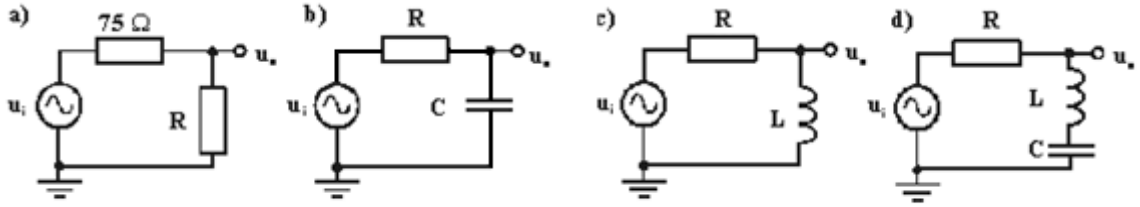
Measurement Methods in Physics I
Fall 2016
Exercise 3
27.9. - 29.9.

Hand-in assignments. You have to return an answer sheet, even if it would be empty.
Return by 22.9.2016 16:00.

1. Calculate the amplitudes and phases of the output signals u_o when f = 10 kHz, u_i = 12 V· sin(2π·f·t), R = 180Ω, C = 470 nF, ja L = 680 μH. *Hint: Voltage division can also be calculated for reactive components.*



2. Examine the circuits from 1 as filters. Make Bode-plots of the amplitude response for each circuit and determine the passband, stopband, -3dB cutoff frequency and slope of the stopband (decibels per decade) for each. The Bode-plot can be made using e.g. Matlab or LTspice.

3. a) How big can the rms-value of the noise be if a voltage signal, which fluctuates between 10 mV and 100 mV, is measured, is measured and the desired SNR is 25dB?
b) You are transmitting a voltage signal, which fluctuates between 0 V and 10 V, from one device to another. The analog transmission and reception adds a noise to the signal with an rms-value of 25 mV. You can avoid the noise by transferring the signal digitally. You have an A/D-converter at your disposal with a resolution of 8 bits and according to the data sheet the conversion precision is 2×LSB. Does the use of the A/D-converter reduce the uncertainty of the signal?

"Check box"-assignments. Bring these to the exercise session.

4. a) What does crosstalk in a measurement device mean?
b) What causes Johnson noise and how can you reduce it? Calculate the Johnson noise in a 10 kΩ resistor, when the frequency band is 1 kHz - 1 MHz and the temperature is 20 °C.
c) The mutual capacitance between the channels of a signal generator is 100 pF. How large is the capacitive coupling into channel 1 if a voltage signal passes through channel 2 with rms-value U=500 mV and frequency 1 kHz. A load R_L = 1 kΩ is connected to channel 1.

5. a) Explain what the so called four-terminal sensing is.
b) Why is four-terminal sensing better than two-terminal sensing?