Lab 7 – Maximum Unclipped peak-to-peak Output (MPP)

Note: The maximum unclipped peak-to-peak output is also called: Maximum Undistorted Output and Maximum Peak-to-Peak output (MPP). Use β = 150 for all calculations

GOAL

The overall goal of this lab is to explore the effect of Q-point on Maximum unclipped output..

OBJECTIVES

To build, test, and understand the following circuits:

1) Biased common emitter amplifier and chanq Q-point

GENERAL GUIDELINES

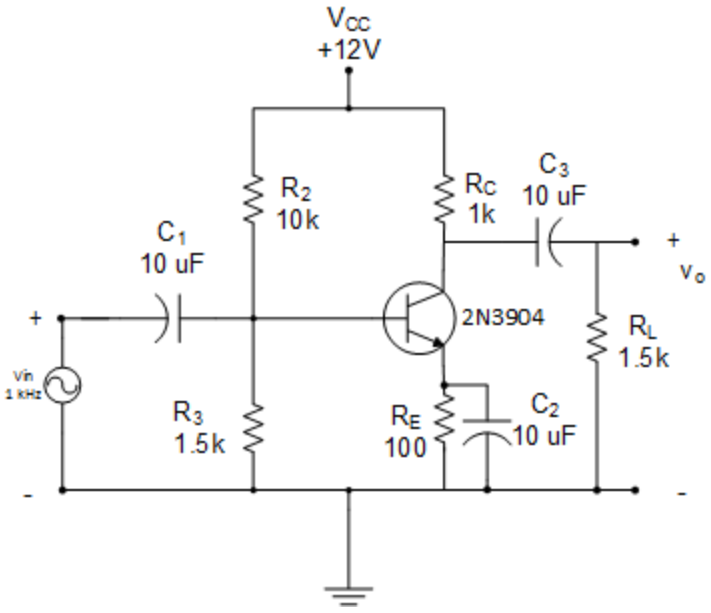
1) Each student must build, test, and demo all circuits.
2) During the lab session, students may need to share test stations.
3) Students are allowed (even encouraged) to help each other. Hedrick and/or the lab teaching assistant will be around to help as well. Use neat wiring for your circuits! A messy circuit will cost you 10 pts from your lab demo grade.
4) Ask questions! The more questions you ask, the more you learn (assuming Hedrick can provide adequate answers ☺).
5) Build your circuits with neat wiring! Messy circuits will result in a 10 pt deduction from your lab demo grade.
6) Please keep your lab kit and work area organized.

PARTS AND MATERIALS

- Lab kit (breadboard, wire stripper, wire)
- Function generator, multimeter, oscilloscope, benchtop power supply
- BJT transistor: 2N3904 (1)
- Resistors: 1.5k (2)
  10 k (1)
  100 Ω (1)
  470 Ω (1)
  1 k (2)
  2 k
- Capacitors: 10 uF (3)

PART 1: COMMON EMITTER AMPLIFIER

- **Step 1a**: Build the common emitter amplifier in Fig. 1.
    - Use neat and color-coded wiring!
        - RED wire = (+) voltage supply (12V)
        - BLACK wire = ground
        - YELLOW wire = everything else
    - +12V and GND come from the benchtop supply.
    - The pin diagram for the 2N3904 transistor is on the course website.
    - Be careful with the orientation of Cin and Cout!
    - The sine wave comes from the Agilent function generator.



- **Step 1b**: Check the transistor bias by measuring the DC operating point.
    - **With no input signal make the necessary multimeter measurements to fill in Table 1 below**.

I_{CQ}	V_{BQ}	V_{EQ}	V_{CQ}	V_{CEQ}

- **Step 1c**: Measure the Maximum unclipped peak-to-peak output.
    - Input a test sine wave (100mV$_{PP}$, 1 kHz) to the circuit using the function generator.
        - Set the Agilent waveform generator to "High Z" output.
            - Press "Utility", then press "Output", then press "High Z", and finally press "Done".
        - Set the amplitude to 20 mV V_{Pk} and frequency to 1 kHz. You may need to construct a voltage divider to reduce the input signal.
        - Connect the output of waveform generator to the circuit input using the coaxial cable with alligator clips.
        - Press the "Output" button on the waveform generator to turn on the output.
            - NOTE: "High Z" means the load is expected to be high impedance (as opposed to 50 ohm, which is pretty low). Otherwise, the generator will output TWICE the voltage that you want (very annoying for this course).

- Find the maximum unclipped output:

1. Increase the input to the amplifier while monitoring the output. Stop when the output is no longer symmetrical: $+V_{pk} \neq -V_{pk}$.
2. Does it clip first on the top or on the bottom?

Answer: _____

3. Decrease the amplifier input until the output is symmetrical.
    a. Fill in the table 2 below:

Theoretical MMP	Measured MMP

    b. Capture and print output waveform on the oscilloscope.

- **Step 1d: replace R_3 with a 1k Ω resistor**

  - With no input signal make the necessary multimeter measurements to fill in Table 3 below.

I_{CQ}	V_{BQ}	V_{EQ}	V_{CQ}	V_{CEQ}

  - Connect the function generator to the amplifier

4. Find the maximum unclipped output:
    a. Increase the input to the amplifier while monitoring the output. Stop when the output is no longer symmetrical: $+V_{pk} \neq -V_{pk}$.
    b. Does it clip first on the top or on the bottom?

Answer: _____

    c. Decrease the amplifier input until the output is symmetrical.
    d. Fill in the table 4 below:

Theoretical MMP	Measured MMP

    e. Capture and print output waveform on the oscilloscope.

- **Step 1e: replace R_3 with a 2 kΩ resistor**

  - With no input signal make the necessary multimeter measurements to fill in Table 5 below.

I_{CQ}	V_{BQ}	V_{EQ}	V_{CQ}	V_{CEQ}

  - Connect the function generator to the amplifier

5. Find the maximum unclipped output:
   a. Increase the input to the amplifier while monitoring the output. Stop when the output is no longer symmetrical: $+V_{pk} \neq -V_{pk}$.
   b. Does it clip first on the top or on the bottom?

Answer: _____

   c. Decrease the amplifier input until the output is symmetrical.
   d. Fill in the table 6 below:

Theoretical MMP	Measured MMP

   e. Capture and print output waveform on the oscilloscope

- Simulate the circuit for R3 = 1.5k and print the MPP.
- Draw load lines for the circuit using R3 = 1.5kΩ, 470 Ω, and 2 kΩ. For each case use the following steps:
  1. Calculate I_{CQ} using a β = 150.
  2. Find V_{CEQ}
  3. Find R_{AC} and R_{DC}
  4. Plot AC and DC load lines and determine the MMP.

- There is no formal lab report for this lab – hand in this lab with the tables filled in, the labeled oscilloscope waveforms, and the load lines.

(End of Lab 7)