System Dynamics Exam 2 Winter 2009

1. Sketch the step response of the following systems

   (a) $\frac{X(s)}{F(s)} = \frac{1}{10s^2+100s+1000}$

   (b) Second order system with settling time $t_s = .5$ seconds and natural frequency of 10 Hz

   for 1 second calculating and labeling:

   (a) Overshoot
   (b) Decay envelop
   (c) Settling time
   (d) 1 period and its numerical value (when appropriate)

2. Plot the following poles (roots of the characteristic equation) on the complex plane and describe their behavior and stability characteristics (and relative to other poles in the list when valid).

   (a) 1
   (b) -1
   (c) 10
   (d) -10
   (e) $1 \pm 10i$
   (f) $10 \pm i$
   (g) $-1 \pm i$
   (h) $-10 \pm i$
   (i) 0
   (j) $\pm i$

3. The equilibrium position is at $x = 0$. Neglect the mass of the pulley and presume the cables are inextensible. Derive the equation of motion.
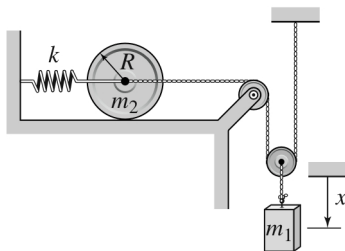
4. Derive the governing equation or system of equations for the following system *presuming the shaft has a torsional stiffness k_t.*