國立臺北科技大學九十七學年度碩士班招生考試

系所組別：2112　2130 電機工程系碩士班甲丙組

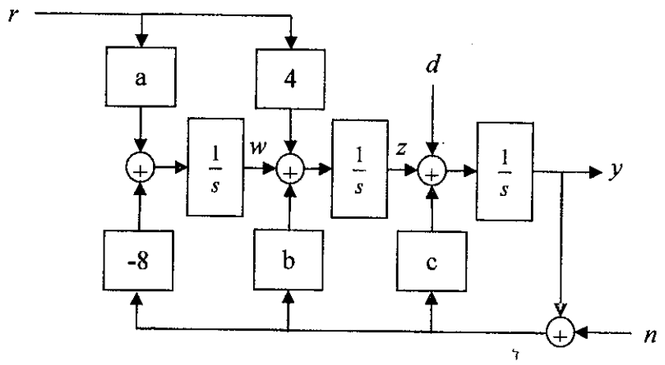
第一節　控制系統（選考）試題

填 准 考 證 號 碼

注意事項：

1. 本試題共 4 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。

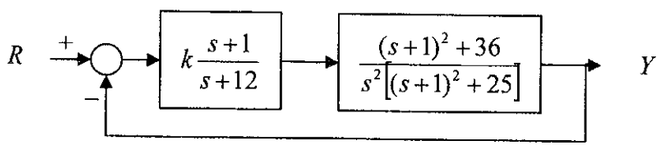
1. For the feedback control system shown in the following figure:



(a) Consider the system from input r to output y. Determine the parameters a, b, and c such that there is a pole-zero cancellation at $s=-2$, the system is critically damped, and there is no steady-state error ($e=y-r$) for a unit step input r. (15%)

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

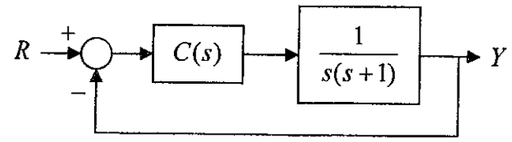
2. Consider the feedback control system shown below.



(a) Sketch the root locus of closed-loop roots with respect to k. Give details on angles of departure and arrival and all possible breakaway points, break-in points, and imaginary-axis crossings. (20%)

(b) Based on the root locus, determine the range of k that results in a stable system. (5%)

3. Consider the feedback control system shown in the following figure.



(a) Draw the Nyquist plot for the system with $C(s)=k$. Determine based on Nyquist stability criterion if the closed-loop system is stable and the corresponding range of k. (10%)

(b) Design a lead-lag compensation $C(s)$ using Bode plot sketches such that the 1% settling time $t_s=4.6\,\text{sec}$, the damping ratio $\zeta=0.5$, and the velocity constant $K_v=100$. (15%)

4. Consider the system.

$$\dot{x}=\begin{bmatrix}0 & -4\\ 1 & 0\end{bmatrix}x+\begin{bmatrix}0\\ 1\end{bmatrix}u$$
$$y=\begin{bmatrix}-2 & 0\end{bmatrix}x$$

(a) Design an observer to estimate the state of the system so that the observer error poles are located at $-10\pm 4j$. (10%)

(b) Design a state feedback controller $u=r-\begin{bmatrix}k_1 & k_2\end{bmatrix}x$ for the system so that the closed-loop step response has a rise time under $\frac{0.9}{\sqrt{2}}$ sec and a 1% settling time under 2.3 sec. (10%)

(c) Find the closed-loop characteristic equation if $u=r-ky$ and determine if the same closed-loop poles in (b) can be placed. (5%)

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