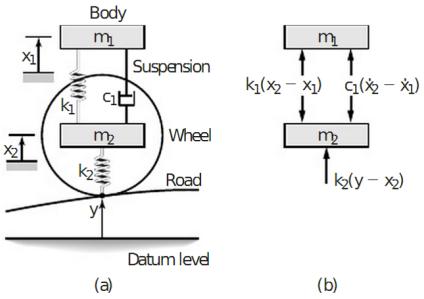
Car Suspension System

Due online: Thursday May 11th at 11pm

Consider the two-mass, quarter-car model of a suspension system from class (week 3) with

$$m_1 = 320kg$$
$$m_2 = 44kg$$
$$k_1 = 3.2 \times 10^4 \frac{N}{m}$$
$$k_2 = 1.8 \times 10^5 \frac{N}{m}$$
$$c_1 = 3430 \frac{N \cdot s}{m}$$



1. Write a MATLAB function to use with ode45 for this system
2. Write a MATLAB script to numerically integrate the system using ode45
3. Use your codes to study the vehicle as it goes over a speed hump at various speeds. In all simulations, use zero initial conditions. The road profile is given as

$$y(t) = \begin{cases} 0 & 0 \le t < \frac{d}{v} \\ h \sin\left(\frac{\pi v}{L}\left(t - \frac{d}{v}\right)\right) & \frac{d}{v} \le t \le \frac{d+L}{v} \\ 0 & t > \frac{d+L}{v} \end{cases}$$

where the forward velocity of the car is v, the initial distance to the bump is d, and the length of the bump is L. For a standard highway road profile according to IRC-99-1988, $L = 3.7m$ and $h = 0.1m$. Investigate for $v = 5, 10,$ and $35mph$. To align the simulations, let's have each vehicle be 1 second from the speed hump (i.e. $d = v \cdot 1s$).

   (a) Plot the position of mass 1 and the road displacement for each velocity (3 plots in total)

   (b) Plot the acceleration of mass 1 for each velocity on one plot.
   Just to note: The acceleration can be further analyzed according to ISO 2631 to determine ride comfort!

   Write a short discussion about your results.

Deliverables:

You may work in a group of up to 2 students. Per group submit the following to Gradescope (remember to select all the members of the team when submitting!)

1. A typed document of the results from question 3. All figures and tables must be presented formally (see the document on the course website about formal reports, it includes a section about figures and tables). Do NOT write a formal report for this, just answer the questions as an engineer and present the figures and tables included formally.
2. MATLAB code (ALL of you calculations should be in your MATLAB code and your code should be sufficiently commented so that anyone from the class can follow and understand your code)