Lab 07 – Common Collector

Toronto Metropolitan University

ELE404 – Electronics I

Hani Ahmed

Date Published: Mar 25, 2025

Introduction:

Our team is building a Common-Collector (CC) BJT amplifier in this lab session, paying close attention to comprehending its crucial feature: buffering. Additionally, the goal of the session is to improve our practical experience by examining and testing a multi-stage amplifier, with a focus on a two-stage setup. Two 2N3904 NPN BJTs will be used by our team for this project.

Objective:

This lab's main goal is to evaluate the amplifier's voltage gain, which is consistent with the objectives of our previous labs. We start our process by building a Common-Emitter (CE) amplifier. A Common-Collector (CC) amplifier will then be incorporated, acting as a buffer to the original CE configuration. The CE stage, CC stage, and load are the three separate parts of the experimental circuit. Our objective is to assess the voltage gain (AV) in three different configurations: when the CE amplifier is connected to both the CC amplifier and the load, when the CC amplifier is connected to the CE amplifier, and when the circuit is composed only of the CE amplifier and load. The ultimate goal is to investigate how the CC amplifier affects the performance of the CE amplifier, especially when a load is present, while meticulously monitoring the voltage gain in each situation.

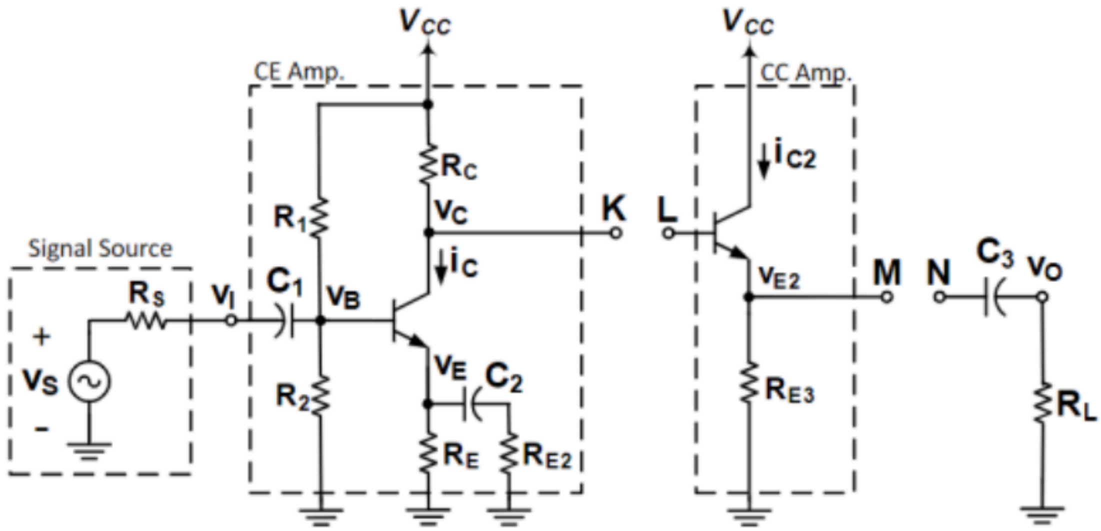
Circuit Under Test:

The Common-Emitter (CE) amplifier, the Common-Collector (CC) amplifier, and the load comprise the three main components of the experimental circuit that we have put together. The jumper connections have been labeled as follows for clarity: "K" for the CE amplifier, "L" for the CC amplifier with the output marked "M," and "N" for the load jumper.

A voltage divider at the base and two resistors at the emitter and collector points complete the CE amplifier's construction. The base is then connected to a signal source via a series capacitor, which acts as our input. To improve the circuit's performance, we also connect RE2, another resistor (together with a capacitor), in parallel with the original resistor RE.

After the CE setup is finished, we build the CC amplifier. To create the CC configuration, this entails grounding the emitter via a resistor and connecting the collector to the VCC (power supply).

Building the circuit's load segment and finishing the experimental setup are the last steps. We can examine the complex behaviors and interactions between the CE and CC amplifiers when a load is present thanks to this setup.



Experimental Results:

Table E1. Quiescent parameters of CE amp. of Figure 1 and two-stage amp. of **Figure 2**.

Amplifier	Jumpers	$V_C\ [V]$	$V_E[V]$	$I_C[mA]$	$V_{E2}[V]$	$I_{C2}[mA]$
CE (Figure 1)	**None**	11.991	7.587	1.11mA	--	--
Two-Stage (Figure 2)	**K-L**	11.8674	7.579	1.16mA	11.1527	9.31mA

Table E2(a). No-load AC voltages and gain of the CE amplifier of **Figure 1**.

Amplifier	Jumpers	$v_I\ [Vrms]$	$v_C[Vrms]$	$v_{E2}[Vrms]$	$v_O[Vrms]$	$A_{vo}[V/V]$
CE	**None**	63.411mV	0.70887V	--	--	11.19

Table E2(b). Loaded AC voltages and gain of the CE amplifier of **Figure 1**.

Amplifier	Jumpers	$v_I\ [Vrms]$	$v_C[Vrms]$	$v_{E2}[Vrms]$	$v_O[Vrms]$	$A_v[V/V]$
CE	**K-N**	63.411mV	44.66mV	--	44.534	0.704

Table E3(a). No-load AC voltages and gain of the two-stage amplifier of **Figure 2**.

Amplifier	Jumpers	$v_I\ [Vrms]$	$v_C[Vrms]$	$v_{E2}[Vrms]$	$v_O[Vrms]$	$A_{vo}[V/V]$
Two-stage	**K-L**	63.411mV	0.70081	0.70027	--	0.999

Table E3(b). Loaded AC voltages and gain of the two-stage amplifier of **Figure 2**.

Amplifier	Jumpers	$v_I\ [Vrms]$	$v_C[Vrms]$	$v_{E2}[Vrms]$	$v_O[Vrms]$	$A_v[V/V]$
Two-stage	**K-L, M-N**	63.411mV	0.65248	0.63836	0.63676	10.289

Conclusion & Remark:

C1:

Table C1(a). Calculated and measured (DC) voltages of the CE amplifier of **Figure 1**.

	$V_C[V]$	$V_E[V]$	$V_{E2}[V]$
Calculated values (from Table P1)	12	7.58	---
Measured values (first column, Table E1)	11.991	7.579	----
Percent error, $e\%$	0.075 %	0.013 %	----

Table C1(b). Calculated and measured (DC) voltages of the two-stage amplifier of **Figure 2**.

	$V_C[V]$	$V_E[V]$	$V_{E2}[V]$
Calculated values (from Table P2)	11.8	7.58	13.1
Measured values (second column, Table E1)	11.8674	7.579	11.1527
Percent error, $e\%$	0.56 %	0.013 %	17.46 %

Most of the percent errors are under 1%, which shows that those values were measured and calculated well. The percent error for VE2 is at 17%, showing that the value is somewhat correct, which can be attributed to calculation error.

C2:

Table C2(a). Calculated and measured voltage gains of the CE amplifier of **Figure 1**.

	$A_v[V/V]$	$A_{vo}[V/V]$
Calculated Values (from Table P1)	- 0.716	-11.5
Measured Values (from Table E2(a) and Table E2(b))	-0.704	-11.19
Percent Error, $e\%$	1.70 %	2.77 %

Table C2(b). Calculated and measured voltage gains of the two-stage amplifier of **Figure 2**.

	$A_v[V/V]$	$A_{vo}[V/V]$
Calculated Values (from Table P2)	- 10.15	- 10.28
Measured Values (from Table E3(a) and Table E3(b))	- 10.289	- 0.999
Percent Error, $e\%$	1.35 %	>100 %

Most of the percent errors are under 3%, which shows that those values were measured and calculated well. The percent error for Avo is over 100%, which can be attributed to calculation error.

C3:
When the load resistance is around the same as the output resistance, the circuit operates at maximum power. But if the output resistance is larger than the load resistance, then most of the voltage drops over the output resistance and leaves a small voltage drop over the load. This is called the loading effect. In the circuit, the CC amplifier has a high input impedance (Rout = Rc)and low output impedance (Ri = $(\beta + 1)$(re + RE3 || RL)). This means that loading effect is reduced on the CE amplifier, allowing the circuit to keep gain low while driving the smaller load. Without the load, input resistance of the CC would be Ri = $(\beta + 1)$(RE3). With the load, it is Ri = $(\beta + 1)$(RE3 || RL), which means that it drops while staying higher than RL, acting as a buffer for the CE.

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Remark

We studied the typical collector BJT amplifier in this lab. Additionally, we studied its buffering property. Additionally, we used two 2N3904 NPN BJTs to conduct an in-person analysis of a multi-stage amplifier. All things considered, this lab improved our comprehension of these electronic ideas.