

COEN 45, MATLAB Programming  
Spring Quarter, 2010

Lab assignment #8  
Experiments with a dynamic system  
May 31, June 1

In this lab you will experiment with a two-degree-of-freedom dynamic system. Two masses are connected by a spring and damper and are free to drop under gravity onto a rigid surface. Before hitting the surface, the equations of motion are

$$\begin{aligned}m_1\ddot{x}_1 + b(\dot{x}_1 - \dot{x}_2) + k(x_1 - x_2) &= -m_1g \\m_2\ddot{x}_2 + b(\dot{x}_2 - \dot{x}_1) + k(x_2 - x_1) &= -m_2g\end{aligned}$$

When the lower mass hits the ground, it stops moving and the system becomes a SDOF system. During the time it is grounded we must monitor the spring and damper forces  $b(\dot{x}_2 - \dot{x}_1) + k(x_2 - x_1)$  to see if they are sufficient to cause liftoff.

Download the script `twomass.m` from the class web site along with the function it uses, `twomassfun.m`, which is incomplete. You will also need `drawbox.m`. Finish it by solving the equations above for  $\ddot{x}_1$  (`x1ddot`) and  $\ddot{x}_2$  (`x2ddot`). Then perform the following experiments with `twomass.m`:

1. Run it as is and count the number of times it lifts off. You can see this from either Figure 1 or Figure 2. (Three liftoffs.)
2. Try giving  $m_2$  an initial upward velocity of 5 in/sec. Does this change the number of liftoffs?
3. Put the initial velocity back to zero and reduce mass  $m_2$  to 9, 8,  $\dots$  1. Record (by hand) the number of liftoffs for each mass value.
4. What happens to the number of liftoffs when you reduce the damping  $b$ , say from 25 to 10?