ELECTRONICS (ETEN1000)

STUDENT NUMBER: **22663281**

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GROUP: **12 pm to 2pm Thursday**

LABORATORY: 5: Bipolar Junction Transistors

LABORATORY SUPERVISOR: : Dr King Sun Chan

LABORATORY PARTNERS: **Tashi Lhadon 22155746**

DATE PERFORMED:

DATE DUE:

DATE SUBMITTED: 28/10/24

I hereby declare that the calculation, results, discussion and conclusions submitted in this report is entirely my own work and have not copied from any other student or past student.

Student Signature: Troyee

Bipolar Junction Transistors

Introduction

The purpose of this lab was to work and understand the bipolar junction transistor and to observe the function of a bipolar junction transistor (BJT) as an amplifier and switch. In electrical circuits, BJTs are essential for signal amplification and current management. Analysing the behaviour of the transistor in each configuration and demonstrating these functionalities are the goals of this experiment.

Aim

The goal of this project is to measure voltages, currents, and the impact of an emitter bypass capacitor on amplifier gain in order to investigate the BJT's function as a switch and amplifier.

Summery

The lab emphasized on using a transistor in two different ways: as an amplifier in a circuit and as a switch for an LED. Calculations were performed based on the idea that removing a resistor would function as a switch for the LED configuration. The importance of the capacitor on amplification performance was highlighted by the observation that adding a capacitor close to the emitter significantly increased the circuit's gain in the amplifier role.

Circuit

From this picture we can have a clear understanding of NPN and PNP Transistors. Here,

C: collector B: base E: emitter

figure1 – NPN & PNP Transistor

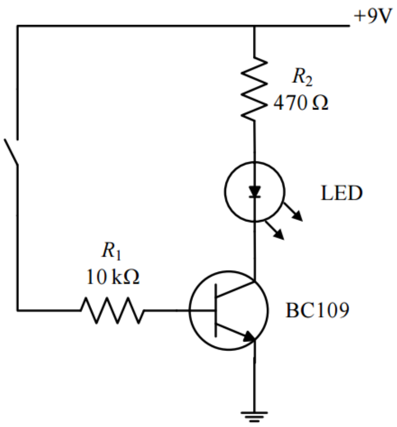


Figure2 – Transistor as a switch

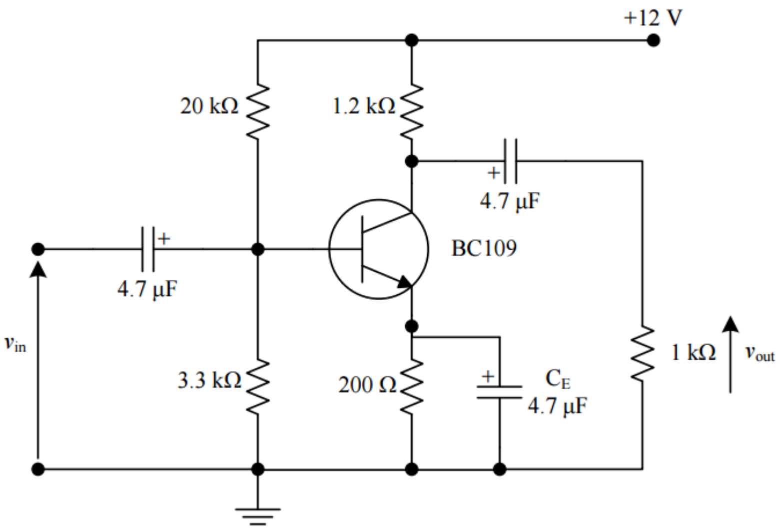
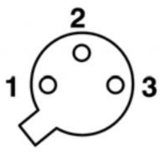


Figure3 – Transistor as an amplifier

Results



Bottom View
of BJT

(i) Junction Resistance

Pin pair (in order)	Resistance	Pin pair (in order)	Resistance
1-2	0	**2-1**	9.2mΩ
2-3	8.9mΩ	**3-2**	0
1-3	0	**3-1**	0

Identify the pins:

Pin 1 - emitter

Pin 2 - base

Pin 3 – collector

(ii) Transistor as a Switch

Operation:

Switch	LED(ON/OFF)
ON	ON
OFF	OFF

Currents when switch is ON :

I_B	0.8964 mA
I_C	16.51 mA

Voltages:

Voltages:	When Switch is OFF	When Switch is ON
V_{BE}	0	0.7760 V
V_{CE}	7.791 mV	104.65 mV

(iii) Transistor as an Amplifier

DC bias point:

Parameter	Theoretical Value	Measured Value
V_{BE}	0.7 V	0.65 V
V_{CE}	5.27 V	5.10 V
I_B	23.8 μA	14.909 μA
I_C	4.8mA	4.76mA

Theoretical value from prelab calculation

Given as $V_{BE} = 0.7$ V

$$V_B = (V_{CC} \times \frac{R_2}{R_1+R_2})$$

$$= 12 \times \frac{3.3 \times 1000}{20{,}000 + 3300}$$

$$= \frac{39600}{23.000} = 1.699 \text{ V}$$

Using value of V_B

$$V_E = V_B - V_{BE}$$

$$V_E = \mathbf{1.699}\text{ V} - 0.7\text{ V} = 0.969\text{ V}$$

$$I_E = \frac{V_E}{R_E} = \frac{0.969\text{ V}}{200} = 0.0048\text{A} = 4.8\text{mA}$$

$$I_B = \frac{I_E}{\beta+1} = \frac{0.0048\text{A}}{200+1} = 0.0000238\text{A} = 23.8\ \mu\text{A}$$

$$V_C = V_{CC} - (I_C \times R_C)$$

$$V_C = 12 - (0.0048\text{A} \times 1200)$$

V_C = 6.24 V, as here $I_E = I_C$

$$V_{CE} = V_C - V_E = \mathbf{6.24V} - 0.969\text{ V} = 5.271\text{ V}$$

Signal voltages and gain:

Parameter	with C_E	Without C_E
V_{in}	20mV	20mV
V_{out}	256mV	55mV
Gain(V_{OUT}/ V_{IN})	12.8	2.75

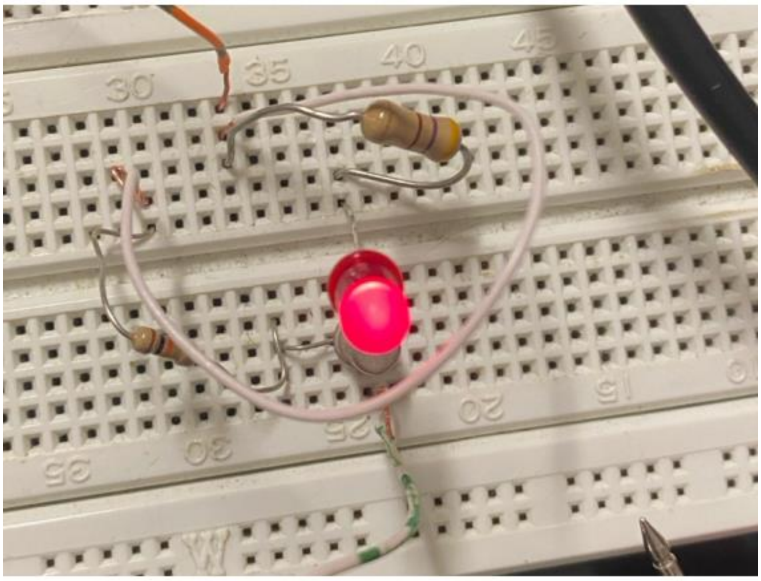


Figure4 – Transistor as an switch turning LED on

Discussion

Here, we will compare the theoretical expectations with practical value for the transistor used as a switch

$$\boldsymbol{I_B} == \frac{\boldsymbol{V}}{\boldsymbol{R}} \quad \text{(}\textit{Using Ohm's Law)}$$

$$\boldsymbol{I_B} == \frac{\mathbf{(9-0.7\,)}\boldsymbol{V}}{\mathbf{10{,}000\Omega}} \quad = 0.00083 \text{ A} = 0.83 \text{ mA}$$

While the practical measurement was 0.8964mA

$$\boldsymbol{I_C} == \frac{\mathbf{(9-0.2\,)}\boldsymbol{V}}{\mathbf{470\Omega}} \quad = 0.0187\text{A} = 18.7\text{mA}$$

With a practical result of 16.51 mA

Minor human and technical errors during lab measurements, as well as fluctuations in transistor and circuit tolerances, are the causes of these differences.

When a transistor is used as an amplifier, the output signal is amplified through a complex circuit. Since a capacitor helps in amplification, the signal voltage and gain table show that the presence of a capacitor at the emitter significantly affects gain, with a gain of about 13 and a gain of around 3 without.

Additionally, the gain is just the output voltage divided by the input voltage. To measure the voltage between the base and the emitter, place the positive probe on the base and the negative probe on the emitter. Then, record the voltage from the signal generator. This is how the tables estimate the current and voltage. In contrast to the gain, waveforms are analysed to determine the results.

Conclusion

Overall, it can be said that the results were approximately 96% correct, with a few minor variations caused by human error in measurements and tiny disruptions in the circuit's element connections that slightly impacted flow and readings. The goal of understanding and working with bipolar junction transistors was achieved successfully.

References

lecture notes

Appendices

Nil