1996 碩士班入學考 (線性控制)

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(1). Consider the feedback system shown in Fig. 1, with $G(s) = \dfrac{2K}{s(s+1)(s+10)}$.

14% (a). Determine the value of K such that the percent overshoot to a step input is 20%.

(b). Calculate the velocity error constant k_v for the resulting system with K obtained in (a).

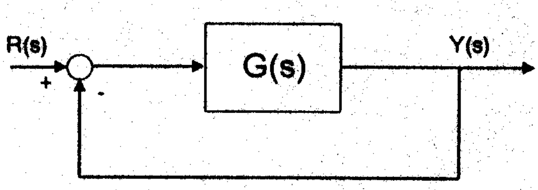

Fig. 1

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(2). Consider the system shown in Fig.2, with $G(s) = \dfrac{(s+10)}{s(s-1)}$.

20% (a). Plot the Bode plot of G(s), with frequency range 0.1 rad/sec - 100rad/sec.

(b). Plot the Nyquist plot of G(s) and determine the range of the value of K such that the system will be closed-loop stable using the Nyquist stability criterion.

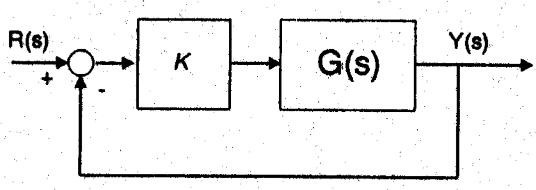

Fig. 2

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(3). Consider the feedback control system shown in Fig. 3, with $G(s) = \dfrac{(s-5)}{s(s+1)}$

16% and $K(s) = \dfrac{k(s+2)}{(s+p)}$. Determine the parameter p and k, such that the desired dominant closed-loop poles are $-1 \pm j$, using the root locus analysis..

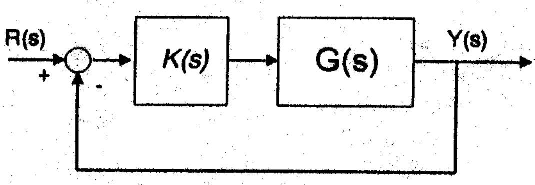

Fig. 3

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4. Linear System

(1) 10 % Explain the physical meanings of (A) Controllable (B) Observable (C) stabilizable (D) Detactable.

(2) 20 % Consider the following second-order system:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} a_1 & 0 \\ 0 & a_2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} u$$

$$y = [c_1 \ c_2] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

For each of the following five cases, determine whether they are controllable (observable) or not. Notice that the determination is based on the definition you have given in part (1), and the use of rank conditions to determine controllability and observability is not permitted. There are five possible answers you can choose : (A) Controllabie (B) Observable (C) stabilizable (D) Detactable (E) neither stabilizable nor detectable (multiple answers are allowed). Briefly describe the reason why you choose these answers.

(i) $b_i \neq 0$, $c_i \neq 0$, i=1,2.

(ii) $a_1 > 0$, $a_2 < 0$, $b_1 = 0$, $b_2 \neq 0$, $c_1 = 0$, $c_2 \neq 0$.

(iii) $a_1 < 0$, $a_2 < 0$, $b_1 = b_2 = 0$.

(iv) $a_1 < 0$, $a_2 < 0$, $b_1 \neq 0$, $b_2 \neq 0$, $c_1 = 0$, $c_2 \neq 0$.

(v) $a_1 > 0$, $a_2 > 0$, $b_1 \neq 0$, $b_2 \neq 0$, $c_1 \neq 0$, $c_2 = 0$.

(3) 10 % Consider $a_1 = 3$, $a_2 = -1$, $b_1 = 1$, $b_2 = 3$, and employ state feedback control:

$$u = [k_1 \ k_2] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Please find the values of k_1 and k_2 such that the closed-loop system has eigenvalues at -1 and -2.

(4) 10 % Consider $a_1 = 3$, $a_2 = -1$, $b_1 = 0$, $b_2 = 3$, and repeat the problem (3).