Experiment #3 – Transistor Biasing

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# EEE3307 Electronics I

Section 0014

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# **Project Description**

The objective of this experiment was to construct and analyze circuits based on transistors. The primary aim was to familiarize students with transistor biasing, bias stability, and Q-point.

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

# The laboratory session took place on the Monday section between 6:00pm and 8:50pm on September 25, 2023. My lab partners were Nicolas and Brandon. The equipment for the is experiment is listed below,

1. Breadboard
2. Tektronix MSO 4034 Oscilloscope
3. Tektronix AFG3022 Function Generator
4. Resistors
5. 2N2222 NPN BJT Transistor

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

A) Consider the circuit in Fig. 1.b with RC = 1.8 kΩ, RB = 5.6 kΩ, and RE = 0 Ω.

A diagram of a circuit

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Fig. b

B) Calculate VBB so that IC = 2 mA. Assume β = 220 and VBE = 0.7 V. Find the Q-point.

Q-point: (1.8V, 2mA)

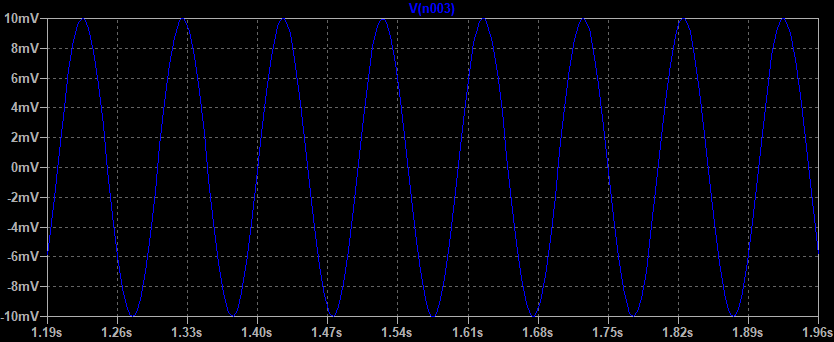
C) If β changes to 150, what is the new IC from your circuit simulation? (Consult with your lab instructor how to change the current gain β in the 2N222 model parameter in MultiSim.)

D) Repeat (B) above if RE is changed to 1.8 kΩ.

Q-point: (3.6V, 2mA)

E) Consider the circuit in Fig. 3 with RC = RE = 1.8 kΩ. Calculate the values for R1, R2 so that ICQ = 2 mA. Use a sinusoidal input (small-signal peak to peak voltage of 20 mV) and current gain of 150 in your circuit simulation. Plot vi, VC, VE, and VCE versus time.

R1=24 kΩ and R2=2.8 kΩ



Vi

A screen shot of a graph

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VCE

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VC

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VE

# **4.0 Experiment Procedure**

a) Connect the circuit of Fig. 1.b with values calculated in the pre-lab preparation. Measure the Q-point and compare with expected value. Measure IC and IB and compute the current gain β.

We adjusted the DC voltage until we reached collector current equal to 2mA, our base current was 0.017mA. Therefore, .

b) If needed, adjust VBB so that ICQ is about 2 mA. Replace the transistor with another one and check if the ICQ remains the same. Repeat with a third transistor. Does the collector current remain the same? Why or why not?

ICQ did not remain the same because the β value changes with different transistors. The following were the measured ICQ:

|  |  |  |
| --- | --- | --- |
|  | Collector Current | β |
| Transistor 1 | 2.00 mA | 118 |
| Transistor 2 | 1.95 mA | 114 |
| Transistor 3 | 1.50 mA | 88 |

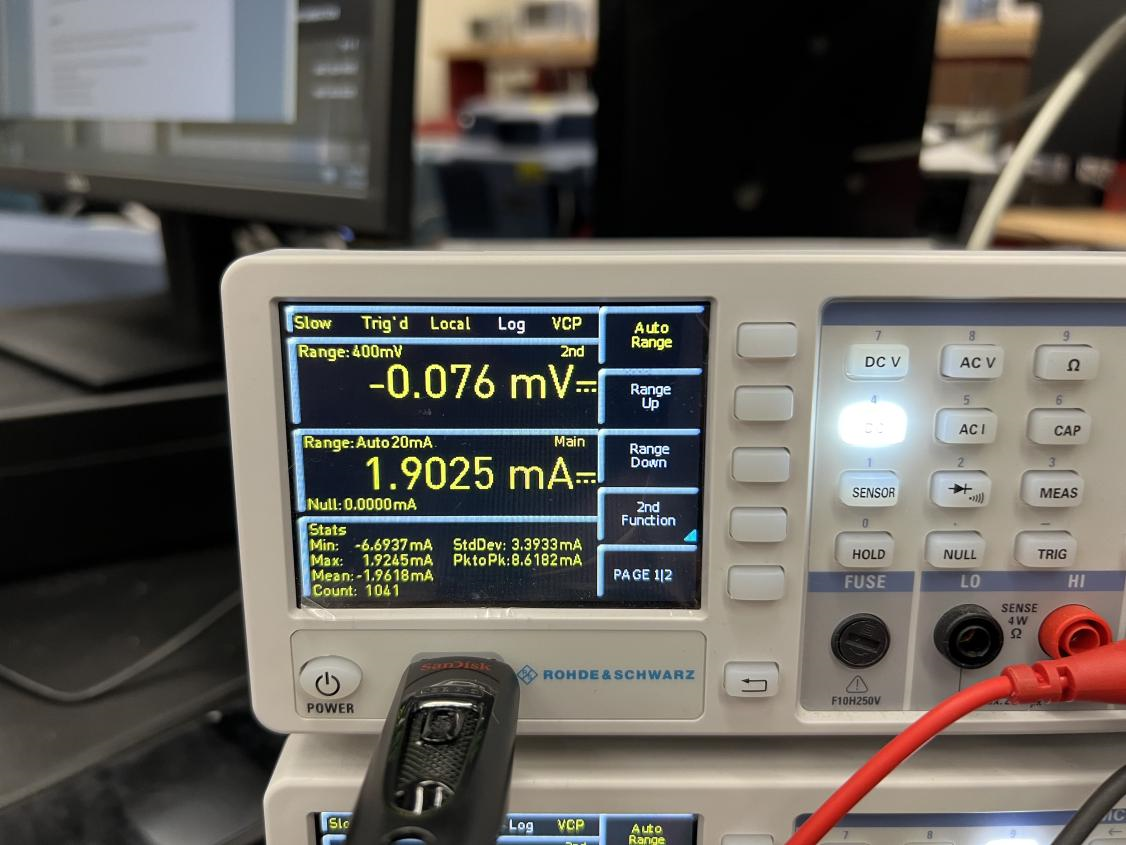
c) Modify the circuit by inserting RE as in the preparation and repeat parts a) above.

|  |  |  |
| --- | --- | --- |
|  | Collector Current | β |
| Transistor 1 | 2.00 mA | 107 |
| Transistor 2 | 2.15 mA | 115 |
| Transistor 3 | 1.98 mA | 101 |

We used different transistors for this step.

d) Connect the circuit in Fig. 3 using the values you have calculated in the preparation. Measure the Q-point and compare with the expected value.

The Q-point for Fig. 3 (4.8, 2mA), the experiment value is within the margin of error for the computed value.



Measured Collector Current

e) Connect and set the generator to a sinusoidal of 3 kHz. Use 10 µF for the capacitor C. Make sure the capacitor is connected with the correct polarity. Adjust the input amplitude so that none of the waveforms is clipped. Observe and include in your report the following waveforms: Input voltage vi, collector voltage VC, emitter voltage VE, and collector-emitter voltage VCE. Plot all those waveforms on a common time scale using 2 to 3 sinusoidal cycles.

A screen with a graph on it

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Measured Voltage Waveforms

# **5.0 Learned Objectives**

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

# **6.0 Conclusion**

In conclusion, this experiment on transistor biasing provided a greater understanding of transistor operation, biasing techniques, and the impact of various parameters on transistor behavior. Through this experiment, we learned how to calculate and set the Q-point, which is essential for biasing transistors in electronic circuits. We also discovered the sensitivity of the circuit to changes in parameters such as β, demonstrating the importance of precise component selection for desired performance. We applied our knowledge to construct a circuit as per Fig. 3 and successfully measured the Q-point, demonstrating the practical application of biasing techniques. Through the small-signal AC analysis, we gained insights into the amplifier characteristics and the relationships between input and output waveforms.