3. Find the range of K for the system with the following open-loop transfer function to be stable:

$$G(s)\,H(s) = \frac{K}{s(s+1)(2s+1)}.$$

(a) By Routh's stability criterion. (10%)

(b) By frequency-response method, such as the Nyquist stability criterion. (10%)

4.(a) Referring to Fig. 4, suppose $d(t)=0$. Design a compensator $G_c(s)$ so that the closed-loop system is stable, has a zero steady-state error to step and ramp inputs (i.e., $K_p = K_v = \infty$), and the static acceleration error coefficient satisfies $K_a \geq 10$. (12%)

(b) What effect do step disturbances (i.e., $d(t)$ = constant) have on the steady-state output response? Support your answer. (8%)

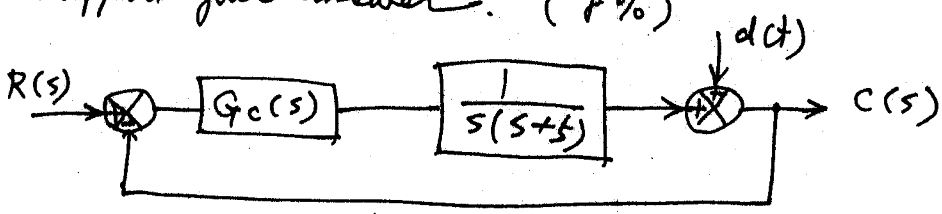

Fig. 4

5. Consider the system (A, B, C) with $A = \begin{bmatrix} -2 & 0 \\ 0 & -3 \end{bmatrix}$, $B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$, and $C = [-1 \ \ 2]$.

(a) Calculate the transfer function $G(s)$ (5%)

(b) Suppose that we want to shift the poles from $-2, -3$ to $-1, -10$ by using linear state feedback $u = Kx$ (where K represents feedback gain matrix and $x = [x_1 \ \ x_2]^T$ are the state variables). Find K. (15%)

1. (a) Obtain the closed-loop transfer function $C(s)/R(s)$ of the system shown in Fig. 1(a). (10%)

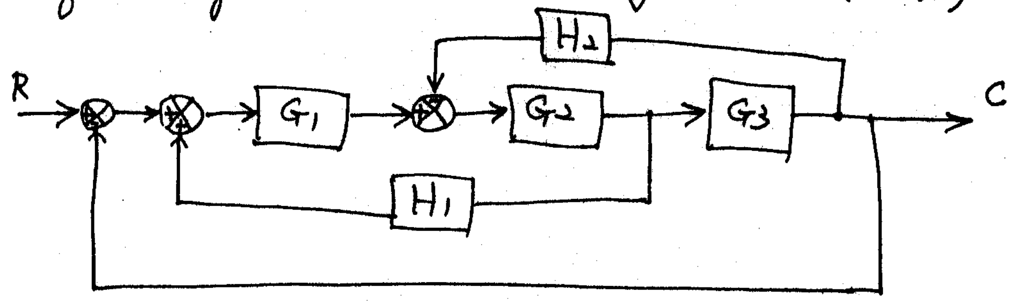

Fig. 1(a).

(b) Consider the system shown in Fig. 1(b). This system is subjected to two signals, one the reference input and the other the external disturbance. Show that the characteristic equation of this system is the same regardless of which signal is chosen as input. (10%)

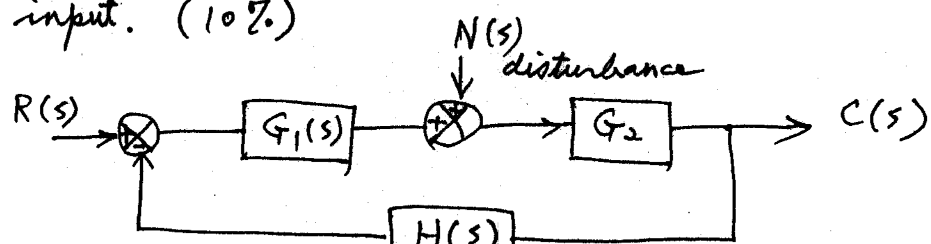

Fig. 1(b).

2. Draw the Bode diagram of the following nonminimum phase system:

$$\frac{C(s)}{R(s)} = 1 - Ts \qquad T > 0.$$

Obtain the unit-ramp response of the system and plot c(t) versus t.

Observing the c(t)-versus-t plot of the unit-ramp response, make comments about the transient response of this nonminimum phase system. (20%)