Final Assessment Test – November/December 2023

VIT
Vellore Institute of Technology

Course: BECE202L - Signals and Systems

Class NBR(s): 2251 / 2253 / 2255 / 2257 / 2259 / 2261

Slot: B1+TB1

Time: Three Hours

Max. Marks: 100

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS TREATED AS EXAM MALPRACTICE

General Instructions: If any of the values are missing, assume suitable value and clearly specify your assumption.

Answer ALL Questions

(10 X 10 = 100 Marks)

1. a) For the signal $x(t)$ shown in Fig.1., draw the following signals; **[5]**

(i) $x(2t+2)$ (ii)) $x\left(\frac{1}{2}t-2\right)$

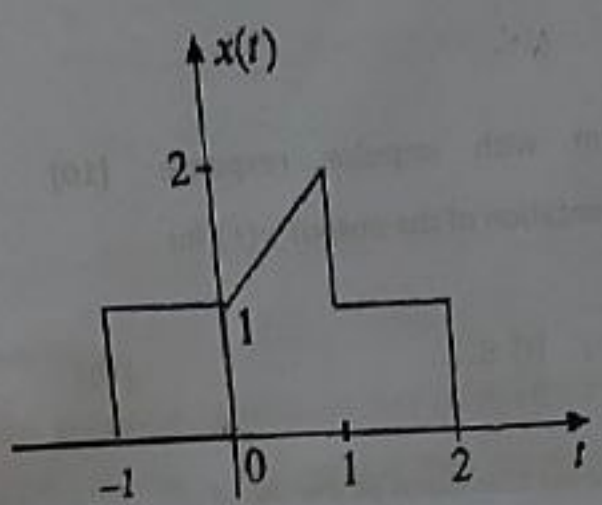

Fig.1

b) (i) Find the even and odd component of the signal $x(t) = \cos\left(\omega_0 t + \frac{\pi}{3}\right)$ **[5]**

(ii) Find which of the following signals are causal or non-causal. Justify your answer.

$(a).\, x(t) = e^{-3t}u(-t+2)$

$(b).\, x(n) = u(-n)$

2. a) Find whether the signal x[n] is a power signal or energy signal. **[5]**

$$x(n) = \begin{cases} n^2, & 0 \le n \le 3 \\ 10-n, & 4 \le n \le 6 \\ n, & 7 \le n \le 9 \\ 0, & otherwise \end{cases}$$

Also find the energy / power of the signal.

b) (i) From the given impulse response h[n], find whether the system is causal and stable. **[5]**

$$h(n) = e^{2n}u(n-1)$$

(ii) Check whether the following system is linear, time invariant and causal.

$$y(n) = x(n) + nx(n-1)$$

3. Consider the interconnection of four LTI systems, as depicted in fig.2. The impulse response of the systems are; **[10]**

$h_1(n) = u(n)$; $h_2(n) = u(n+2) - u(n)$;

$h_3(n) = \delta(n-2)$; $h_4(n) = \alpha^n u(n)$

Find the impulse response *h(n)* of the overall system

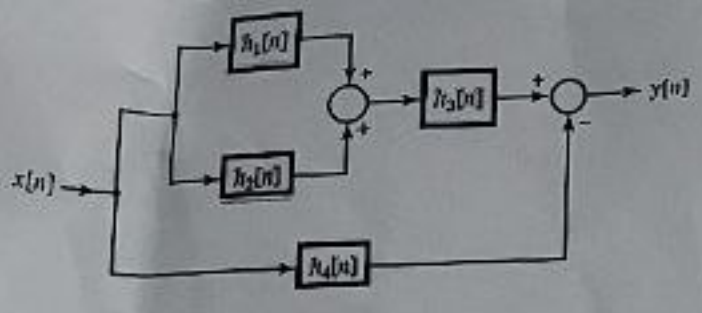

Fig.2

4. Consider a continuous-time LTI system with impulse response $h(t) = e^{-4|t|}$. Find the Fourier series representation of the output $y(t)$ for the input $x(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT)$. **[10]**

5. Consider a signal x(t) defined as, $x(t) = \begin{cases} 1 & ; \ |t| \leq 1 \\ 0 & ; \ |t| > 1 \end{cases}$ **[10]**

Express g(t) in terms of x(t) and determine Fourier transform of the signal g(t) shown in Fig.3.

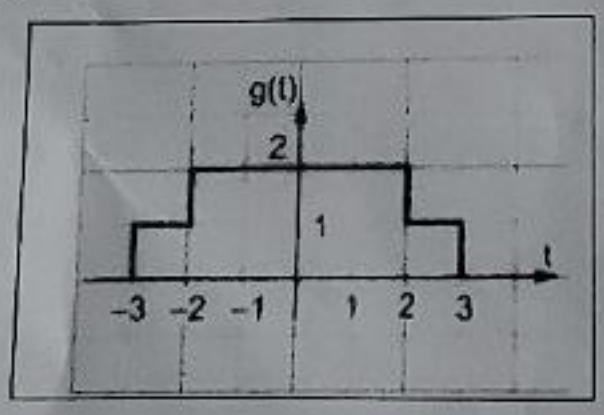

Fig.3

6.(a) Evaluate DTFT of the following sequences; **[10]**

$(i).x[n] = \delta[n] - 3\delta[n-3] + 2\delta[n-4]$

$(ii).x[n] = \left(\frac{1}{2}\right)^n u[n] - \left(\frac{1}{3}\right)^n u[-n-3]$

OR

.(b) The input and output of a causal LTI system are related by differential equation; **[10]**

$$\frac{d^2y(t)}{dt^2} + 6\frac{dy(t)}{dt} + 8y(t) = 2x(t).$$

(i) Find the impulse response of this system.

(ii) What is the response of the system if $x(t) = te^{-2t}u(t)$.

7. (a) The Hilbert transform does not change the domain of the signal. Justify. [4]

(b) Determine the Hilbert transform of $x(t) = \cos(2\omega_0 t)$. [6]

8. a) Determine the Nyquist sampling interval for the signal [5]

$f(t) = sinc(50\pi t)sinc(100\pi t)$.

b) The signal $f(t) = sinc(200\pi t)$ is sampled at a rate of 200 Hz. [5]

(i) Sketch the spectrum of the sampled signal.

(ii) Explain if you can recover the signal $f(t)$ from the sampled signal.

9. Consider a signal $y(t)$ which is related to input signals $x_1(t)$ and $x_2(t)$ by, [10]

$$y(t) = x_1(t-2) * x_2(-t+3)$$

Where,

$x_1(t) = e^{-2t}u(t)$; $x_2(t) = e^{-3t}u(t)$.

Given that $e^{-at}u(t) \overset{L}{\leftrightarrow} \frac{1}{s+a}$, $Re\{s\} > a$,

Using properties, determine the Laplace transform $Y(s)$ of $y(t)$ with ROC.

10.(a) Find the Inverse Z Transform of the Following signal, [10]

$$X(z) = \frac{-1+5z^{-1}}{1-\frac{3}{2}z^{-1}+\frac{1}{2}z^{-2}}$$

$$with\ \ ROC\ \ a)|z|>1\ \ b)|z|<\frac{1}{2}\ \ c)\frac{1}{2}<|z|<1$$

OR

10.(b) A linear time-invariant system is characterized by the system function; [10]

$$H(z) = \frac{3-4z^{-1}}{1-3.5z^{-1}+1.5z^{-2}}$$

Specify the ROC of $H(z)$ and determine $h(n)$ for the following conditions:

i. The system is stable.

ii. The system is causal.

iii. The system is anticausal.

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