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： 1630 電機工程系碩士班 丙組
第一節 控制系統 試題

第一頁 共一頁

注意事項：
1. 本試題共5題，每題20分。
2. 請標明題號、子題編號作答，不必抄題。
3. 全部答題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](image)

   (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](image)

   (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 $u(t) = 3*1(t)-1*1(t-3)$, 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 $\{x_0, x_1, x_2, \ldots\}$ 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.

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

   with $a$ and $b$ both negative 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 uncontrollable? (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%)