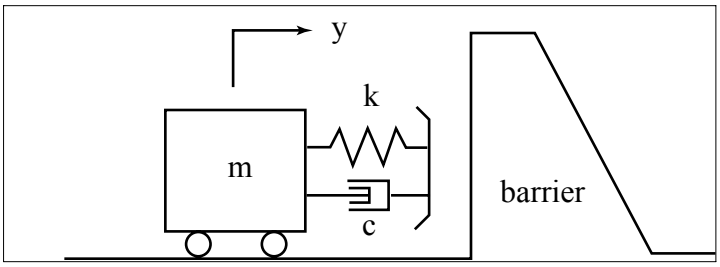
Problem 3 (20 points)

A fender is mounted on a automobile though dampers (to absorb collision energy) and springs (so that the fender can recover after low-speed collisions). During a crash-test, the automobile is moving at 2 m/s when its fender strikes a concrete barrier. The vehicle mass, m, is 1,000 kg. (In comparison, the fender itself is essentially massless.) The springs that mount the fender have a stiffness, k, of 1,000,000 N/m.



1) Write a differential equation for the deflection of the springs when the fender is in contact with the barrier.

2) If the damping coefficient, c, is 30,000 N-s/m, what is the damping ratio of the mass-spring-damper system when the fender is in contact with the barrier?

3) For that damping coefficient, make a reasonably accurate sketch (with properly labeled axes) of the time-course of the force exerted on the barrier, starting from the moment of first contact.

4) Is there any value of the damping coefficient, c, that would yield *no* rebound of the vehicle from the barrier? If so, what is it? If not, why not?