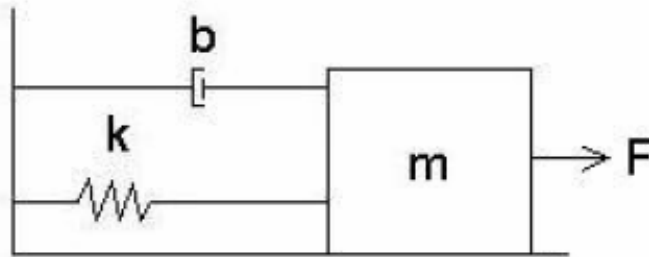


**Homework – Simulation of Dynamic Systems and Motor Theory**

Due Next Week – No Electronic Copies will be graded



$x$  : position of mass  
 $\dot{x}$  : velocity of mass  
 $\ddot{x}$  : acceleration of mass  
 $F$  : applied force  
 $m$  : mass  
 $b$  : damping coefficient  
 $k$  : spring constant

$F = 3 \text{ N}$	$m = 5 \text{ kg}$
$b = 2 \text{ Ns/m}$	$k = 5 \text{ N/m}$

Use the mass-spring-damper system figure and values shown above to answer Questions 1 to 4

- Derive the system's equations of motion in terms of the higher order term (i.e.  $\ddot{x} = \dots$ ) (10 points)
- Derive the system's open-loop transfer function (10 points)
- Create a LabVIEW Simulation using 2 integrator blocks. Include screen shots of your model as well as the graph of the block's position versus time. (20 points)
- Based on answers above, where does the block finally stabilize (i.e.  $x = ?$ )? Prove this theoretically (10 points).
- For a DC motor mathematically prove that each of the statements is either true or false (10 points)
  - Current increases linearly with torque and is dependent on applied voltage
  - Back EMF increases proportionally with armature speed
- Derive that the motor torque constant and the Back EMF constant are equal i.e.  $K_t = K_e$  (20 points)
- Derive the motor equation  $\omega = -\frac{TR}{K^2} + \frac{V}{K}$  where  $T$  is torque (20 points)