國立臺北科技大學九十五學年度碩士班招生考試

系所組別：1630 電機工程系碩士班丙組

第一節 控制系統 試題

填准考證號碼

第一頁 共一頁

注意事項：

1. 本試題共 5 題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. Consider the electrical network shown in Figure 1.

(a) By use of nodal analysis, derive the differential equations modeling the dynamics of this network. (5%)

(b) Define the state of the system as $x = \begin{bmatrix} e_1 \\ e_2 \end{bmatrix}$ and the input of the system as $u = e_0$. Find the state equations of the network. (5%)

(c) Under what condition does the system become uncontrollable? (5%)

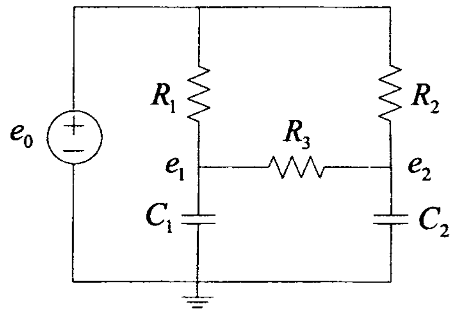

Figure 1. Linear time-invariant network

2. Consider the following transfer function

$$\frac{Y(s)}{U(s)} = \frac{s^3 + 6s^2 + (p+q)s + 3}{s^3 + 5s^2 + qs + 2}$$

(a) Draw the block diagram for the system in three-dimensional observer canonical form and determine F, G, H, and J. (10%)

$$\begin{cases} \dot{x} = Fx + Gu \\ y = Hx + Ju \end{cases}$$

(b) For what values of p and q does the transfer function have a one-dimensional, controllable and observable realization? Justify your answer. (5%)

3. Consider the cascade compensated system in Figure 2.

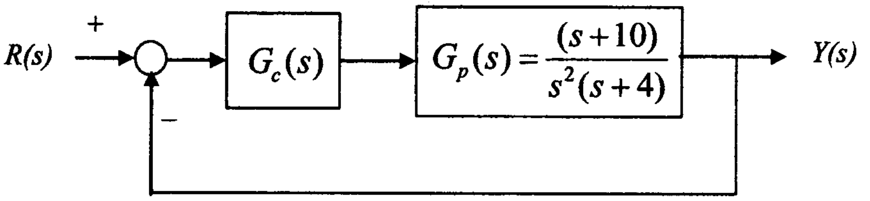

Figure 2. Cascade compensated system

(a) Design a compensator G_c so that the closed-loop system is a third-order system with one closed-loop pole at -50 and the other two closed-loop poles 0.7 damped with an undamped natural frequency of 3 rad/s. In addition, there is a closed-loop zero at -10, and there should be zero steady state error for a unit step input. (10%)

(b) Introduce a gain K for $G_c(s)G_p(s)$, and sketch the root locus for variable K, locating the desired closed-loop poles for $K=1$. (15%)

4. Consider the control system shown in Figure 3.

(a) Draw the Nyquist plot for the open-loop transfer function. (15%)

(b) Determine the values of positive a and b, if any, for which the closed-loop system is stable using only the Nyquist stability criterion. (10%)

(c) Repeat question 4(b) using Routh-Hurwitz criterion. (5%)

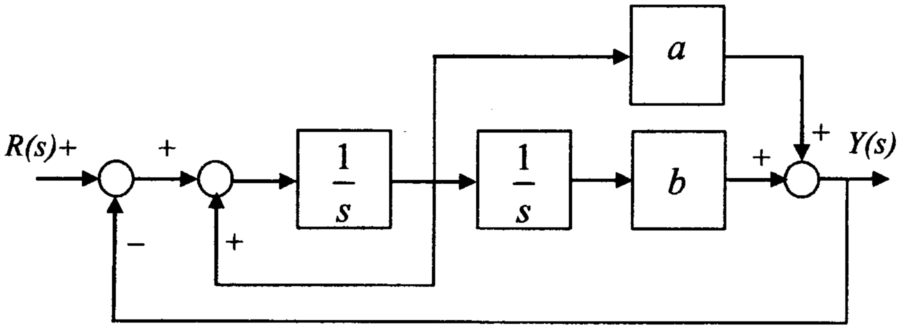

Figure 3. A feedback control system

5. $u(kT)$ and $y(kT)$ are the input and the output signals from a sampled-data system respectively. $G(s)$ is the transfer function of the system that is being sampled.

(a) Derive the discrete transfer function from $u(kT)$ to $y(kT)$. Note that this sampled-data system is with ZOH and sampling period T and the z-transform is denoted by $Z\{\cdot\}$. (10%)

(b) Compute the discrete transfer function for the case when $G(s) = \frac{2}{s+2}$ and $T = 1$. (5%)