SM FALL 01 B

There is a microscopic LC circuit embedded in your Pentium IV PC (see the figure for the LC circuit embedded in the circuit board). In principle, thermal noise and quantum noise limit the PC's reliability. Treat the LC circuit quantum mechanically to handle the general situation.

In this problem, ω is the resonant frequency of the LC circuit which matches the operating frequency of the PC. Write your answers in terms of k, Boltzmann's constant, $\hbar$, Planck's constant, the inductance L, and the capacitance C. Treat the system as free of impurities.

Assume that the PC is not connected to any external power source and no external charges or currents have been applied to the circuit.

a) Find the average energy stored in the LC circuit at temperature T.

b) Find the RMS noise voltage in the LC circuit in the case thermal fluctuations are much larger than quantum fluctuations, $kT \gg \hbar\omega$. (You could use the result of part a) here, but you don't have to.)

c) Now suppose that quantum fluctuations are much larger than thermal fluctuations, $\hbar\omega \gg kT$, and find the RMS noise voltage in the LC circuit in this case.

d) Use your results of parts b) and c) to decide if thermal fluctuations or quantum fluctuations are numerically more important for the PC on your desktop which runs at $1.5 \cdot 10^9$ cps.

Circuit Board