Midterm Examination of [Signals and Systems]

2021-2022 Spring-term

Southern University of Science and Technology

Name:_____ Class:_____ Student ID:_____

Collaboration and Plagiarism are Not Allowed!

PART 1:

Choose the correct answer(s) or fill in the blank. (2'x 10=20')

1. Choose all correct statements: _____

a) A system with input-output relation y(t)=2+x(t) is not a linear system, where x and y are the input and output signals, respectively.

b) A causal system is a memoryless system.

c) If the input signal to a LTI system is periodic, then the output is also periodic with the same period.

d) The system y(t)=x(t) sin(t+1) is a causal system.

2. For a CT LTI system, if the linear-constant-coefficient differential equation connecting input x(t) and output y(t) is given, we can also have _____.

a) The system function of the LTI system

b) Frequency response of the LTI system

c) The Unit impulse response of the LTI system

d) System output y(t) when the input signal x(t) is given

3. For signal $x(t) = \delta(t)$, its Fourier transform $X(j\omega) =$ _____, and for signal $x(t) = 2\delta(t-1)$, its Fourier transform $X(j\omega) =$ _____

4. Please 1) describe the frequency response of an ideal lowpass filter, and 2) discuss whether it is a causal system and why:

_____

_____

_____

_____

5. For a CT, time-limited (aperiodic) signal, its Fourier transform is _____.

a) discrete b) continuous c) not sure

6. Please describe the steps to get the Fourier transform of a periodic signal.

_____

_____

_____

The Fourier transform of a CT periodic signal is a _____ spectrum.

a) discrete b) continuous c) Depends on the input signal

7. For a LTI system with unit impulse response h(t) and input signal x(t), please describe at least 2 ways to determine the output signal y(t).

_____

_____

_____

_____

8. $\int_{-\infty}^{3}(2t^2+3t)\delta(\frac{1}{2}t-2)dt$ = （ ）

A. 0 B. 27 C. 44 D. 88

9. The Fourier transform of f(t) is F ($j\omega$), then the Fourier transform of $f'(2t)$ is ( )

A. $j4wF(j2w)$ B. $j\frac{w}{4}F(j\frac{w}{2})$

C. $j\frac{w}{2}F(j\frac{w}{2})$ D. $j2wF(j2w)$

10. For a DT LTI system S, the shape of the frequency response of

$y[n]=(x[n]+x[n-1]+x[n-2]+x[n-3])/4$ is _____; while the shape of the frequency

response of $y[n]=x[n]-x[n-1]$ is _____.

a) Low-pass filtering b) High-pass filtering

c) Band-pass filtering d) Dependent on the spectrum of the input signal x[n]

PART 2：

P1 (15' =10'+5')

(1) Calculate the convolution of the following two signals:

$$x(t)=\begin{cases}1, & 0<t<2\\ 0, & \text{otherwise}\end{cases}, \text{ and } h(t)=\begin{cases}t, & 0<t<4\\ 0, & \text{otherwise}\end{cases}.$$

and plot the waveform of y(t)=x(t) * h (t)

(2) Describe a different method to compute y(t)=x(t) * h (t). Elaborate the procedure without computation.

P2 (10'=2'+4'+4')

For a CT periodic signal $x(t)=\sin(\pi\cdot t/4)+3\sin(\pi\cdot t/2)$,

(1) What is the fundamental period (T)?

(2) Represent the signal x(t) in the form of Fourier series.

(3) Plot its Fourier series and Fourier transform, respectively.

P3 (20'=5'+5'+5'+5')

Consider an LTI system with impulse response $h[n]=0.3^n\,u[n]$, and with an periodic input

$$x[n]=\cos(\frac{\pi n}{4})+3\cos(\frac{\pi n}{2})$$

(1) Represent the input signal $x[n]$ in the form of Fourier series.

(2) Determine the Fourier series coefficients from a_{-5} to a_2, and a_{32}, a_{47}.

(3) What is the frequency response of this system?

(4) Express the system output $y[n]$ in the form of Fourier series.

Note:

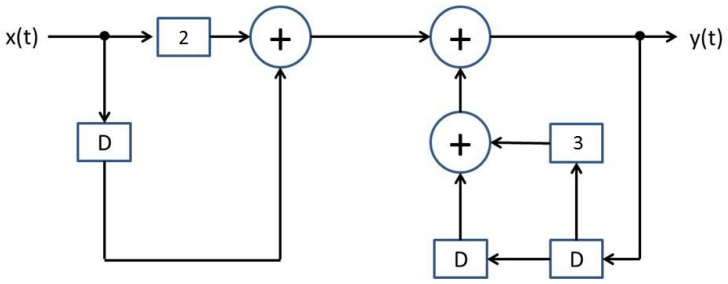
$$H(e^{j\omega})=\sum_{n=-\infty}^{+\infty}h[n]e^{-j\omega n}$$

P4 (15'=10'+5')

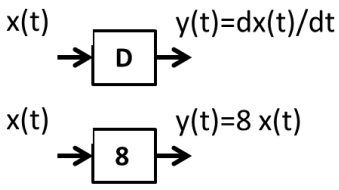
Consider the following block diagram of an CT LTI system.

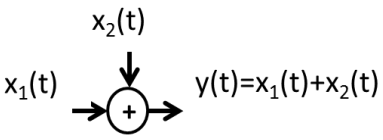
1) Write a differential equation relating the input $x(t)$ and output $y(t)$

2) Write the frequency response $H(j\omega)$ of this LTI system..



Note:





P5 (20' =5'+5'+10')

A causal and stable LTI system S has the frequency response of

$$H(j\omega)=\frac{Y(j\omega)}{X(j\omega)}=\frac{2j\omega+2}{15-\omega^2+8j\omega},$$

(1) Determine a differential equation relating the input $x(t)$ and output $y(t)$ of S.

(2) Determine the impulse response $h(t)$ of S.

(3) What is the output of S when the input is $x(t)=e^{-t}u(t)$?