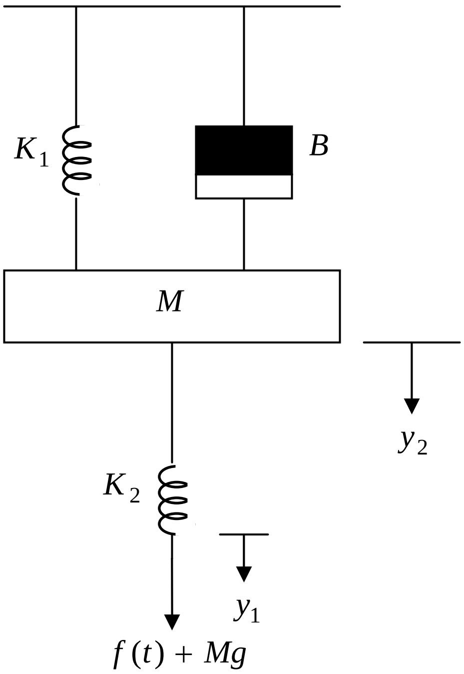
1. (20%) (a) Write the state equations of the linear translational system shown in figure. (b) Find the transfer functions $Y_1(s)/F(s)$ *and* $Y_2(s)/F(s)$. Set Mg=0 for the transfer functions.

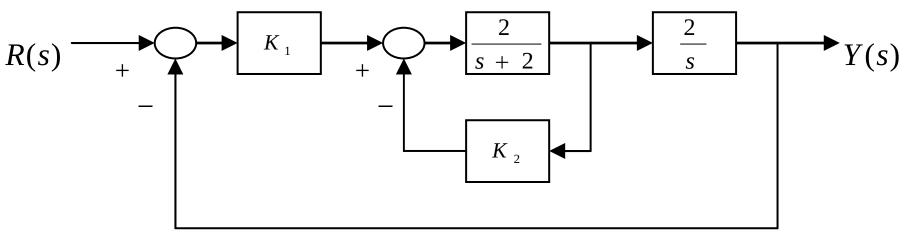


2. (20%) A system is described by the differential equation:

$$\frac{d^3y(t)}{dt^3} + 3\frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + y(t) = r(t)$$

Let the state variables be defined as $x_1 = y$, $x_2 = dy/dt$, $x_3 = d^2y/dt^2$. (a) Find the state equations of the system. (b) Find the state-transition matrix $\phi(t)$.

3. (20%) Considering the system of figure, determine the percent overshoot and the approximate setting time (use the approximation $t_s = \frac{4}{\xi\omega_n}$) in response to a step input if K_2 is equal to 9.0 and $K_1 = 100$.



4. (20%) A unity-feedback control system has the forward-path transfer function given in the following.

$$G(s) = \frac{K}{s(s+10)(s+20)}$$

(a) Find the values of *K* at all the breakaway points. (b) Find the intersection of the root locus with imaginary axis.

5. (20%) The forward-path transfer function of a unity-feedback control system is

$$G(s) = \frac{K}{s(s+6.54)}$$

(a) Find the resonance peak M_r and resonance frequency w_r of the closed-loop system with K=100. (b) If K=1, find the phase margin and the gain crossover frequency of the system.