淡江大學 100 學年度碩士班招生考試試題 53-1

系別：電機工程學系控制系統組
電機工程學系機器人工程所

科目：控 制 系 統

考試日期:2 月 28 日(星期一) 第 2 節

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1. Find a state space representation for the transfer function
$G(s)=\begin{bmatrix}\frac{-(12s+6)}{3s+34} & \frac{22s+23}{3s+34}\end{bmatrix}$. (10%)

2. Consider the control system shown in Fig. 1. The plant dynamics are described by the transfer function $G(s)=\frac{1}{s^2+3s+2}$ If we assume a unity-feedback control system with a PID control $D(s)=K(1+2s+T_I/s)$

   (i) Find the range of K for which this system is stable when $T_I=5$. (10%)

   (ii) With no integral control, i.e., $T_I=0$ find a sufficient value for the gain K so that the poles $s_{1,2}$ of the closed loop system have $\mathrm{Re}(s_{1,2})<-0.5$ and $|\mathrm{Im}(s_{1,2})|<2$ (10%)

3. An open-loop mechanical system is governed by the second order system $\ddot{y}+6\dot{y}+5y=u(t)$, where $u(t)$ is considered the input and $y(t)$ is the output state.

   (i) Take the Laplace transform (with zero initial conditions) to determine the open-loop transfer function between $U(s)$ and $Y(s)$. (10%)

   (ii) Is the open-loop system stable? (10%)

   (iii) Design a feedback control system with variable gain K which will remove the steady-state error when the system is subjected to a unit step input. (10%)

   (iv) For what values of K is the closed-loop system stable? (10%)

4. For the electrical circuit shown in Fig. 2, find the transfer function from $u(t)$ to $y(t)$. (10%)

5. Consider a robot manipulator described by Fig. 3. If gravity and friction are ignored the system has the dynamics

$$(J+ML^2)\ddot{\theta}=T(t),\ (1)$$

where θ is angular displacement, T is motor torque, J = 1, M = 8, and L = 2. To improve the performance we consider using the proportional-derivative controller

$$T(s)=K(\theta_r-\theta)-K_v\dot{\theta}(s),\ (2)$$

where K and K_v are the proportional and derivative gains respectively.

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(i) Draw a unity feedback block diagram (not simplified) described by Eq. (1) and (2). (10%)

(ii) Use the block diagram to find the transfer function $G(s)=\frac{\theta}{\theta_r}$ (10%)

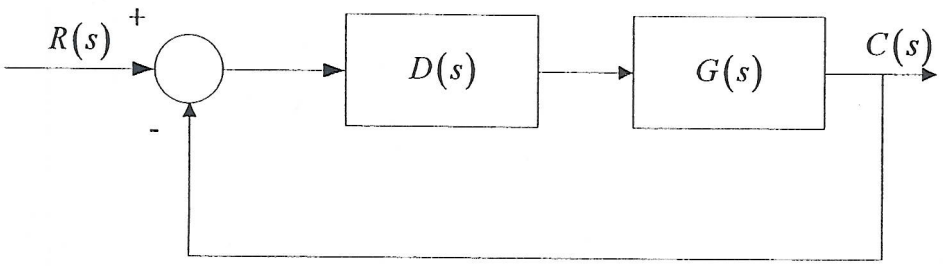

Figure 1

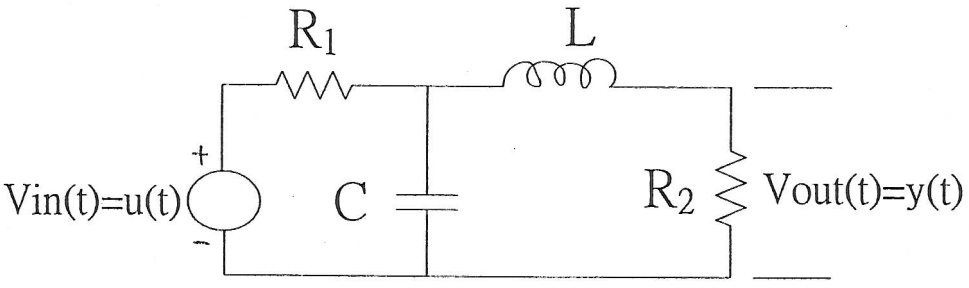

Figure 2

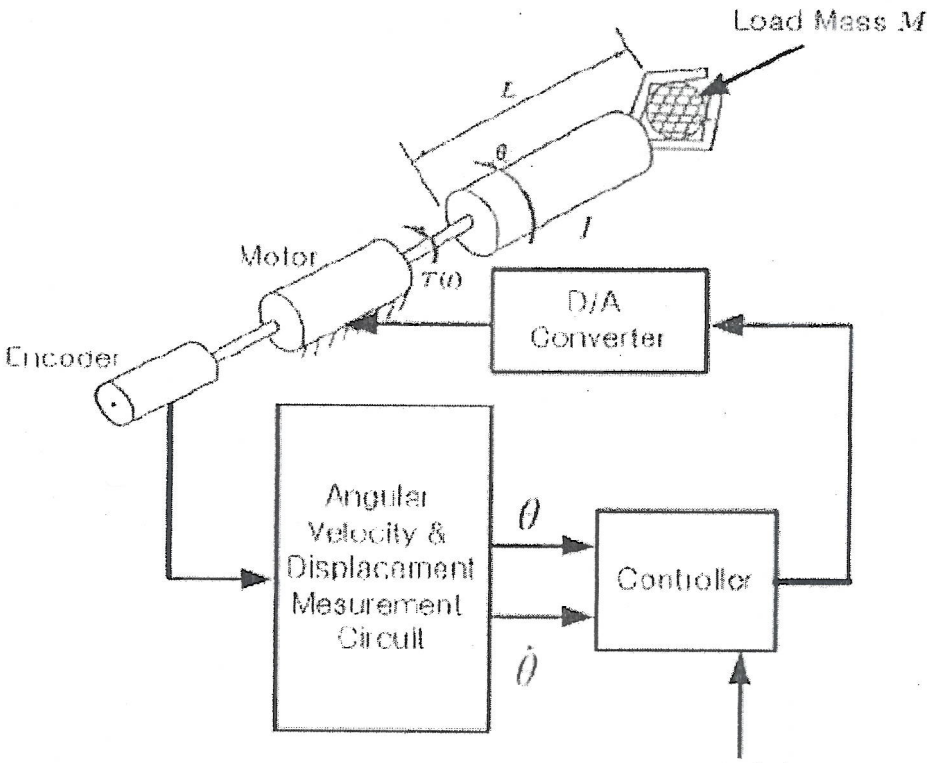

Figure 3