

KATHMANDU UNIVERISTY
End Semester Examination
May/June, 2022

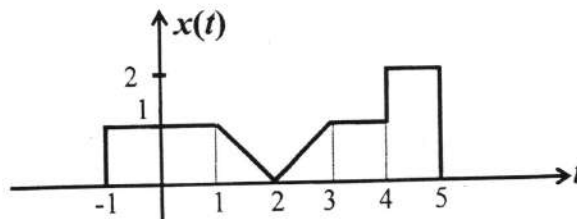
Level : B.E.
Year : II
Time : 2 hrs. 30 mins.

Course : EEG 221
Semester : II
F.M. : 40

SECTION "B"
[5Q. × 8 = 40 marks]

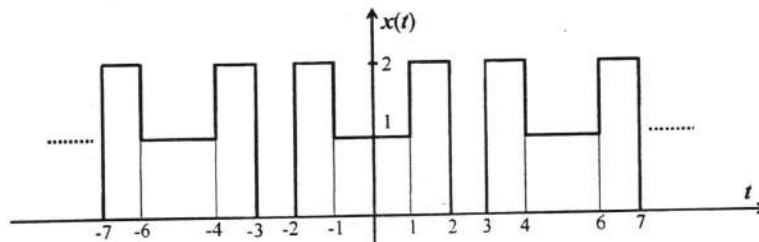
Attempt *ANY FIVE* questions. Symbols and abbreviations have usual meanings. Assume suitable values for missing data.

1. a. Any signal can be expressed as sum of its even and odd components. Find the even and odd components of the following CT signal. [3]



- b. Define following signal classifications with suitable examples: [2]
 i) Periodic and aperiodic signals
 ii) One dimensional and multidimensional signals
- c. Check if the DT system described by following input-output equation is linear, time invariant and stable or not. (Show the checking steps clearly) [3]

$$y[n] = a n x[n - 1]$$
2. a. CT and DT signals have some fundamental differences regarding the frequencies. Elaborate these differences by comparing CT and DT complex exponential signals, $e^{j\omega t}$ and $e^{j\Omega n}$. Also check if the DT signal $x[n] = \sin[0.2n]$ is periodic or not. [2+1]
- b. Using the analysis equation, find the complex exponential Fourier series of the following periodic signal. Also plot the spectrum using at least first 3 coefficients. [3]



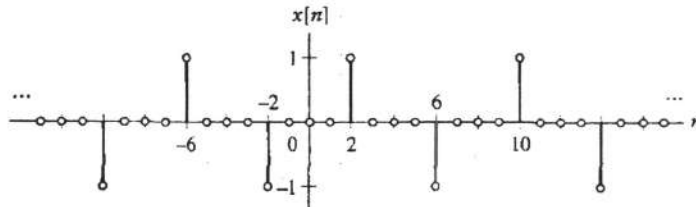
- c. What do you understand by LTI systems? How can we use impulse response to represent a LTI system? [2]
3. a. An LTI system with impulse response $h(t)$ and input $x(t)$ has the output designated as $y(t)$. Using graphical fold, shift and overlap method, compute the output if, [4]

$$x(t) = e^{-2t} \{u(t + 1) - u(t - 2)\}$$

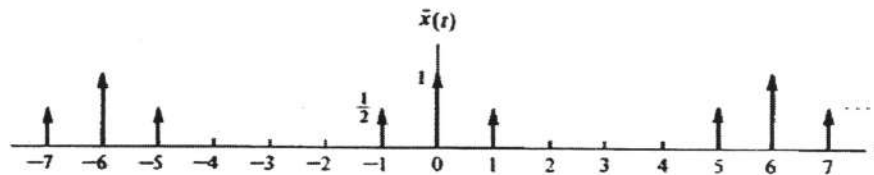
$$h(t) = e^{-t} u(t)$$

Show all related plots of the figures with proper labeling.

- b. State and prove the commutative property for convolution sum. [2]
- c. When the FS coefficients of a CT periodic signal are known, the FS coefficients of its derivative (differentiation) can be computed directly using a property of CTFS. State and prove how can this be done. [2]
4. a. A DT periodic signal is shown in figure below. Using analysis equation, evaluate the DTFS coefficients of the signal. Sketch the magnitude and phase spectra. [3]



- b. What do you know about 'Gibbs Phenomenon'? Is it applicable in case of DTFS? [2]
- c. Determine the Fourier transform of the CT signal $x(t) = e^{-t/2}u(t)$ and obtain $\Re\{X(j\omega)\}$, $\Im\{X(j\omega)\}$, $|X(j\omega)|$, $\angle X(j\omega)$. Also show the approximate plot of the spectrum. [3]
5. a. Fourier transform can be computed for periodic signals also. FT of periodic signals consists of impulses in frequency domain. Using this information, compute the FT of the following periodic signal. [3]



- b. A two sided DT exponential signal is given by the following expression: $x[n] = 0.5^{|n|}$ [3]
Find the DTFT of the signal. What general comment can be done by observing its approximate spectra?
- c. Explain the terms 'white noise' and 'thermal noise'. [2]
6. a. Explain impulse train sampling with relevant time domain and frequency domain expressions. Also use some example to elaborate the situations of under-sampling and oversampling. [3]
- b. Define signal energy and power. Compute the total energy of the DT signal $x[n] = \begin{cases} 1, & 0 \leq n \leq 5 \\ 0, & \text{otherwise} \end{cases}$ [2]
- c. A Butterworth filter is to be designed for following specifications: $\alpha_p = 3 \text{ dB}$, $\alpha_s = 14 \text{ dB}$, $f_p = 4 \text{ kHz}$, $f_s = 6 \text{ kHz}$ [3]
Determine the minimum order required and also the cutoff frequency of the corresponding filter.

KATHMANDU UNIVERSITY
End Semester Examination
May/June, 2022

Marks Scored:

Level : B.E.
Year : II

Course : EEG 221
Semester : II
F. M. : 10

Exam Roll No. : Time: 30 mins.

Registration No.:

Date :

SECTION "A"
[20Q. × 0.5 = 10 marks]

Encircle the most appropriate option.

- A DT signal $x[n] = (-1)^{n^2}$ is
 - Non periodic
 - Periodic with fundamental period 2 samples
 - Periodic with fundamental period 4 samples
 - a constant signal
- A signal $x(t) = u(t - a)$ will have values equal to zero for all
 - $t - a = 0$
 - $t - a > 0$
 - $t - a < 0$
 - $|t| < a$
- For a signal $x(t)$, $x(2) = 0$. It is then guaranteed that signal $x(2t - 3)$ will have value zero at $t = \dots\dots\dots$
 - 5
 - 2.5
 - 0.5
 - 2
- Which of the following operation does change the frequency components of the signal?
 - Inversion
 - Time shifting
 - Amplification
 - Time scaling
- Which of the following is not the correct property of the unit impulse signal?
 - $\int_{-\infty}^{\infty} 2 \delta(t) dt = 2$
 - $\int_{-\infty}^{\infty} x(t) \delta(t - 2) dt = x(2)$
 - $\delta(t) = \delta(-t)$
 - $\delta(2t) = 2\delta(t)$
- Does the system with input output equation $y[n] = 2x[-n]$ needs memory?
 - Yes
 - No
 - Sometimes
 - Not enough information to conclude
- What is the impulse response of the system $y(t) = \int_{-\infty}^t x(\tau) d\tau$?
 - $h(t) = \delta(t)$
 - $h(t) = u(t)$
 - $h(t) = 1$
 - $h(t) = \begin{cases} 0, & \text{for } t < 0 \\ t, & \text{for } t > 0 \end{cases}$
- A LTI system with impulse response $h(t) = \delta(t - 1)$, also called an unit delay system stable and memory less?
 - Stable and memoryless
 - Stable but not memoryless
 - Unstable and memory less
 - Unstable and not memoryless
- For a system, the input $x(t) = e^t$ produces an output $y(t) = e^{-at}$. What can we say about its BIBO stability?
 - It is BIBO unstable
 - It is BIBO stable
 - Cannot classify with given information
 - Depends on value of a

10. The minimum sampling rate to avoid aliasing when sampling a CT sinusoidal signal
- >400 Hz
 - =400 Hz
 - =800 Hz
 - >200 Hz
11. $x(t)$ and $y(t)$ are two periodic signals with same fundamental frequency, such that, $x(t) \stackrel{FS}{\leftrightarrow} a_k$ and $y(t) \stackrel{FS}{\leftrightarrow} b_k$. If, $z(t) = 2x(t)y(t)$ and $z(t) \stackrel{FS}{\leftrightarrow} c_k$ then,
- $c_k = 2 a_k b_k$
 - $c_k = \frac{1}{2} a_k b_k$
 - $c_k = \sum_{l=-\infty}^{\infty} a_l b_{k-l}$
 - $\frac{1}{2} c_k = \sum_{l=-\infty}^{\infty} a_l b_{k-l}$
12. If $x(t) = e^{2jt}$ is an eigen function of an LTI system with impulse response $h(t) = e^{-t}u(t)$, the corresponding Eigen value associated to it is
- $\int_0^{\infty} e^{-(1+2j)\tau} d\tau$
 - $\int_0^{\infty} e^{(1+2j)\tau} d\tau$
 - $\int_{-\infty}^{\infty} e^{-(1+2j)\tau} d\tau$
 - $-\frac{1}{2+j}$
13. The Fourier transform of a rectangular CT pulse signal is a sinc signal in frequency. If the width of the pulse in time decreases
- the width of the main lobe of sinc function also decreases
 - the height of the main lobe of sinc function increases
 - the width of the main lobe of sinc function increases
 - the width and height of main lobe does not change
14. The Fourier transform of the exponential signal $x(t) = e^{-t}u(t)$ is $X(j\omega) = \frac{1}{1+j\omega}$. Now, based on duality property of FT, The FT of $x(t) = \frac{1}{1+jt}$ is.....
- $e^{-\omega}u(t)$
 - $e^{-j\omega}u(t)$
 - $2\pi e^{-\omega}u(\omega)$
 - $e^{-j\omega}u(\omega)$
15. Which of the following is **TRUE** about DTFS coefficients?
- They are periodic and even.
 - They are periodic and continuous.
 - They are periodic and discrete.
 - They are aperiodic and discrete.
16. The inverse DT Fourier transform of $X(e^{j\Omega}) = \frac{3}{1-0.5e^{-j\Omega}}$ is $x(t) = \dots\dots\dots$
- $3 \times (0.5)^n u[n]$
 - $0.5 \times (3)^n u[n]$
 - $(3 \times 0.5)^n u[n]$
 - $1.5 \times (0.5)^n u[n]$
17. Which of the following is **FALSE** about cross-correlation operation between two functions?
- It provides the measure of similarity between two functions.
 - It is even with $\phi_{xy}(0) = 0$.
 - It is not commutative operation.
 - The function is conjugate symmetric.
18. A mixer is a signal processing device, that produces new signals with frequencies.....
- sum of originally existing frequencies.
 - sum and difference of originally existing frequencies.
 - difference of originally existing frequencies.
 - modulated signal.
19. The input to a filter is $x(t) = \sin 10000 \pi t + \sin 20000 \pi t + \cos 40000 \pi t$ and the output is $y(t) = 0.9 \sin 20000 \pi t$, the filter can be called as
- bandpass filter
 - low pass filter
 - high pass filter
 - band stop filter
20. If a signal $x(t)$ has Fourier transform $X(j\omega)$, the Energy Spectral Density (ESD) of the signal $x(t)$ is given by.....
- $X(j\omega)^2$
 - $|X(j\omega)|$
 - $\int_{-\infty}^{\infty} |X(j\omega)|^2 d\omega$
 - $|X(j\omega)|^2$