SECTION ONE
LTspice
(Week 1)

SECTION OVERVIEW

This section functions as a training/review of LTspice. Learning outcomes are:

- Able to perform design-then-simulate engineering process
- Able to perform LTspice simulation.
- Able to add models to LTspice.

Bring a printed copy of *Appendix A: A simple guide on LTspice* with you to the lab. This will enable you to work lab quickly.

PROCEDURE

A key success factor for cost effective and timely development is prototyping based on simulation and optimization. It is important to design the prototype by the given specification, followed by verification of the design via simulation before constructing the actual prototype.

Task One: Design

Design an amplifier with the following specification **on paper**:

- 5V supply voltage
- Gain = 5 ± 5%
- Small signal input of 200mV$_{p\text{-}p}$, 500 Hz
- Using only resistor(s), capacitor(s), and one 2N4401 OR 2N4403
- Use a reasonable value for β (refer to datasheet)

Task Two: Simulation

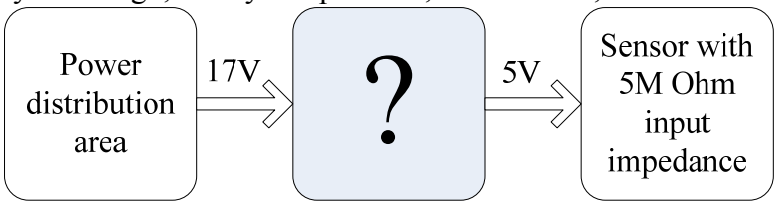
Simulate your design in LTspice using the correct parts that match your design. Print the following simulation results:

- A plot that contains both input and output waveform. (.TRAN)
- A plot that contains both magnitude (bode) plot and phase plot. (.AC)
- Simulation results on input and output impedance.
    - Hint: Research the transfer function simulation (.tf)

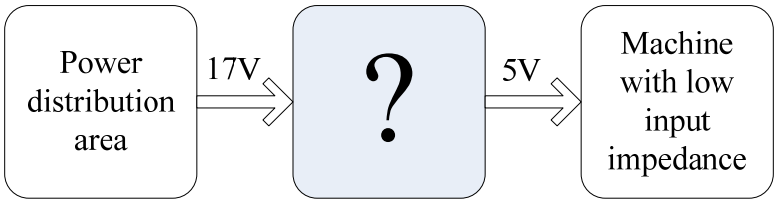
STUDY QUESTIONS

1. Were there any inconsistencies between your calculated and simulated results? What might be some of the causes? You had the option to choose either a 2N4401 or 2N4403 transistor. Which one did you choose and why did you choose it? Provide pros and cons for both transistors. Please give detailed answers for all of the above questions.

2. A sensor with 5M Ohm input impedance needs 5V to operate correctly. Assume that you get exactly 17V from the power distribution area. Design a functional block, (represented by the gray block), which will be able to change 17V to 5V. Use **ONLY** discrete parts (resistor, capacitor, diode, and transistor). Please provide detailed solution including reasoning of your design, theory of operation, calculations, detailed schematic, and simulation result.



3. A machine with low input impedance needs 5V and current ranges from 0.5 – 1 Amp to operate correctly. Assume that you get exactly 17V from the power distribution area. Design a functional block, (represented by the gray block), which will be able to change 17V to 5V. Use **ONLY** discrete parts (resistor, capacitor, diode, and BJT). Please provide detailed solution including reasoning of your design, theory of operation, calculations, detailed schematic, and simulation result.



4. Construct a parts list for the circuits designed in #3 and #4. Minimal requirement: location of purchase, vendor parts number, unit cost, total cost.

TURN-IN

☐ A copy of your design process, include equation used and calculation results with units.
   a. Equations used to initially calculate all resistors in your design.
   b. Calculations showing that the circuit still functions for maximum and minimum values of Beta from the datasheet.

☐ A copy of your simulation result including:

a. Input and Output Waveforms (on one graph)
b. Magnitude and Phase Plots (on one graph)
c. Input and Output Impedance

☐ Answers to study questions (typed, with SPICE schematic, equation editor for equations).

SECTION TWO
Design the prototype
(Week 2 – 3)