Johnson Noise Pre-Lab

1. First, read the short file "Fourier Analysis" and then watch the youtube video "Power Spectrum." What are the units of power spectral density in an electrical system?

2. Read the Johnson noise Guide

3. Read: Melissinos pp119-133

4. Read: Nyquist, *Phys. Rev.* 32, 110 (1928)
[file Nyquist-1928 included on 122 web page]

5. Look at Brownian motion video

6. Read "Sources of Noise" web page

7. Do Problem 1 in the Guide (show all work):

Knowing the propagation time from the generating resistor to the absorbing resistor $\Delta t = L/c$, show that the absorbed power by the "equivalent" resistor R equals

$$P(f)\Delta f = k_B T \Delta f$$

8. Answer the following question and show math:

What is the integrated power of this Johnson noise over all frequencies? [i.e., why can't a single resistor supply the world's energy needs?]

9. In your Hi-Q ~1MHz resonant LC circuit you built in the 122 electronics lab, the Q was not infinite because of power dissipation in the circuit. This can be represented by including a resistor in series with the inductor in an "equivalent" LRC circuit. At room temperature, what would the power spectrum of your LCR circuit look like? Sketch, label axes. [You will be given the opportunity to do this 1 MHz Johnson noise experiment.]

10. Read and understand the instrument manuals. You will use this equipment on your first day.