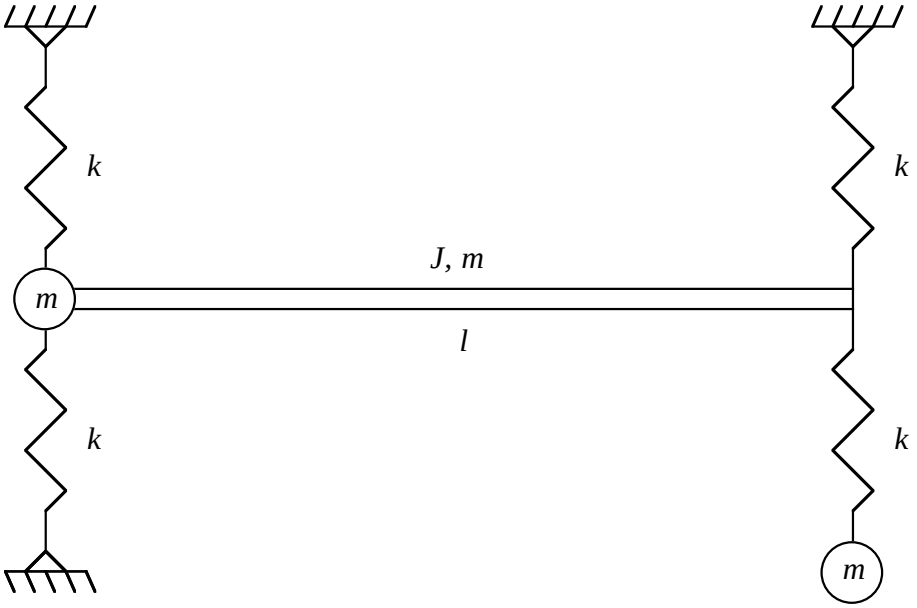
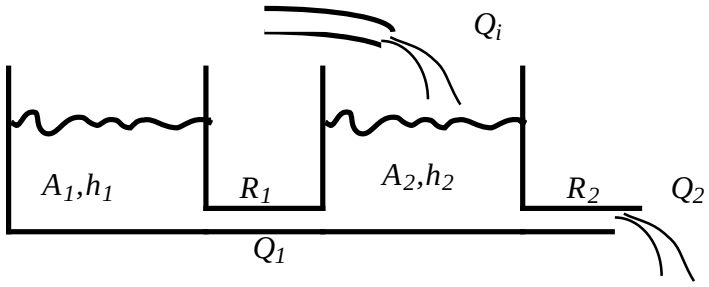
Mechanical System Modeling and Design Exam 2 Winter 1998

1. Determine the number of states in the system below. Write the state space equations for the system shown below. (20 points)



2. Determine the number of states in the system below. Write the state space equations for the system shown below in terms of the heights. (20 points)



3. For the following system of equations (20 points):

   (a) How many states does the system modeled by the following equations have?

   (b) Put the equations of motion in state space form.

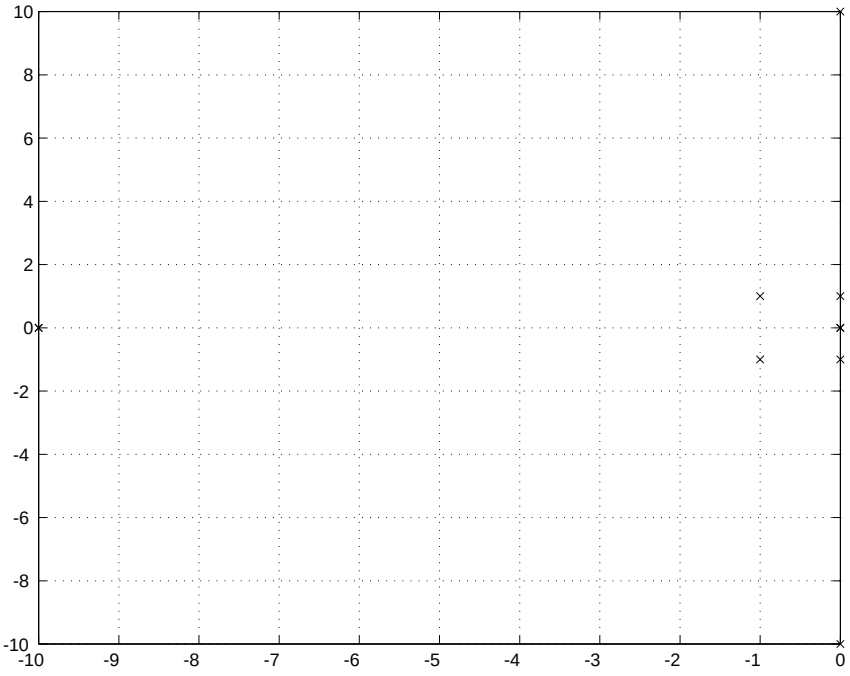
   (c) Linearize the state space equations.

$$\frac{d^3y}{dt^3} + \frac{d^2y}{dt^2}^2 + \sqrt{y-x} = f_1(t)$$

$$\frac{d^2x}{dt^2} + \sqrt{x-y} = f_2(t)$$

4. The poles of a system are shown in the complex plane below. (20 points)

   - List the roots (or pair) and discuss the type of motion resulting from each one. (oscillatory/exponential/combined, relatively fast/slow, stable/unstable)
   - Rank the roots in terms of their relative importance.
   - Summarize the most significant component of the ensuing free response of the system if it is perturbed slightly from equilibrium.
   - Consider: You need to simplify the model by removing three roots. Which three do you remove to retain an essentially accurate model? What is the most likely phenomenon that could prevent you from simplifying the model in this way?



5. A system is excited by a step of magnitude 5. Its response is shown below. Estimate the system model. (20 points)