 15K. R7 cannot be lower than 100 Ohms and the capacitor 1μFD is available in your parts bag. Notice the polarity for the capacitor. Assemble the circuit neatly with short wires and neatly folded interconnections. After assembling the circuit, double check the wiring.

1.2 Testing:

Set the current limit to 100mA and configure a +/- 10V dual supply. Power the circuit. Now select 100KHz in the function generator, set the DC-shift control to zero and reduce the amplitude to the minimum. Power on the function generator and feed the signal to the circuit input. Gently increase the signal amplitude while periodically pressing the touch-switch capacitor. When you have reached the appropriate input signal level you will notice the LED glow each time you depress the touch-switch capacitor plates. You have to demonstrate the working touch switch to a TA or instructor using the 220-lab copper-clad capacitor.

1.3 Reporting:

Your lab report should explain how the circuit works as a touch switch. The report should have answers to the following questions as well:

1. What is the purpose of resistor R3?
2. What is the purpose of resistors R1 and R2?
3. What does the first OPAMP circuit do?
4. What is the purpose of 15K, 1μFD RC circuit section?
5. What will happen to the operation of the circuit if the 1μFD capacitor is removed?
6. What is the purpose of the second OPAMP circuit?
7. Can you configure the touch-switch with one OPAMP? If so, what will be the limitation?

You may want to probe the signals at various points in the circuit to get the answers for the questions listed above. Q#4 is a important question and 20% of the marks of this report is allocated for the (correct) answer.

2. AM Radio

The schematic shown in Circuit-2 is an AM radio. The circuit has four sections. The input section consists of your inductor and a variable capacitor in parallel connection. One side of this circuit is connected to ground and the other side connected to an external antenna. A real ground connection and an antenna connection is available in the lab bench adjacent to the electronics stores. The antenna connection is the center-core of the black co-ax cable and the ground connection is a thick multi-strand wire with green insulation. Both these wires come from the ceiling of the lab near the lab bench.

2.1 Circuit Assembly:

Construct the circuit. You should choose the component values as close to the indicated value as possible for the circuit to work properly. Assemble the circuit neatly with short wires and neatly folded interconnections. After assembling the circuit, double check the wiring.

2.2 Testing:

To demonstrate the functioning circuit the TA/instructor have access to a test board (see Fig. 3) that contains a variable capacitor and a head-phones jack. Connect the ground, external antenna and power the circuit. By choosing appropriate taps from the inductor and adjusting the variable capacitor you should be able to tune the board to receive at least a few AM broadcast stations. You have to demonstrate this to your TA/instructor.

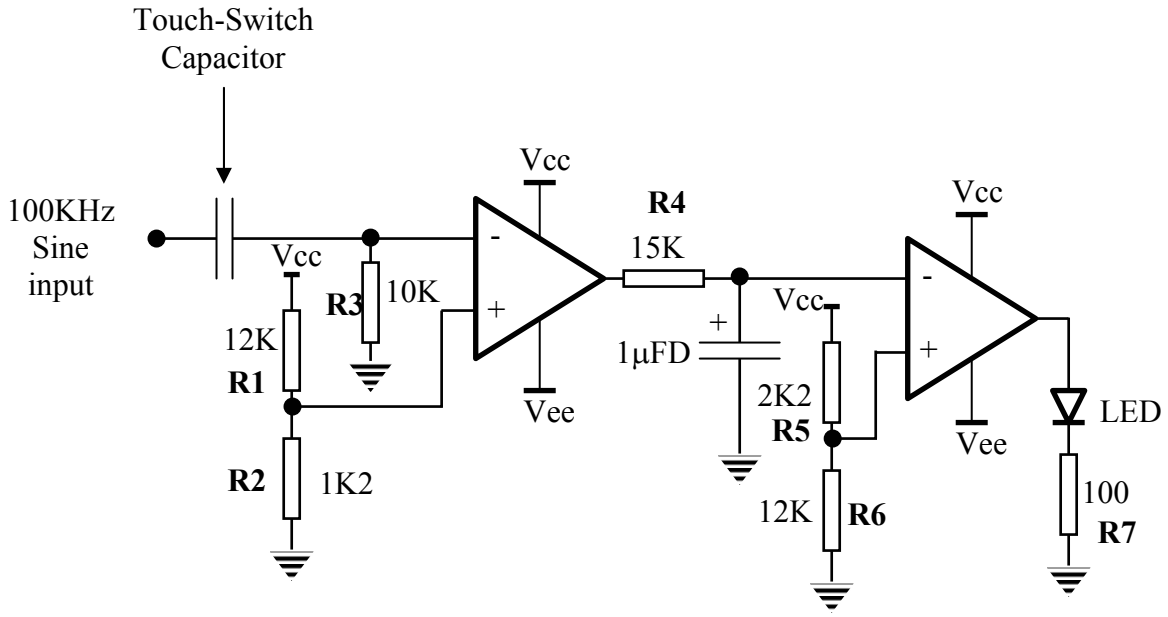
The test set-up with variable capacitor (Fig. 4) will be available only during the posted TA hours. You can however use fixed capacitors in parallel with your multi-tap inductor to receive different broadcast stations for your measurements. Your components bag should contain several fixed value capacitors and you can use them for this experiment. Many function generators in the lab has Amplitude-Modulation option and therefore you can simulate an AM broadcast using the function generator to do your tests, observe the signal waveforms and also sketch the waveforms at various points in the circuit.

1.3 Reporting:

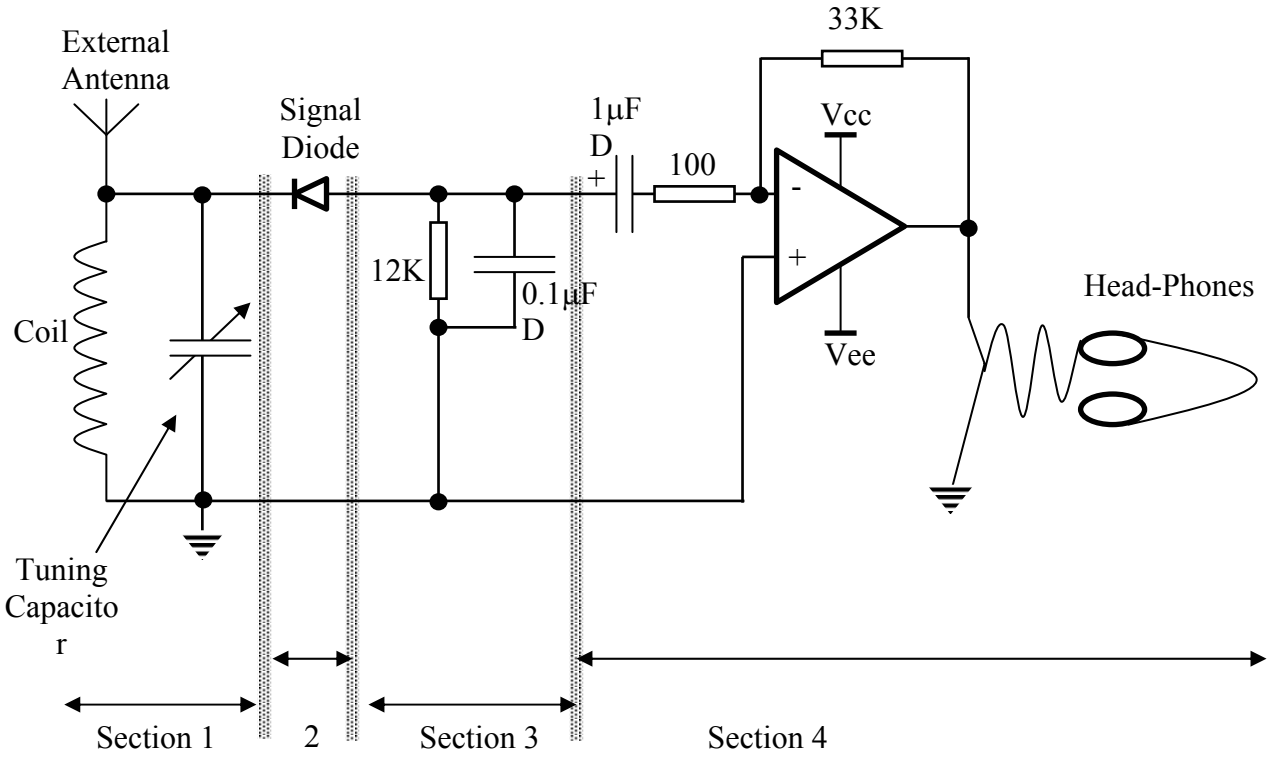
You lab report should explain how does this AM radio work. The report should have answers to the following questions as well:

1. What are the four sections indicated in the circuit diagram?
2. If you did not make taps in your inductor, what should be the capacitance range the variable capacitor should offer to cover the standard AM broadcast band?
3. What is the purpose of section 2?
4. What will happen if the diode is reversed in section 2?
5. What is the purpose of Section 3?
6. In section 3, for the 0.1μFD capacitor what will be the optimum resistor value? Why?
7. What is the purpose of 1μFD capacitor?
8. How will you modify the circuit to operate with a single supply, say a single 9V battery? Draw the modified circuit with appropriate component values. If you have time try building and testing the single-supply radio.

Set a function generator to AM mode, and you should be able to feed the AM signal to your circuit by simply placing the function generator probe right next to the inductor. Choose a carrier frequency between 600KHz and 2 MHz. Probe the signals at various points in the circuit and sketch the waveforms to explain how the AM radio works and also to answer the questions listed above. Q#4 and 6 are very important questions and 30% of the marks of this report is allocated for these (correct) answers.



Circuit-1: Schematic of a Touch-Switch



Cirucit-2: Schematic of an AM Radio

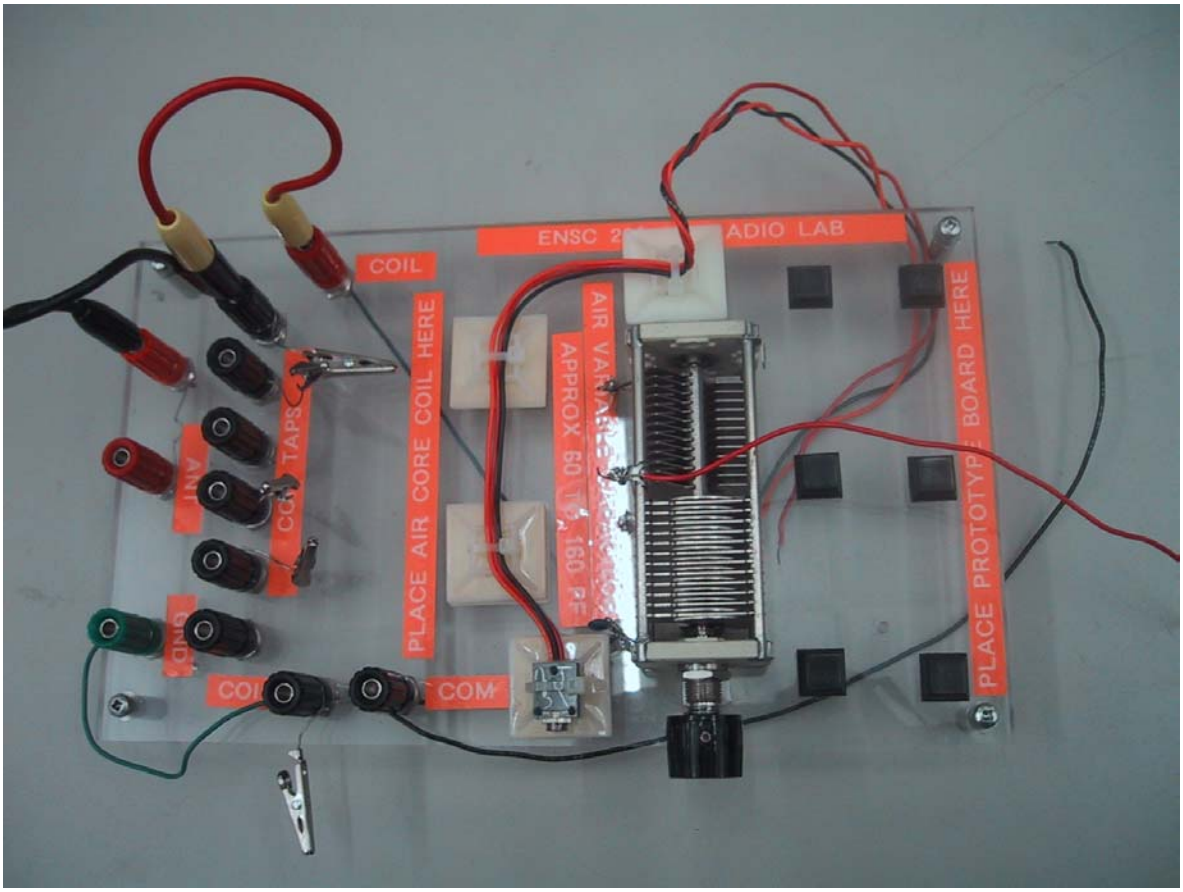


Figure 3: Test board for radio receiver with variable capacitor

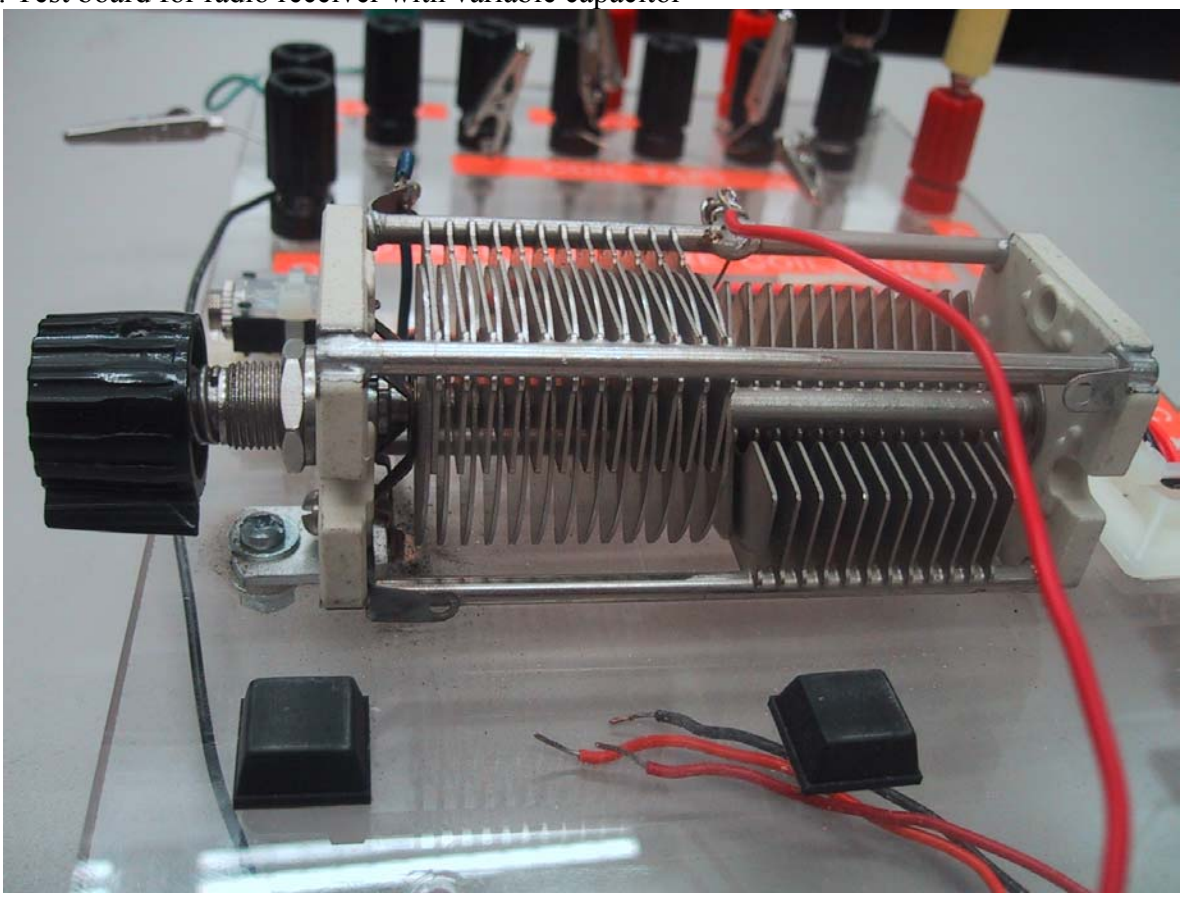


Figure 4: Variable capacitor for radio receiver