編號： 77

國立成功大學 105 學年度碩士班招生考試試題

系　　所：機械工程學系

考試科目：自動控制

考試日期：0227，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. (25%)

There are six different pole/zero patterns (1)~(6) and six different step responses (A)~(F) as shown in Fig. 1. Please match each pole/zero pattern with the correct step response and give the reason for justifying your answer.

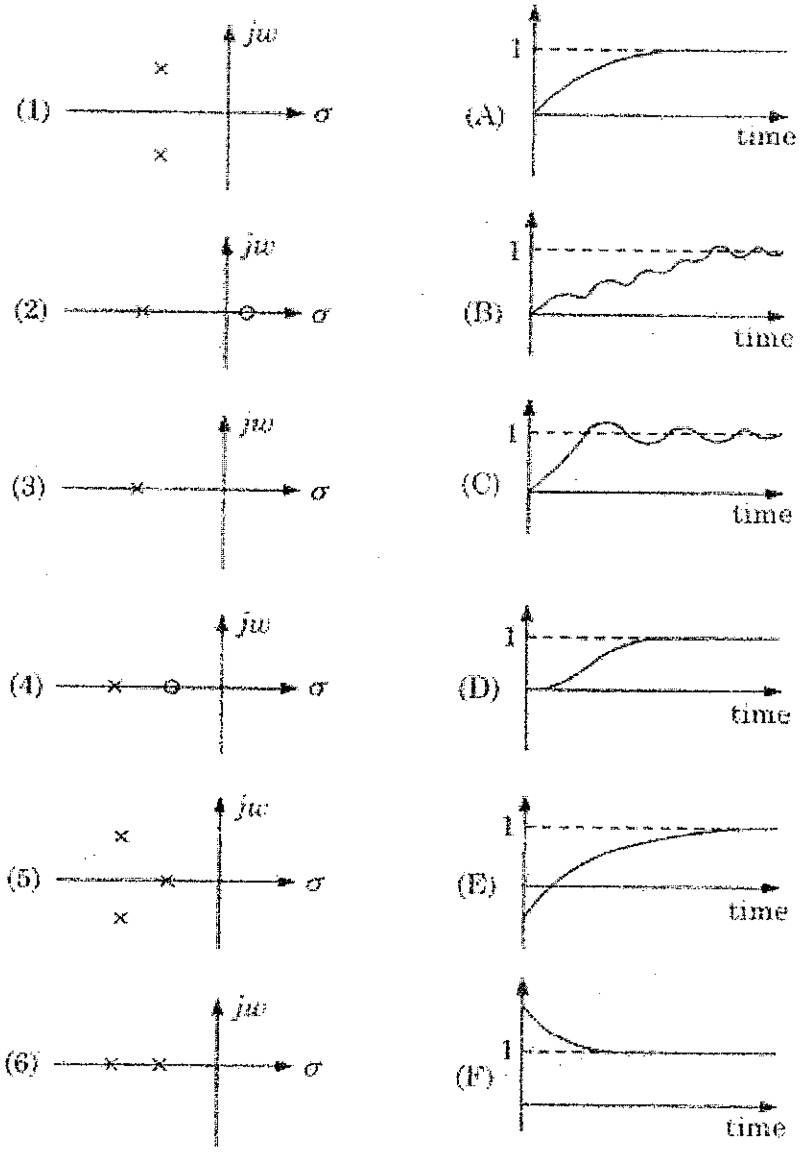

Figure 1

2. (25%)

A feedback control system has the structure shown in Fig. 2.

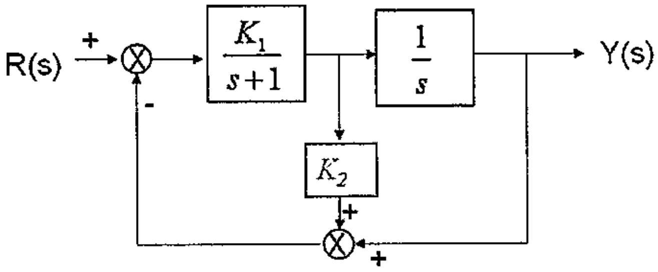

Figure 2

(1) (10%) Determine the closed-loop transfer function Y(s)/R(s)

(2) (8%) 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) (7%) Based on the answer of (2), please derive the unit-step response y(t).

Useful Laplace formulas:

$\mathscr{L}[t]=\frac{1}{s^2}$　　$\mathscr{L}[e^{-at}]=\frac{1}{s+a}$　　$\mathscr{L}[te^{-at}]=\frac{1}{(s+a)^2}$

$\mathscr{L}[\sin\omega t]=\frac{\omega}{s^2+\omega^2}$　　$\mathscr{L}[\cos\omega t]=\frac{s}{s^2+\omega^2}$　　$\mathscr{L}[e^{-at}f(t)]=F(s+a)$

$\mathscr{L}[tf(t)]=-\frac{d}{ds}F(s)$　　$\mathscr{L}[\frac{df(t)}{dt}]=sF(s)$　　$\mathscr{L}[\int_0^t f(\tau)d\tau]=\frac{F(s)}{s}$

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3. (20%) A pure inertia system, $1/(ms^2)$, is under linear unity feedback control. The controller is of PID type,

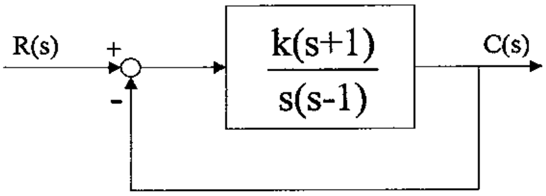
$$G_c(s)=K_c(1+1/(T_i s)+T_d s)$$

i) An engineer from the Alpha Inc. has tuned the controller so that the closed-loop poles are all at -2 when $m=5$. What are the values of K_c, T_i and T_d that he selected? (5%)

ii) The inertia m may be subject to change. For the values of K_c, T_i and T_d that you obtained in i), the closed-loop system cannot remain stable for all $m>0$. Find the condition(s) for stability. Find all the closed-loop poles at the stability boundary also. (10%)

iii) Draw the root locus plot for m changing from 0 to ∞ when the values of K_c, T_i and T_d are fixed to what you obtained in i). (5%)

4. (10%) Consider the closed-loop system shown below. Determine the range of k for stability by use of the Nyquist stability criterion.



5. (20%) Consider the closed-loop system shown below.

i) If $G(s)=k$ $(k\geq 0)$, sketch the root locus as k varies from 0 to ∞. (5%)

ii) You are requested to design a new controller, $G(s)$, for the system using root-locus method such that the dominant poles of the system are located in the region shown in the s-plane. (15%)