Laboratory 5: Common Emitter Amplifier Design Project

Issued Friday, Oct. 18, 2019 ⇨ <u>Due 5 p.m., Tuesday, Nov. 12, 2019</u>

A. OBJECTIVE

In this laboratory exercise, you will design, build, and demonstrate a one-stage common emitter amplifier that meets the following specifications:

(a) Midband gain: $A_v = \left|\frac{v_o}{v_s}\right| > 270$ V/V

(b) Lower corner frequency: $f_l < 100$ Hz

(c) Upper corner frequency: $f_h > 85$ kHz

(d) Rise time: $t_r < 5$ μsec

(e) Undistorted output voltage swing: $V_o(\text{max}) > 1.5$ V (zero-to-peak)

(f) All specifications must be met while loaded by an oscilloscope probe and a load capacitor C_L=39pF.

(g) Minimize total external capacitance (coupling and bypass).

(h) Reasonable bias stability: $\frac{R_E}{\alpha} \geq 10\frac{R_B}{\beta}$, $V_B \geq 2.5$ V

(i) All resistors and capacitors must be standard 10% values (no parallel/series combination).

(j) R_s = 680Ω, R_c < 100kΩ.

(k) Circuit topology depicted in Fig. 1

(l) Use transistor 2N3904. (See data sheets in your course packs.)

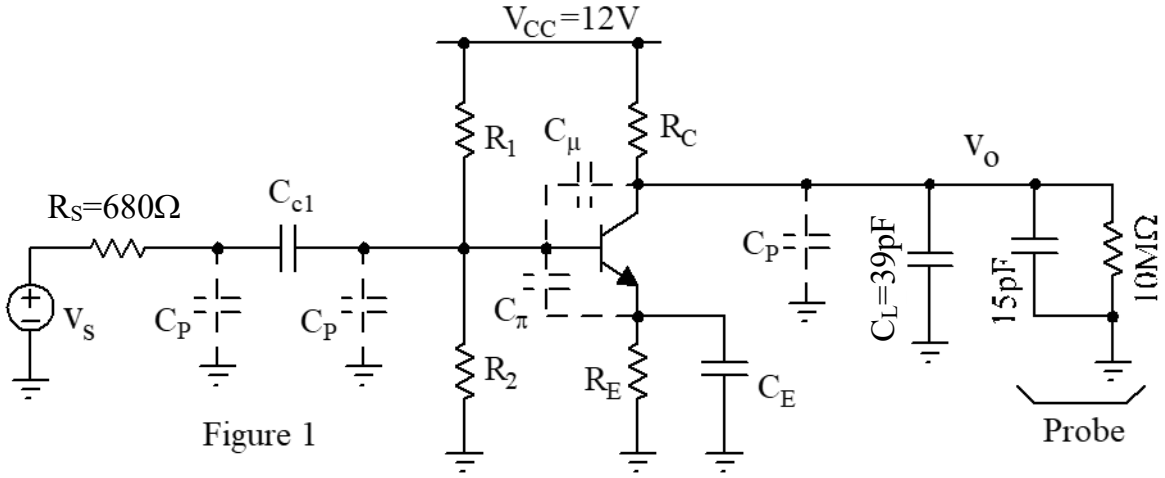

Figure 1

Note that there is no output coupling capacitor in Fig. 1. This lab has three phases: hand design, SPICE simulation, and lab verification. You must write a complete laboratory report describing your efforts in a professional-looking format, e.g., with figure captions, tables, etc.

B. LAB REPORT

Your report should be a concise yet comprehensive description and evaluation of your design, simulation, and laboratory measurements. Excessive paperwork and extraneous information is not acceptable. Your report should contain no more than 10 pages of text and figures. Extra pages may be necessary for spice output graphs. Neatness will be a percentage of your grade. The report should look professional, with nice figures and captions.

(a) Format: You should have the following separate sections in your lab report:

1- Design Strategy and Discussion (~10-15%)

2- Hand Design (~35-45%)

3- Computer and SPICE Simulations (~10-20%)

4- Experimental Results (~20%)

5- Summary Including Table (~10%)

Note that the above indicates the approximate weight of each section towards the overall report grade.

The Design Strategy section should include a discussion of how you approached the design problem and what trade-offs in the specifications you encountered. If you had to iterate, describe what guided your iterations. You should use equations to help explain this. This section should contain a clear diagram showing the entire circuit topology, and a table summarizing your complete design, including the operating bias point. The hand design section should contain only the final design iteration.

The summary section should include a table that compares the specified parameters from hand design, SPICE, and lab measurements. You should compare results and explain discrepancies between the three values. Again, be concise in your explanations.

(b) Calculations: Show all equations in variable form before evaluating. But just show final equations and those that are relevant to your design. We do not need long derivations.

(c) Graphics and Computer Outputs: Include plots that definitively show your results for each specification. Neatly label all plots and spice outputs.