2.14/2.140 Problem Set 10b (revised 5/4/07)

Assigned: Thurs. May 3, 2007
Due: Thurs. May 10, 2007, in class
Reading: F,P,E Sections 7.8,7.9.1

The following problems are assigned to both 2.14 and 2.140 students.

Problem 1 Archive Problem 4.16

Problem 2 Archive Problem 4.18. For this problem, first develop a state-space model with input F, and with two outputs x_1 and x_2. Use the mass positions and velocities as state variables. That is, write your model in terms of a state vector $\mathbf{x} = [x_1\ \dot{x}_1\ x_2\ \dot{x}_2]'$. Use this state-space model as the basis for calculating the transfer functions requested. Note that the formula for the transfer function $\mathbf{H}(s\mathbf{I} - \mathbf{F})^{-1}\mathbf{G} + \mathbf{J}$ will give a transfer function matrix which contains the two desired transfer functions. You may use Matlab to calculate the transfer functions after substituting in the numerical values given in part b); for this you can simply use the command `ss2tf`, and do not need to use the symbolic result above. That is, you do not need to give us a symbolic result for the transfer functions requested in part a); their numerical representation is sufficient.

This mechanical structure can be used as a *tuned mass absorber* which, for a given sinusoidal disturbance F of known frequency, can reduce the amplitude of vibration on mass m_1. Such components are useful in automotive, aerospace and other applications where vibrations might be a problem. Describe qualitatively how the force on m_1 is "absorbed". What design condition (relation between parameter values) would be required in order to have *zero* motion on m_1 for an input sinusoid in F of known frequency ω_{in}?

Problem 3 Archive Problem 9.9. You solved the referenced Problem 9.4 on Problem Set 1. Please use your results or the solution results from Problem 9.4 to answer part d) of Problem 9.9.

Problem 4 Archive Problem 13.1e–g

Problem 5 Archive Problem 17.19

Problem 5 F,P,E Problem 7.52

Problem 6 F,P,E Problem 7.54

The following problems are assigned to only 2.140 students. Students in 2.14 are welcome to work these, but no extra credit will be given.

Problem G1 F,P,E Problem 7.55