國立成功大學

113學年度碩士班招生考試試題

編　號：69

系　所：機械工程學系

科　目：自動控制

日　期：0201

節　次：第 1 節

備　註：不可使用計算機

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1. (35%) Consider a closed-loop control system given in the figure.

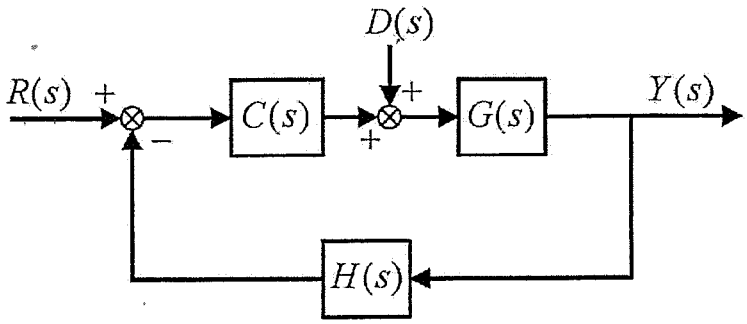

Fig. 1 Closed-loop control system for Problem 1.

If the controller is given as $C(s)=K$ without disturbance $D(s)=0$, and the plant and the feedback transfer functions are given as

$$G(s)=\frac{(s+5)}{(s+3)(s+7)(s+8)} \quad \text{and} \quad H(s)=\frac{(s+4)}{(s+6)(s+1)}.$$

Answer the following.

(a) Find the range of control gain K so that the control system is stable.

(b) Find the control gain K so that the percent overshoot is 10%, and validate the second-order approximation.

(c) Find the steady-state error of the control system when K is equal to one.

(d) Design $C(s)$ by adding a pole and/or zero to ensure zero steady-state error of the control system.

(e) Check the range of the control gain K for stable system.

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2. (15%) Consider a general underdamped second-order open-loop control system (*R(s)* as the input, *G(s)* as the plant, and *Y(s)* as the output), whose transfer function is given as

$$G(s)=\frac{\beta}{s^2+\alpha s+\beta}$$

If the system input is unit-step function, answer the following.

(a) What is an underdamped second-order system?

(b) Find the time response of the output function *y(t)*.

(c) Plot the time response of *y(t)* and denote peak time, settling time, raise time, and percent overshoot.

(d) What are the relation of the poles and zeros of the system to the specifications, peak time, settling time, and percent overshoot.

(e) Sketch the pole plot for the system by denoting the pole location with respect to peak time and settling time.

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3. Consider a unity feedback control system as shown in Fig. 3 where $G(s) = \frac{10}{s^2}$. A compensator is design to meet two specifications. The first specification is that the settling time is 4 s (with a 2% criterion). The second specification is that the system damping constant is 0.45. Please answer the following questions and demonstrate computational detail.

(a) 'Frequency response represents the frequency of natural oscillation of a system.' Is this statement of frequency response correct? If not, please correct it. (5 pts)

(b) State one situation where phase-lead compensator is not applicable and one situation where phase-lag compensator is not applicable. (10 pts)

(c) Determine the compensator. (15 pts)

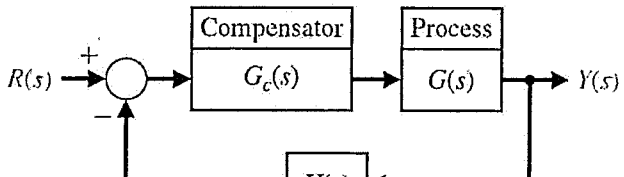
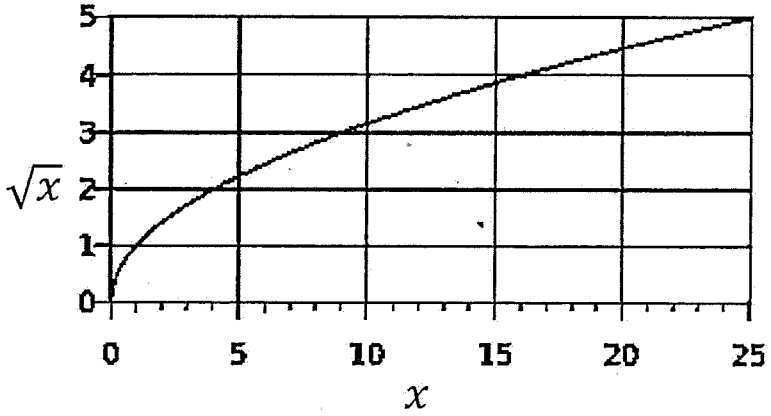
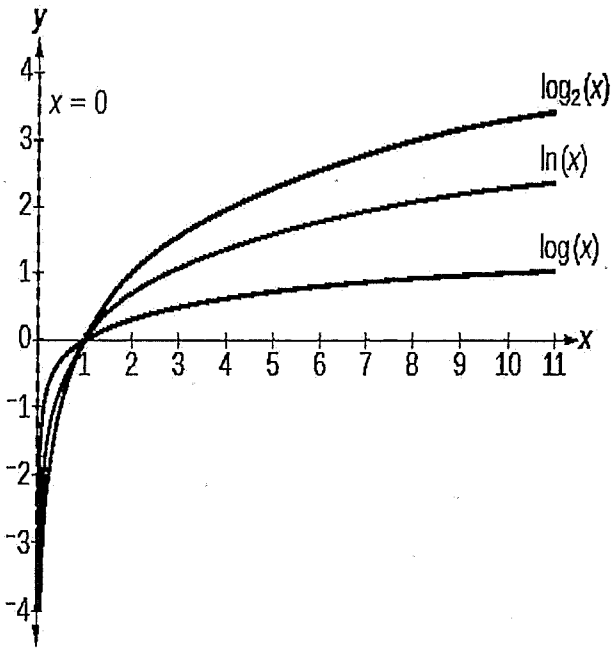


Fig. 3





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4. The frequency response of a process is shown as Fig. 4. Please answer the following questions and demonstrate computational detail.

(a) Determine the transfer function of the system. (10 pts)

(b) Calculate the steady-state error to a unit step input. (10 pts)

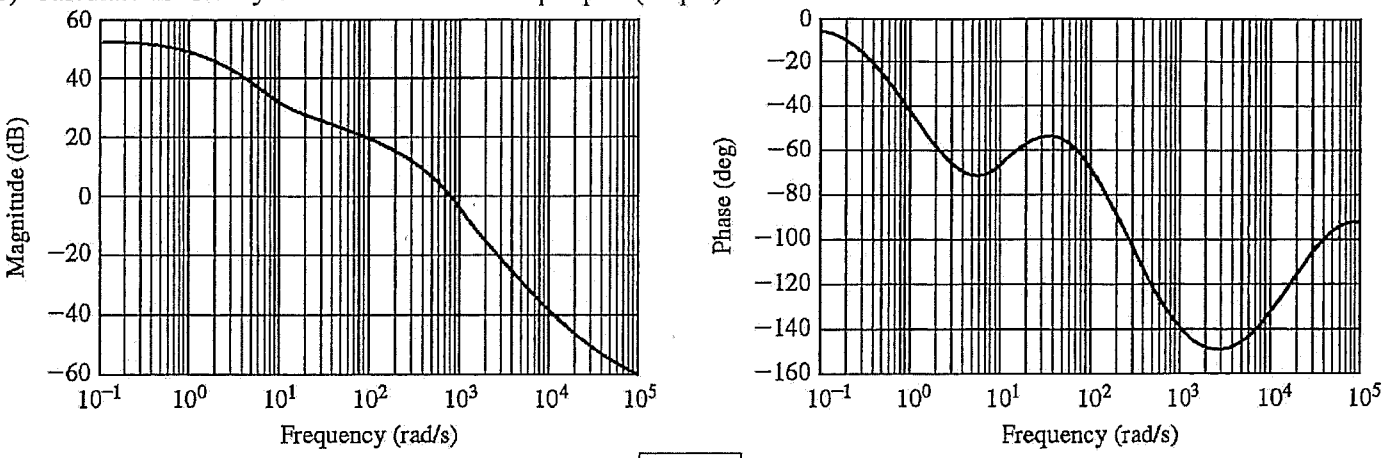

Fig. 4