國 立 臺 北 科 技 大 學

九十九學年第二學期電機系博士班資格考試

控制系統(大學部) 試題

注意事項：

1. 本試題共【6】題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在試卷答案欄內，否則不予計分。
4. 考試時間:二小時。

1. A first step toward a realistic (non-ideal) model of an op amp is given by the equations:

$$V_{out} = \frac{10^7}{s+1}(V_+ - V_-)$$
$$i_+ = i_- = 0$$

(a) Show that the op amp connection shown in Fig. 1(a) is unstable. (5%)
(b) Find the transfer function of the simple amplification circuit shown Fig. 1(b). (5%)

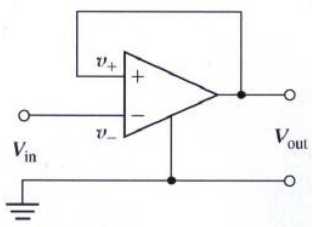

Fig. 1(a)

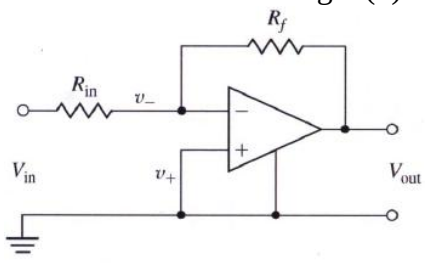

Fig. 1(b)

2. For the unity feedback system shown in Fig. 2, specify the gain and pole location of the compensator so that the overall closed-loop response to a unit-step input has an overshoot of no more than 25%, and a 1% settling time of no more than 0.1 sec. (10%)

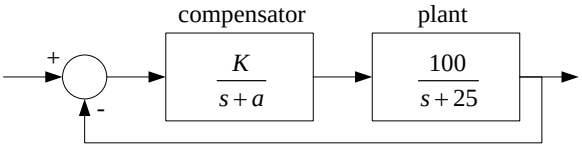

Fig. 2

3. Consider the system shown in Fig. 3:

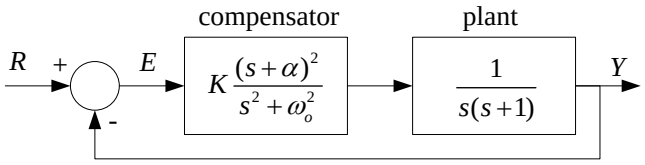

Fig. 3

(a) Prove that if the system is stable, it is capable of tracking a sinusoidal reference input $r = \sin \omega_o t$ with zero steady-state error. (Look at the transfer function from *R* to *E* and consider the gain at ω_o.) (10%)

(b) Use Routh's criterion to find the range of K such that the closed-loop system remains stable if $\omega_o = 1$ and $\alpha = 0.25$. (5%)

4. Consider the system shown in Fig. 4:

(a) Find the transfer function from *U* to *Y*. (5%)

(b) Write state equations for the system using the state variables indicated. (10%)

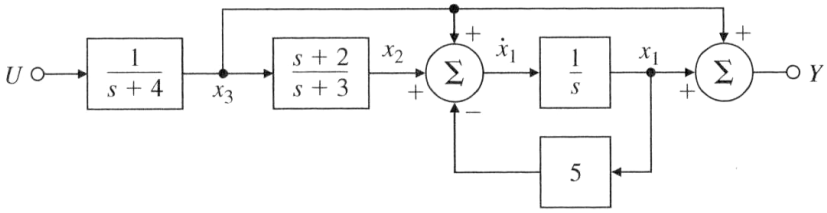

Fig. 4

5. Consider the system

$$\begin{cases} \dot{\mathbf{x}} = \mathbf{F}\mathbf{x} + \mathbf{G}u \\ y = \mathbf{H}\mathbf{x} \end{cases}, \quad \text{where } \mathbf{F} = \begin{bmatrix} -2 & 1 \\ 1 & 0 \end{bmatrix}, \mathbf{G} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}, \mathbf{H} = \begin{bmatrix} 1 & 2 \end{bmatrix},$$

and assume that you are using feedback of the form $u = -\mathbf{K}\mathbf{x} + r$, where *r* is a reference input signal.

(a) Show that (**F**, **H**) is observable. (5%)

(b) Show that there exists a **K** such that (**F** - **GK**, **H**) is unobservable. (5%)

(c) Compute a **K** of the form **K** = [1, K_2] that will make the system unobservable as in part (b); that is, find K_2 so that the closed-loop system is not observable. (5%)

(d) Compare the open-loop transfer function with the transfer function of the closed-loop system of part (c). What is the unobservability due to? (10%)

6.

(a) Explain how the Laplace transform, z transform, continuous-time Fourier transform (CTFT), and discrete-time Fourier transform (DTFT) are related. (20%)

(b) **S**ketch the line segments l_1, l_2, l_3, l_4 in the s-plane in Fig. 5 are mapped into where in the z-plane. (5%)

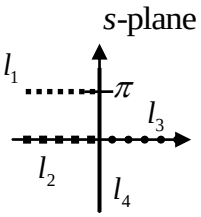

Fig.5