國 立 清 華 大 學 命 題 紙

99 學年度 動力機械工程學系乙組(電控組) 碩士班入學考試

科目 控制系統 科目代碼 0902 共 4 頁，第 1 頁 *請在【答案卷卡】作答

1. For the following system with input V_{in} and output T as shown in Fig. 1, (a) plot the block diagram and find the transfer function $\dfrac{T(s)}{V_{in}(s)}$ (10%), (b) find the steady state response $T(t=\infty)$ for a unit step input on V_{in} (5%)

(**Assume** the spin speed of the motor is so small that the back electromotive force e can be ignored.)

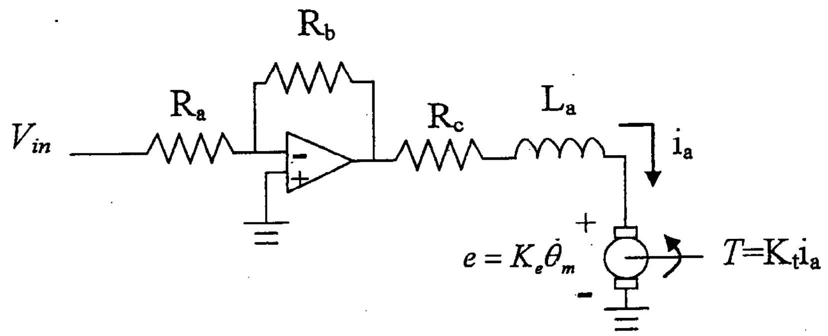

Fig. 1

2. For a system $\dfrac{Y(s)}{R(s)} = \dfrac{4}{s^2+1.6s+4}$, the unit step response is shown as (a) in Fig. 2. Please relate curve(b), (c) and (d) to the unit step responses of the following systems. (10%)

(1) $\dfrac{Y(s)}{R(s)} = \dfrac{-4s+4}{s^2+1.6s+4}$

(2) $\dfrac{Y(s)}{R(s)} = \dfrac{4}{(s^2+1.6s+4)(s+1)}$

(3) $\dfrac{Y(s)}{R(s)} = \dfrac{4s+4}{s^2+1.6s+4}$

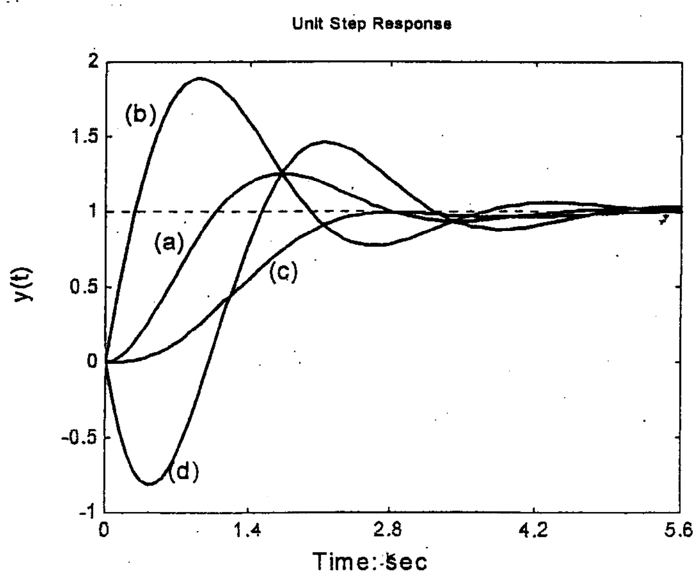

Fig. 2

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3. Consider the submarine depth control problem shown in Fig. 3 (a). The objective is to reach and maintain the desired depth. The submarine dynamics are given by G(s) (followed by an integrator), the stern plate actuator has a gain of K, and the dynamics of the pressure transducer is assumed to be very fast (namely, H(s)=1, as shown in Fig. 3(b))

(a) Determine the range of K that will result in a stable closed-loop system. (10%)

(b) What is the closed-loop oscillation frequency (write down the unit) for marginally stable case? (10%)

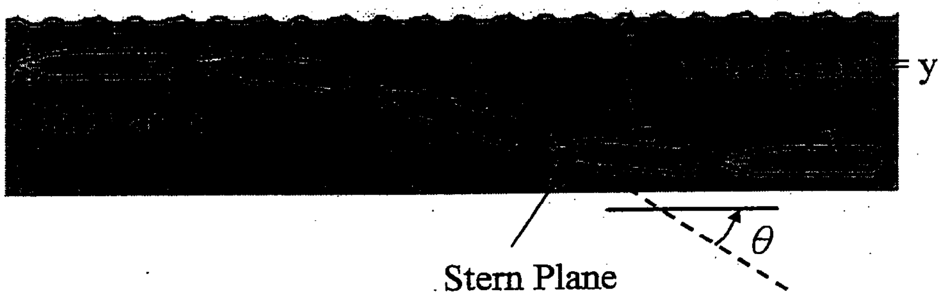

Fig. 3(a)

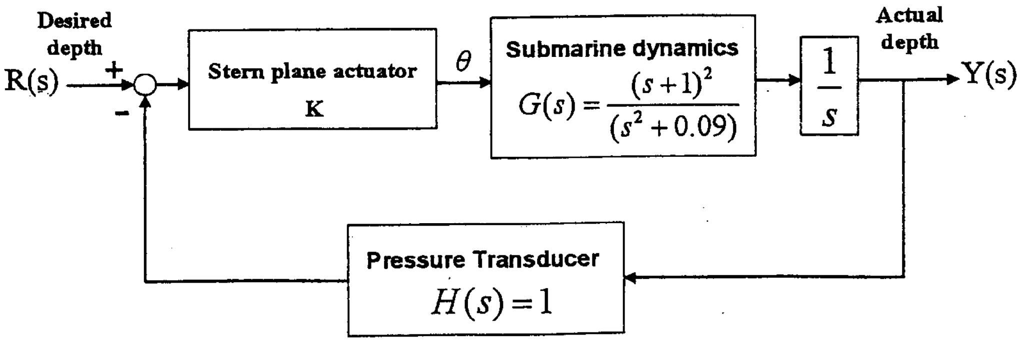

Fig. 3(b)

4. Please match the following impulse time responses (1)~(9) to the poles location (a)~(i). (5%; note: no partial credit)

(1) (2) (3) (4) (5) (6) (7) (8) (9)

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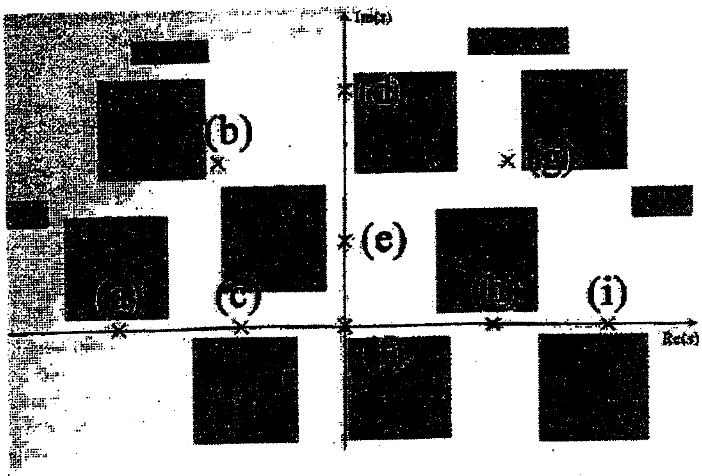

5. Consider a system shown as Fig. 5, where $G(s)=\dfrac{1}{(s+2)^2}$ and $H(s)=\dfrac{1}{s+3}$.

(a) Sketch the root locus of the system when K varies from 0 to ∞. Be sure to give the asymptotes and the breakaway point. (10%)

(b) If the system requires one pair of complex conjugate poles with real part equal to −1, determine the constant gain K and the corresponding system poles. (10%)

(c) Design a phase lead compensator, i.e., $K=K_p\dfrac{s+Z}{s+P}$, so that the system has one pair of complex conjugate poles with damping ratio $\xi=\dfrac{2}{\sqrt{5}}$ and undamped natural frequency $\omega_n=\sqrt{5}$. (10%)

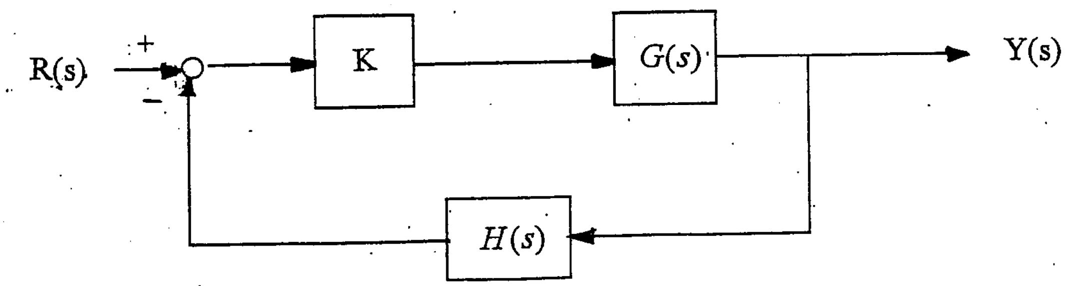

Fig. 5

6. A system is shown as Fig. 6(a), where $G(s)=\dfrac{11}{s(s+10)}$ and $H(s)=\dfrac{1}{s+1}$.

(a) Sketch the polar plot of $G(s)H(s)$ and calculate the gain margin of the system if the closed contour of s is chosen as Fig. 6(b). (10%)

(b) Determine the stability of the system by use of the Nyquist stability criterion. (5%)

(c) Sketch the Bode plot of $G(s)H(s)$ and point out the gain margin and the phase margin of the system on your plot. (5%)

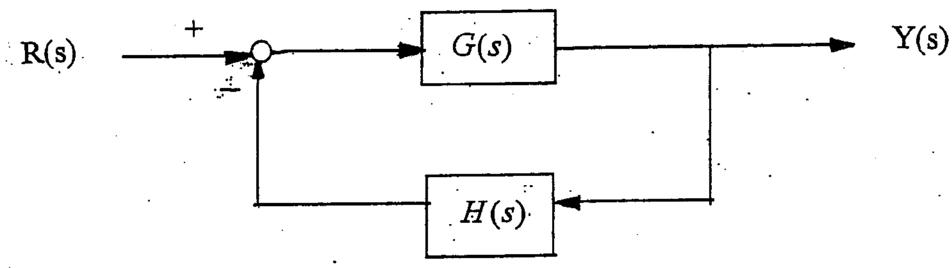

Fig. 6(a)

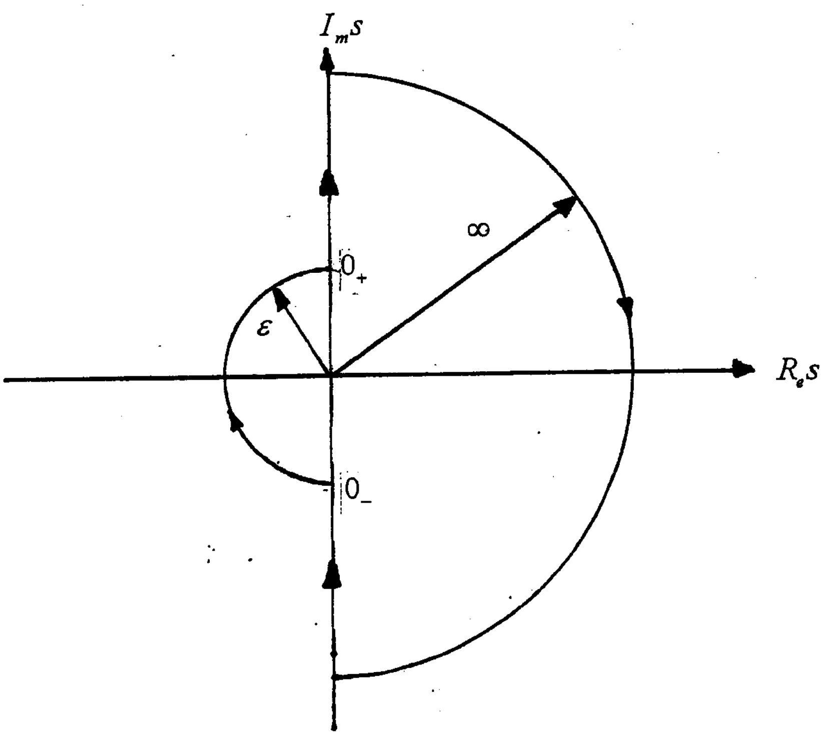

Fig. 6(b) : Where ε is very small.