UE18EC251: Control Systems
Assignement-3

1. A control system has the following transfer function H(s) = $\frac{1}{s(s+1)(s+2)}$

Compute the system response to the following inputs using MATLAB.

(i) $x(t) = u(t)$

(ii) $x(t) = tu(t)$

(iii) $x(t) = 2(sin2t)u(t)$

(iv) $x(t) = 2(sin10t)u(t)$

Also find the steady state error in case of step and ramp response ((i) and (ii)).
Comment on the responses in (iii) and (iv).

2. Consider the system $G(s) = \frac{N(s)}{s^2+0.5s+1.5}$

a. For N(s)=1.5 , using formulas for step response of a second order system, estimate peak overshoot, peak time and setting time (for 2% tolerance) of the system.
Find the step response using MATLAB and compare your results.

b. Let $N(s) = \frac{-s+3}{3}$, find the step response.

c. Let $N(s) = \frac{s+3}{3}$, find the step response.
Comment on the observation in Part (b) and (c). Use Matlab for (b) and (c).

3. Consider the third order system with the following transfer function.

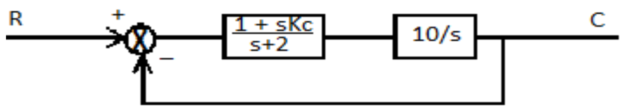
$$H(s) = \frac{25}{(s^2 + 7s + 25)(s + 1)}$$

a. Obtain the step response.

b. Now consider $H(s) = \frac{25}{s+1}$ and obtain the step response. Compare both the responses.

c. Now add a zero at s= -0.9 to the existing transfer function. Adjust the constant so that steady state value is still 1. Find the step response.
Comment on the observation w.r.t dominant poles (poles near jω axis).

4. Consider the control system, which employs proportional plus error rate control



a. For maximum peak overshoot of 9.5%, calculate the value of K_c.

b. Using the above K_c, plot unit ramp response of the system and find out t_s, t_p, e_{ss} and M_p

c. If for some reason, error rate control is removed, then plot the system response for unit ramp input and measure t_s, t_p and M_p

d. Compare and comment on your results.

5. Consider a unity feedback system with $G(s) = \frac{K(s+30)}{(s+1)(s^2+20s+116)}$

a. Draw the root locus of the system manually and find the range of k for system to be stable. Verify the same using MATLAB.
b. Add a zero at s=-2 and again plot root locus.
c. Add a pole at s=-2 to G(s) and plot the root locus.
d. Add a zero at s=+2 to G(s) and plot the root locus.
e. Compare and comment on the stability of the system and response time using results in (b), (c) and (d).

For (b),(c) and (d) use Matlab.

6. Sketch the asymptotic Bode plot on a semilog sheet for the transfer function given

$$G(s) = \frac{2(s+0.25)}{s^2(s+1)(s+0.5)}$$

Verify the same using MATLAB. Find

a. Phase crossover frequency
b. Gain crossover frequency
c. Gain margin
d. Phase margin

Comment on system stability

7. Consider the plant G(s) and a proportional integrator (PI) compensator K(s) given as

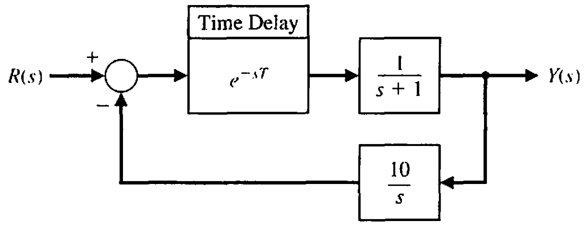
$$G(s) = \frac{4}{s(s+2)} \; and \; K(s) = \frac{s+1}{s}$$

a. Show that if K(s) is in series with G(s) with unity feedback, the system will be stable and can track step and ramp inputs with zero error.
b. Place K(s) in feedback path and check its stability and steady state error to step and ramp inputs.
   Comment on the results of (a) and (b).
a. Suppose during implementation, the following incorrect compensator is used $K_2(s) = \frac{s+0.5}{s}$
   Repeat part (a) with this compensator. Are the tracking properties lost?

8. Obtain the Nyquist plot and comment on stability of a system given by the following open loop transfer function $G(s)H(s) = \frac{k(s-1)}{(s+1)(s+2)}$

Verify the same using root locus technique.

9. A closed-loop feedback system is shown in Figure below.



(a) Obtain the Nyquist plot and determine the phase margin. Assume that the time delay $T = 0$ s. (b) Compute the phase margin when $T = 0.05$ s. (c) Determine the minimum time delay that destabilizes the closed-loop system.

10. Given the plant $G(s) = \frac{400}{s(s^2+30s+200)}$

a. Find the closed loop step response of the above system.
b. Determine the root locus of the plant.
c. Use a PID controller $K_P + K_D s + \frac{K_I}{s}$ with $K_p = 9, K_D = 0.5\ , K_I$=40
   Obtain the Bode plots and the closed loop step response of the system before and after compensation.
d. Comment on the result.
   Use Matlab

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