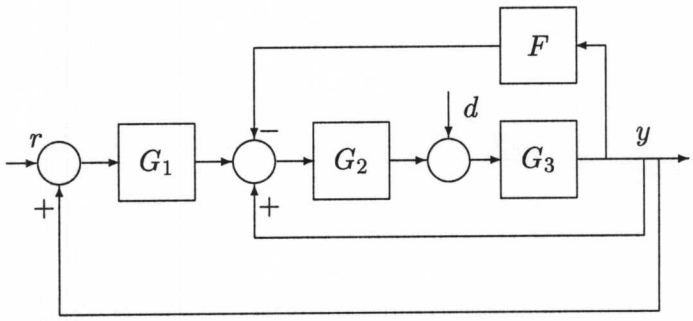
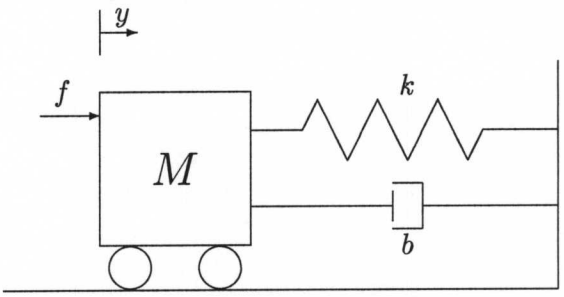
# EE481.3 Mid-term test, Control systems

6 Questions. Duration 80 minutes.
You may use a formula sheet, and a calculator.
Attempt all the questions. Justify your answers.

(6 marks) 1) Find the output as a function of the input $r$ and the disturbance $d$.



( 6 marks) 2- What is the equation describing the motion of the system shown below? Find the transfer function $Y/F$. Take $M$ =1.4kg, the spring constant $k = 15N/m$ and the friction constant $b = 5Ns/m$. What is the steady state value of the output $y$, if a steady input force of 1N is applied to the system after time zero? What is the settling time to within 2 percent of the final value? What is $T_p$? How much overshoot does the system have? Sketch the output as a function of time.




( 3 marks) 3. Take a system with a transfer function $H(s)$. Denote the impulse response of the system as $g(t)$ and denote its step response by $y(t)$. What is the relationship between $g(t)$ and $H(s)$? What is the relationship between $y(t)$ and $g(t)$?

( 6 marks) 4. - Take the system with the transfer function $H = \frac{s+12}{(s+0.2)(s+0.5)}$. Find a state space representation for this system. Design a controller by pole assignment such that it has a 10 percent overshoot and a settling time of 4 seconds.

(6 points) 5. Take a tank with a cross-section of 1 $m^2$. The rate of water flowing out is given by 0.8 $\sqrt{H}$, where $H$ is the height of water in the tank. Prior to time zero water is flowing in at a rate of 1 $m^3/h$. Assume that water level has reached steady-state at $t = 0$. At $t = 0$, the flow of water into the tank is set to 0.9 $m^3/h$. Find water level as a function of time.

(3 points) 6. Explain the concept of bounded input-bounded output stability. Discuss the stability of the following system.