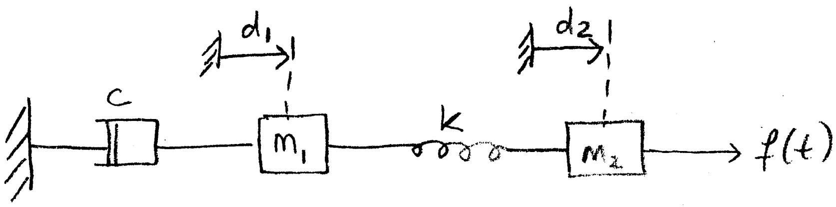
Unified Engineering Fall 2007
Signals & Systems Problems

Assigned: Friday, November 16
Due: Monday, November 26

Problem S6.1: Look-back to Lectures 9 and 10 (10 points)

Consider the following spring-mass-damper system:



where d_1 is the displacement of mass m_1 and d_2 is the displacement of mass m_2, both measured relative to the mass rest positions. k is the spring constant, c is the damping coefficient, and f is the force applied to m_2 as shown in the diagram.

(a) Derive the differential equations governing this system.

(b) If the input is the applied force f and the output of interest is d_2, what are the state-space matrices A, B, C, and D?

(c) Sketch a block diagram of your state-space system in part (b).

(d) If the input is the applied force f, and the outputs of interest are d_1 and d_2, what are the state-space matrices A, B, C, and D?

(e) For the following parameter values: $m_1 = 1$, $m_2 = 0.1$, $k = 0.1$, $c = 2$, compute the eigenvalues and eigenvectors of your matrix A from part (b). You can do this computationally using Matlab as follows. First, define the matrix A in Matlab. Then the command "`[V,D] = eig(A);`" returns the eigenvectors of A as columns of the matrix V and the corresponding eigenvalues of A on the diagonal entries of the matrix D. Type "`help eig`" for more help on how to use this function.