國立成功大學 79 學年度工程科學研究所考試(控制系統 試題) 共 1 頁 第 1 頁

1. The block diagram of a control system is shown in Fig. 1.

(i) For $G(s) = \frac{K(s+a)(s+2)}{s(s^2-1)}$, find the requirements on a and K so that the system is stable. Express the stable region in the K-versus-a plane. (Use K as vertical and a as horizontal axis)

(ii) For $G(s) = \frac{K}{(s+2)^n}$, how large can the constant K for each positive integer value of n if the overall system is to be stable?

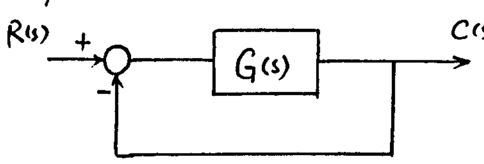

Fig. 1.

2. Find the transfer function $C(z)/R(z)$ for the sampled-data system shown in Fig. 2, where $G_1(s) = \frac{2}{s(s+1)}$, $G_2(s) = \frac{1}{s+1}$, $H(s) = \frac{1}{s}$.

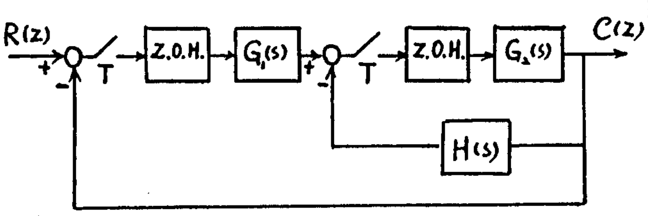

Fig. 2.

3. Given the n-th order system

state equation: $\dot{x}(t) = A\,x(t) + B\,u(t)$

output equation: $c(t) = D\,x(t)$

where the pair $[A, B]$ is completely controllable, and the pair $[A, D]$ is completely observable.

The closed-loop system obtained through state feedback,

$u(t) = r(t) - G\,x(t)$

so that the state equation becomes

$\dot{x}(t) = (A - BG)\,x(t) + B\,r(t)$

(i) Is the pair $[A-BG, B]$ still completely controllable? prove it.

(ii) Is the pair $[A-BG, D]$ still completely observable? prove it.

4. A system is shown in Fig. 3. The controlled process $G_p(s)$ is modeled by the following equations:

state equation: $\frac{dx_1(t)}{dt} = -2\,x_2(t)$

$\frac{dx_2(t)}{dt} = -2\,u(t)$

output equation: $c(t) = x_1(t)$

(i) The controller is the PD controller, $G_c(s) = K_p + K_D s$, Find the values of K_p and K_D so that $e_{ss} = 0$ when $r(t)$ = unit step function and the poles of the closed-loop system are at -2 and -2.

(ii) Using the state-feedback control, $u(t) = r(t) - G\,x(t)$, Find the feedback gain G so that minimize the performance index, $J = \int_0^\infty [x_1^2(t) + x_2^2(t) + u^2(t)]\,dt$.

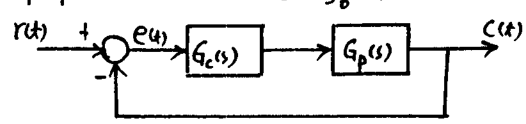

Fig. 3

5. Write dynamic equations for systems, each with modes e^{2t}, e^{-3t}, $e^{(-4+j)t}$, and $e^{(-4-j)t}$ which have the following properties:

(i) The mode e^{2t} is uncontrollable.

(ii) The mode e^{-3t} is unobservable.

(iii) The mode e^{2t} is both uncontrollable and unobservable.

(iv) The modes $e^{(-4+j)t}$ and $e^{(-4-j)t}$ are uncontrollable.

(v) The mode e^{-3t} is uncontrollable and the mode e^{2t} is unobservable.