1. (20%) 請回答下列有關回授系統的問題:
   (a) 請以數學式來輔助說明為何回授控制系統要採「負回授」(negative feedback)。(5%)
   (b) 請說明採用回授控制系統的三個最主要目的是什麼? (5%)
   (c) 何謂回授系統(feedback system)之根軌跡(root locus)? (5%)
   (d) 何謂「nonminimum-phase system」? 有何特性? (5%)

2. (30%)請回答下列有關動態系統的問題:
   (a) 何謂動態系統 G(s)的頻寬(band width)? (5%)
   (b) 何謂動態系統 G(s)的脈衝響應函數(impulse response function)? 請說明它有什麼特殊的意義。(10%)
   (c) 請繪製一個具高通濾波(high-pass filter)特性的動態系統頻率響應圖(不包括相位圖)。(5%)
   (d) 請說明為何要用有點抽象的轉移函數(transfer function) G(s)來描述一個動態系統行為? (5%)
   (e) 下面兩個動態系統，那一個對步階輸入的反應較快?(說明原因否則不計分) (5%)

$$G(s)=1/(s+1) \qquad H(s)=1/(s+10)$$

3. (25%) Consider the two-tank liquid-level system shown in Figure 1 below. The two tanks are identical and the tank cross-sectional area is A. Water enters the first tank from the top and exists through the valve in the bottom of the second tank. The volume flow rates at the valve inlet of the first tank is Q_{in} and the volume flow rate at the valve outlet of the third tank is Q_{out}. The valve resistances are denoted by R_1, and R_2, the fluid capacitances are denoted by C_1 and C_2, and the fluid inductance/inertance is denoted by I. (The fluid capacitance is defined as the ratio of the fluid flow rate to the change rate of pressure.) The density of water, ρ, is constant. The fluid heights in the two tanks are, h_1, and h_2.

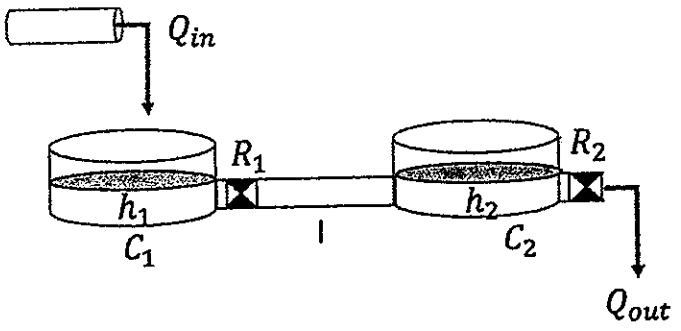

Figure 1 Two-tank liquid-level system A.

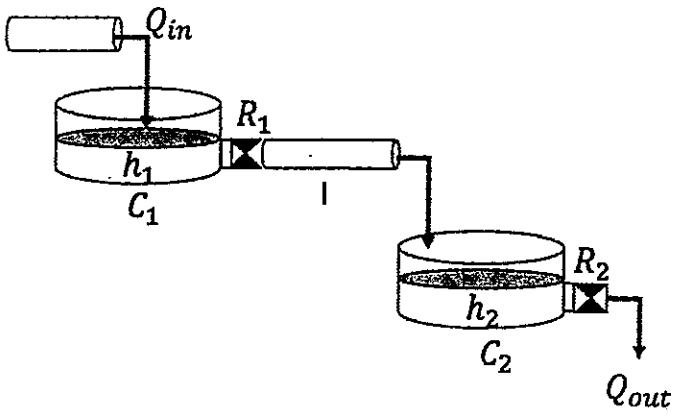

Figure 2 Two-tank liquid-level system B.

見背面

(a) What are the energy storage element(s) of the system shown in Figure 1? (3%)
(b) What are the *damping* element(s) of the system shown in Figure 1? (3%)
(c) Draw a sketch of the electrical circuit, which is *analogous* to the two-tank liquid-level system shown in Figure 1. (Systems described by the same mathematical model are called *analogous* systems.) (7%)
(d) Is the system shown in Figure 2 *analogous* to the system shown in Figure 1? Please explain your answer. (7%)
(e) Suppose that the inertance of the system shown in Figure 2 can be neglected. What is the minimum dimension of the state transition matrix of the system? (5%)

4. (25%) Please answer the following questions:
(a) Compared with the Routh-Hurwitz criterion, what are the features of the Nyquist criterion regarding the analysis of stability of control systems? Please describe at least three features. (5%)
(b) Figure 3 shows the Bode diagram of an unknown system, whose transfer function is $G_1(s)$. Determine the transfer function $G_1(s)$ and sketch the impulse response of $G_1(s)$. (10%)
(c) Figure 4 shows the Bode diagram of an unknown system, $G_2(s)$. Suppose that the loop transfer function of the closed-loop system is $L(s) = K \cdot G_2(s)$. Determine the range of value of K for the closed-loop system to be stable. (5%)
(d) Continue from (c). Suppose that $G_2(s)$ is compensated by a controller, $C(s) = K(1 + T_d s)$. Prove that the *relative stability* of the closed-loop system can be improved with an appropriate choice of T_d value. (Hint: Show that the Gain margin can be increased by using the controller $C(s)$.) (5%)

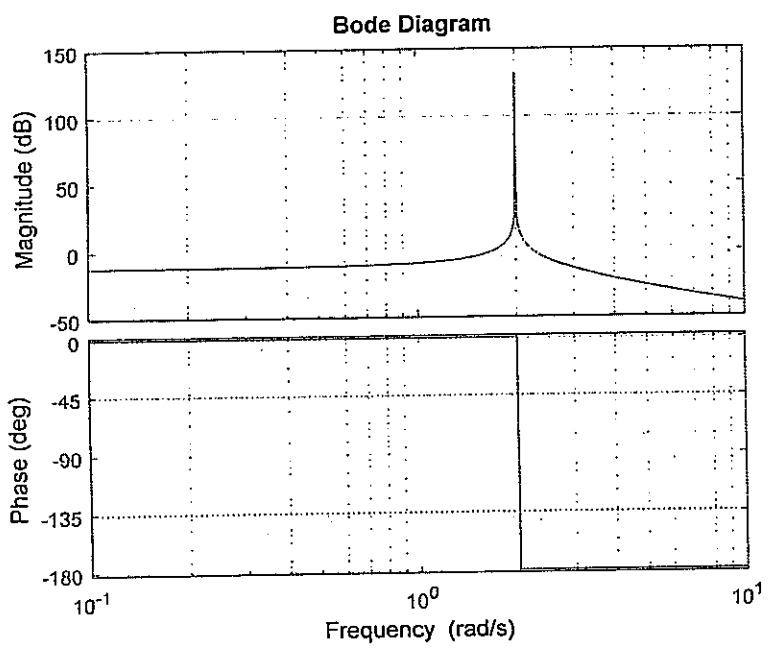

Figure 3

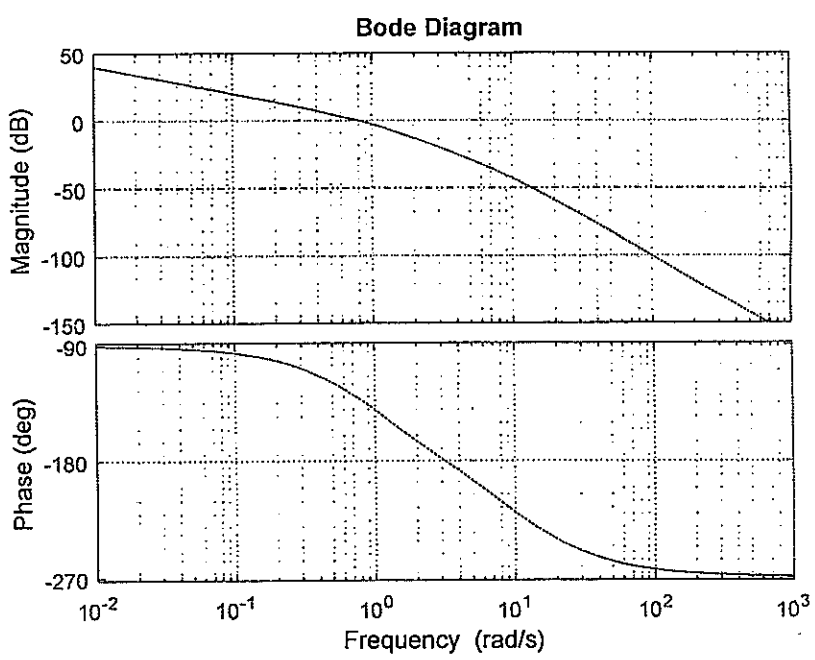

Figure 4

試題隨卷繳回