Assignment -1

Course- AE649A

Due date – 7th September 2019

1. Design a control system given in the following Fig. 1 by choosing appropriate values K_1 and K_2. The design should satisfy the following

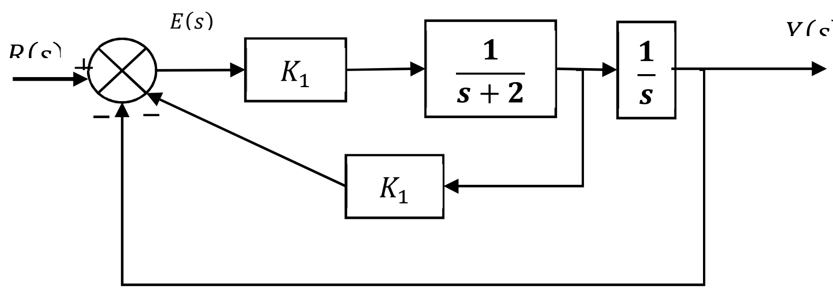


Fig. 1

   a. The settling time is $t_s \leq 3\ sec$ (with 2% criterion)
   b. The percentage overshoot $\leq 5\%$

   Find the type of the system and steady state error to a ramp input.

2. Consider the following closed loop control block diagram (Fig. 2) of the vertical position of a fighter aircraft. Here, the controller is assumed to be PID controller and the vertical position of the fighter aircraft can be approximated by the equation:

$$\dot{y}(t) + 0.05y(t) = u(t)$$

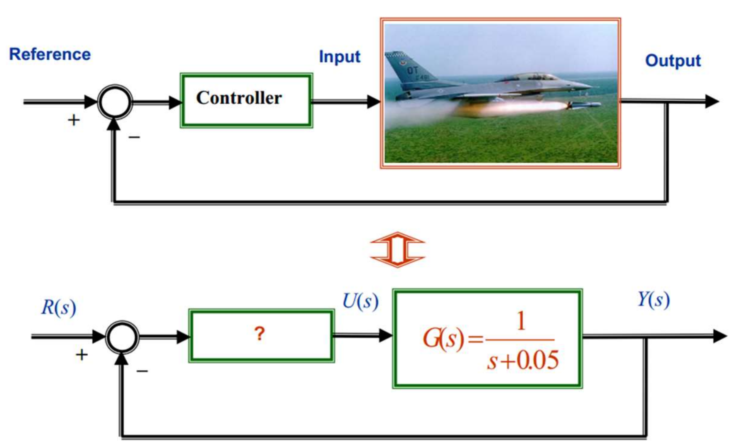
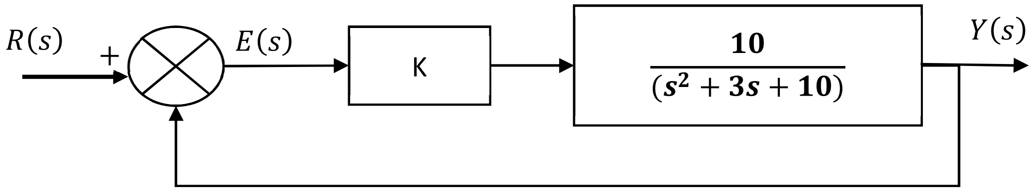


Fig. 2

Design a PID controller for the above system such that the aircraft will reach the desired vertical level of 10 KM in 30 seconds (i.e., the settling is 30 sec), the maximum overshoot is less than 10%, and steady state error should be less than 2%.

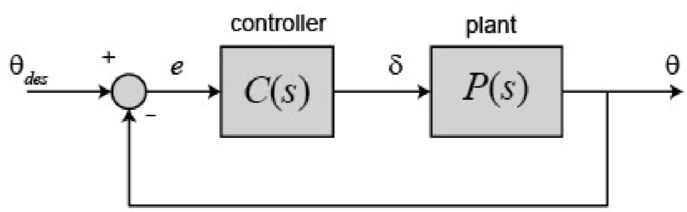
3. Consider the following system (Fig. 3):



a. Find the value of K so that steady state error for step-input is <10%
b. Find the closed loop poles of the simple proportional control feedback system.
c. What is the damping coefficient?
d. Sketch the step response of the feedback system.
e. Is this good design?

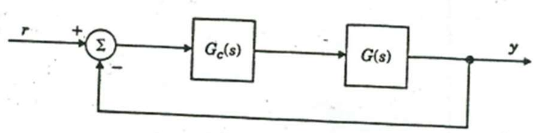
4. Consider the following PID controlled closed loop aircraft longitudinal control system. Choose the proper PID gains so that the following design criteria are met for step response of 0.2 radians.
a. Overshoot less than 10%.
b. Rise time less than 2 seconds
c. Settling time less than 10 seconds
d. Steady state error less than 2%

$$C(s) = K_p + \frac{K_i}{s} + K_d s = \frac{K_d s^2 + K_p s + K_i}{s} \qquad P(s) = \frac{\Theta(s)}{\Delta(s)} = \frac{1.151s + 0.1774}{s^3 + 0.739s^2 + 0.921s}$$



5. Sketch the asymptotes of the Bode plot magnitude and phase for each of the following open-loop transfer functions. After completing the hand sketches verify your results using MATLAB. Turn your hand sketches and MATLAB results on the same sclaes.
a. $G(s) = \frac{4000}{s(s+400)}$
b. $G(s) = \frac{100}{s(0.1s+1)(0.5s+1)}$
c. $G(s) = \frac{1}{(s+1)^2(s^2++2s+1)}$

6. Consider the following system



a. Suppose $G(s) = \frac{2500K}{s(s+25)}$, design a lead compensator with D.C. gain equal to unity to that the phase-margin $\geq 45^0$, the steady state error due to ramp should be ≤ 0.01.

b. Draw the compensated bode-plot. (Use the compensated plot given in the following figure)