國立台灣海洋大學九十二學年度碩士班甄試入學考試試題

系所名稱：導航系碩士班（控制組）　　＊答案以橫式由左至右書寫於答案卷上！

科目名稱：控制原理　　＊可使用計算機

1. (20%)
A linear time-invariant multivariable system is described by the following set of differential equations:

$$\frac{d^2y_1(t)}{dt^2}+2\frac{dy_1(t)}{dt}+3y_2(t)=r_1(t)+r_2(t)$$

$$\frac{d^2y_2(t)}{dt^2}+3\frac{dy_1(t)}{dt}+y_1(t)-y_2(t)=r_2(t)+\frac{dr_1(t)}{dt}$$

Find the following transfer functions:

(a) $\frac{Y_1(s)}{R_1(s)}$ for $R_2(s)=0$, (b) $\frac{Y_2(s)}{R_1(s)}$ for $R_2(s)=0$,

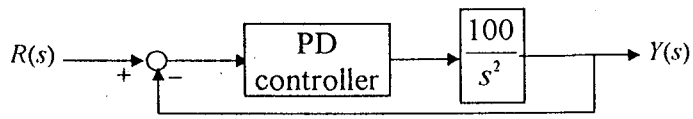
(c) $\frac{Y_1(s)}{R_2(s)}$ for $R_1(s)=0$, (d) $\frac{Y_2(s)}{R_2(s)}$ for $R_1(s)=0$.

2. (10%)
Consider a system with following transfer function

$$\frac{Y(s)}{U(s)}=\frac{2s^2+5s+6}{s^3+5s^2+6s},$$

where y is the output and u is the input.
Find the dynamic equations in vector–matrix form such that the state equations are decoupled from each other.

3. (20%)
The block diagram of a PD control system is shown below



(a) Find K_P and K_D on which the damping is critical and the natural undamped frequency ω_n is 50 rad/sec.
(b) From part (a), with unit-step input, find the steady-state error.
(c) From part (a), with unit-step input, find the steady-state value of $y(t)$.
(d) Find K_P and K_D on which the parabolic-error constant K_a is 1000 $\sec^{-2}$.

4. (20%)
Given the open-loop transfer function of a unity-feedback system

$$G(s)=\frac{K}{(T_1s+1)(T_2s+1)};\ \text{where } T_1=1,\ T_2=0.5.$$

(a) Draw the root locus for the system.
(b) Locate the roots for K=0, 0.125, and ∞.
(c) If we add a zero at −5, draw the new root locus and describe the effect on system stability.
(d) If we add a pole instead of a zero at −5, draw the new root locus and describe the effect.

5. (10%)
The characteristic equation of a linear digital control system is

$$z^3 + z^2 + 1.5Kz - (K + 0.5) = 0$$

Determine the values of K for the system to be asymptotically stable.

6. (20%)
Consider the system with

$$G(s) = \frac{4(1 + \frac{s}{2})}{s(1 + 2s)(1 + \frac{s}{20} + (\frac{s}{8})^2)}.$$

(a) Draw the Bode plot for the system.
(b) Draw the Bode plot for a lead compensator. Describe the effect if we add it to the system.
(c) Draw the Bode plot for a lag compensator. Describe the effect if we add it to the system.