Diagnostics Tutorial

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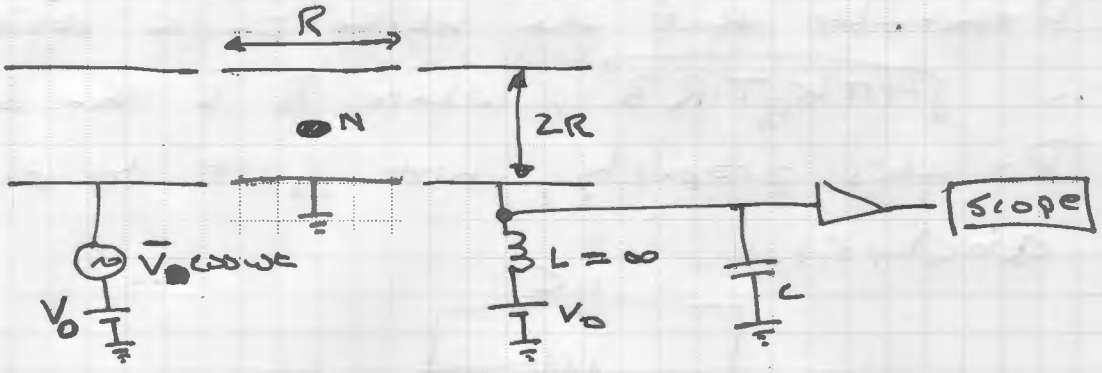
Les Houches

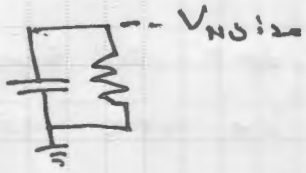
1) Consider a small plasma with N charges held in the trap below:



The left electrode oscillates with frequency ω and amplitude $\bar{V}$. Both right and left electrodes are biased at voltage V_0. The oscillation, which is at a frequency well below any resonances, ~~is at~~ causes the plasma to oscillate in z, along the trap axis. The plasma oscillation is picked up on the right electrode. What is the size of the signal? Is this a viable diagnostic?

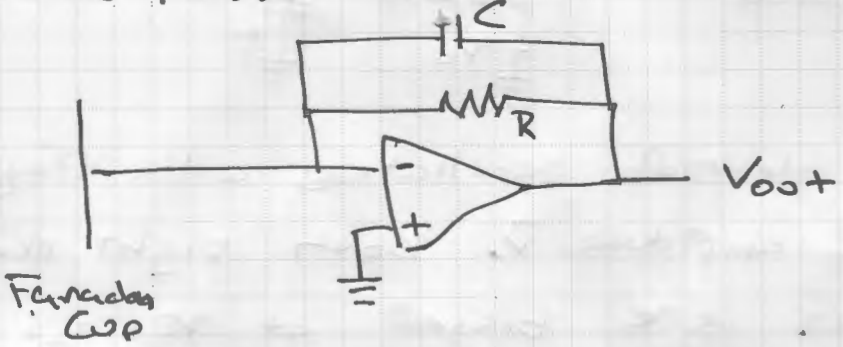
Use ~~any~~ and <u>all</u> simplifications that you can think of.

2) Prove that the noise in the following circuit is $\sqrt{\frac{k_B T}{C}}$.



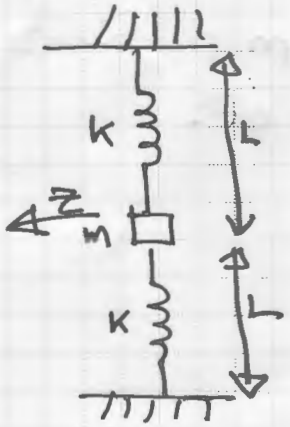
Remember that the noise on a resistor is $\sqrt{4\pi k_B T R B}$, where B is the bandwidth. Do this properly, not just by dimensional analysis.

3)



What is the response of this circuit, and what does it measure?

4) (Autoresonance) Almost all nonlinear oscillators reduce to the Duffing Equation at low amplitude. Consider the following mechanical problem.



Initially the springs are at their unstretched length. Ignore gravity.

What is the differential equation that describes small sideways oscillations in this system? (Oscillations in z, consider planar oscillations only.)

Does this equation reduce to the Duffing equation? If so, what is the nonlinear