編號： 192

國立成功大學 108 學年度碩士班招生考試試題

系　　所：製造資訊與系統研究所

考試科目：自動控制

考試日期：0223，節次：1

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (20%) The space satellite using a control system to readjust its orientation is shown in Figure 1.
   (1) Determine a second-order model for the closed-loop system.
   (2) Determine the sensitivity of the steady-state error to a unit step input with respect to the control gain K.
   (3) Using the second-order model, select a gain K so that the percent overshoot is less than 10%, and the steady-state error to a step is less than 8%.
   (4) Whether can you select K so that the closed-loop system obtained in part (3) is stable? Explain.

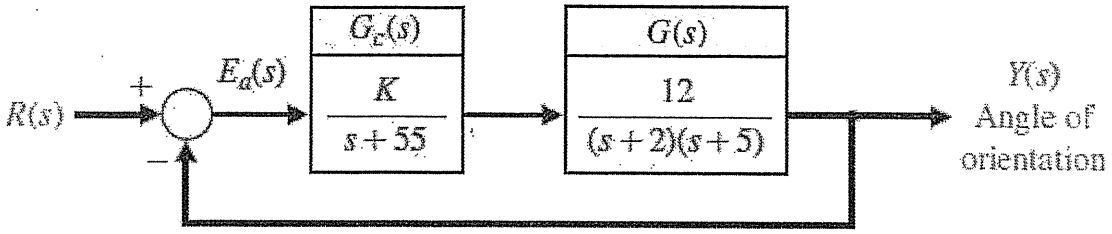


Figure 1. Control of a space satellite

2. (20%) Consider the closed-loop system in Figure 2.
   (1) Determine the closed-loop transfer function $T(s)=Y(s)/R(s)$.
   (2) Determine the steady-state error of the closed-loop system response to a unit ramp input.
   (3) Determine the sensitivity of the steady-state error obtain in part (2) with respect to the change of K_a.
   (4) For the system with unit step input, whether can you select a value of K_a so that the steady-state error of the system is zero? If yes, what is the value of K_a?
   (5) Check the stability of the closed-loop system for the value of K_a obtained in part (4).

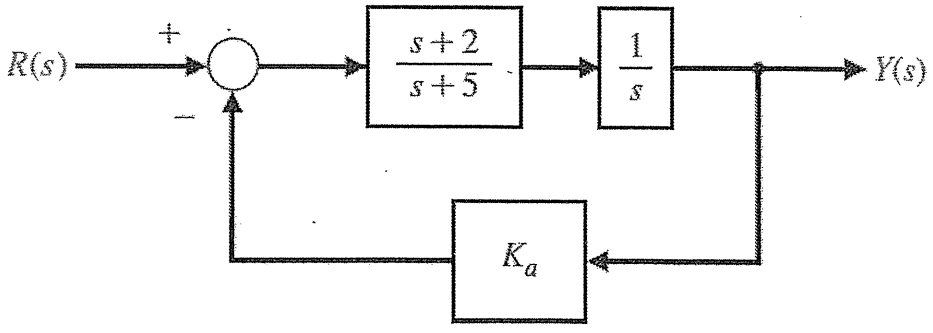


Figure 2. Non-unity closed-loop feedback control system with parameter K_a.

3. (20%) A control system, as shown in Figure 3, has a process

$$G(s)=\frac{1}{s(s-1)}$$

(1) When $G_c(s)=K$, show that the system is always unstable by sketching the root locus.

(2) When

$$G_c(s)=\frac{K(s+2)}{s+20}$$

Sketch the root locus and determine the range of K for which the system is stable.

(3) By following part (2), determine the value of K and the complex roots when two roots lie on the $j\omega$-axis. What is the oscillation frequency?

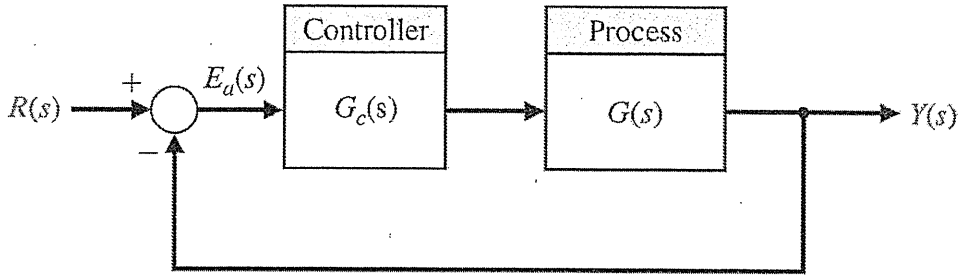


Figure 3. Negative unity feedback system

4. (20%) Consider the closed-loop control system shown in Figure 4

(1) Determine the equivalent single block that the represents the transfer function $T(s)=C(s)/R(s)$.

(2) Determine the damping ratio, natural frequency, percent overshoot, settling time, peak time, rise time, and damped frequency of oscillation with unit-step input. (Figure 6)

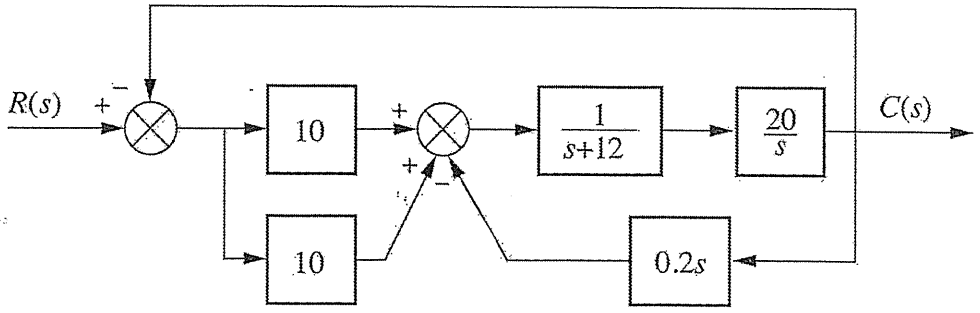
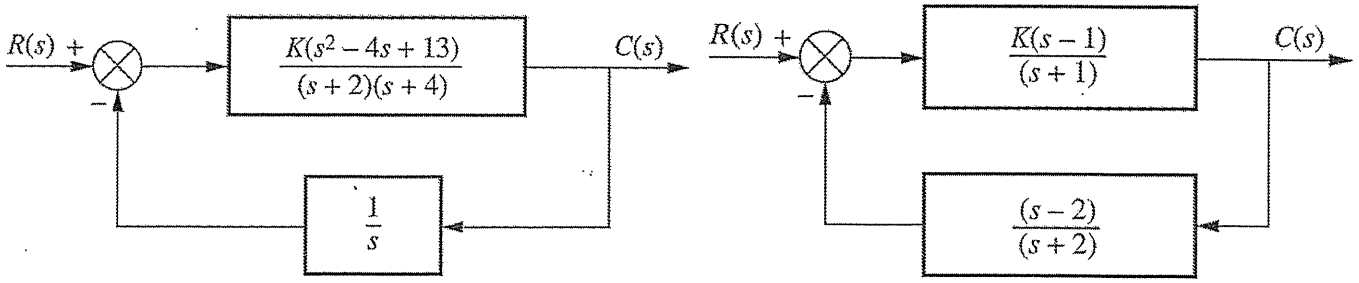


Figure 4. Closed-loop control system for Problem 4.

5. (20%) Using the Nyquist criterion, find the range of K for stability for each of the systems in Figure 5.



System 1　　System 2

Figure 5. Non-unity feedback control system for Problem 5.

Damping ratio	Normalized rise time
0.1	1.104
0.2	1.203
0.3	1.321
0.4	1.463
0.5	1.638
0.6	1.854
0.7	2.126
0.8	2.467
0.9	2.883

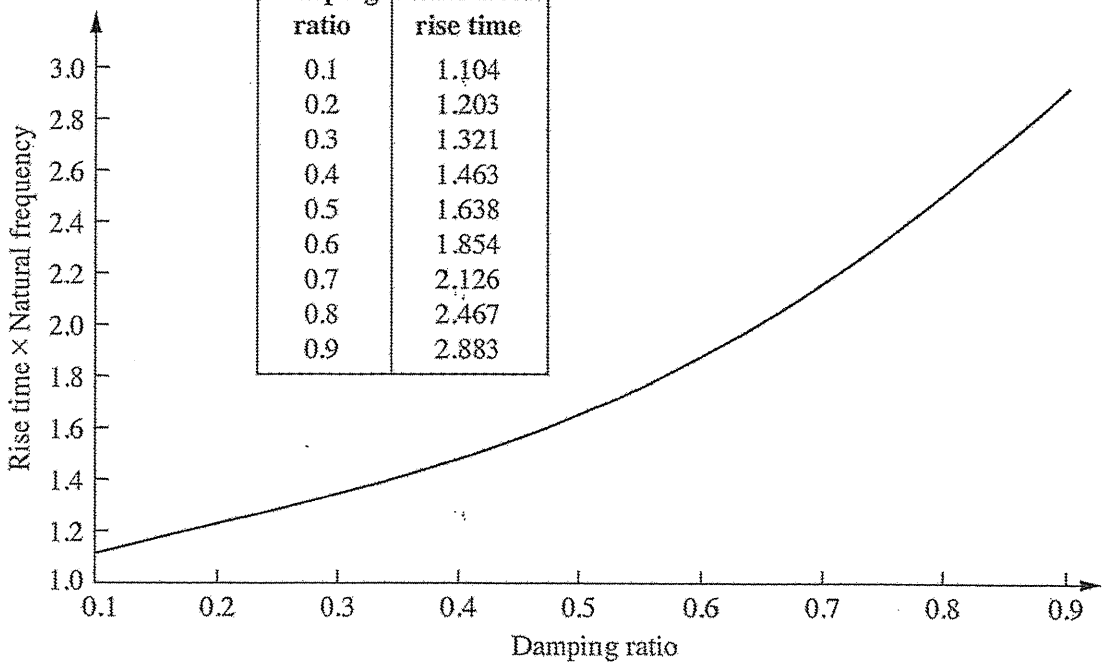


Figure 6. Normalized rise time versus damping ratio for a second-order underdamped response.