PreLab 4 – Common Emitter Amplifier

• GOAL

The goal of Lab 4 is to build a microphone preamplifier. The PreLab 3 assignment is intended to give you a better understanding of transistor biasing and voltage gain.

COMMON EMITTER AMPLIFIER

A voltage amplifier requires a properly biased transistor. A popular method is to use a voltage divider to establish a bias voltage at the transistor base.

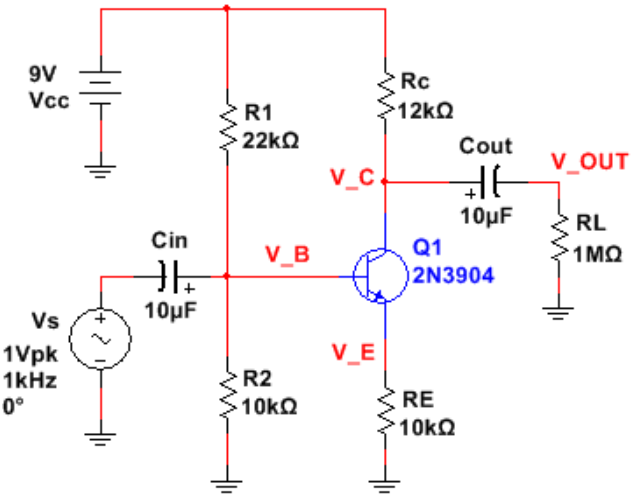

Fig. 1: Schematic of the common emitter amplifier.

- **TASK 1**: Enter the circuit schematic shown in Fig. 1 in Multisim.
  - Use a 2N3904 NPN transistor.
  - Electrolytic capacitors are located in **Place >> Components >> Basic >> CAP_ELECTROLIT**
  - The AC signal source is a 1 Vp sine wave at 1 kHz.
  - Label the transistor base, emitter, and collector as V_B, V_E, and V_C, respectively (see Fig. 1).
  - **Submit this circuit schematic**.

- **TASK 2**: Perform a DC Operating Point Analysis in Multisim:
  - Fill out Table I with your simulated values for V_B, V_E, and V_C.
  - Calculate (e.g. by hand) the theoretical values for V_B, V_E, and V_C. Is the voltage divider stiff? Assume V_BE= 0.7V and beta = 100. Show all work!

Table I: DC Operating Point Analysis

Simulation			Theory		
V_B	V_E	V_C	V_B	V_E	V_C

- **TASK 3**: Perform a Transient Analysis:
  - Use simulation start and stop times of TSTART = 0 and TSTOP = 2 ms, respectively.
  - **Submit a plot showing both waveforms (V_B and V_C)**.
  - Measure the peak-to-peak values for V_B and V_C and compute the resulting amplifier gain.
  - Compute the theoretical gain using $A = -\alpha\ (R_C \,//\, R_L) / (r_e' + R_E)$. Assume $\beta = 100$ and $V_{BE} = 0.7V$. Show all work.

- Complete Table II with your measured and calculated values.

Table II: Transient Analysis

V_B (peak-to-peak)	V_C (peak-to-peak)	Gain (sim)	Gain (theory)

- **TASK 4**: Now add a 100 uF emitter bypass capacitor (electrolytic type).
  - **Reduce the amplitude of VS to 0.010Vp**.
  - Display the waveform for V_B by itself and measure its peak-to-peak value.
  - Repeat for V_C.
  - Compute the voltage gain based on the peak-to-peak measurements of your waveforms.
  - Compute the theoretical amplifier gain and input impedance (e.g. using formulas from lecture).
  - Complete Table 3 with your measured and calculated values.

Table III: Transient Analysis (with emitter bypass capacitor)

V_B (peak-to-peak)	V_C (peak-to-peak)	Gain (sim)	Gain (theory)	Z_IN (theory)

- **TASK 5**: Analyze your simulation results to see if they make sense! Answer the following:
  - Proper biasing of a common emitter amplifier typically uses $V_{BB} \approx V_{CC}/3$ and $V_{CQ} \approx 2V_{CC}/3$. Is this "rule of thirds" approximately satisfied by our common emitter amplifier?
  - Is the BJT in active mode? Hint: Think about the values of V_{CB} and V_{BE}.
  - Is there reasonable agreement (e.g. within 10%) between your simulated and theoretical values for V_B, V_E, V_C, and amplifier gain?

➢ **Make sure you submit the following**:

- Circuit schematic from TASK 1.
- Completed Table 1, 2, and 3. Include all work for theoretical calculations.
- Waveforms for V_B and V_C from TASK 3.
- Answers to the TASK 5 questions.

(End of PreLab 4)