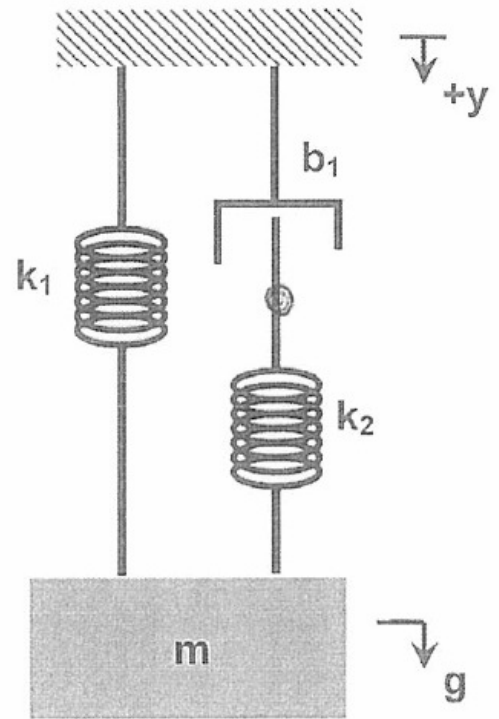


EXAMPLE 5: Example problem from Previous Quiz)

Consider the one dimensional problem shown in the Figure to the right, consisting of two springs, a damper, and a mass. Assume gravity in the +y direction as shown.

Note that the damper and spring k_2 are in series.

Derive the first order state equations describing the system behavior. Clear and work will eligible for partial credit.



1) CL $f_{s1} = k_1 x_{s1}$ $f_{b1} = b v_{d1}$ $f_{s2} = k_2 x_{s2}$

2) GC $v_{s1} = v_m$

$v_d + v_{s2} = v_m$

3) FBD

$$\sum F_y = m a_y = 0$$

$f_d = f_{s2}$

$$\downarrow \sum F_y^+ = m a_y$$

$m g - f_{s1} - f_{s2} = m a_m$

Note that the equation on the right could also be obtained due to the fact that the elements are in series.

4) SVs: x_{s1} , x_{s2} , v_m

$$5) x_{s1}' = v_{s1} = \underline{\underline{v_m}}$$

$$x_{s2}' = v_{s2} = v_m - v_d = v_m - \frac{f_d}{b} = v_m - \frac{f_{s2}}{b} = \underline{\underline{v_m - \frac{k_2 x_{s2}}{b}}}$$

$$v_m' = a_m = \frac{1}{m} (mg - f_{s1} - f_{s2}) = \underline{\underline{\frac{1}{m} (mg - k_1 x_{s1} - k_2 x_{s2})}}$$