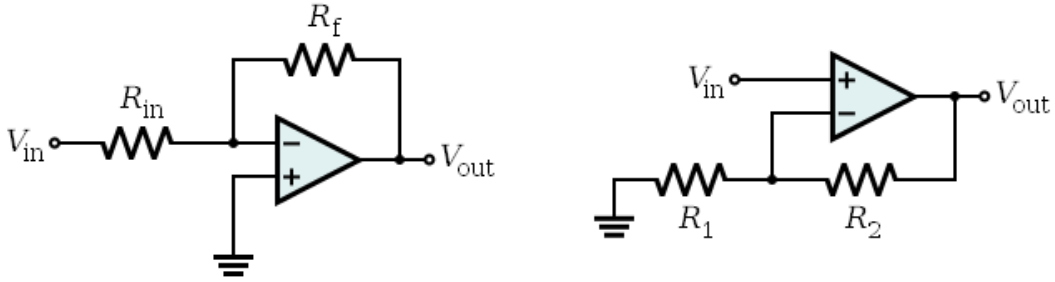
Measurement Methods in Physics I
Fall 2016
Exercise 5
11.10 - 13.10

Hand-in assignments. You have to return an answer sheet, even if it would be empty.
Return by 6.10.2016 16:00.

1. In an ultrasonic measurement you receive 40 kHz voltage signals, whose amplitudes typically are about 10 mV. Your neighbour has an AM radio station, whose transmitted program is comparable to a 2 MHz noise. The radio transmission is detrimental to your measurements' precision. Design a filter circuit that dampens to amplitude of the noise by at least 20 dB, but dampens the amplitude of your 40 kHz voltage signal by at most 10 %.

2. The picture below shows one inverting and one non-inverting operational amplifier circuit.
a) Calculate the output voltages as a function of the input voltages.
b) What other practical differences are there between the circuits?
c) Find the data sheet of one operational amplifier of your choice. What features are used to advertise the component and what possible weaknesses could it have?



3. Wheatstonen bridge.
Your task is to design a circuit which measures the temperature of a heat reservoir. The circuit will be used as part of a thermostat, the task of which is to keep the temperature of the reservoir at 75 °C. The circuit should put out a voltage that is zero when the temperature is 75 °C, is positive when the temperature exceeds 75 °C, and is negative when the temperature falls below 75 °C. The circuit is allowed to consume a maximum current of 1 mA regardless of temperature. At your disposal you have a 5 V DC-voltage source, basic electronic components and a thermistor PT100, whose resistance is $R = 0.3821\ \Omega/°C \times T + 100\ \Omega$, where T is the temperature in Celsius. Draw the circuit and determine values for the components.

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

4. Signal modulation.
a) What is the basic idea in signal modulation? What is meant by frequency, phasem and amplitude modulation?
b) With what kind of circuit can you receive and amplitude modulated signal?

5. a) How is covariance defined mathematically? What does covariance mean in practice?
b) Covariance can also be problematic in research. What practical meaning could covariance have?
c) ANCOVA can be used to remove Regression to Mean (RTM)-artefacts from data. What is RTM and how does it distort measurements?

Hint: wikipedia can help