國立臺北科技大學

九十二學年度電機工程系碩士班入學考試

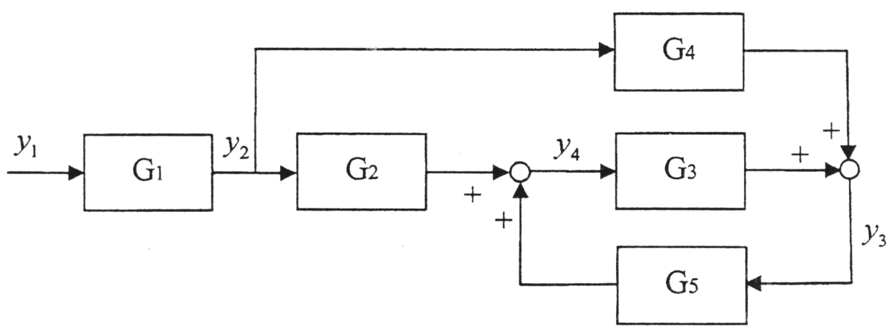
控制系統試題

填准考證號碼　　　　　　　　　　　　　　　　　　第一頁　共二頁

注意事項：

1. 本試題共 7 題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

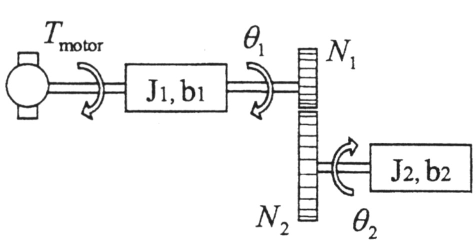
1. (10%) Draw the signal flow graph for the system and then determine the transfer functions.



(a) from y_1 to y_2. (5%)

(b) from y_1 to y_4. (5%)

2. (10%) Consider the following gear transmission system.



T_{motor} : torque generated from a motor

$J_{i;i=1,2}$: mass moment of inertia of load

$b_{i;i=1,2}$: viscous friction coefficient of load

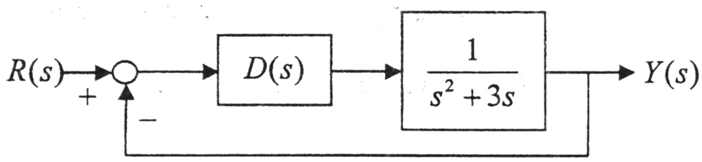
$\theta_{i;i=1,2}$: angular position of the i-th gear

$N_{i;i=1,2}$: number of teeth of the i-th gear

Determine the transfer function from T_{motor} to θ_1.

3. (10%) Consider the step response of the system with transfer function $\dfrac{\alpha s+4}{s^2+2s+4}$. Determine all possible values of α such that there will be an undershoot. Justify your answer by comparing it with the step response of the system with transfer function $\dfrac{4}{s^2+2s+4}$ and explain exactly why there is such an undershoot.

4. (30%) Consider the system shown below,



(a) Let $D(s)=\dfrac{K(s+z)}{s+p}$. Find K, z, p so that the closed-loop system has a 5% overshoot to a step input and a settling time of $\dfrac{4}{3}$ sec (1% criterion). (10%)

(b) Let $D(s)=K$. Determine the Nyquist plot and apply the Nyquist criterion to determine the range of values of K for which the system will be stable. (10%)

(c) Design a lead-lag compensator $D(s)$ so that the closed-loop system has a 16% overshoot, a settling time 2.3 sec (1% criterion), and a velocity error constant 100. (10%)

5. (15%) The open-loop transfer function of a system has two poles at $s=-1$ and a zero at $s=-2$. There is a third real-axis pole located somewhere to the left of the zero. Several different root loci are possible, depending on the exact location of the third pole. The extreme cases occur when the pole is located at infinity or when located at $s=-2$. Sketch all different types of root loci.

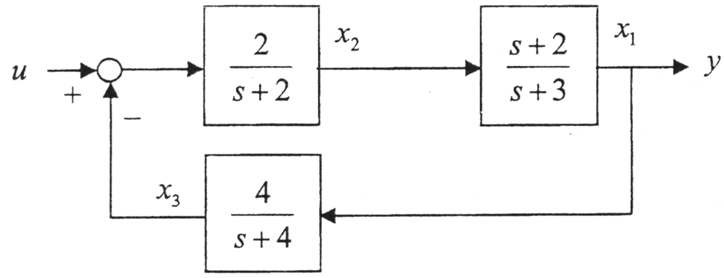
6. (10%) Is the system

$$\dot{x}=\begin{bmatrix}-3 & 0\\ 0 & 2\end{bmatrix}x+\begin{bmatrix}0\\ 1\end{bmatrix}u$$

controllable? Moreover, is it possible to design a state feedback controller so that the closed-loop response has a rise time less than 0.6 sec and a 1% settling time under 1.54 sec? Justify your answer.

注意：背面尚有試題

7. (15%) A block diagram of a dynamical system is drawn below.



(a) Give state matrices F, G, H, J that describe this system in the following form where the state vector $x_{3\times1} = [x_1\ x_2\ x_3]^T$ and the state variables are defined in the diagram. (superscript T denotes transpose) Is the system controllable and/or observable? (10%)

$$\dot{x} = Fx + Gu$$
$$y = Hx + Ju$$

(b) Is it possible to transform this state description to control and/or observer canonical form? Justify your answer by giving the corresponding canonical form. (5%)