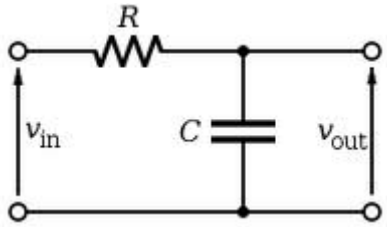
ELEC 361 Measurement and Analysis
Lab 2. Time and frequency response of RC circuits

References

•Theoretical & Computer Analysis of Systems & Networks – Bold and Tan (text for ELEC 353)
•The Art of Electronics – Horowitz and Hill, section 1.13, 1.14, 1.19
•Signals and Systems – H. P. Hsu, section 5.47 (on Bode plots)

Pre-lab homework

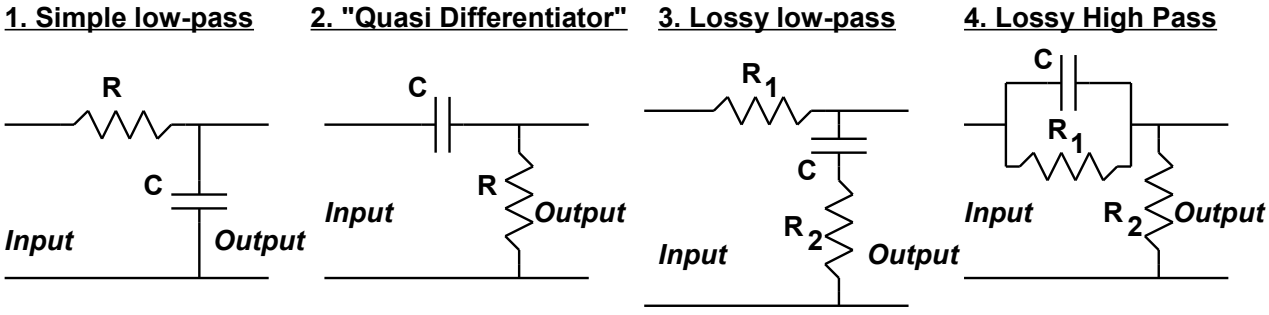
1. Read the following:
   •The Art of Electronics – Horowitz and Hill, section 1.13, 1.14, 1.19
   •Signals and Systems – H. P. Hsu, section 5.47 (on Bode plots)
2. For the following RC circuit



   i. Use simple arguments about the components to determine the behaviour of this circuit for sinusoidal signals at very high frequency, and at d.c.
   ii. The step response is the output voltage when the input voltage steps from 0 V to 1 V instantaneously at time t=0. Use simple arguments about the components to determine the step-response of this circuit at times immediately after t=0, and after a long time.
3. Calculate the time constant of the circuit, and explain how it relates to the corner frequency (also called the '3dB point') for the circuit.
4. Can you justify the reasons for this circuit being called a 'low pass filter' and a 'quasi integrator'?
5. What is the time constant of the circuit when a second resistor of value R is put in parallel with the capacitor?

Lab tasks

Task 1: For each of the following RC filters:



Build the circuit with some sensible component values, and then use the NI ELVIS II

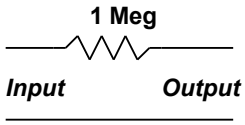
system to measure the component values, the frequency response, and the step response. Accurately determine the time constant and the corner frequency and verify that your results for the pre-lab assignment are actually correct.

You should plan the measurements you need to make, and perhaps discuss this with your lab demonstrator – particularly the way that you will make accurate estimates of times and frequencies.

Some handy hints
The BODE tool measures the frequency response and displays it as Bode plots. Use "scope inputs" on ELVIS II for best results. After measurement, you can save the data to file (log to txt file). You can then import the txt data into MatLab (or whatever analysis package you like) to replot the data, and to estimate frequencies, etc.

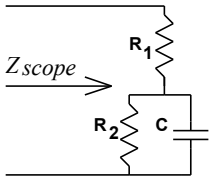
The step response is a time domain measurement for which the function generator and oscilloscope are most useful. Again, you can save the data as text to allow accurate analysis in MatLab.

Equivalent circuit for 'scope inputs
Task 2: Measure the Bode plot for the following circuit



Amazingly, it is not flat at high (enough) frequency.

Show the effect of the oscilloscope's finite input impedance (Z_{scope}). Find an equivalent circuit with component values that replicates the measured frequency response (Bode plot). Hint: perhaps the following network could emulate Z_{scope}.



Lab reports
Present clearly all your results. Include all set-ups and measurements, and results derived from measurements. Describe how you found accurate estimates from your measurements, and give the basis of calculations or code that you used. Include some conclusions.

Please note: Your lab book needs to me marked as 'completed' before you can hand in your lab report. You can only have one lab report outstanding (not graded as 'passed') to be able to start another lab.

This is a 1-week lab.