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## Project #2: [BJT Transistor and Amplifier]

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### Project General Rules:

- This project is out of **10** points.
- You work individually.
- Any copied or late projects will take **ZERO**.
- **Due Date is Monday January 11<sup>th</sup>, 2021.**
- Show your hand calculations in a report with a cover page containing your name and ID, draw the schematics on the **MULTISIM** and do the required simulations then insert the required graphs in the report.
- Write down your observations and conclusion.
- Any missing requirement from the final report will be penalized in the final grading.
- Submit a soft copy (pdf) of your report on Blackboard.

In this project, use the NPN transistor (2N3414) from the library of MULTISIM or if you can't find it, use any alternate NPN transistor from the library.

### **Part 1: I/V Characteristics:**

Using MULTISIM software, construct a test bench to sketch the I/V characteristics of a BJT transistor from the program library.

#### 1) Sketch:

- a)  $I_C$  vs  $V_{CE}$  (for different  $V_{BE}$  values)
- b)  $I_C$  vs  $V_{BE}$  (In the Active region)
- c) Estimate the value of Early voltage ( $V_A$ ) for this transistor.

#### 2) Parameter Estimation:

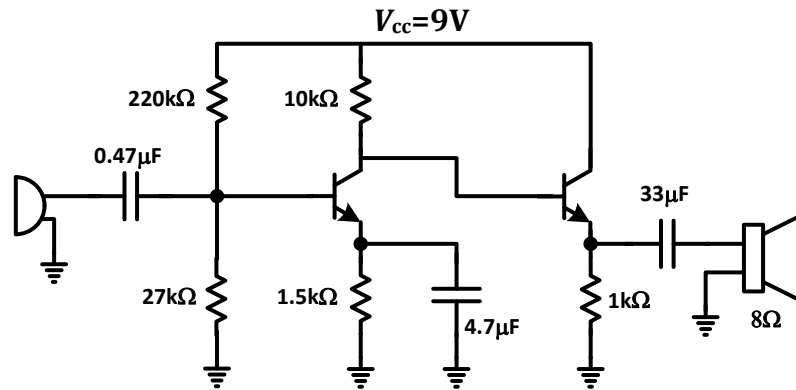
- a) Pick any bias point in the Active Region and record  $I_C$ ,  $V_{BE}$  and  $V_{CE}$ .
- b) From the sketches in (1) estimate both the transconductance ( $g_m$ ), the output resistance ( $r_o$ ).
- c) Compare your results with the analytical expressions (You can use the  $I_C$  value from (a) to find them).

#### 3) Repeat (1) and (2) for a PNP transistor.

**Note:** Choose reasonable values for the voltages and currents.

## **Part 2: Amplifier Simulation:**

The following schematic is an amplifier that amplifies the output of a microphone and drives it to an 8 $\Omega$ -speaker. Use the same NPN transistor in Part 1.



- 1) Using small-signal analysis, find the DC-gain ( $A_v$ ), input resistance ( $R_{in}$ ) and output resistance ( $R_{out}$ ) of the amplifier above.
- 2) Using MULTISIM, find the three parameters above and compare the results of (1) and (2). You can replace the mic with an input voltage source and the speaker with an 8- $\Omega$  resistor to Ground.
- 3) Assume a sinusoidal input at the microphone side with a frequency of 5kHz and an amplitude of 10mV, use MULTISIM to sketch both input and output and find the gain of the amplifier.
- 4) Comment on your results.

## **Report Requirements**

- Report your results in a clear way.
- Capture all schematics, and simulation results in your report.
- After each part, write down your observations and conclusion.