Aim ↬ To design a Voltage based Feedback Amplifier and study its gain.

Equipment Required ↬

Bipolar Junction Transistors, resistors, capacitors, power supply, multimeter, waveform generator, breadboard, and connecting wires.

Theory ↬

A Voltage-based Feedback Amplifier is a type of amplifier that uses negative feedback to control its gain, improve stability, and reduce distortion. In this circuit, a portion of the output voltage is fed back to the input in such a way that it opposes the input signal. This method of feedback leads to a reduction in overall gain but significantly enhances the amplifier's performance by stabilizing the gain, improving linearity, and expanding the bandwidth. The primary advantage of using negative feedback is that it makes the amplifier less sensitive to changes in component values, temperature, and power supply variations.

The amplifier uses a Bipolar Junction Transistor (BJT) to amplify the input signal, with the output signal being partially fed back through a network of resistors. The feedback network determines the amount of the output signal that is fed back into the input, controlling the amplifier's gain. The voltage gain of the amplifier with feedback is given by the equation:

$$A_V = \frac{A_0}{A_0 + \beta}$$

where A_0 is the open-loop gain (the gain without feedback) and β is the feedback factor. Including feedback in the circuit reduces the gain but stabilizes it, making it less dependent on the transistor's characteristics or external conditions. This improved control over the gain allows for more consistent performance over a wide range of operating conditions.

The voltage-based feedback amplifier works by adjusting the input signal using feedback from the output. This reduces the overall voltage gain but improves other aspects of the amplifier's performance, such as bandwidth and output impedance. The high input impedance and low output impedance, achieved through feedback, make this amplifier ideal for driving various loads with minimal distortion. The trade-off for stability and improved bandwidth is a lower gain, but the amplifier becomes more linear and predictable in its behavior, even under varying loads.

The expected outcome when using voltage feedback is a more stable gain, as the negative feedback compensates for variations in transistor parameters or circuit

components. The amplifier's bandwidth will increase, allowing it to handle a broader range of frequencies with minimal distortion. The overall voltage gain will be lower than that of an open-loop amplifier, but the circuit will be more reliable and consistent.

Circuit Diagram ↬

- **Amplifier without Feedback ↪**

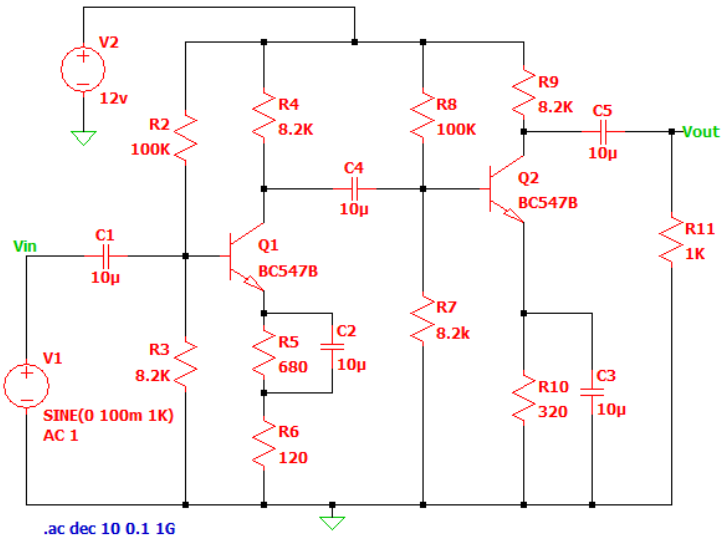

Fig. i) Circuit in LTSpice

- **Amplifier with Feedback ↪**

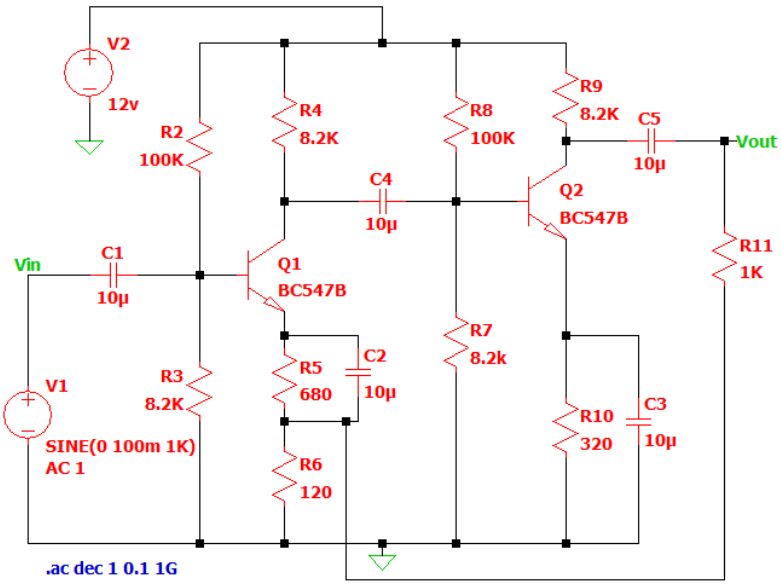

Fig. ii) Circuit in LTSpice

Observation Table ↬

- Amplifier without Feedback ↪

S.No.	Freq[Hz]	Vout	Gain	Gain[dB]
1	0.1	0.0027	0.0027	-51.27
2	1	1.57	1.57	3.92
3	10	11.48	11.48	21.20
4	100	75.25	75.25	37.53
5	1k	359.8	359.8	51.12
6	10k	387.7	387.7	51.77
7	100k	381.5	381.5	51.63
8	1M	183.44	183.44	45.27
9	10M	20.68	20.68	26.31
10	100M	1.49	1.49	3.47
11	1G	0.087	0.087	-21.24

- Amplifier with Feedback ↪

S.No.	Freq[Hz]	Vout	Gain	Gain[dB]
1	0.1	0.0034	0.0034	-49.47
2	1	1.83	1.83	5.26
3	10	5.77	5.77	15.22
4	100	9.21	9.21	19.28
5	1k	9.15	9.15	19.23
6	10k	9.14	9.14	19.22
7	100k	9.14	9.14	19.22
8	1M	9.14	9.14	19.22
9	10M	9.00	9.00	19.08
10	100M	52.78	52.78	34.45
11	1G	0.034	0.034	-29.30

Graphs ↬

- **Amplifier without Feedback ↪**

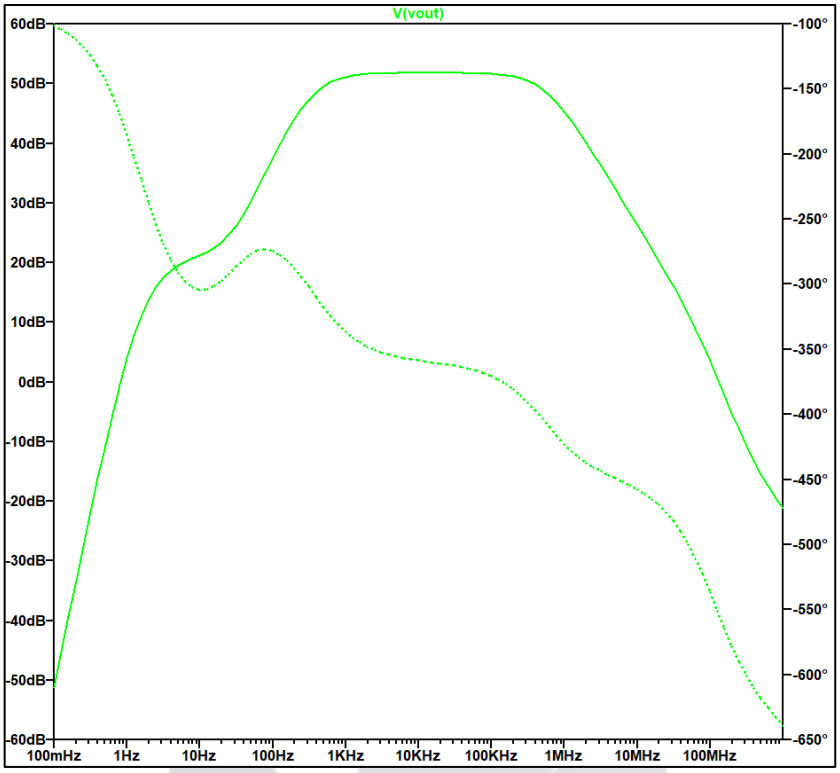

Fig. iii) Frequency Response [Decibel]

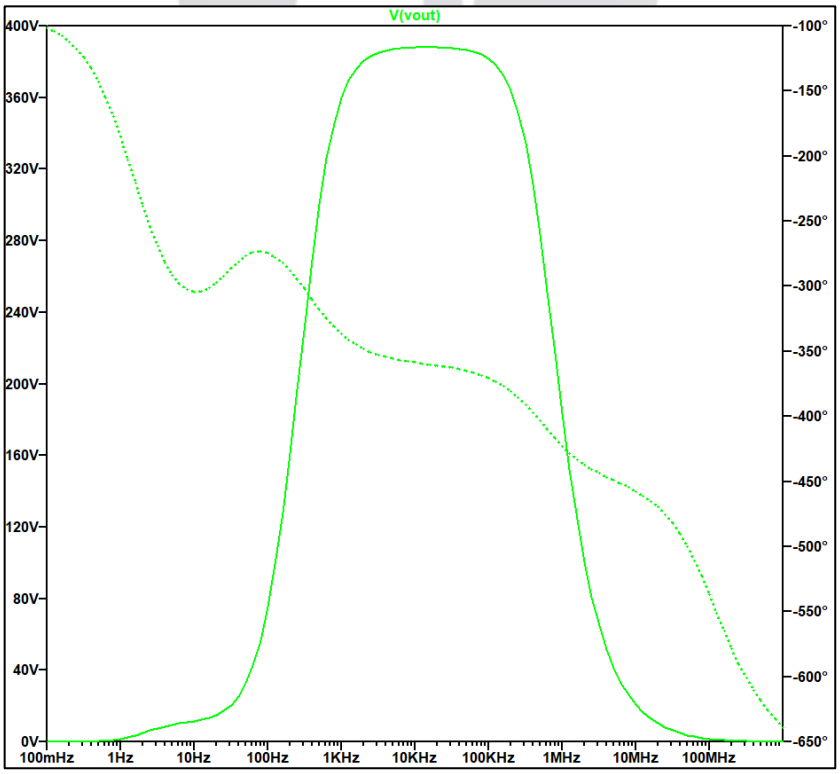

Fig. iv) Frequency Response [Linear]

➢ Amplifier with Feedback ↪

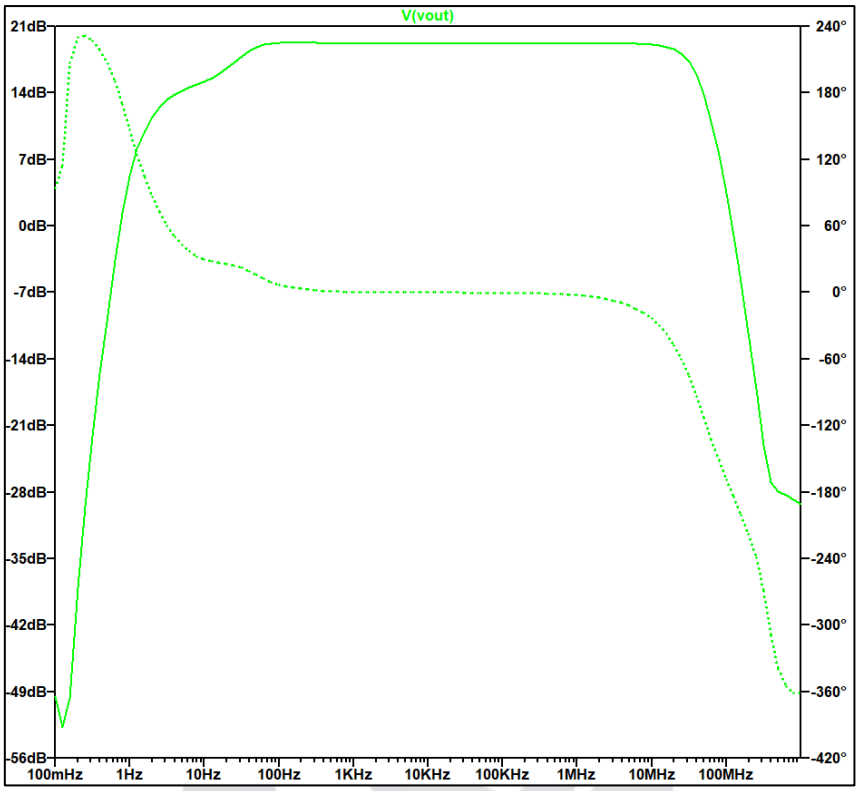

Fig. v) Frequency Response [Decibel]

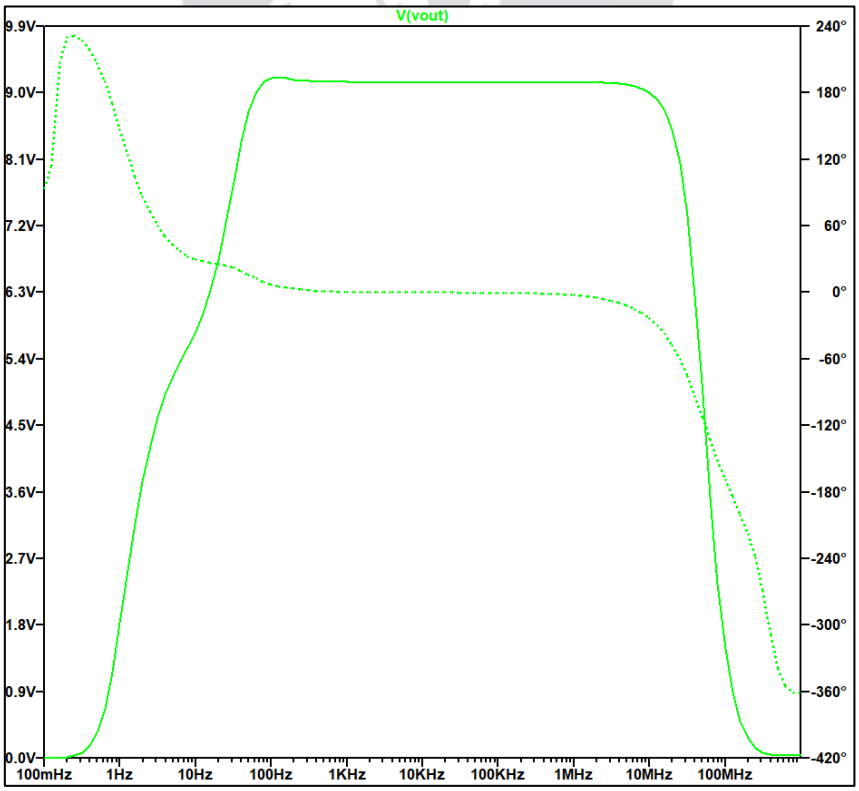

Fig. vi) Frequency Response [Linear]

Result ↬

The voltage-based feedback amplifier showed improved stability and linearity with a controlled and predictable gain. The bandwidth was wider compared to an amplifier without feedback, confirming the effectiveness of negative feedback**.**

Conclusion ↬

The feedback amplifier successfully demonstrated the advantages of negative feedback in stabilizing gain and improving overall performance. The results were consistent with the theory, with a trade-off between gain and stability.

Precautions ↬

- Ensure proper biasing of the transistors to prevent thermal runaway and maintain circuit stability.
- Verify all connections before powering the circuit to avoid short circuits or improper feedback operation.
- Handle all components carefully, especially resistors and capacitors, to ensure their values are correctly implemented in the feedback network.