Experiment #5 – Transistor Small-Signal Amplifiers

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# EEE3307 Electronics I

Section 0014

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# **Project Description**

To study small signal transistor amplifiers

# **2.0 About Laboratory Day and Equipment List**

# The laboratory session took place on the Monday section between 6:00pm and 8:50pm on October 30 and Nov. 1st, 2023. My lab partners were Nicolas and Brandon. The equipment for the is experiment is listed below,

1. Tektronix MSO 4034 Oscilloscope
2. Tektronix AFG3022 Function Generator
3. 2N2222 NPN BJT Transistor
4. Rohde & Schwarz HMC 8012 Digital Multimeter

# **3.0 Pre-Laboratory Question and Simulation (SPICE)**

A diagram of a circuit

Description automatically generatedA diagram of a circuit

Description automatically generatedConsider the circuit of Figure 1 with VCC = 12 V, RC = 6.2 kΩ, RE = 1.8 kΩ, RL = 2.2 kΩ, RS = 1.8 kΩ, and CE = 100 µF.

Common Emitter Amplifier:

1) Calculate the values R1, R2 so that ICQ ≈ 1 mA and good bias stability (see also preparation in Experiment #3).

Assume ,

2) Compute the Q-point and the maximum unclipped output voltage.

The Q-point is (2.5, 1mA)

3) Compute the small-signal voltage gain Avi = vo/vi and Avs = vo/vs.

4) Compute the input and output resistances.

Input Resistance:

Output Resistance:

5) Repeat 2) to 4) above if capacitor CE is removed.

LT-spice Circuit

A diagram of a circuit

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Simulated voltage at Q-point.A screen shot of a graph

Description automatically generated

Simulated Q-Point Emitter Current

A screen shot of a graph

Description automatically generated

Clipped Output Waveform

A green line graph on a black background

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# **4.0 Experiment Procedure**

Common Emitter Amplifier:

2) Measure the small-signal voltage gains Avs and Avi .

A screen shot of a computer

Description automatically generated

Vi plotted along with Vout

A screen with a green and yellow line

Description automatically generated

Vs plotted along with Vout

3) Measure the voltages vs and vi and from these measurements calculate the input resistance (input resistance ≡ (vs peak -vi peak)/iS)

4) Measure the output voltage with the RL connected and disconnected, respectively. Use the measurement results to compute the output resistance (output resistance = RL×(vo –vL)/vL, where vo is the maximum output voltage without RL connected and vL is the maximum output voltage with RL connected).

|  |  |
| --- | --- |
| Without | With |
|  |  |
|  |  |

The input and output resistance

Emitter Follower:

Connect the circuit of Figure 2 with component values as calculated in the preparation and repeat all the experimental parts from 1) through 4) in the common emitter amplifier above.

A screen with green lines

Description automatically generated

Vi plotted along with Vout

A screen with green lines

Description automatically generated

Vs plotted along with Vout

|  |  |
| --- | --- |
| Without | With |
|  |  |
|  |  |

# **5.0 Learned Objectives**

* Transistor Biasing
* DC Load Line Analysis
* AC Load Line Analysis
* Transistor Amplification
* Small AC Signal Analysis

# **6.0 Conclusion**

In conclusion, the experimentation conducted on small-signal transistor amplifiers provided comprehensive insights into the intricacies of common emitter amplifiers and emitter followers. The practical application and theoretical aspects aligned well, demonstrating the principles of transistor biasing, DC and AC load line analysis, and amplification of transistor circuits using small AC signals. The results obtained from both simulation and practical measurements showcased a correlation, affirming the theoretical underpinnings. Understanding the significance of components such as resistors R1, R2, RC, RE, and RL in determining bias stability, Q-point, voltage gains, input and output resistances was a pivotal aspect of the experiment. The practical measurements closely mirrored the simulated values, validating the theoretical framework and enhancing comprehension of small-signal analysis in transistor circuits. Both the common emitter amplifier and emitter follower configurations exhibited expected behaviors, reinforcing the learning objectives. Overall, the experiment provided a solid foundation for comprehending small-signal amplification in transistor circuits, reinforcing the relevance and practical application of the studied concepts in electronic engineering.