

KATHMANDU UNIVERSITY
End Semester Examination
June/July, 2023

Marks Scored:

Level : B.E.
Year : II

Course : EEG 221
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date

02 JUL 2023

SECTION "A"

[20Q. \times 0.5 = 10 marks]

Encircle the most appropriate option.

1. Which of the following signal is an example of DT signal?
 - a. Temperature of a room
 - b. Voltage across a capacitor
 - c. Amount of garbage collected each day
 - d. Trajectory of sun from rising in the east to setting on the west.
2. Is a bounded signal absolutely integrable?
 - a. Always
 - b. Yes but not always
 - c. Never
 - d. None of above
3. Which of the following signal is an odd signal?
 - a. $x(t) = t^3 - t$
 - b. $x(t) = t^3 - t - 1$
 - c. $x(t) = \cos 0.5\pi t - 1$
 - d. $x(t) = \sin(0.5\pi t - 0.5\pi)$
4. Which is **TRUE** about the signal $(t) = e^{2t} \sin 0.5\pi t$?
 - a. It is an exponentially decaying sinusoidal signal.
 - b. It is periodic with fundamental period of 4 units.
 - c. It is periodic with fundamental period of 2π units.
 - d. It is an exponentially growing signal.
5. Which of the following is **NOT** a characteristic of deterministic signal?
 - a. Exhibits no uncertainty.
 - b. Can be represented by a mathematical model.
 - c. Instantaneous value can be accurately predicted.
 - d. Value always remains within a limit.
6. Condition for sum of two periodic signals to be periodic is:
 - a. Ratio of their time periods is unity.
 - b. Ratio of their time period is a rational number.
 - c. Ratio of their time periods is smaller than 1.
 - d. Ratio of their time periods is an integer.
7. Which is **TRUE** for the system $[n] = x[n - 5] - x[n - 3]$?
 - a. System is linear and time invariant.
 - b. System is linear and time variant.
 - c. System is non linear and time variant.
 - d. System is non linear and time invariant.
8. The system needs memory means,.....
 - a. The system always stores output values for future needs.
 - b. The system needs past or future input/output values to compute present output
 - c. The system output is sum of all past input values.
 - d. The system output is equal to the output value one unit earlier.

9. Where does the distributive property of convolution apply in LTI system?
 a. Cascade connection of LTI systems. b. Systems with feedback.
 c. Parallel connection LTI systems. d. Checking stability of LTI systems.
10. An LTI system has impulse response $h[n]$ such that $h[n] = 0$, for $n < 0$ and it has the input $x[n]$ such that $x[n] = 0$, for $n < 1$. The output signal $y[n]$ will satisfy ...
 a. $y[n] = 0$ for $n < 1$ b. $y[n] = 0$ for $n < 0$
 c. $y[n] = 0$ for $n > 0$ d. $y[n] = 0$ for $n > 1$
11. The exponential Fourier series coefficients of a rectangular pulse train can be computed using
 a. Shifted impulse signals b. Exponential functions
 c. Rectangular functions d. Sinc functions
12. As the fundamental period of the periodic signals become larger and larger, the spectral coefficients are
 a. farther separated in frequency axis b. nearer in frequency axis
 c. not changed in frequency d. at same separation but different values
13. The DTFS coefficients are
 a. continuous in nature b. aperiodic
 c. periodic with period N d. periodic with period 2π
14. The Fourier transform of an $x(t) = e^{at}u(-t)$ $a > 0$ is exponential signal is:
 a. $X(j\omega) = \frac{1}{a+j\omega}$ b. $X(j\omega) = \frac{-1}{a+j\omega}$ c. $X(j\omega) = \frac{1}{a-j\omega}$ d. $X(j\omega) = \frac{1}{-a+j\omega}$
15. The impulse response of a zero-order hold circuit is.....
 a. a rectangular function b. an impulse function
 c. a triangular function d. sinc function
16. Before sampling a CT signal satisfying the Nyquist rate, we must.....
 a. filter out low frequencies b. quantize the signal
 c. make the signal bounded d. filter out the high frequencies
17. Shot noise is produced by.....
 a. Electrons and photons b. thermal effect
 c. Starting of machines d. spurious signals in antenna
18. The noise characterized by a constant PSD is.....
 a. Gaussian noise b. additive noise
 c. white noise d. salt and pepper noise
19. Low pass Butterworth filter has magnitude response that has
 a. monotonic growth along increasing frequency.
 b. monotonic decay along increasing frequency.
 c. ripples in lower frequencies but monotonic decay at higher frequencies.
 d. ripples at higher frequencies but monotonic decay at smaller frequencies.
20. Signal mixing is signal operation most commonly found in
 a. image processing systems.
 b. transmission and reception of communication systems.
 c. digital control systems.
 d. instrumentation and measurement application.

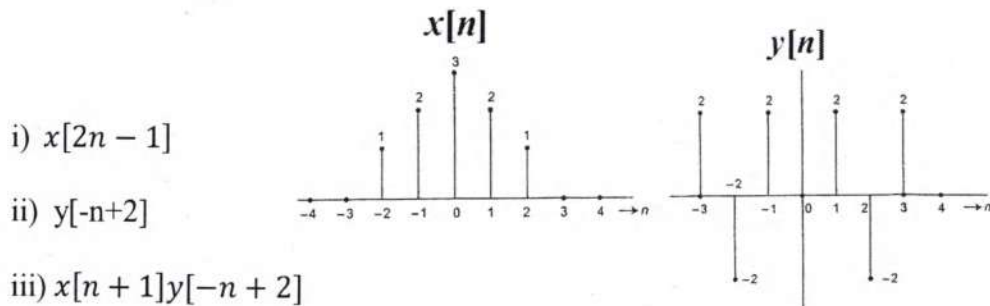
Level : B.E.
Year : II
Time : 2 hrs. 30 mins.

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. Given two DT signals below, find and sketch the following: [3]

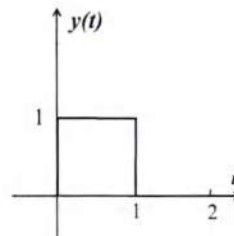
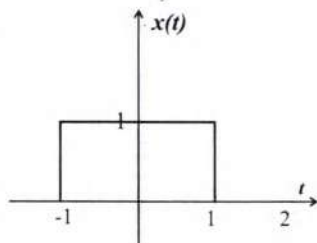


- b. Define following fundamental signal models with required expressions and figures: [3]
- i) CT and DT unit step signal
 - ii) CT and DT unit impulse signal

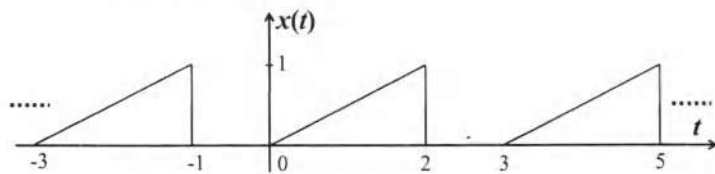
- c. How CT and DT signals can be related to the terms 'analog and digital signals'? [2]

2. a. Define the term 'impulse response'. With proper derivation, show that the output of a CT LTI system can be computed as convolution between its impulse response and input signal. [1+3]

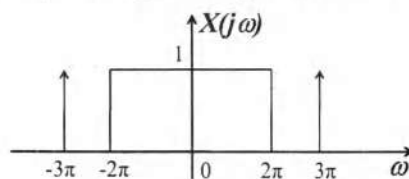
- b. Two CT signal $x(t)$ and $y(t)$ are shown in figures below. Find and plot the signal $z(t)$ resulting after the convolution between $x(t)$ and $y(t)$. Use graphical fold, shift and overlap method and show all related plots of the figures with proper labeling, [4]



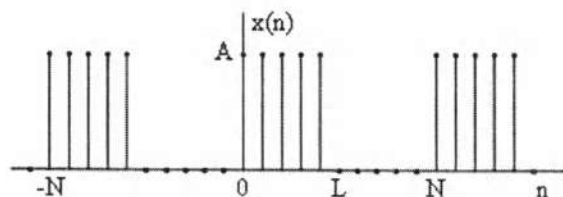
3. a. Consider a DT LTI system described by the difference equation:
 $y[n] = \frac{1}{3}y[n-1] + x[n]$. The system satisfies the condition of initial rest (i.e, if $x[n] = 0$ for $n < n_0$, then $y[n] = 0$ for $n < n_0$). If the input to the system is $x[n] = \left(\frac{1}{2}\right)^n u[n]$, find the following: [3]
- homogeneous solution,
 - particular solution
 - total solution
- b. State and prove the associative property for convolution sum. [2]
- c. A CT periodic sweep voltage waveform is shown in figure below. Using analysis equation, evaluate the exponential CTFS coefficients of the signal. What is the average value of the signal? [3]



4. a. Find the Fourier Transform of the signal $x(t) = e^{-2|t|}$. Also plot the approximate frequency spectrum. [3]
- b. A continuous time Fourier series includes terms over an infinite duration while a discrete time Fourier series synthesis equation includes only N terms. Why? [2]
- c. The following figure shows the Fourier transform of a signal $x(t)$. Using the related properties (linearity, duality etc), find the signal $x(t)$. [3]



5. a. Derive the forward and inverse transform equations for the DTFT of a DT aperiodic signal. Also show that DTFT is periodic function. [3]
- b. A DT periodic pulse train is shown in figure below. Find its DTFS coefficients for $L=4$ and $N=10$. [3]



- c. What do you understand by 'cross correlation' and 'auto correlation'? [2]

6. a. What do you understand by the term 'aliasing'? Compute the Nyquist rate for [3]
the following CT signal:
 $x(t) = 5 \cos(1500 \pi t) - 2 \sin^2(2000 \pi t) + 3 \sin(1850 \pi t)$
- b. Compute energy and power of following Ct signal and hence determine [2]
whether it is a energy or power signal:
 $x(t) = e^{-3t} u(t - 2)$
- c. Define an ideal low pass filter using its frequency response. Compute its [3]
impulse response and explain why an ideal LPF is not physically realizable.
How does a practical LPF magnitude response look like?

Some useful relationships:

Integration by parts:

$$\int u v dx = u \int v dx - \int \left(\frac{du}{dx} \int v dx \right) dx$$

Duality property of FT

$$\text{If, } x(t) \xrightarrow{FT} X(j\omega), \text{ then, } X(jt) \xrightarrow{FT} 2\pi x(-\omega),$$

The FT pairs:

$$x(t) = \begin{cases} 1, & \text{for } -T_1 \leq t \leq T_1 \\ 0, & \text{Otherwise} \end{cases} \xrightarrow{FT} X(j\omega) = 2 \frac{\sin \omega T_1}{\omega}$$

$$\delta(t) \xrightarrow{FT} 1 \quad \text{and} \quad 1 \xrightarrow{FT} 2\pi \delta(\omega)$$

Double angle Formulas:

$$\sin 2\theta = 2 \sin \theta \cos \theta$$

$$\cos 2\theta = 2 \cos^2 \theta - 1 = 1 - 2 \sin^2 \theta$$