The input to the system is the time-varying displacement $y_d(t)$ corresponding to changes in the terrain. The shock absorber is characterized by its spring rate $k_2$ and damping coefficient $c_2$. Damping in the tire is neglected. (There is no $c_1$ term.)

Applying Newton's law of motion and force balances to the wheel and vehicle chassis yields the following system of equations:

$$m_1 \ddot{y}_1 + c_2 (y_1 - y_2) + k_2 (y_1 - y_2) + k_1 y_2 = k_2 y_d(t),$$

$$m_2 \ddot{y}_2 - k_1 (y_2 - y_1) = 0.$$  

(a) Convert these two second-order equations into an equivalent system of first-order equations. (How many first-order equations are required?)

(b) Use an appropriate ODE integration routine to solve this system for $m_1 = 1104 \text{kg}$, $k_1 = 116 \text{ N/m}$, $m_2 = 1900$, $k_2 = 16 \text{ N/m}$, $c_2 = 15 \text{ N s/m}$ and a forcing function $y_d(t) = 0.05 \sin(3\pi t)$. 

(c) Repeat the solution with $c_2$ reduced by a factor of 5. Describe the change in behavior of the system caused by reducing $c_2$. 

Vehicle chassis, $m_2$

Wheel, $m_1$