ENG-100 Lab

LAB 2 - CIRCUIT RESPONSE

The purpose of this laboratory assignment is for you to examine the dynamic time-domain response and frequency domain responses of two electronic circuits shown below. Dynamic time-domain response is often determined by application of a unit step input signal. Frequency response is normally determined as the steady-state response to a sinusoidal input signal. For this lab assignment you will determine the circuit responses by (1) solution of the circuit equations, and (2) experimental measurement. It is recommended but not required that you look at a third evaluation option: (3) numerical simulation with PSPICE. You should verify the results for each solution technique, and compare the results of the various techniques.

This is a one-week assignment with the following schedule:

(1) solution of circuit equations – **on your own time, at home, BEFORE your lab meeting**.

(2) experimental measurement – during the Lab meeting.

(3) numerical simulation, if you choose to do this– on your own time. If you do this, the results and evaluation can be turned in for extra credit at any time before the final exam. This skill will be useful in the analog design project. A Windows student version of PSPICE can be downloaded from the web site. Also read the documents on the course web site that discuss PSPICE simulation.

Your documentation is due at the **beginning** of the next lab meeting.

Circuits Analyses

Analyze the circuits shown in figures a and b below and find for each circuit:

1) the time domain responses $v_{out}(t)$ for a unit step input; and

2) the output/input transfer functions ’

$$T(s) = \frac{Vout(s)}{Vin(s)}$$

Plot by hand each $v_{out}(t)$ vs. time.

Document the sinusoidal steady state circuit response of each circuit and plot by hand vs. frequency f: the magnitude in dB and phase in degrees of each T(s) you found above.

Document your work with enough detail to verify your work.

The above will serve as the expected responses of the circuits that you build and test.

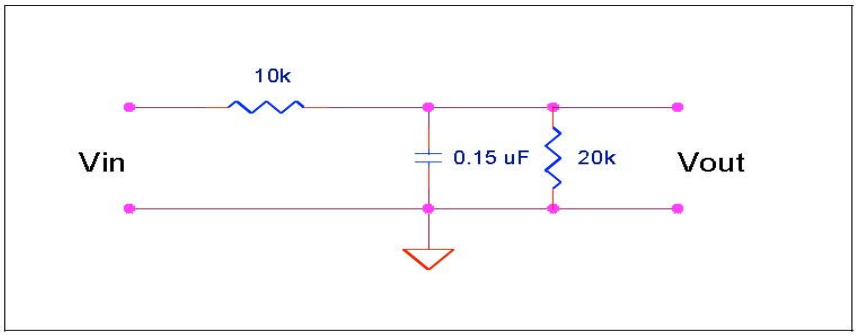
Experimental Measurements

Construct the circuits on your protoboard using components from the issue bench. Frequency response should be measured using the function generator for input and the oscilloscope for viewing the output. Set the function generator for a 1.0 V peak-to-peak sine wave. Magnitudes and phase angles can be measured by setting the oscilloscope to view both input and output signals simultaneously. (**Suggestion** -Before taking any data, sweep a wide range of frequencies, 1 Hz to 1 MHz, to get an idea of the circuit response. Then, take data where the response is changing, and only a few points where the response is constant).

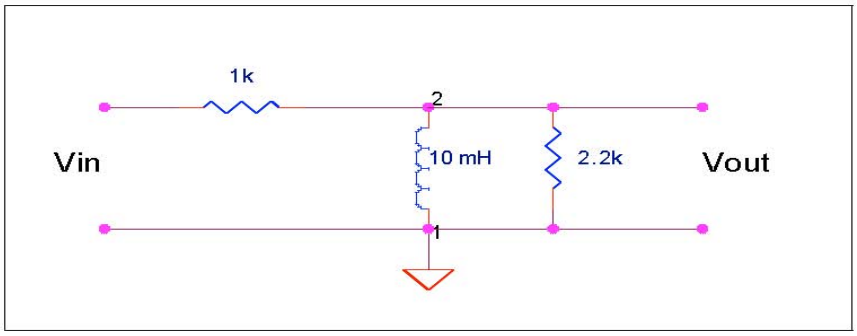
Step response should also be measured by using the function generator for the input signal. Using the offset and magnitude adjustments, set the function generator for a square wave from 0 to 1.0 V. Select a frequency so that you can see the entire transient response of the

network before the next pulse. Carefully sketch the circuit transient response to a unit step, including voltage levels and times.

A



b



OPTIONAL TASK – NOT REQUIRED - Numerical Simulation Turn in for extra credit.

Use the circuit simulation program PSPICE to numerically solve for the circuit response. You can download the program (windows) from the class website (91pspstu.exe) and run it at home. Refer to the handout on the web site "Circuit Simulation with PSPICE" to get started and spend some time familiarizing yourself with the program. It's quite easy to use, and extremely powerful. Do the simulations on the documents on the web site for practice. (You don't have to turn these in.)

Simulate the step and sinusoidal response of circuits a and b. Include copies of your schematics, net lists, and plotted results. You can create a Bode plot (dB and φ vs. log f) from the simulation results by adding a plot and then adding traces to the plot using the DB( ) and P( ) functions. You can also use the text drawing tool to add labels to the schematic and plots.

Overall Discussion

Compare and contrast the analysis and experimental results. Explain differences. Show all analytical work, measured data, and plots. Your lab report is due at the **beginning** of the **next** lab meeting.