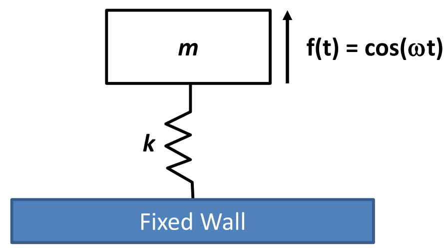
**MAE 3134 – Linear System Dynamics Spring 2017**

**Homework # 4**

**NOTE:** Please make sure to show and explain (using sentences) the various followed to arrive at the solution. Otherwise we are unable to assess your understanding of the material and give you credit for your answers.

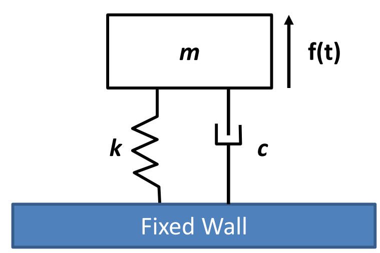
1. (i) Set up the equation of motion for the spring-mass system shown in the diagram, which is under the influence of a sinusoidal force (assume that $\omega$ is an arbitrary frequency, *different* from the natural frequency $\omega_n$). (ii) Solve the differential equation for $t > 0$ using the Laplace transform method, for the case when the initial position and velocity are both zero.




2. Derive the *steady state* solution for a system similar to that of problem 1, for which the excitation force consists of three sinusoidal forces: $f(t) = F_1 \cos(0.5\ \omega_n t) + F_2 \cos(0.6\ \omega_n \mathrm{t}) + F_3 \cos(0.7\ \omega_n \mathrm{t})$. $F_1 = 2$ N, $F_2 = 1$ N and $F_3 = 0.5$ N. $\omega_n$ is the natural *angular* frequency given by $\omega_n = \sqrt{\frac{k}{m}}$.

3. Consider the system shown in the figure, which has parameters $m = 1$ Kg, $c = 2$ Ns/m and $k = 1$ N/m, and zero initial position and velocity. Derive the time-dependent position of the system $x(t)$ for the case when $f(t)$ consists of an infinite number of impacts according to the following:

   $f(t) = \sum_{k=0}^{\infty} f_o \delta(t-k)$, with $f_o = 1$ Kgm/s. In other words, one impact is given to the system every $k$ units of time, and all impacts are identical.




**<u>BONUS PROBLEM</u> (30 points)**

4. An engineer excites the system in the figure with an impact $f(t) = f_o \delta(t)$ with $f_o > 0$, and observes that the system oscillates with an amplitude of 0.25 m. (i) Provide an expression for $x(t)$. (ii) Calculate the value of $f_o$. For this system $m = 6$ Kg and $k = 12$ N/m.