

※請在答案卷內作答

一、(5%) The I-O relation of a CT system is $y(t) = e^{-t}x(t), t > 0$. Determine whether the system is
(a) memoryless, (b) stable, (c) causal, (d) linear, and (e) time invariant.

二、(10%)

(a) (5%) The impulse response of an LTI system is $h(t) = \begin{cases} \cos(\pi t), & |t| < 0.5 \\ 0, & \text{otherwise} \end{cases}$. Use linearity and time

invariance to determine and plot the output $y(t)$ for $x(t) = \delta(t+1) - \delta(t-1)$.

(b) (5%) Evaluate the convolution sum: $y[n] = (u[n+3] - u[n-1]) * u[n-4]$.

三、(15%)

(a) (10%) Find the frequency response (5%) and impulse response (5%) of the discrete-time system described by $8y[n] - 2y[n-1] - y[n-2] = x[n] + x[n-1]$.

(b) (5%) Draw direct form II implementation of the system in (a).

四、(10%)

Find the time domain signal $x(t)$ corresponding to the following Fourier Transform representations

(a) (4%) $X(j\omega) = 4\pi\delta(\omega - 3\pi) + 2j\pi\delta(\omega - 5\pi) + 4\pi\delta(\omega + 3\pi) - 2j\pi\delta(\omega + 5\pi)$

(b) (6%) $X(j\omega) = \sum_{k=0}^6 \frac{\pi}{1+|k|} \left\{ \delta\left(\omega - \frac{k\pi}{2}\right) + \delta\left(\omega + \frac{k\pi}{2}\right) \right\}$

五、(20%)

A periodic signal has the Fourier Series (FS) representation

$x(t) \xleftrightarrow{FS; \pi} X[k] = -k2^{-|k|}$. Without determining $x(t)$, find the FS representation ($Y[k]$ and ω_0) if

(a) (2%) $y(t) = x(3t)$

(b) (2%) $y(t) = \frac{d}{dt}x(t)$

(c) (2%) $x(t) = x(t-1)$

(d) (2%) $y(t) = \text{Re}\{x(t)\}$

(e) (6%) $y(t) = \cos(4\pi t)x(t)$

(f) (6%) $y(t) = x(t) * x(t-1)$ [* stands for convolution]

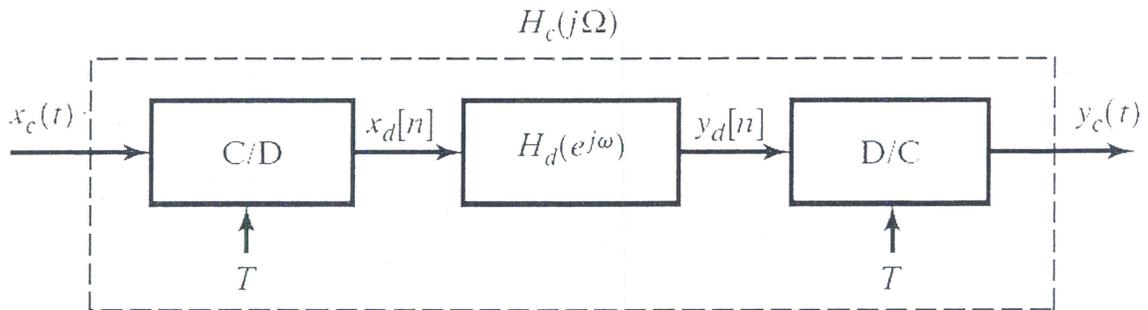
六、(10%)

The system shown below is intended to approximate a differentiator for bandlimited continuous-time input waveforms.

注意：背面有試題



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- The continuous-time input signal $x_c(t)$ is bandlimited to $|\Omega| < \Omega_M$.
- The ideal C/D converter has sampling period $T = \pi/\Omega_M$, and produce the signal $x_d[n] = x_c(nT)$.
- The discrete-time filter has the frequency response $H_d(e^{j\omega}) = \frac{e^{j\omega/2} - e^{-j\omega/2}}{T}$, $|\omega| \leq \pi$.
- The ideal D/C converter is such that $y_d[n] = y_c(nT)$.

(a) (4%) Find the continuous-time frequency response $H_c(j\Omega)$ of the end-to-end system.

(b) (6%) Find $x_d[n]$, $y_c(t)$, and $y_d[n]$ when the input signal is $x_c(t) = \frac{\sin(\Omega_M t)}{\Omega_M t}$.

七、(5%)

A BIBO stable system has a transfer function $H(s) = \frac{s(s-1)}{(s+2)(s+a)}$, which has a partial fraction expansion:

$H(s) = A + \frac{B}{s+2} + \frac{C}{s+a}$. If $a \neq 2$ and $B = 1.5$, then put the correct answers in the following blanks.

(a) (3%) $a =$ _____, $A =$ _____, $C =$ _____

(b) (2%) The ROC (region of convergence) of the transfer function $H(s)$ is _____

八、(10%)

The following figure shows some pole-zero plots of transfer functions of systems of the general form:

$H(s) = A \frac{(s-z_1) \cdots (s-z_N)}{(s-p_1) \cdots (s-p_D)}$, where $A=1$, z_i 's are the zeros, and p_i 's are the poles. Answer the following

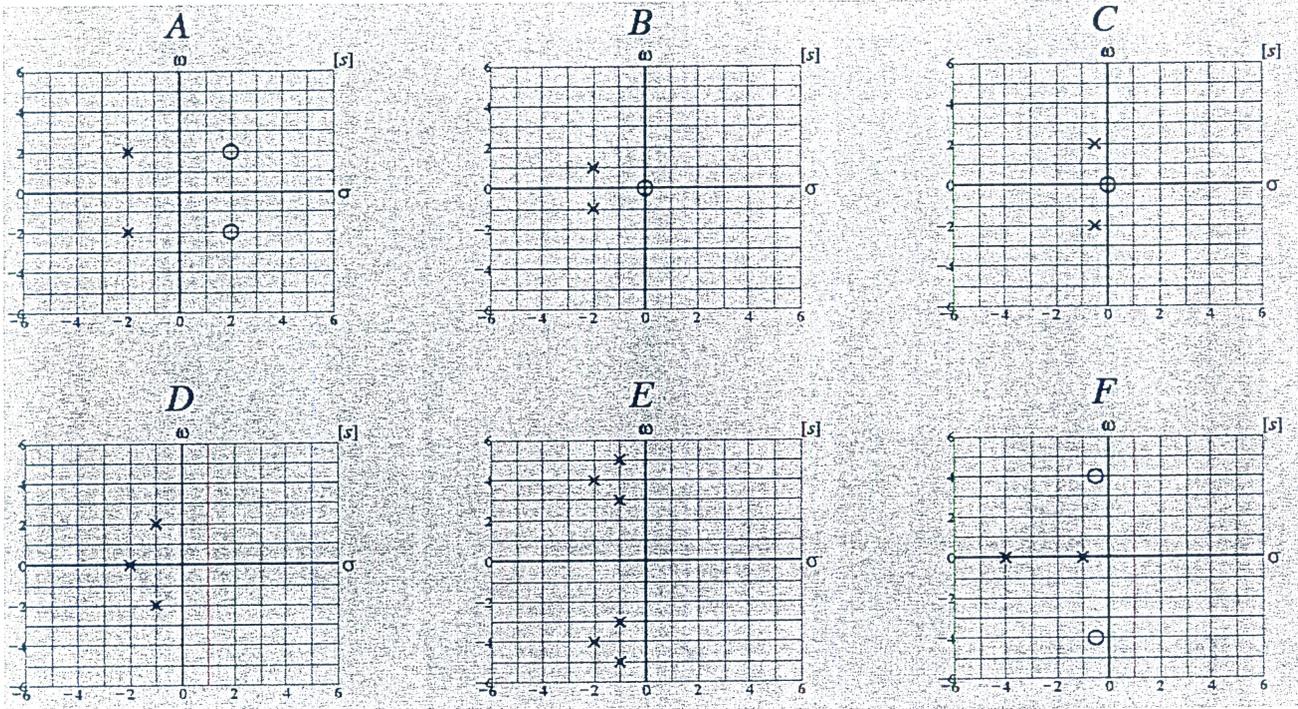
questions.

- (a) (2%) Which one(s) have a magnitude frequency response that is nonzero at $\omega = 0$?
- (b) (2%) Which one(s) have a magnitude frequency response that is nonzero at $\omega \rightarrow \infty$?
- (c) (2%) There are two that have a bandpass frequency response (zero at $\omega = 0$ and $\omega \rightarrow \infty$). Which one is more underdamped?
- (d) (2%) Which one has a magnitude frequency response whose shape is closest to being a bandstop filter?
- (e) (2%) Which one has a magnitude frequency response that is constant?

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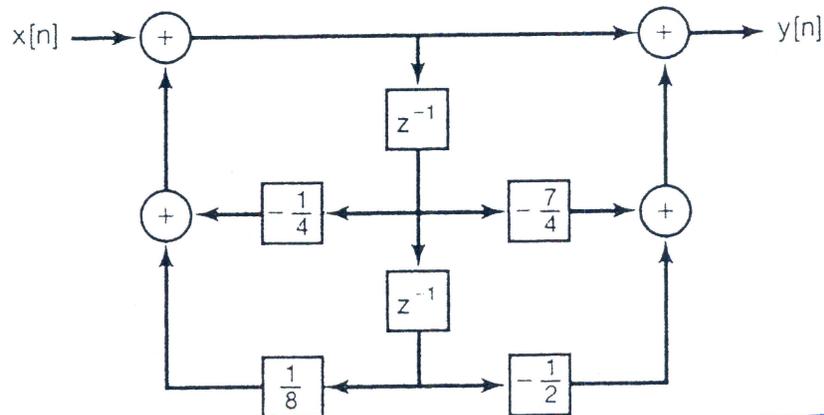
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九、(15%)

A causal LTI system with system function $H(z)$ is represented by the following block diagram.

- (3%) Determine the system function $H(z)$.
- (3%) Give a linear constant coefficient difference equation describing the system.
- (3%) What is the region of convergence of $H(z)$?
- (4%) Find the impulse response of the system.
- (2%) Is the system stable?



參考用