**Integrated Electrical Project (IEP)**

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**Summary**

The design of the circuit included a variety of different key components which are essential to building a fully functioning AM radio receiver circuit which is able to pick up signals transmitted by the antennas in the EIETL. The various components consist of a tuner circuit, a RF amplifier circuit, a demodulator, an audio amplifier and a loud speaker. The radio was able to pick up the middle and upper frequencies during the test session and with a little help from an additional capacitance added on the circuit during testing the radio was able to pick up the lower frequency being transmitted. Overall the circuit performed as expected. The modifications that I would propose would be for the variable capacitor used to have a larger range of values.

**Design**

Overall:

The general design was followed through with the help of the various activity handouts and instructions on the handouts. For the tuner circuit, an inductor and a variable capacitor were connected in series to produce a resonance circuit with the other end of the inductor connected to the ground to create a complete circuit. The next component was the unity gain buffer circuit. This was done using a source follower circuit in which the output was taken at the source of a transistor with a resistor connecting the source to the ground generating the required Vgs for the unity gain circuit. The following was the amplifier circuit. For this, a drain follower was used with a resistor connected to the power rail and another resistor in parallel with a capacitor connecting the source and the ground with two other capacitors at the input and output signals respectively. Following this is the demodulator. In the demodulator circuit, a diode is used to cancel out the negative parts of the output signal from the amplifier circuit. The output is then fed into a unity gain buffer circuit involving an op-amp. Then it is connected to an audio amplifier which uses an op-amp which increases the output voltage of the signal received enough for a loud speaker to convert the signal into an audible sound.

W0 = 2πƒ0 = 1/√LC

Tuner Circuit:

The tuner circuit was made using a self-made inductor by coiling wire around an iron core to increase the inductance of the coil of wire. The inductance of the coil measured 216µH. The variable capacitor had a range of capacitance of 46.5pF to 375.7pF including an extra 20pF to account for the input of the next stage RF amplifier. By using the formula below, the maximum value of the inductance was calculated to be 269µH. Which is higher than the measured value of the circuit inductor.

RF Amplifier Circuit:

For this, a source follower amplifier circuit with almost unity gain was used to avoid amplifying the parasitic capacitance of the jFET and also to avoid greatly reducing the Q factor of the circuit if it were to couple with the drain resistor of the amplifier circuit and the tuner circuit which is known as the Miller effect. Then it is amplified using a similar jFET but this time the output is connected to the drain instead of the source. The theoretical gain of the circuit was found to be about 10. With this the circuit designed was then implemented to the bread board. For the source follower unity gain amplifier circuit, a 4.7kΩ resistor was used to create the required Vgs for the input terminals. For the drain follower amplifier circuit, a 10kΩ resistor was used to connect the drain to the supply voltage and a 470Ω with a 1µF capacitor in parallel connecting the source to the ground. A 330nF capacitor is added at the output circuit to eliminate the dc voltage due to the jFET.

Demodulator Circuit:

This circuit was built using a Schottky diode with both ends connected to a 47kΩ and to ground. There is also another 13nF capacitor in parallel with the output resistor which acts as a low pass filter in which only the audible bandwidth required by the rest of the circuit is transmitted through the rest of the circuit.

Audio Amplifier Circuit:

The signal is then fed into a unity gain buffer circuit using a capacitor to remove any dc voltage the circuit has a 741 op-amp which has the output connected to the inverting input of the op-amp and a 10kΩ potentiometer which acts as the volume control of the circuit. Then a LM 386 op-amp is used as the amplifier which amplifies the signal by about a factor of 20 times. The circuit diagram in which the op-amp is connected is shown in detailed in the appendix.

List of parts:

| **No.** | **Part** | **Quantity** | **No.** | **Part** | **Quantity** |
| --- | --- | --- | --- | --- | --- |
| 1 | Self coiled inductor | 1 | 12 | 10kΩ resistor | 1 |
| 2 | Variable capacitor | 1 | 13 | 470Ω resistor | 1 |
| 3 | 1MΩ resistor | 4 | 14 | 1µF capacitor | 1 |
| 4 | jFET | 2 | 15 | 470kΩ resistor | 2 |
| 5 | 4.7kΩ resistor | 1 | 16 | Schottky diode | 1 |
| 6 | 330nF capacitor | 3 | 17 | 1nF capacitor | 1 |
| 7 | LM 741 op-amp | 1 | 18 | 10kΩ variable resistor | 1 |
| 8 | LM 386 op-amp | 1 | 19 | 1000µF capacitor | 1 |
| 9 | 100µF capacitor | 2 | 20 | 10Ω resistor | 1 |
| 10 | 330µF capacitor | 1 | 21 | 33µF capacitor | 1 |
| 11 | Loud speaker | 1 |  |  |  |

Problems in building the complete circuit

The main problems encountered during the building process of the radio circuit was that the live wires would accidentally touch the ground wires creating a short circuit which prevents the circuit from having any voltage or current across the components of the circuit. To solve this, we decided to bend the live wires away from the ground wires preventing this from happening.

**Testing:**

The circuit was able to tune to the middle roughly 950 kHz and also the 1422 kHz but was not able to reach the lower frequency as there may have been a defect in the maximum capacitance of the variable capacitor or an over estimate of the parasitic capacitance of the bread board and the components of the circuit.

**Conclusion:**

An AM frequency can be picked up by a resonance circuit involving a capacitor and inductor in series which then can be amplified and then demodulated to obtain the actual signal which was encoded into the transmitted AM signal. With the help of op-apms then the demodulated signal can be amplified to a high enough voltage to be able to be converted into an audible sound by a loud speaker. To improve the circuit, I would have probably found a variable capacitor with a larger range of capacitance. A couple of hours of overtime was done to manage to complete the circuit for the deadline proposed. But overall the work load was split equally between my lab partner and me.