

Linear Control Final Exam

Time : 180 Minutes

1- State equation of a system follows.

$$\dot{x}_1 = kx_1 - ax_2$$

$$\dot{x}_2 = bx_1 - hx_2$$

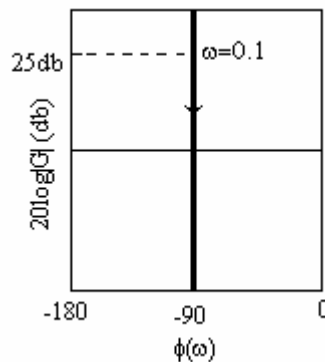
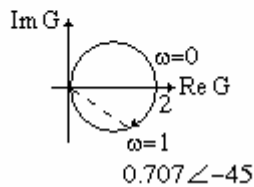
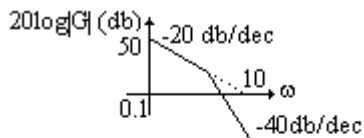
System has no input.

a) What are the requirement on a , b , h , k for the system such that any initial condition, at $t = \infty$ leads to $x_1(t) = x_2(t) = 0$.

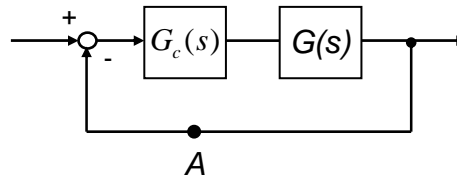
b) Determine the transition matrix when $a = b = 2$, $h = 3$ and $k = 1$.

c) Determine $x_1(t)$ and $x_2(t)$ when $a = b = 2$, $h = 3$, $k = 1$ and $x_1(0) = x_2(0) = 10$

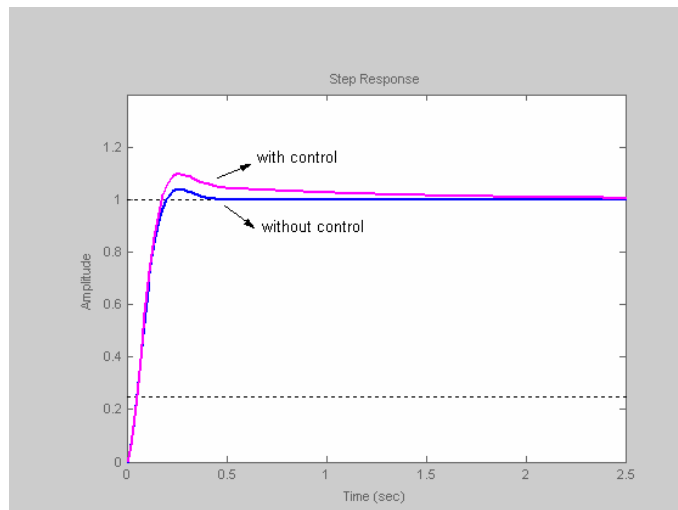
2- Find transfer function or transfer functions corresponding to each figures:



3- Consider the following system.

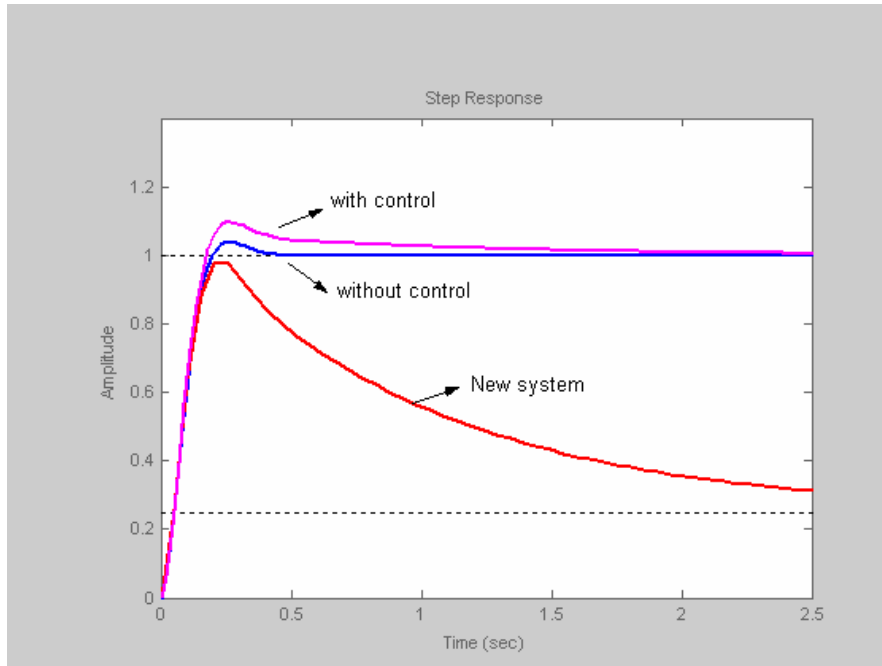


$G_c(s) = \frac{s+1}{s+0.25}$ is a lag controller and step response of compensated system and uncompensated system follows.

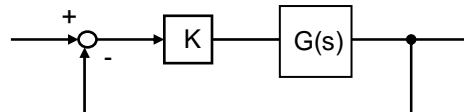


- a) It seems that controller destroy the performance, explain this point quantitatively.
 b) If the controller remove from the series position and put in feedback position (point A) , draw the step response of new system and explain the reason for it.

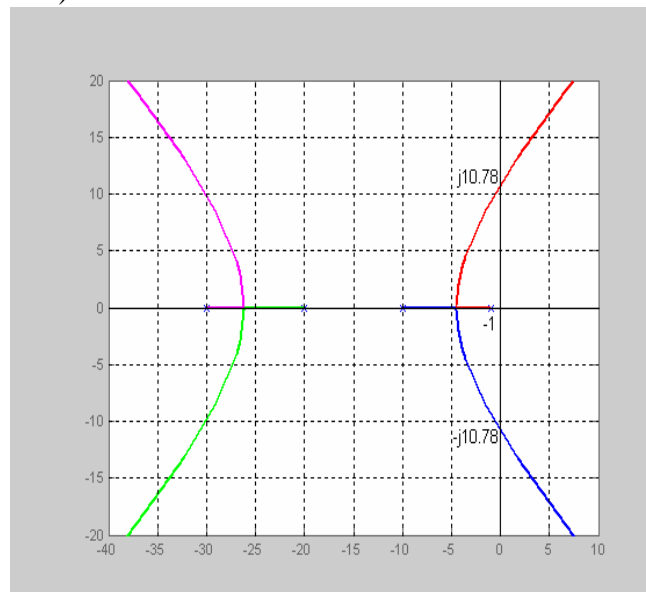
Solution:



4- Consider the following system.



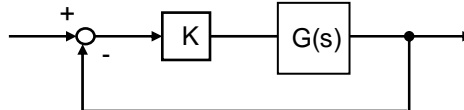
Root loci of system ($K > 0$) follows.



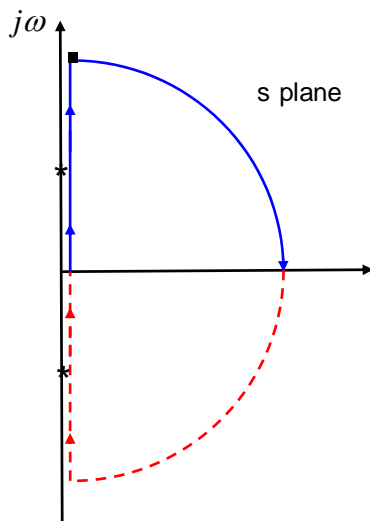
- a) Discuss the stability and number of right half plane roots of the closed loop transfer function for various K .

- b) Choose the value of K such that the dominant roots of system has $\xi = 0.707$.
- c) Show that setting the value of K for step error constant equal to 25 leads to an unstable system.
- d) Design a lag controller such that the dominant roots of system has $\xi = 0.707$ and the step error constant equal set to 25.
- e) Design a controller such that the steady state step error set to zero and the dominant roots of system has $\xi = 0.707$.

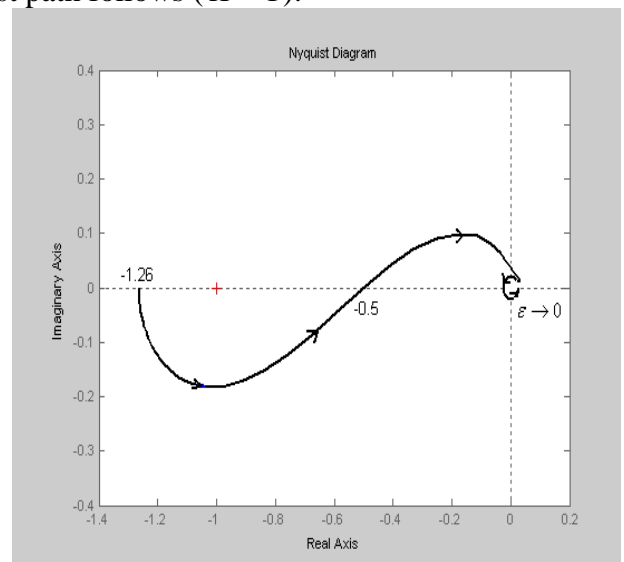
5- Consider the following system.



Nyquist plot corresponding to solid line of Nyquist path follows ($K = 1$).

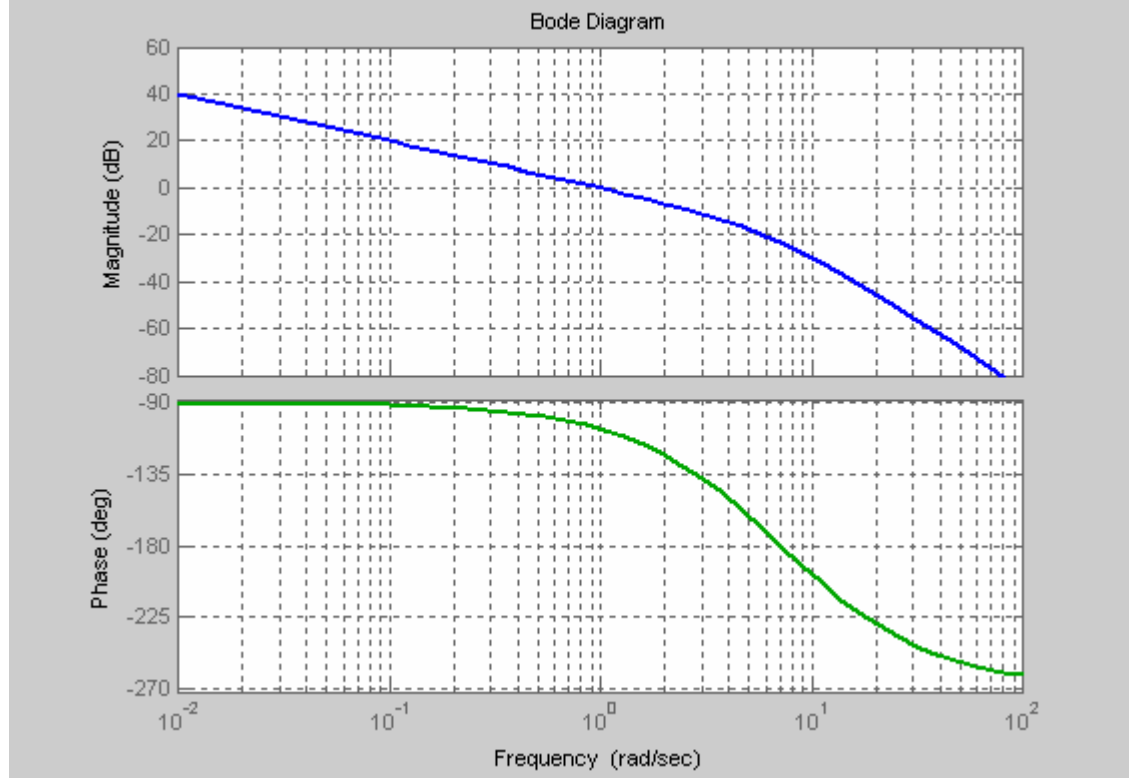


$G(s)$



Discuss the number of right half plane roots of the closed loop transfer function for various K .

6- Bode diagram of a system with ramp error constant of 1 follows.



- a) What is the gain margin and phase margin of this system?
- b) Design a controller to have ramp error constant of 10 and phase margin 45° .
- c) Draw the compensated Bode diagram.

Solution:

