元智大學 102 學年度研究所 碩士班 招生試題卷

系(所)別：電機工程學系碩士班　組別：控制工程組　科目：控制系統　用紙第 / 頁共 / 頁

●不可使用電子計算機

1. (42%) Consider a system described by the differential equation:

$$y(t)'' - y(t)' - 2y(t) = u(t)$$

where $y(t)$ and $u(t)$ are input and output of the system, respectively.

(a) (6%) Please find the transfer function of the system.

(b) (6%) What are the poles of the system? Is the system stable?

(c) (6%) Please find $y(t)$ when $y(0)' = 0$, $y(0) = 1$ and $u(t) = 0$.

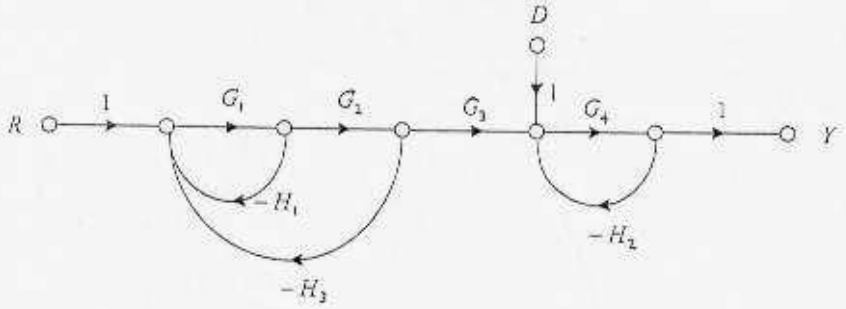
(d) (6%) Please write the system in state-space form by choosing state variables: $x_1(t) = y(t)$ and $x_2(t) = y(t)'$.

(e) (6%) Show that the system is controllable and observable.

(f) (6%) Determine the estimator gain $L = \begin{bmatrix} l_1 \\ l_2 \end{bmatrix}$ to place the estimator error poles at -2 and -3.

(g) (6%) Use the estimator in (f) to construct a state feedback controller, $u(t) = r(t) + \boldsymbol{Kx}$ $= r(t) + [k_1 \quad k_2]\boldsymbol{x}$, and to place the poles of the system at $-1 \pm j$.

2. (a) (8%) Please express Y in terms of R and D when the signal flow graph of the system is:



(b) (8%) Let input $D = 0$, and set system parameters $G_1 = \frac{1}{s}$, $G_2 = \frac{(k-1)}{s}$, $G_3 = 1$, $G_4 = \frac{1}{s}$, $H_1 = 1$, $H_2 = 2$ and $H_3 = 3$. Please determine the range of k to ensure the stability of the system.

3. (24%) Please choose the correct statements:

(a) PD controller can improve the relative stability of the closed-loop system.

(b) PD controller usually can increase the bandwidth of the closed-loop system.

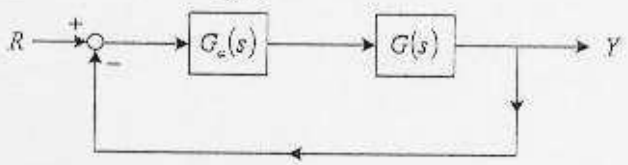
(c) PI controller is a low-pass filter.

(d) PI controller can improve the steady-state error of the closed-loop system.

(e) PD controller can reduce the maximum overshoot of the step response of the closed-loop system.

(f) PI controller will degrade the relative stability of the closed-loop system.

4. (18%) A unit feedback system with $G(s) = \frac{4}{s(s+4)}$ is shown below.



(a) (6%) Let $G_c(s)$ a proportional controller, *i.e.*, $G_c(s) = k$. Please find k such that the steady state error for the unit ramp input is 0.01.

(b) (6%) Please sketch the Bode plot of $G_c(s)G(s)$ obtained in (a).

(c) (6%) If we want to increase the phase margin of the system, what kind of compensator should be chosen (phase lead compensator or phase lag compensator)?