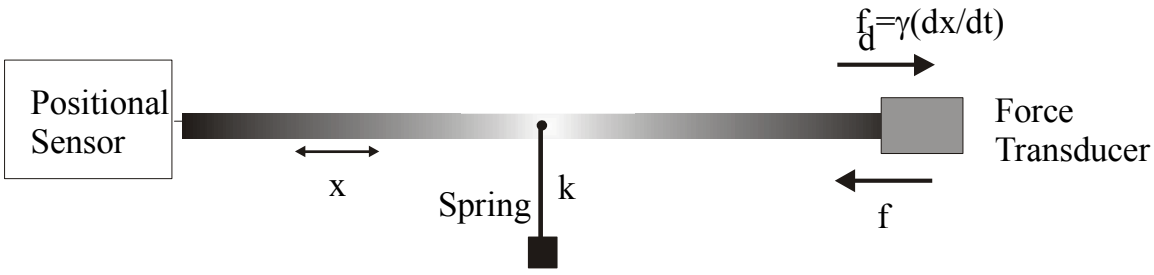
2.004: MODELING, DYNAMICS, & CONTROL II

Spring Term 2003

PLEASE ALSO NOTE THAT ALL PRELAB EXERCISE ARE DUE AT THE START (WITHIN 10 MINUTE) OF THE LAB SESSION, NO LATE WORK IS ACCEPTED.

Pre-Lab Exercise for Experiment 6

Consider a second order mechanical system. A steel rod of mass m is driven by a transducer with force f. The position of the rod, *x*, is monitored by a positional sensor. The coupling between the rod and the force transducer also exerts a damping force, $F_d = \gamma \frac{dx}{dt}$. The damping force opposes the motion of the rod and is proportional to the velocity of the rod with a proportional constant, γ. The steel rod is further coupled to a spring with coefficient k.



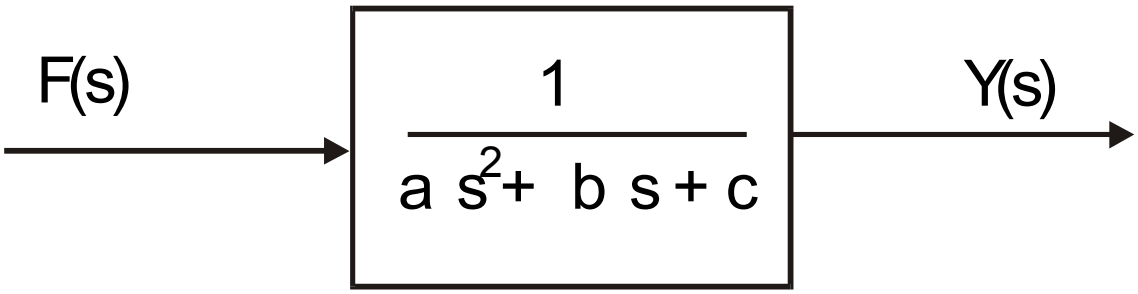
(a) Show that the equation of motion has the form:

$$a\ddot{y}(t) + b\dot{y}(t) + cy(t) = f(t)$$

Express coefficients a, b, c, in terms of physical parameters.

(b) Show that the transfer function can be expressed as:

$$\frac{Y(s)}{F(s)} = \frac{1}{as^2 + bs + c}$$



(c) Using the following parameters:

$m = 0.85kg$

$k = 500\frac{N}{m}$

$\gamma = 14\frac{Ns}{m}$

Where are the poles of this system?

(d) Sketch the open loop root-locus of this system.

(e) Consider implementing proportional gain feedback, sketch the root-locus of this system.

(f) Consider implementing differential feedback. Where would you put the zero? Sketch the root-locus of this system.