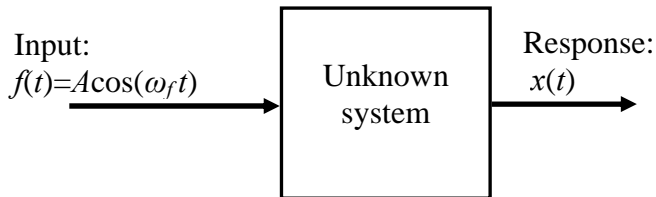


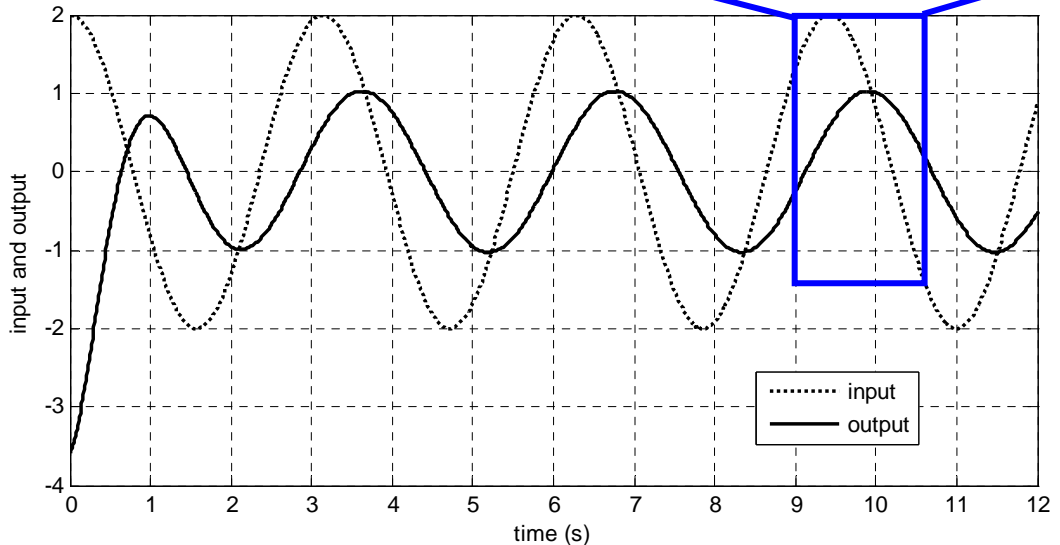
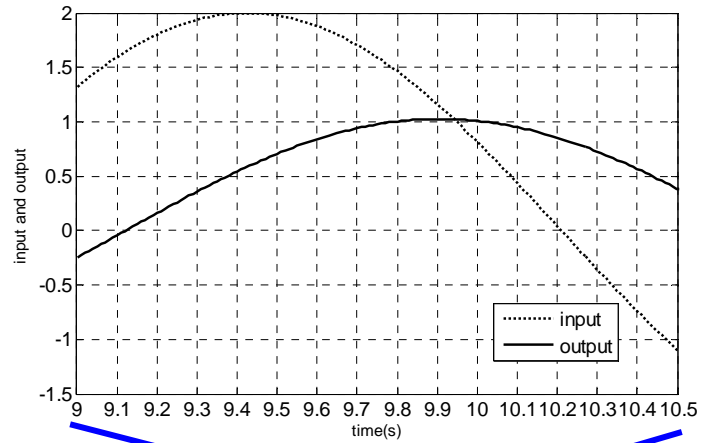
Lesson 20

Problem 20.1

A harmonic input signal is sent into an unknown system.



Both the input signal and the response are shown on the plot below.

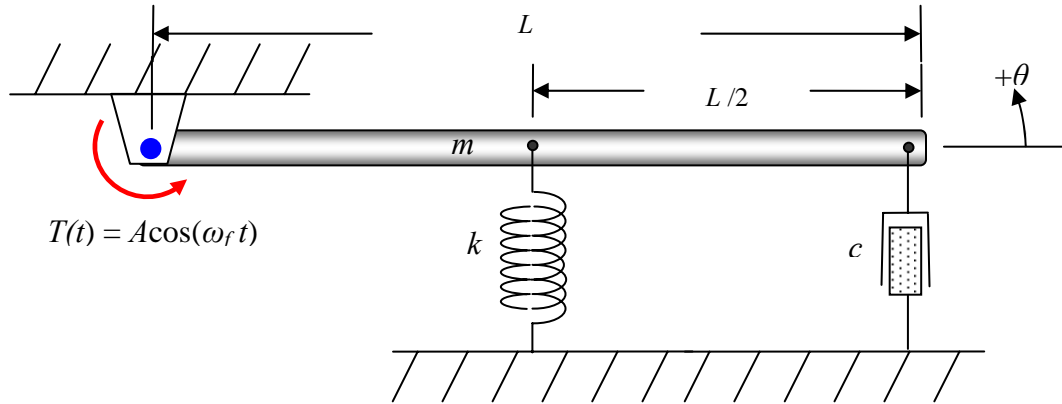


Determine the equation of motion for this system for any general input assuming:

- the system is 1st order
- the system is 2nd order and it is known that the system has a natural frequency of 3 rad/s

Problem 20.2

A long thin bar with attached elastic and damping components is subjected to a harmonic input moment.



- a) Show that the model of the system (for small amounts of angular displacement) may be given as

$$\frac{4m}{3k} \ddot{\theta} + \frac{4c}{k} \dot{\theta} + \theta = \frac{4}{kL^2} T(t)$$

- b) Using the parameters given below, determine the magnitude and phase of the bar's rotational displacement response to the input moment. Assume that the bar starts from equilibrium and at rest.

Mass, $m = 2$ kg	Length, $L = 0.4$ m
Spring constant, $k = 50$ N/m	Damping constant, $c = 0.5$ N/(m/s)
Moment amplitude, $A = 2$ N-m	Moment frequency, $\omega_f = 8$ rad/s

- c) Use a Simulink diagram of the model in (a) to create a Matlab plot that shows both the input moment and the bar's angular displacement response on the same plot. Identify
- the amplitude of the input moment
 - the amplitude of the steady-state response displacement
 - the phase difference on the plot.
 - the time required for the transient to die out.
 - the amplitude of the peak response.

Is the output response consistent with application of small angle theory?