國立臺北科技大學九十六學年度碩士班招生考試

系所組別：1612　　電機工程系碩士班甲組

第一節 控制系統（選考）試題

注意事項：

1. 本試題共 5 題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. Consider the feedback control system in Figure 1.

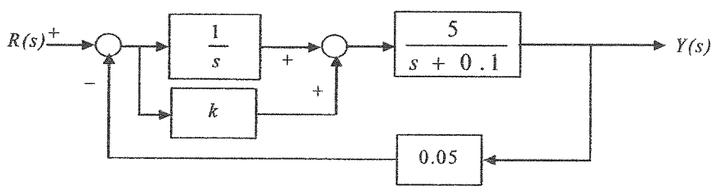

Figure 1. A feedback control system

(a) Give a definition of "system type" and determine the system type number of the feedback control system shown in Figure 2. (10%)

(b) To satisfy transient-response requirement in the controller design, try to plot a root locus as the parameter k is varied. (10%)

(c) Determine the value of k when the closed-loop poles are located at $s = -0.5$. (5%)

2. Consider the feedback control system in Figure 2.

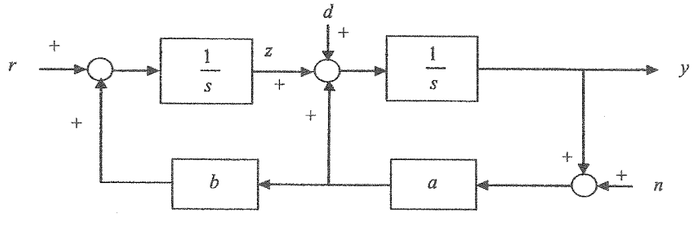

Figure 2. A feedback control system

(a) Consider the system from input r to output y as shown in Figure 1. Determine the parameters a and b such that the system's damped natural frequency and damping ratio are $\frac{\sqrt{3}}{2}$ and $\frac{1}{2}$ respectively. (10%)

(b) If $r(t) = 6*1(t)$, $d(t) = 1(t-1) - 3*1(t-2)$, and $n(t) = 3*1(t) - 1*1(t-3)$, determine the steady state values of y and z. Note that $1(t)$ denotes the unit step function. (10%)

3. Consider a feedback control system with open-loop transfer function

$$\frac{K}{(s+2)(s^2+4)}$$

(a) Draw the Nyquist plot for the open-loop transfer function. (10%)

(b) Determine based on Nyquist stability criterion if the closed-loop system is stable and the corresponding range of K. (5%)

4. By a solution to the n-dimensional difference equation for a discrete system

$$x_k = Mx_{k-1}$$

is meant a sequence of vectors $\{x_0, x_1, x_2, \cdots\}$ satisfying the equation for $k \geq 1$. Show that all such solutions will tend to zero if all eigenvalues of M have magnitudes less than 1. (10%)

5. Consider the following process.

$$\frac{d^2x(t)}{dt^2} + a\frac{dx(t)}{dt} + bx(t) = \frac{du(t)}{dt} + 2bu(t)$$

with a and b both *negatrive* constants.

(a) Is it *linear*? *time-invariant*? Give reasoning to justify your answer. (5%)

(b) Find a state space representation for the system. (5%)

(c) Under what condition is this state space representation of the system controllable but unobservable? (10%)

(d) Determine the stabilizing feedback law $u(t) = Kx(t)$ such that the closed-loop poles are located at $s = -2 \pm j2$. (10%)