UNH

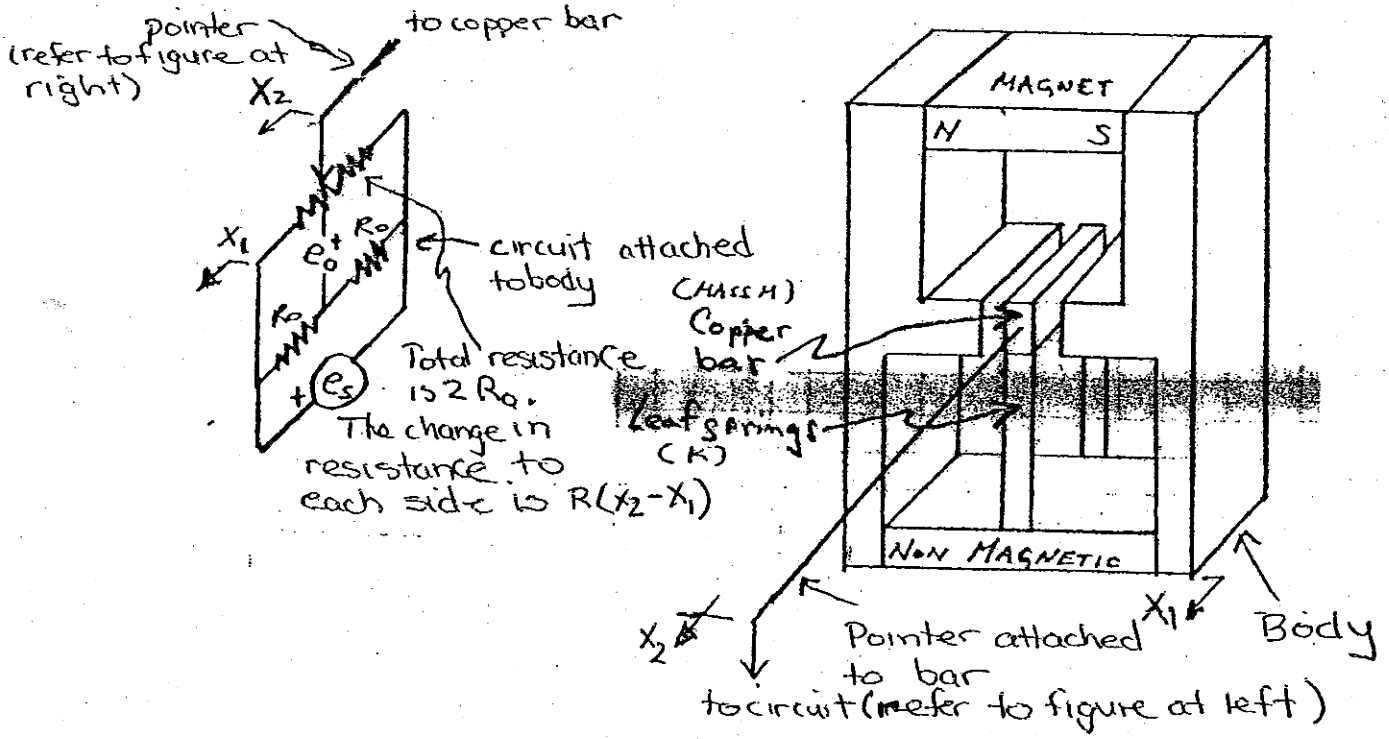
University of New Hampshire
Department of Mechanical Engineering

ME 747
Experimental Measurement and Modeling of Complex Systems

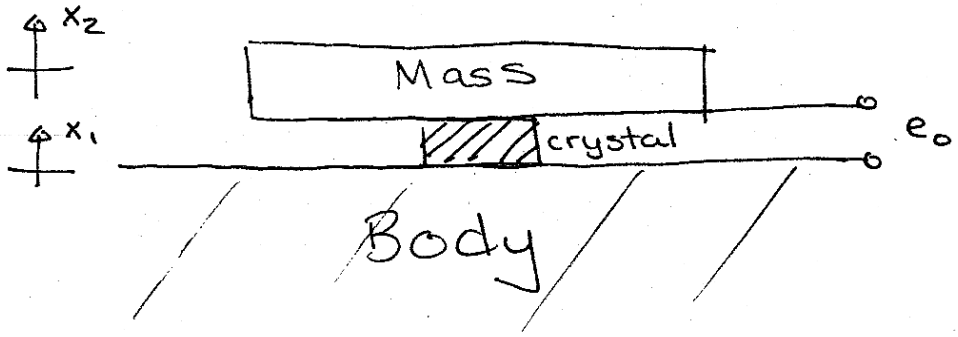
Problem Set No. ~~5~~ 6

An accelerometer can be constructed by connecting a mass to the transducer body through a spring. Body acceleration can then be measured by detecting the relative motion between the mass and the body. Consider the 2 accelerometers: a *piezoelectric accelerometer* and a *potentiometer*.

potentiometer In a potentiometer, a copper bar of mass M moves within a magnet via leaf springs of constant k_{pot}. An electric circuit is attached to the copper bar. The motion of the bar within the magnets causes eddy currents which, in turn, produce forces proportional to and opposing the velocity. The copper mass moves the potentiometer wiper to unbalance the bridge circuit.



piezoelectric A piezoelectric accelerometer is comprised of a mass M and a crystal. The crystal is the transducer and can be modeled as a spring k_{piez} and a damper B. The crystal also has a capacitance C and a resistance R and is placed in parallel with a load resistance R_L and a current source I_c, where I_c is equal to a gain C_2 times the relative velocity between the mass and the body in motion. (Note: All electrical elements are in parallel.)



Using the descriptions above for both the potentiometer and piezoelectric accelerometer:

(a) Derive the differential equation which describes each of the two accelerometers.

(b) Sketch the Bode plots relating acceleration to voltage for both accelerometers.

(c) In each case, show how the sensitivity and natural frequency are related.

(d) Compare the two measuring devices to each other (i.e. advantages and disadvantages).