KATHMANDU UNIVERSITY
End Semester Examination
January/February 2024

Marks Scored:

Level : B.E.
Year : II

28 JAN 2024

Course : EEEG 221
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date :

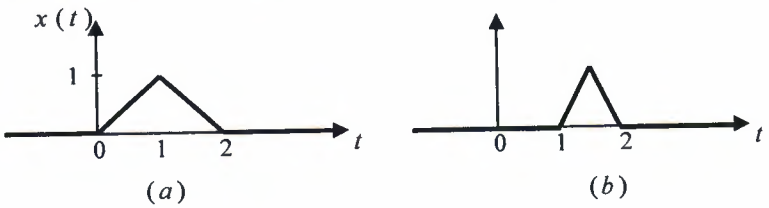
SECTION "A"
[20 Q. × 0.5 = 10 marks]

Encircle the most appropriate answer OR give an appropriate objective answer.

1. An 1-D analog signal is characterized by
   a. a continuous-value independent variable and a continuous-value dependent variable.
   b. a discrete-value independent variable and a continuous-value dependent variable.
   c. a continuous-value independent variable and a discrete-value dependent variable.
   d. a discrete-value independent variable and a discrete-value dependent variable.

2. If $x(t)$ represents a tape recording, then $x(2t-2)$ represents the recording played at
   a. half speed a little later than $x(t)$.
   b. half speed a little earlier than $x(t)$.
   c. double speed a little earlier than $x(t)$.
   d. double speed a little later than $x(t)$.

3. In the following figure, if the signal in (a) is $x(t)$, the signal in (b) is _____.



(a) (b)

4. A unit delay system given by $h(t)=\delta(t-1)$ is
   a. stable and memory-less.
   b. unstable and memory-less.
   c. stable and not memory-less.
   d. unstable and not memory-less.

5. When two systems with their impulse responses $h_1(t)$ and $h_2(t)$ are connected in series, the impulse response $h(t)$ of the resulting system is given by
   a. $h_1(t)+h_2(t)$.
   b. $h_1(t)-h_2(t)$.
   c. $h_1(t)\times h_2(t)$.
   d. $h_1(t)*h_2(t)$.

6. If the input to a discrete time system is $x[n]=\delta[n-1]$ and the impulse response of the system is $h[n]=\delta[n]+0.5\delta[n-1]$, then the output of the system $y[n]$ is _____.

7. The impulse response of a system represented by $\frac{dy(t)}{dt}+0.5y(t)=x(t)$ is _____.

8. The Fourier series coefficient of a real-odd signal is
a. real-odd b. imaginary-odd c. real-even d. imaginary-even

9. The number of non-zero spectral components in the complex Fourier series representation of $1+0.5\cos(\omega_0 t)-0.2\sin(\omega_0 t)$ is
a. 5. b. 4. c. 3. d. 2.

10. According to the shifting property, the Fourier transform of $\delta(t-t_0)$ is _____.

11. Spectrum of a rectangular pulse is represented by a sinc function in frequency. If the width of the pulse decreases in time then the main lobe of the spectrum will be
a. narrower and taller. b. narrower and smaller.
c. wider and taller. d. wider and smaller.

12. The discrete Fourier series coefficients of a periodic sequence is
a. discrete and aperiodic. b. discrete and periodic.
c. continuous and periodic. d. continuous and aperiodic.

13. The discrete Fourier transform of a discrete time energy signal is
a. continuous-valued periodic with period π.
b. continuous-valued periodic with period 2π.
c. discrete-valued periodic with period π.
d. discrete-valued periodic with period 2π.

14. A signal has been sampled at 8 kHz without aliasing. The signal can be reconstructed from its samples by passing the sampled signal through an ideal low-pass filter with cut-off frequency at _____.

15. In order to avoid aliasing in a practical ADC, the signal is first filtered by a
a. low-pass filter. b. band-pass filter. c. notch filter. d. high-pass filter.

16. The Fourier transform of cross-correlation between two signals $x_1(t)$ and $x_2(t)$ is given by
a. $X_1(j\omega)+X_2(j\omega)$. b. $X_1(j\omega)\times X_2(j\omega)$.
c. $X_1(j\omega)\times X_2^*(j\omega)$. d. $X_1(j\omega)*X_2(j\omega)$.

17. In case of an LTI system, the PSD of the input $x(t)$ denoted as $S_x(\omega)$ and PSD of the output $y(t)$ denoted as $S_y(\omega)$ are related by the relation
a. $S_y(\omega)=|H(\omega)|S_x(\omega)$. b. $S_x(\omega)=|H(\omega)|S_y(\omega)$.
c. $S_y(\omega)=|H(\omega)|^2 S_x(\omega)$. d. $S_x(\omega)=|H(\omega)|^2 S_y(\omega)$.

18. Signal mixing is generally used in
a. an ADC.
b. a DAC.
c. a band-pass filter.
d. a radio transmitter.

19. An ideal band-stop filter has the following number of bands.
a. 1 pass and 1 stop.
b. 1 pass and 2 stop.
c. 2 pass and 1 stop.
d. 2 pass and 2 stop.

20. An input signal $x(t) = \cos(2\pi \times 1000t) + \sin(2\pi \times 2000t) + \cos(2\pi \times 4000t)$ was filtered and the output obtained was
$y(t) = 0.9\cos(2\pi \times 1000t) + 0.001\sin(2\pi \times 2000t) + 0.8\cos(2\pi \times 4000t)$.
The filter is a
a. low-pass filter.
b. high-pass filter
c. band-pass filter.
d. band-stop filter.

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SECTION "B"
[5Q. × 8 = 40 marks]

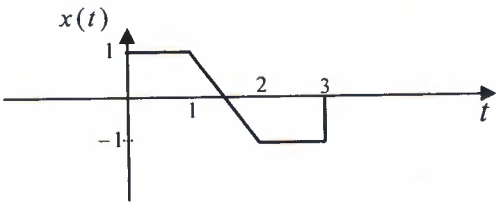
Attempt *ANY FIVE* questions.

1. a. Give examples of the following kinds of signals, clearly mentioning their key properties. [4]

(i) Continuous time and discrete time signals
(ii) Deterministic and stochastic signals
(iii) Energy and power signals
(iv) Control and information signals

b. If signal $x(t)$ is as shown below, sketch graph, label, and give analytical expressions of each of the following derived signals. [4]

(i) $x(1-t)$ (ii) $x(2t-1)$ (iii) $\frac{dx(t)}{dt}$ (iv) $\int_{-\infty}^{t} x(t)dt$



2. a. With appropriate examples, distinguish between the following types of systems. [4]
(i) Linear and non-linear systems
(ii) Time-invariant and time-variant systems
(iii)Invertible and non-invertible systems
(iv)Finite impulse response (FIR) and infinite impulse response (IIR) systems

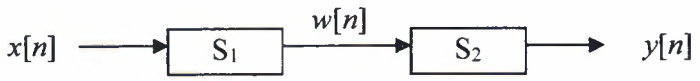
b. Plot the given input signal $x(t)$ and system impulse response $h(t)$. Determine the system output $y(t) = x(t) * h(t)$ in analytical form. Also, sketch the output. [4]

$$x(t) = \begin{cases} t+1 & 0 \le t \le 1 \\ 2-t & 1 \le t \le 2 \\ 0 & elsewhere \end{cases} \quad \text{and} \quad h(t) = \delta(t+2) + 2\delta(t+1)$$

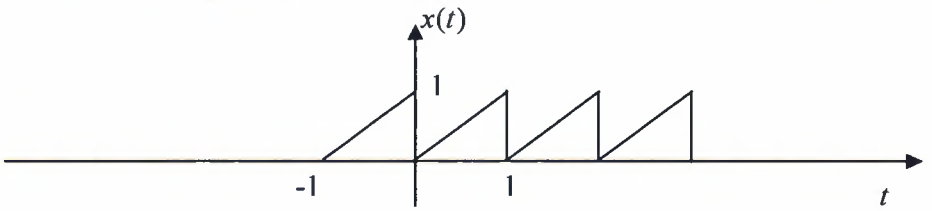
3. a. A system S is realized with a cascade connection between two sub-systems S_1 and S_2 as illustrated in the figure. The input-output relation of individual sub-systems and system S are given as indicated. Find: (i) α and β, and (ii) the impulse response of the system S either analytically or using recursive computation and sketch it. [4]

$$w[n] = \frac{1}{2}w[n-1] + x[n] \quad ; \quad y[n] = \alpha y[n-1] + \beta w[n] \quad ; \quad \text{and}$$

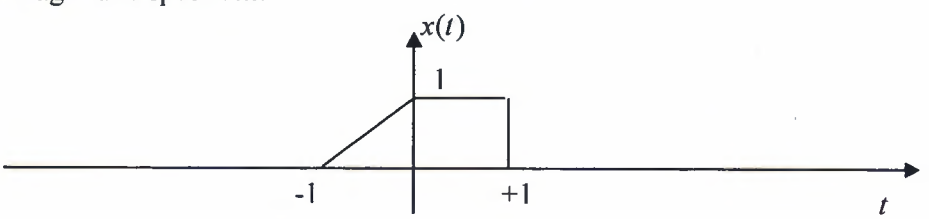
$$y[n] = -\frac{1}{8}y[n-2] + \frac{3}{4}y[n-1] + x[n]$$



b. Determine the complex Fourier series representation of the following saw-tooth wave signal. Plot the magnitude spectrum. [4]



4. a. Evaluate Fourier transform of the given signal. Also, present a rough sketch of the magnitude spectrum. [4]



b. A causal and stable system has a frequency response given by $H(j\omega)$. Determine [4]
(i) the differential equation representation of the system,
(ii) its impulse response, and
(iii) its output when the input is $x(t) = e^{-t}u(t)$.

$$H(j\omega) = \frac{j\omega + 4}{(j\omega)^2 + 5j\omega + 6}$$

5. a. Discuss [4]
(i) periodicity,
(ii) time-shifting,
(iii) time-scaling,
(iv) multiplication/convolution properties of Discrete Time Fourier Series and Discrete Time Fourier Transform with appropriate illustrations.

b. Present an application of the concept/theory of periodic impulse train sampling in the digital processing of an analog signal. Use appropriate illustration in both time and frequency domains. [4]

6. a. Find and plot the correlation between the following two signals. [3]

$$x_1(t) = u(t) - u(t-2) \qquad \text{and} \qquad x_2(t) = \begin{cases} t+1 & 0 \le t \le 1 \\ 2-t & 1 \le t \le 2 \\ 0 & \textit{elsewhere} \end{cases}$$

b. Briefly discuss applications of signal multiplication. [2]

c. Compare pass-band, transition, and stop-band characteristics of low-pass Butterworth, Chebyshev, and Elliptic filters illustrating their magnitude response characteristics. [3]