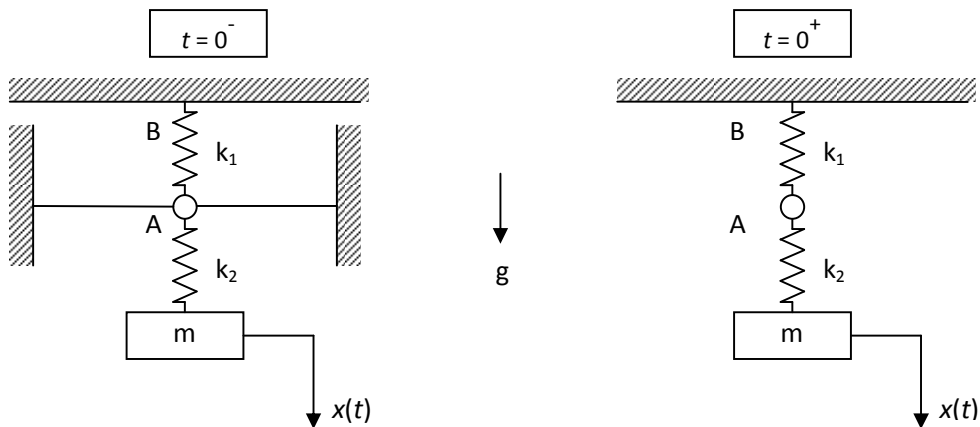


## ME429 Fall 2009 SUPPLEMENTARY SET 1

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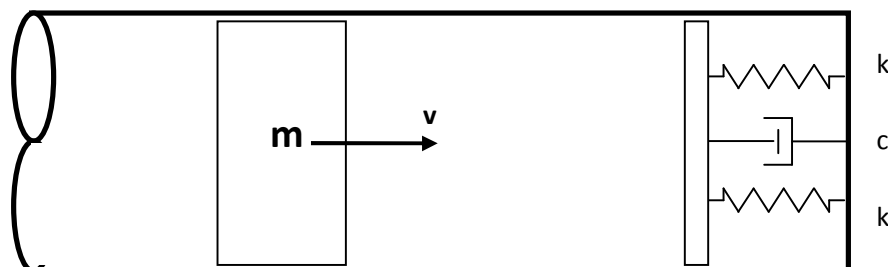
1) The system shown in the figure is at rest under the effect of gravity for  $t < 0$ , while the point A is fixed at a position such that the upper spring has no initial force.



At  $t = 0$ , the ground connection at point A is suddenly broken and the point B becomes the only ground connection. State the initial conditions and the frequency of the subsequent motion of mass  $m$ .

$$\text{Ans: } x(0) = -\frac{mg}{k_1}, \dot{x}(0) = 0, \omega^2 = \frac{k_1 k_2}{(k_1 + k_2)m}$$

2) A slider of mass  $m = 1$  kg travels in a cylinder with a velocity  $v = 80$  m/s and engages a spring-damper system as shown in the figure.



If the stiffness of the spring is  $k = 40 \text{ N/mm}$  and the damping constant is  $c = 0.2 \text{ Ns/mm}$ , find the maximum displacement of the cylinder after engaging the springs and the damper. How much time does it take to reach the maximum displacement?

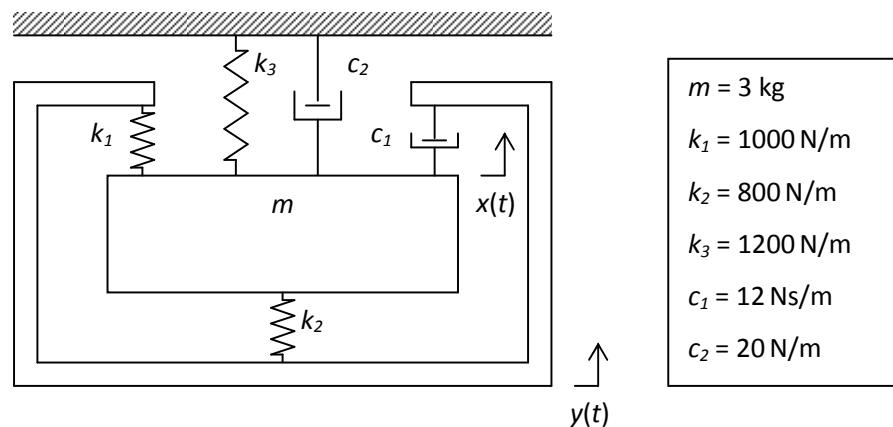
Ans:  $x_{\max} = 0.1735 \text{ m}$ ,  $t_{x_{\max}} = 0.00594 \text{ s}$

3) A vibratory system with a moving base has a mass of  $300 \text{ kg}$ , a spring of stiffness  $40000 \text{ N/m}$  and a damper with unknown damping coefficient. It is observed that the mass vibrates with an amplitude of  $10 \text{ mm}$  when the support oscillates with an amplitude of  $2.5 \text{ mm}$  at the natural frequency of the supported system. Find

- the damping coefficient
- the dynamic force amplitude on the base
- the displacement amplitude of the mass relative to the base

Ans:  $c = 894.431 \text{ Ns/m}$ ,  $F_T = 400 \text{ N}$ ,  $Z = 0.00968 \text{ m}$

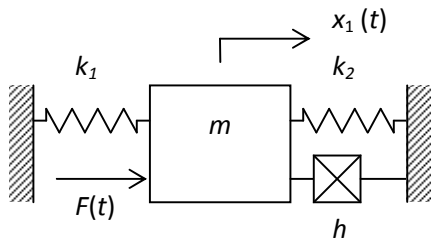
4)



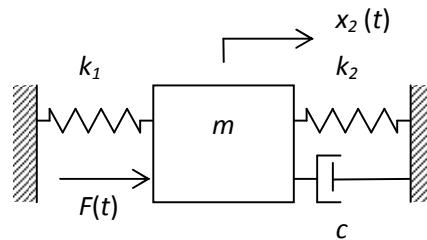
The system shown is excited at the base with  $y(t) = 0.06 \cos(50t - 0.5) \text{ m}$ . Find the response  $x(t)$ .

Ans:  $0.0238 \cos(50t - 2.978) \text{ m}$

5)



SYSTEM-1



SYSTEM-2

$m = 5 \text{ kg}$
$k_1 = 2000 \text{ N/m}$
$k_2 = 3000 \text{ N/m}$
$c = 100 \text{ Ns/m}$
$h = 4500 \text{ N/m}$
$\omega_1 = 45 \text{ rad/s}$
$F_0 = 350 \text{ N}$

Two vibratory systems with different damping characteristics are under the effect of the same harmonic excitation  $F(t) = F_0 \sin(\omega t)$  are shown in the figure. Determine the response amplitude for both systems when;

a)  $\omega = \omega_1$

b)  $\omega = 2\omega_1$

and comment on the results.

Ans: a)  $|X_1| = 0.0513 \text{ m}$        $|X_2| = 0.0513 \text{ m}$

b)  $|X_1| = 0.00978 \text{ m}$        $|X_2| = 0.00956 \text{ m}$