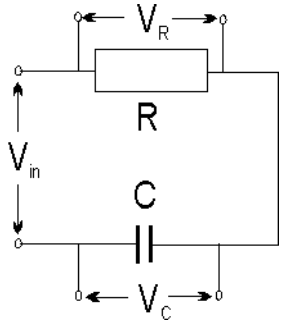
FYS S300 Mittaustekniikka
Lecturer: K. Arutyunov
Exam 27.04.2012

Problem#1 (4 points)
Propose the method of measuring interatomic distance (lattice constant) of solids. Draw schematics of the experiment and write the basic expressions enabling determination the lattice constant from the experimentally measurable quantities.

Problem#2 (6 points)
Consider the RC circuit below with applied time dependent input signal $dV_{in}(t)$.

2.1 (3 points) Write expressions and indicate the condition at which the circuit works as a differentiating element: $V_{out} \equiv V_R = RC(dV_{in}(t)/dt)$.

2.2 (3 points) Write expressions and indicate the condition at which the circuit works as an integrating element: $V_{out} \equiv V_C = (1/RC)\int V_{in}(t)dt$.



Problem #3 (6 points)
3.1 (3 points) Explain principle of operation of a lock-in amplifier. Draw schematic diagram, input and output signals.
3.2 (3 points) Explain how a lock-in amplifier can be used to measure derivative of the current-voltage characteristic dV/dI of a non-linear element.

Problem#4 (4 points)
Explain principle of operation, draw schematics and write corresponding expressions explaining method of measuring resistance using Wheatstone bridge.

Problem#5 (5 points)
5.1 (2 points) What is shot noise? How the shot noise amplitude depends on system parameters. Draw the dependence of the shot noise spectral density on frequency. In what experimental conditions the shot noise is noticeable?
5.2 (2 points) What is Johnson noise? How the Johnson noise amplitude depends on system parameters. Draw the dependence of the Johnson noise spectral density on frequency. In what experimental conditions the Johnson noise is noticeable?
5.3 (1 point) What is the difference between “pink noise” and “white noise”?