23ECE282 ANALOG ELECTRONICS LAB

TERM PROJECT REPORT

Project – 8

AM receiver using BJTs

Group ID

ECE-C (C2)

Submitted By

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Contents

1) Introduction:

This project focuses on designing an AM (Amplitude Modulation) radio receiver using a Bipolar Junction Transistor (BJT). The objective is to create a functional AM receiver circuit capable of detecting and processing AM signals to reproduce audio. AM radio works by modulating the amplitude of a high-frequency carrier signal with an audio signal. This circuit is designed to receive and demodulate the AM signal, amplify it, and produce a clear audio output.

2) Working Principle:

1. Signal Sources:

Two sources, V3 (550 kHz) and V4 (1.5 kHz), represent the carrier wave and audio signal, respectively. The carrier signal (V3) is modulated by the audio signal (V4) to form an amplitude-modulated waveform.

2. Mixer Stage:

This stage combines the carrier and audio signals to produce an AM signal. The mixer component, B1, multiplies the signals, creating a product of the high-frequency carrier modulated by the audio signal.

3. Tuning Circuit:

The LC circuit, consisting of L1 (1 µH) and C1 (400 nF), is tuned to the carrier frequency (550 kHz). This circuit resonates at the desired frequency, selectively allowing the AM signal to pass while filtering out other frequencies.

4. Demodulation Stage:

Demodulation is achieved with D2 (1N5817 diode), which rectifies the AM signal. This stage extracts the audio information by removing the carrier wave, leaving only the modulating audio signal.

5. Amplification Stage:

The Q1 (BC547B) transistor amplifies the demodulated audio signal. The circuit configuration provides a stable gain set by R2 (10 kΩ) and R3 (470 kΩ), which enhance the signal strength, making it suitable for audio output.

6. Decoupling and Filtering:

Capacitors C5 (200 nF) and C6 (100 nF) act as decoupling elements, filtering out high-frequency noise. Additionally, R1 (470 kΩ) and C2 (100 nF) form an RC filter to smooth the demodulated signal, ensuring a clean audio output.

3) Simulation Results:

1. Input Waveforms:

The carrier (550 kHz) and audio (1.5 kHz) signals are observed before mixing. Their combination should yield an AM signal with amplitude variations corresponding to the audio signal.

2. Output Waveform after Demodulation:

After the diode, the output should show a rectified waveform, which is the audio signal separated from the carrier.

3. Amplified Output:

The amplified signal at the output should resemble the original audio frequency, but with greater amplitude, suitable for driving speakers or headphones.

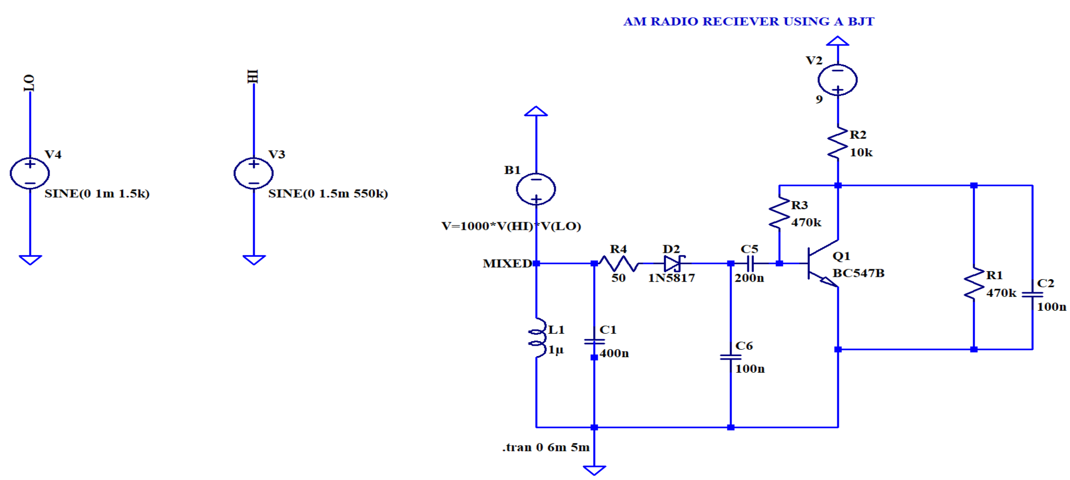

Fig. 3.1. AM Radio Receiver Circuit

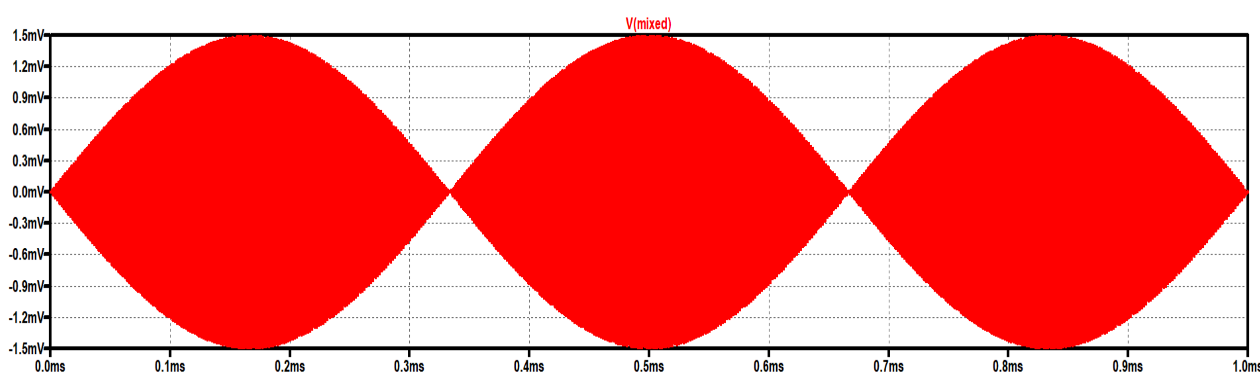

Fig. 3.2. Mixed Input Signal

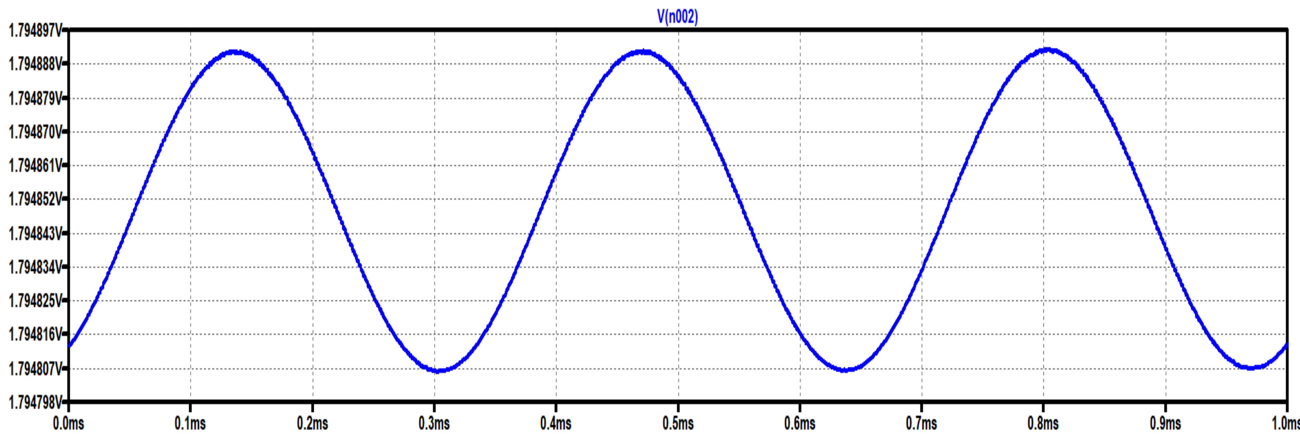

Fig. 3.3. Amplified Output Signal

--- Operating Point ---

V(mixed):	0	voltage
V(n001):	9	voltage
V(n002):	1.79485	voltage
V(hi):	0	voltage
V(lo):	0	voltage
V(n005):	0.629498	voltage
V(n003):	6.29498e-18	voltage
V(n004):	-1.09907e-14	voltage
I(B1):	1.259e-19	device_current
Ic(Q1):	0.000714217	device_current
Ib(Q1):	2.47947e-06	device_current
Ie(Q1):	-0.000716696	device_current
I(C1):	0	device_current
I(C5):	1.259e-19	device_current
I(C6):	-1.09907e-33	device_current
I(C2):	1.79485e-19	device_current
I(D2):	-1.259e-19	device_current
I(L1):	0	device_current
I(R2):	0.000720515	device_current
I(R3):	2.47947e-06	device_current
I(R4):	1.259e-19	device_current
I(R1):	3.81883e-06	device_current
I(V2):	-0.000720515	device_current
I(V3):	0	device_current
I(V4):	0	device_current

Fig. 3.4. Operating points

4) Experimental Results:

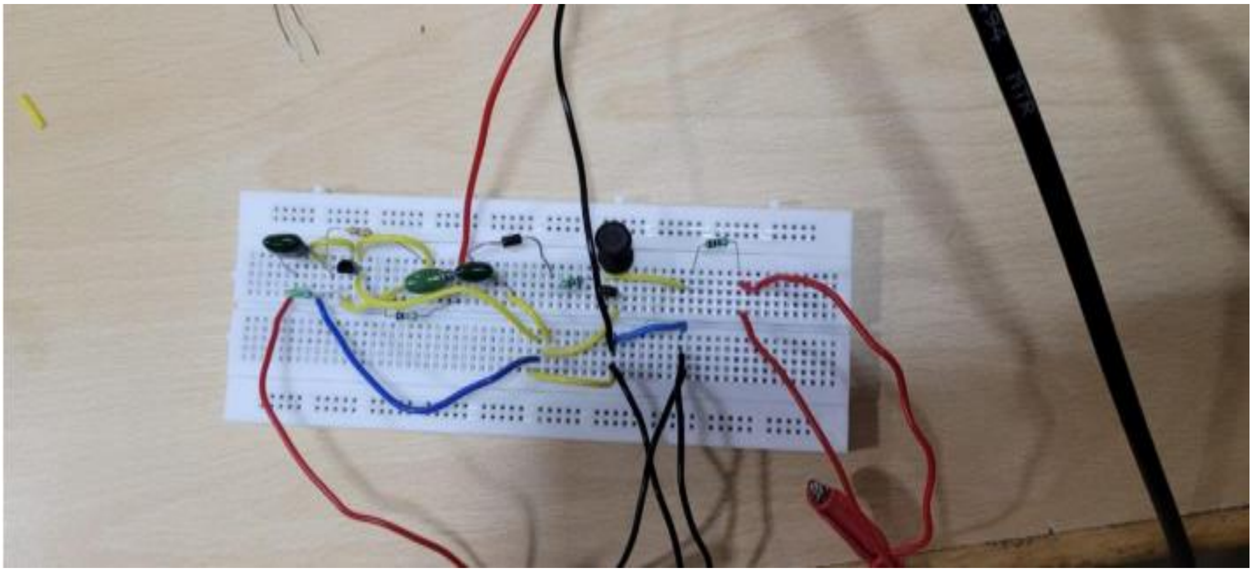

Fig. 4.1. Implemented Circuit

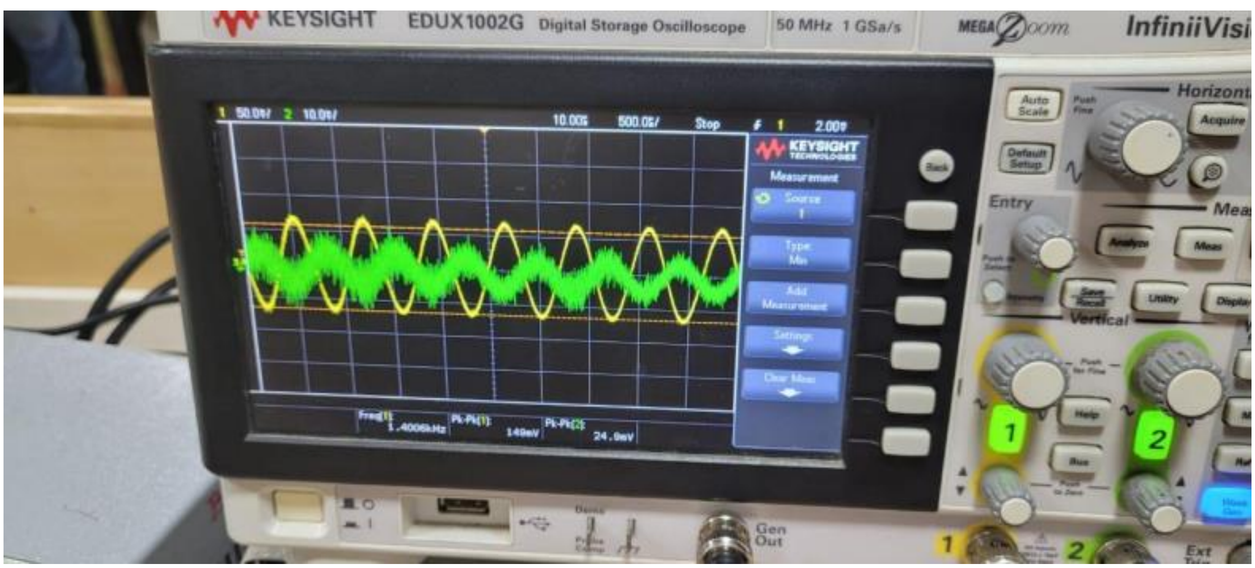

Fig. 4.2. Input and Output Plot

<table>
<tr><td rowspan="7">Single Source</td><td colspan="2">Frequecny</td><td>Vpp Input</td><td>Vpp output</td><td>Gain (Av=Vo/Vi)</td></tr>
<tr><td colspan="2">800Hz</td><td>100mV</td><td>6.07V</td><td>60.7</td></tr>
<tr><td colspan="2">1kHz</td><td>100mV</td><td>5.21V</td><td>52.1</td></tr>
<tr><td colspan="2">2kHz</td><td>100mV</td><td>2.51V</td><td>25.1</td></tr>
<tr><td colspan="2">4kHz</td><td>100mV</td><td>1.09V</td><td>10.9</td></tr>
<tr><td colspan="2">6kHz</td><td>100mV</td><td>590mV</td><td>5.9</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td rowspan="11">Multiplied Source</td><td colspan="2">Frequecny</td><td rowspan="2">Vpp Input</td><td rowspan="2">Vpp output</td><td rowspan="2">Gain (Av=Vo/Vi)</td></tr>
<tr><td>F1</td><td>F2</td></tr>
<tr><td>500hz</td><td>550khz</td><td>100mV</td><td>2.07V</td><td>20.7</td></tr>
<tr><td>1000hz</td><td>550khz</td><td>100mV</td><td>730mV</td><td>7.3</td></tr>
<tr><td>1500hz</td><td>550khz</td><td>100mV</td><td>380mV</td><td>3.8</td></tr>
<tr><td>2000hz</td><td>550khz</td><td>100mV</td><td>290mV</td><td>2.9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1000hz</td><td>500khz</td><td>100mV</td><td>770mV</td><td>7.7</td></tr>
<tr><td>1000hz</td><td>600khz</td><td>100mV</td><td>750mV</td><td>7.5</td></tr>
<tr><td>1000hz</td><td>700khz</td><td>100mV</td><td>770mV</td><td>7.7</td></tr>
<tr><td>1000hz</td><td>800khz</td><td>100mV</td><td>750mV</td><td>7.5</td></tr>
</table>

Table. 4.1. Experimental Result

5) Conclusion:

This AM radio receiver project demonstrates the principles of AM signal detection and processing using a BJT-based circuit. Through the simulation and experimental phases, the circuit successfully tunes, demodulates, and amplifies AM signals, enabling audio reproduction. The design could be enhanced by optimizing component values for better selectivity and sound clarity, potentially adding features like adjustable tuning for different frequencies. This project effectively illustrates the fundamentals of AM radio.