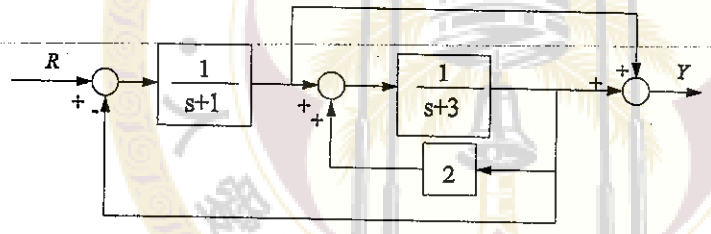
*Note: 請將題號及答案標示清楚

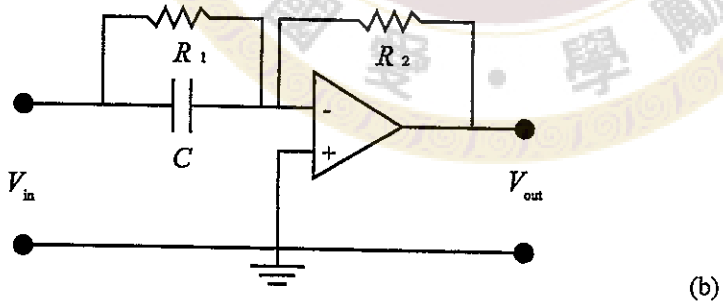
1. (25%) Please **derive** the following transfer functions
   (1) (5%) $T_{R\to Y}$ of Fig. 1(a)

   (2) (5%) $T_{V_{in}\to V_{out}}$ of Fig. 1(b)

   (3) (5%) $T_{u\to y}$ for the state-space model : $\begin{cases}\dot{x}=\begin{bmatrix}-1 & 0 & 1\\ -1 & -1 & 0\\ 0 & 0 & 1\end{bmatrix}x+\begin{bmatrix}1\\0\\1\end{bmatrix}u,\\ y=\begin{bmatrix}1 & 2 & 0\end{bmatrix}x\end{cases}$

   (4) (10%) $T_{\begin{bmatrix}F\\Z\end{bmatrix}\to\begin{bmatrix}x_1\\x_2\end{bmatrix}}$ of the two-mass system of Fig. 1(c), where F and Z are the force and displacement inputs, respectively. x_1 and x_2 are the displacement of m_1 and m_2. k and k_2 are springs, while c is a damper.





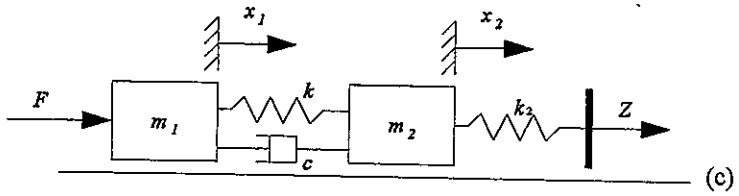


Fig. 1: The systems.

2. (25%) Consider the system of Fig. 1(a), with a unit step input $R(t)$.
   (1) (5%) Derive the output response $Y(t)$.
   (2) (5%) Calculate the peak time of the output response $Y(t)$.
   (3) (5%) Compute the maximum overshoot of the output response $Y(t)$.
   (4) (5%) Estimate the settling time (within 2% error) of the output response $Y(t)$.
   (5) (5%) Find the steady-state error of the output response $Y(t)$.

3. (50%) Consider the system of Fig. 2 with $G(s)=\dfrac{K}{s(s^2+10s+100)}$
   (1) (10%) Suppose $C(s)=2$, draw the root-loci of the closed-loop system as $K=0\to\infty$. Find the range of K such that the closed-loop system is stable.
   (2) (10%) When K=100, sketch the Bode plot of G, and estimate the cross-over frequency of G. What is the corresponding phase margin if $C(s)=1$?
   (3) (10%) Calculate the required value of K to adjust the cross-over frequency of G to 10 rad/sec. What is the corresponding phase margin if $C(s)=1$?
   (4) (10%) Continued from (3), please design a suitable phase-lead controller $C(s)$ such that the phase margin is more than $45°$.
   (5) (10%) Continued from (4), **sketch** the Nyquist plot and Nichols chart of $L(s)=G(s)\cdot C(s)$.

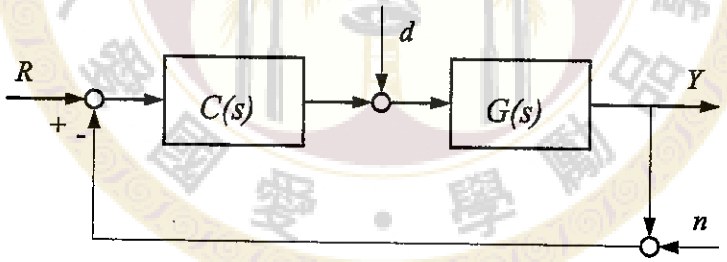


Fig. 2: A closed-loop system.

試題隨卷繳回