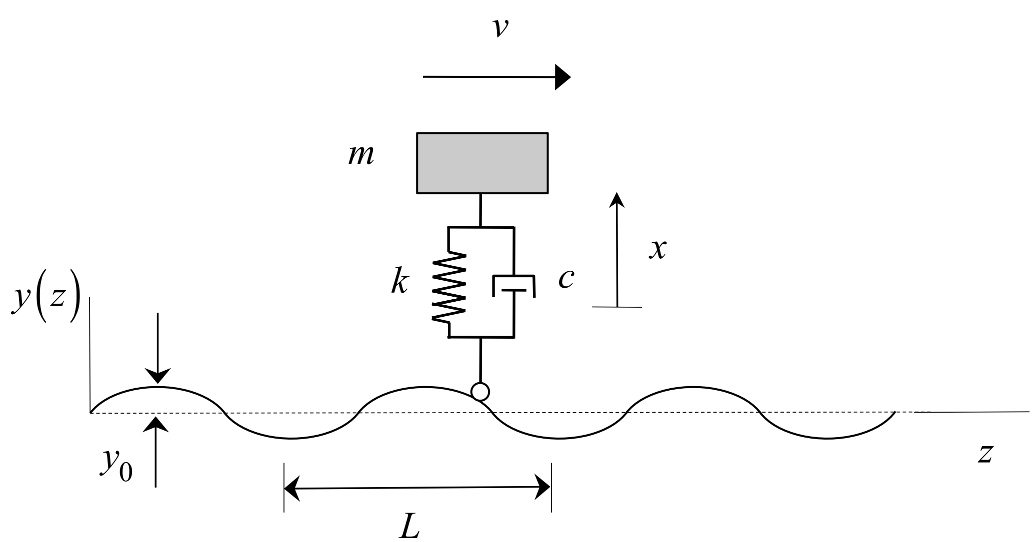
Example A5.1

Given: An automobile moves along a wavy roadway with a constant speed, where the surface of the roadway is idealized by $y(z) = y_0 sin 2\pi z/L$. The single-DOF model below is to be used to represent the vertical motion of the automobile body. Let the coordinate x represent the motion of the automobile body relative to the static equilibrium position.

Find: For given values of L, m, y_0 and v, you are asked to design the automobile suspension (that is, choose k and c) according to the criteria below:

- The amplitude of the vertical motion of the body is no larger than 4 percent of the road roughness amplitude y_0.
- The transmissibility of the vertical force to the suspension by the roadway is no larger than 1.2 when the automobile is traveling at a speed corresponding to the undamped natural frequency of the system.



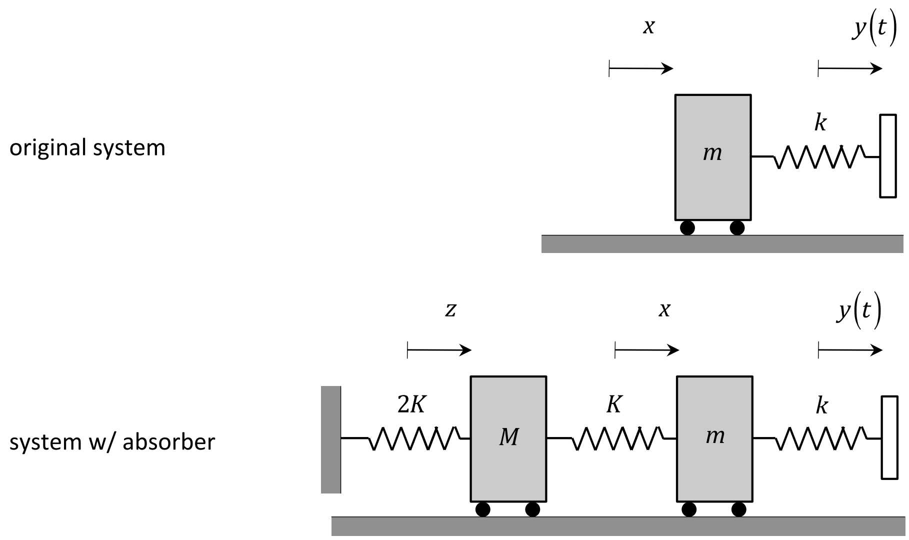
Example A5.2

Given: The single-DOF system shown below experiences a base excitation of $y(t) = y_0 sin\omega t$. For the particular application of this device, it turns out that the excitation frequency is unfortunately tuned exactly to the natural frequency of this system. It is desired to attach a vibration absorber to the original system, creating a two-DOF system with the constraint that the mass of the absorber is no larger than 20 percent of the original system mass; that is, $M \leq 0.2m$.

Find: For this problem:

a) Determine an appropriate set of values for K and M such that perfect vibration absorption is achieved while at the same time the separation between the two natural frequencies of the system is maximized. Write these values in terms of the stiffness k and mass m of the original system.

b) What is the separation between the pair of frequencies of the system with the absorber that you designed?



Example A5.3

Given: Three particles of mass m are attached to a thin beam of length L, with the beam having mass that is negligible compared to the mass of the particles. Let y_1, y_2 and y_3 represent the transverse displacements of particles 1, 2 and 3, respectively.

Find: For this problem:
a) Write down the dynamical matrix $[D]$ for the system.
b) Use the dynamical matrix to produce a lower bound on the lowest natural frequency of the system.
c) Use the Rayleigh method to produce an upper bound on the lowest natural frequency of the system. Use the static deformation due to weight as your trial function. In doing so, write down the Rayleigh quotient using the flexibility matrix (not the stiffness matrix); that is, do so in way that you do not need to invert the flexibility matrix to find the stiffness matrix.
d) Use the power method to produce the lowest natural frequency for the system. Carry out enough iterations such that your result is accurate to four digits to the right of the decimal. Verify that your result is between the bounds determined in a) and b) above.