

本試題是否可以使用計算機： 可使用， 不可使用（請命題老師勾選）

考試日期：0301，節次：1

1. (10%) Consider the closed-loop system (shown in Fig. 1) with

$$P(s) = \frac{1}{s+1}, \quad C(s) = K_1 + \frac{K_2}{s}$$

Find the gains K_1 and K_2 such that the real part of closed-loop poles (i.e., $\text{Re}[s]$) satisfy $\text{Re}[s] < -1$ and the steady-state error due to a unit ramp is less than 0.1.

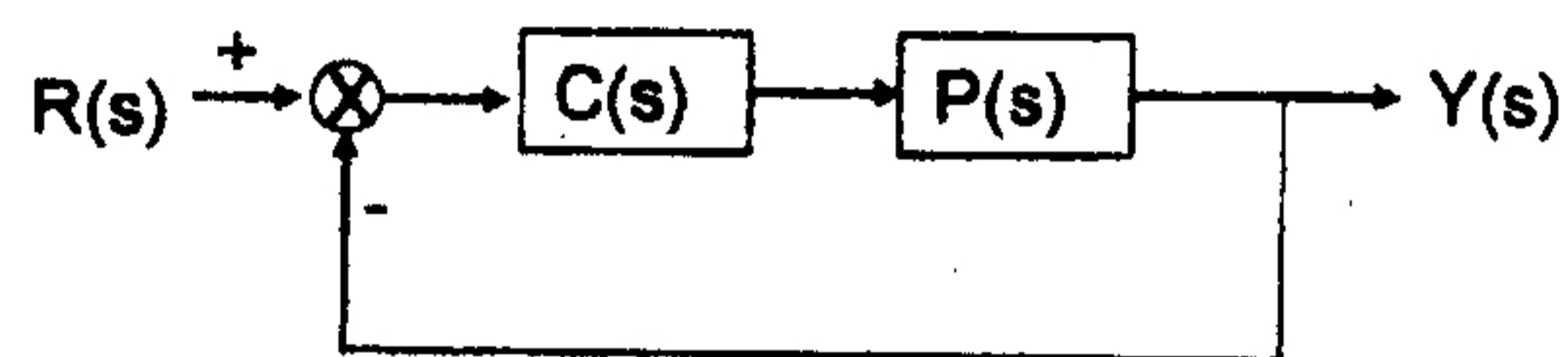


Figure 1

2. (15%) A feedback control system has the structure shown in Fig. 2.

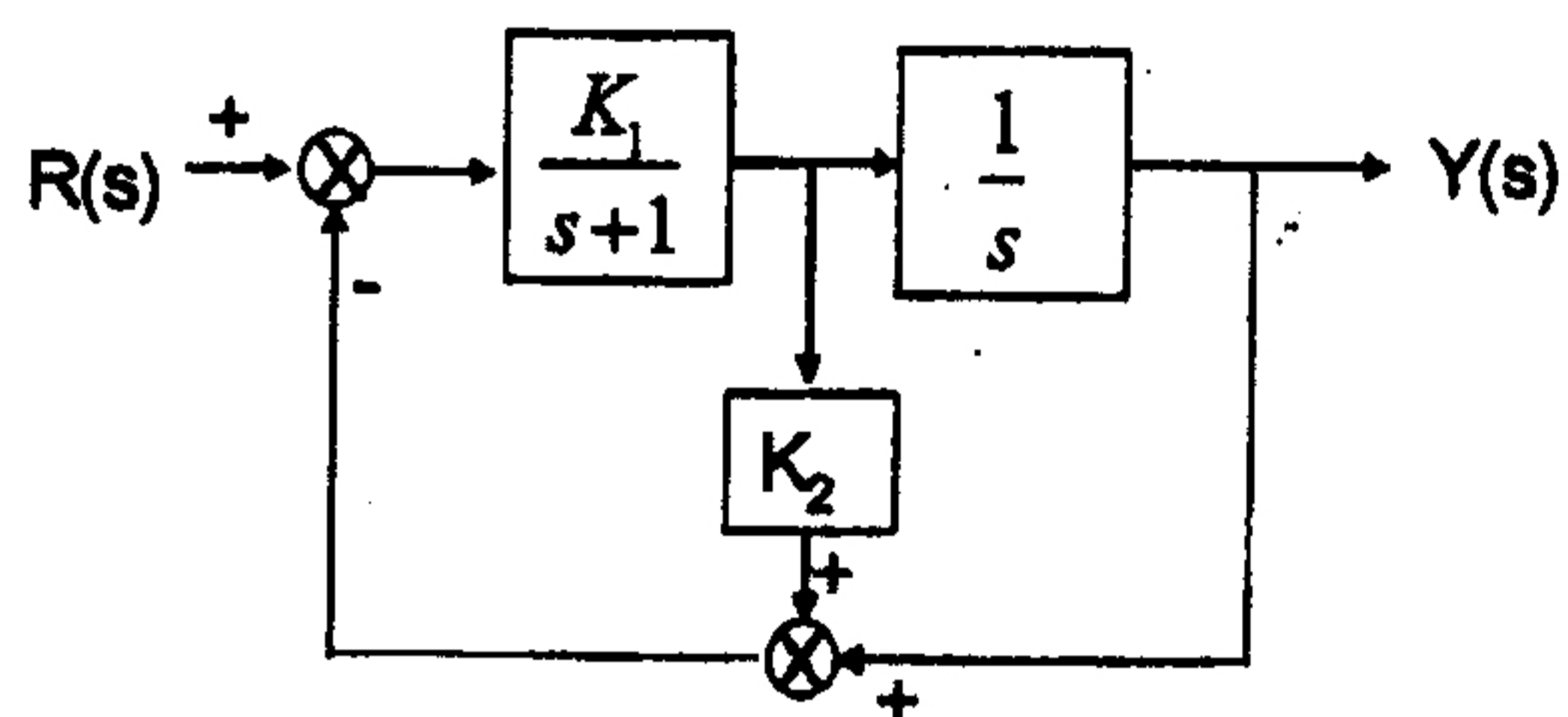


Figure 2

- Determine the closed-loop transfer function $Y(s)/R(s)$
- Determine the gains K_1 and K_2 so that the closed-loop response to a unit-step input is critically damped with two equal roots at $s = -10$.

3. (25%) Consider the closed-loop control system shown in Fig. 3

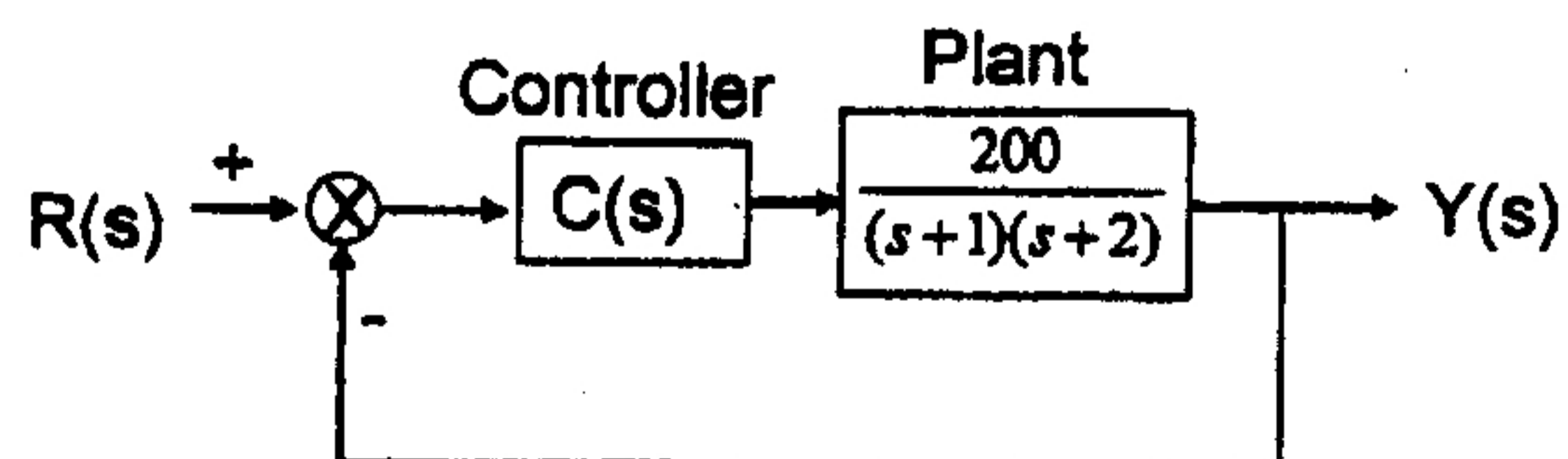


Figure 3

- For $C(s) = 1$, verify that the system is stable and find the steady-state error for the following inputs. (i) unit step (ii) unit ramp
- Repeat (a) when $C(s)$ is a PI controller, with $C(s) = 1 + 0.1/s$
- Compare (a) and (b) to show that how the PI affect the steady-state error.

(背面仍有題目,請繼續作答)

(Continue Problem 3.)

- (d) Compare the damping ratio, ξ , of the closed-loop system when $C(s) = 1$ (P controller) and $C(s) = 1 + 0.1s$ (PD controller)
- (e) What is the effect of the derivative term in the PD controller on the settling time, t_s , of the system? Justify your answer by comparing the settling time in (d). Use

$$t_s = \frac{4}{\xi\omega_n} \quad (\omega_n \text{ is the natural undamped frequency})$$

4. (15%) Given a closed-loop system as shown in Fig. P4, sketch root locus of the system when K is varied from 0 to ∞ . Show that by using a PD controller the closed-loop poles can be placed within a region in the s -plane for the dominant roots which have a damping ratio ≥ 0.707 and settling time ≤ 1 sec.

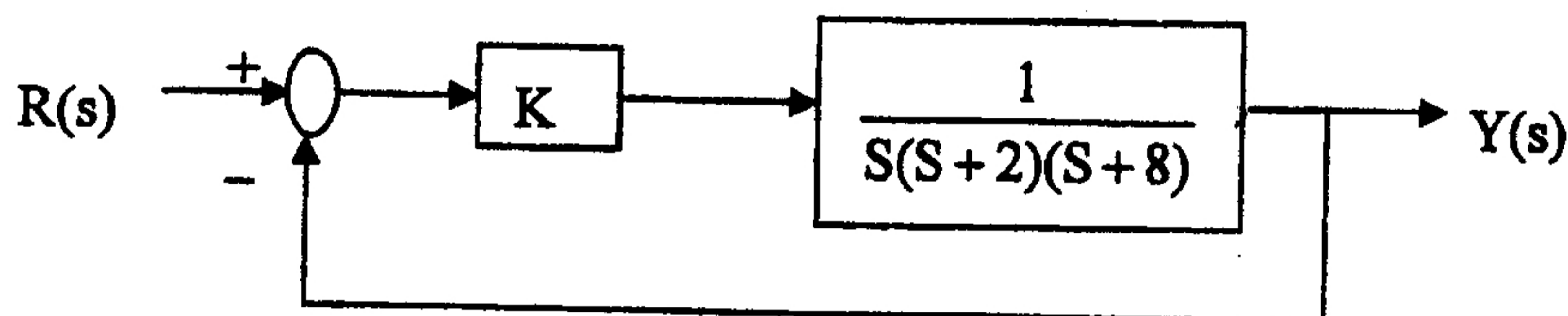


Fig. P4

5. (10%) The polar plot of a conditional stable system is shown in Fig. P5 for a specific gain $K=1$. (a) Determine whether the closed-loop system is stable and find the number of roots (if any) in the right-half s -plane. $GH(s)$ has no poles in the right-half s -plane. (b) If it is unstable adjust value of K such that the closed-loop system is stable.

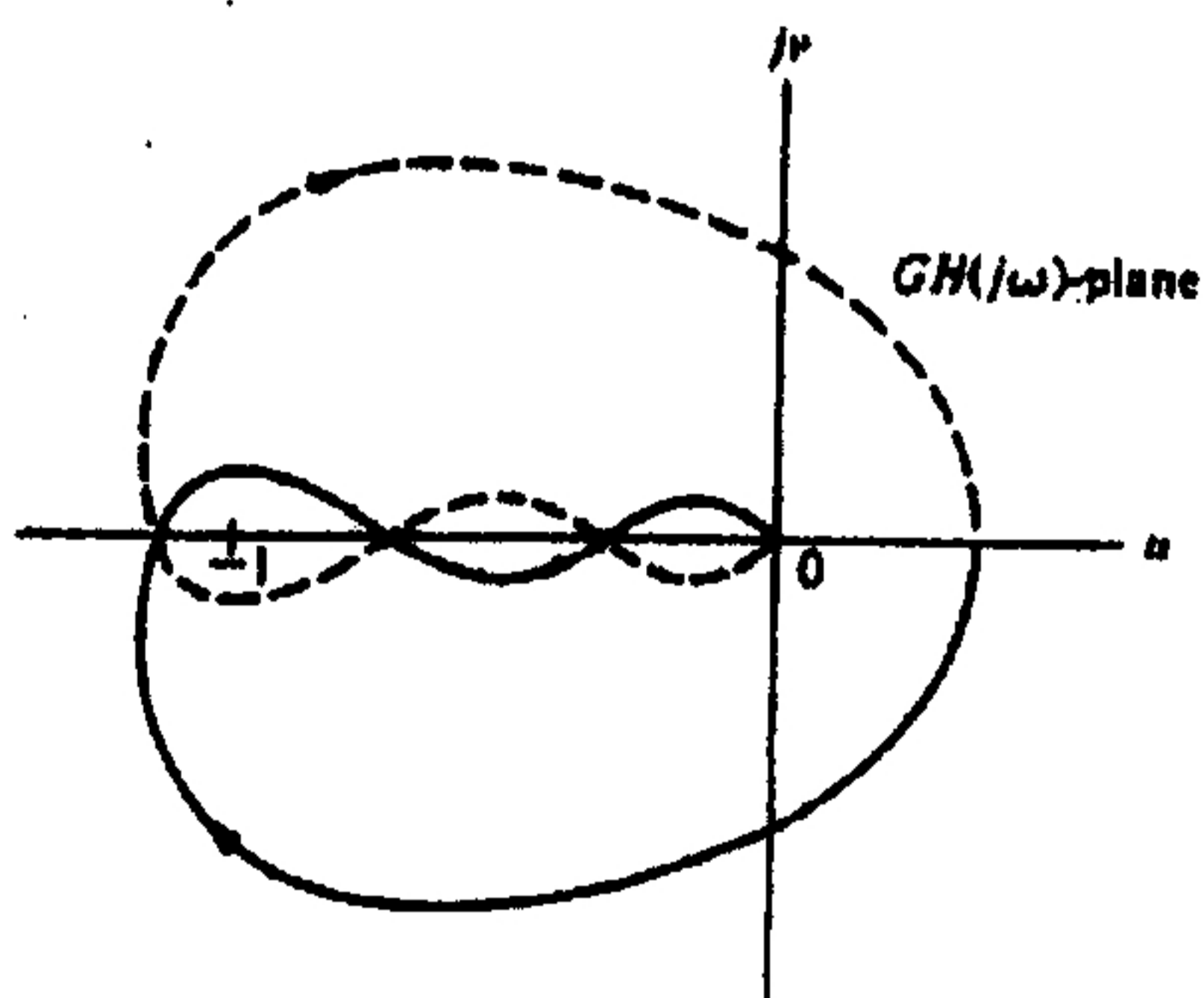


Fig. P5

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6. (25%) A vertical takeoff (VTOL) aircraft is an inherently unstable vehicle and requires an automatic stabilization system. An attitude stabilization system for a VTOL aircraft is shown in Fig. P6. At 40 knots, the dynamics of the vehicle are approximated by $G(s)$.

$$G(s) = \frac{10}{(s^2 + 0.36)}$$

The actuator and filter has a transfer function of $G_1(s)$

$$G_1(s) = \frac{K_1(s+8)}{(s+2)}$$

- (a) Draw the Bode diagram of the loop transfer function when the gain $K_1 = 2$ (b) Determine the resonant frequency and the maximum amplitude of the resonant peak of the closed-loop system. (c) Estimate the damping ratio of the system.

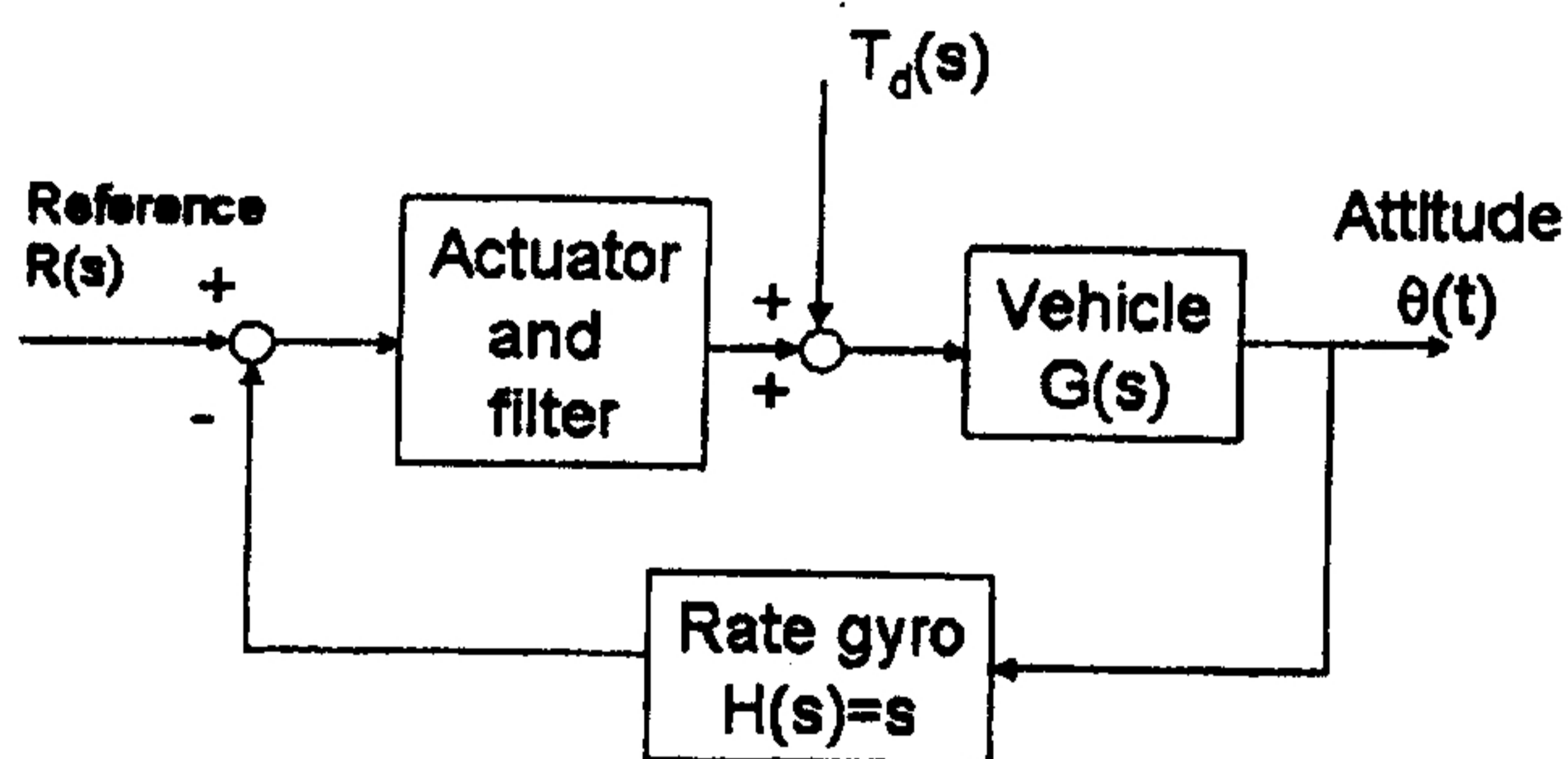


Fig. P6