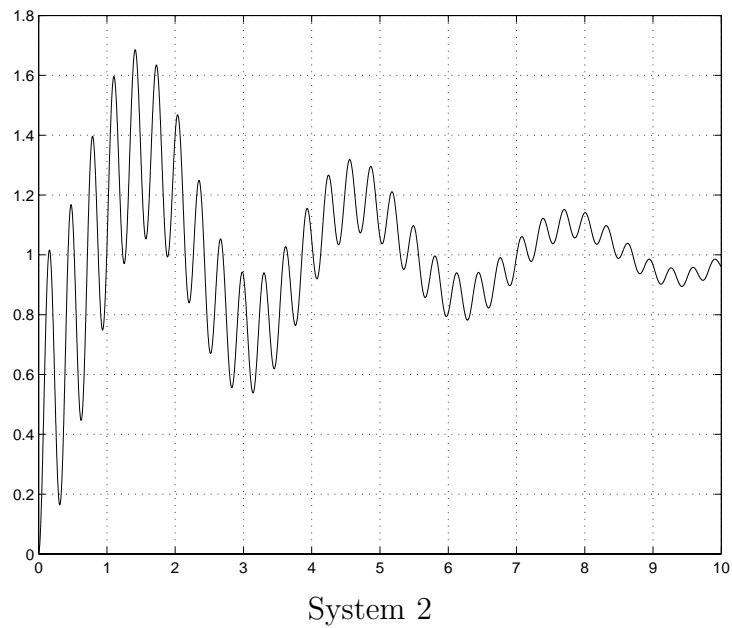
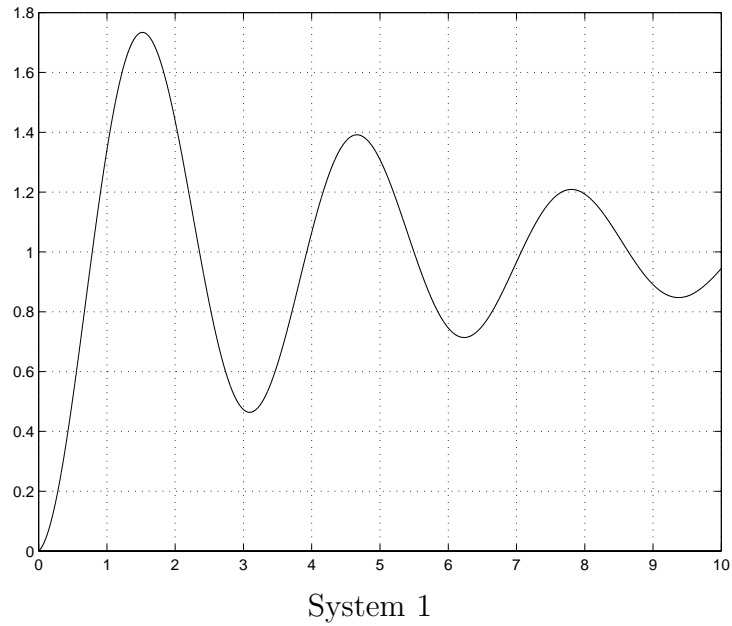


# Mechanical System Modeling and Design Exam 2

January 8, 1998

1. For the graphs below, estimate the following:

- (a) The effective time constant.
- (b) The fundamental frequency.
- (c) The damping ratio for the fundamental frequency.



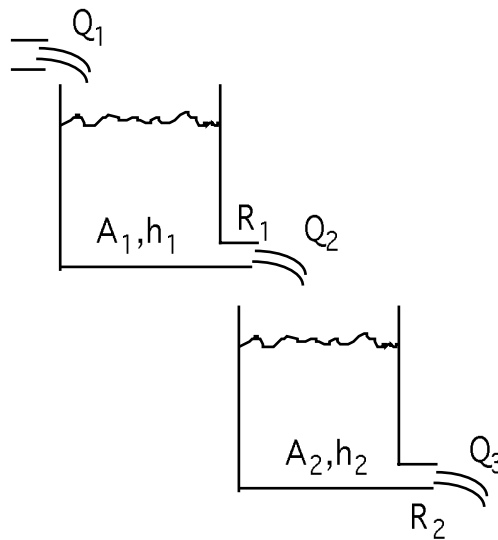
2. For the following system of equations:

- (a) How many states does the system modeled by the following equations have?
- (b) Put the equations of motion in state space form.
- (c) If  $f_1(t)$  is a constant  $f_1$  and  $f_2(t)$  is a constant  $f_2$ , what is the steady state response  $y(t)$ ?

$$\frac{d^3 y}{dt^3} + a \frac{d^2 y}{dt^2} + b \frac{dy}{dt} + c \frac{dx}{dt} = f_1(t)$$

$$\frac{d^2 x}{dt^2} = f_2(t)$$

3. Derive the equations of motion for the following system.



4. The roots of the characteristic equation of a system are shown in the complex plane below.

- List the roots (or pair) and discuss the type of motion resulting from each one. (oscillatory/exponential/combined, relatively fast/slow, stable/unstable)
- Which root is the most important and why?
- Summarize the most significant component of the ensuing free response of the system if it is perturbed slightly from equilibrium.

