(命題用紙)

國立臺灣科技大學

八十七學年度碩士班招生考試試題

所　別：電機工程技術研究所　　組別：控制組　　科目：信號與系統

學程別：

Problem 1. (20%) A system may or may not be (a) memoryless, (b) time invariant, (c) causal, (d) stable, and (e) invertible. Determine which of these properties hold and do not hold for each of the following two systems. **Justify your answers.** In each system, $x(t)$ or $x[n]$ represents the system input, and $y(t)$ or $y[n]$ is the system output.

(1) $y(t) = \int_{-\infty}^{2t} x(\theta)d\theta$

(2) $y[n] = x[4n+1]$

Problem 2. (12%) Suppose we are given the following information about a signal $x(t)$:

(1) $x(t)$ is a real signal.

(2) $x(t)$ is periodic with period $T = 6$ and has Fourier coefficients a_k.

(3) $a_k = 0$ for $k = 0$ and $k > 2$.

(4) $x(t) = -x(t-3)$.

(5) $\frac{1}{6}\int_{-3}^{3}|x(t)|^2\,dx = \frac{1}{2}$.

(6) a_1 is a positive real number.

Find $x(t)$.

Problem 3. (18%) Determine the output of the filter shown in Fig.1 for the following periodic inputs:

(1) $x_1[n] = (-1)^n$

(2) $x_2[n] = 1 + \sin\left(\frac{3\pi}{8}n + \frac{\pi}{4}\right)$

(3) $x_3[n] = \sum_{k=-\infty}^{\infty}\left(\frac{1}{2}\right)^{n-4k}u[n-4k]$

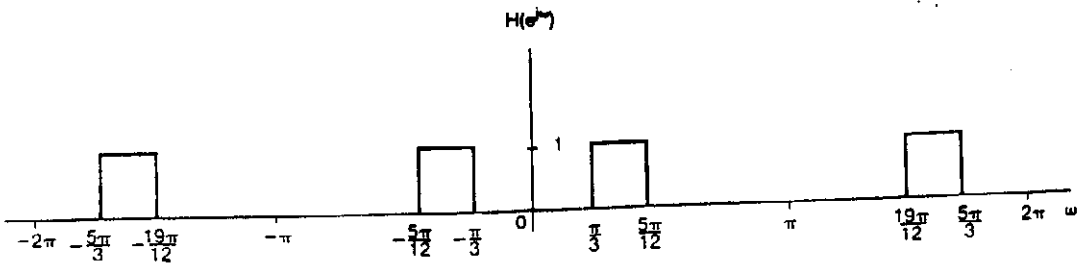

Figure 1

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Problem 4. (20%) The block diagram of a dc motor is shown in Fig. 2.

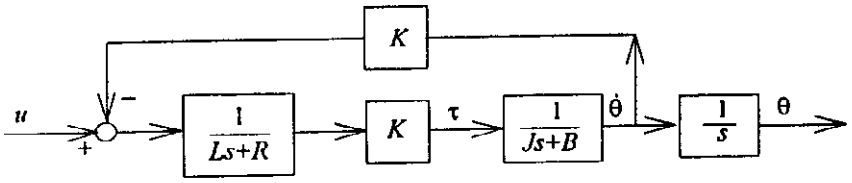

Figure 2. Block diagram of a dc motor.

(a) Find the transfer function $G(s)$ such that the block diagram in Fig. 3 is equivalent to the block diagram in Fig. 2.

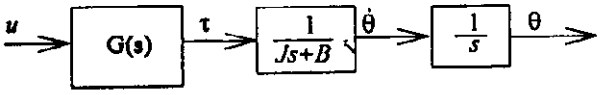

Figure 3. Equivalent block diagram of a dc motor.

(b) Find the closed-loop transfer function $F(s) = \dfrac{\Theta(s)}{R(s)}$ of the dc motor position control system shown in Fig. 4, where k_1, k_2, and k_3 are control gains.

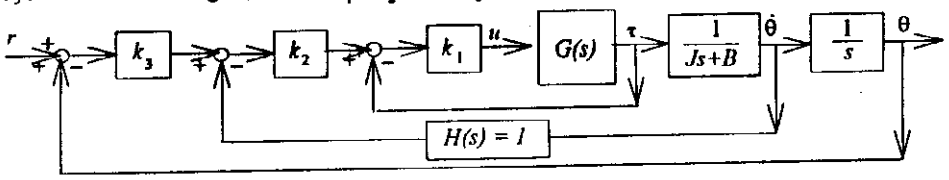

Figure 4. A position control system of a dc motor.

(c) If control gains k_1, k_2, and k_3 are all greater than zero and $H(s) = 1$, is the dc motor position control system in Fig. 4 asymptotically stable? Why?

(d) If the motor speed is not feedback in Fig. 4, i.e. $H(s) = 0$, is the dc motor position control system controllable? Why?

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Problem 5. (20%) For the feedback control system shown below,

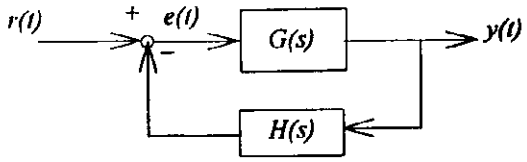

Figure 5. A feedback control system, with $G(s)=\frac{k}{s(s+p)}$, and $H(s)=1+ds$.

find the steady-state errors, $e_{ss}=\lim_{t\to\infty} e(t)$, for input $r(t)$ are

(a) unit step function $r(t)=u(t)$

(b) unit ramp function $r(t)=t\,u(t)$

(c) parabolic function $r(t)=0.5t^2\,u(t)$

(d) sine function $r(t)=\sin(t)$

Problem 6. (10%) The forward-path transfer function of a unit-feedback control system is $G(s)=\frac{k(s+a)}{s^2(s+3)}$, determine the value of a so that the root locus for $k>0$ will have one breakaway point, not including the one at $s=0$. Construct the resulting root locus.