淡江大學 99 學年度碩士班招生考試試題

系別：航空太空工程學系　　　　　　　　科目：自　動　控　制

准帶項目請打「V」	
V	計算機

本試題共 兩 頁，七 大題

本試題雙面印製

1. (15%) For the block diagram of a feedback control system depicted in Fig. 1 below, describe the purpose and basic function of each component (controller, actuator, plant, and sensor). Explain the objective and operation of the control system (Use an example such as motorcycle, aircraft, etc., to backup your explanations).

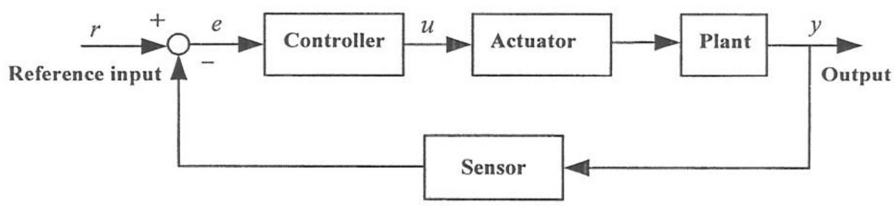

Figure 1

2. (25%) Consider a system $y = P(s)u$ with $P(s) = \dfrac{b}{s+a}$

   (a). (8%) Assume $a = 5$, $b = 2$, design two controllers, $K_1(s)$ for the open loop system as shown in Fig 2(a) and $K_2(s)$ for the closed-loop system as shown in Fig 2(b), such that the transfer function $T(s)$ from the reference input r to the output y is $T(s) = \dfrac{10}{s+10}$

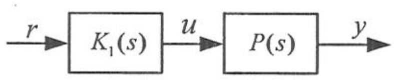

Fig 2(a)

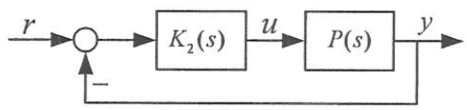

Fig 2(b)

   (b). (17%) With the controllers obtained in part (a), assume now the plant parameters are changed to $a = 4$, $b = 2$, what are the transfer functions for the two designs now? How do they differ from the desired transfer function $\dfrac{10}{s+10}$? (Sketch the step responses to support your explanations.)

3. (10%) Given the linear-time-invariant system $y = H(s)u$ as shown in Fig. 3,

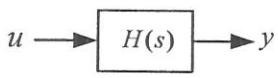

Figure 3

$$H(s) = \frac{3s^2 + 5s + 2}{(s^2 + 9)(s^2 + 2s + 1)}$$

select a bounded input signal $u(t)$, so that the output signal $y(t)$ will be unbounded.

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4. (15%) In control system analysis and design, we are interested not only in the absolute stability of a system, but also the relative stability (how stable it is) of the system. Explain/answer the following terms/concepts and questions.
   (a). (10%) Define the gain margin and phase margin.
   (b). (5%) The Nyquist plot of a minimum-phase system with loop transfer function $L(j\omega)$ is shown in Fig. 4 below. Determine the gain margin and phase margin of the system.

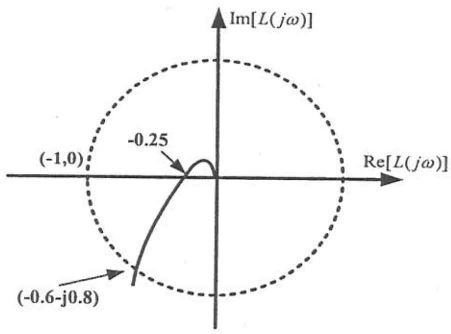
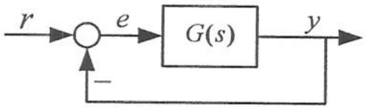


Figure 4

5. (15%) For the unity feedback system shown in Fig. 5, determine the steady state error for a unit-step input $r(t) = u_S(t)$, a unit-ramp input $r(t) = t \cdot u_S(t)$, and a parabolic input $r(t) = \frac{1}{2}t^2 \cdot u_S(t)$.



$$G(s) = \frac{2(s+1)}{s(s+2)(s+3)}$$

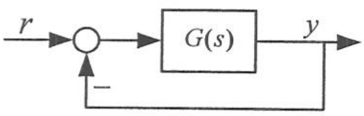
Figure 5.

6. (10%) Sketch the step responses, with detailed explanations, of the following transfer functions.

   (a). $H_1(s) = \frac{1}{s-1}$　(b). $H_2(s) = \frac{3}{s^2+9}$　(c). $H_3(s) = \frac{1}{s^2+2s+1}$

   (d). $H_4(s) = \frac{1}{s^2+2s+2}$　(e). $H_5(s) = \frac{1}{s^2+5s+6}$

7. (10%) The block diagram of a feedback control system is shown in Fig. 6 below, construct the root loci for $\alpha \geq 0$.



$$G(s) = \frac{10(s+\alpha)(s+3)}{s(s^2-1)}$$

Figure 6