REG.NO.:

VIT

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ELECTRONICE ENGINEERING
CONTINUOUS ASSESSMENT TEST - I
FALL SEMESTER 2025-2026

SLOT:C2

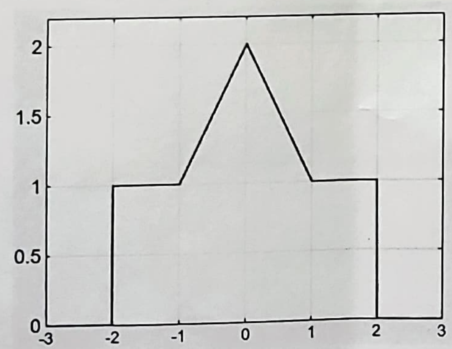
Programme Name & Branch	**:B.Tech (ECE & BML)**
Course Code and Course Name	**:BAECE101-Signals and Systems**
Faculty Name(s)	: Dr. G. Ramachandra Reddy, Dr.J.Valarmathi, Dr. Malaya Kumar Hota, Dr. Christopher Clement J, Dr. Anantha Krishna Chintanpalli
Class Number(s)	: VL2025260105980/5982/5984/5986/5988
Date of Examination	**: 19/08/2025**
Exam Duration	**: 90 minutes**

Maximum Marks: 50

General instruction(s):

- Answer All Questions
- M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcomes (Type the CO statements covered in this question paper. Use the CO number as per the syllabus copy)

Co1- Illustrate the mathematical representations and classifications of continuous and discrete-time signals and systems

Q. No	Question	M	CO	BL
1.	The signal $x(t)$ is shown below. Sketch the following signals:  i. $x(2t+3)$ ii. $x(t-2)$ iii. $x(t+3)$ iv. $x(-2t-2)$	10	1	3
2.	a). Check whether the following signals are periodic or non-periodic. If periodic, compute its fundamental period: $x[n] = \cos\left(\frac{\pi}{2}n\right)\cos\left(\frac{\pi}{4}n\right)$ b). Compute the signal energy and power of the following signals. Determine whether it is an energy or power or neither of them.	4+6	1	3

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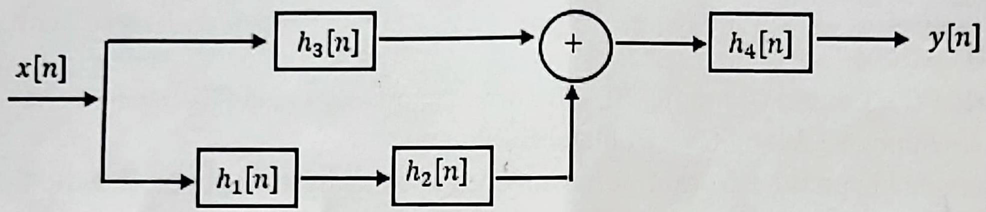
	i). $x[n] = e^{j(\pi/2n+\pi/8)}$ ii). $x[n] = (-0.5)^n u[n]$			
3.	The system given below either have input $x(t)$ or $x[n]$ and output $y(t)$ or $y[n]$, respectively. Determine whether each of the following system is (i) memoryless (ii) causal (iii) linear (iv) time-invariant (v) stable. Justify your answers. (a) $y(t) = [\cos(3t)]\, x(t)$ (b) $(y[n] = x[-n]$	5+5	1	3
4.	The discrete-time LTI system, with $x[n]$ as input and $y[n]$ as output, is shown below. Given are the individual impulse responses of the LTI sub-systems.  $h_1[n] = \delta[n-1]$ $h_2[n] = \left(\frac{1}{2}\right)^n u[n]$ $h_3[n] = 0.2\delta[n] + 0.3\delta[n-1]$ $h_4[n] = \delta[n]$ a) Compute the overall impulse response of this system. b) Sketch the overall step response of this system between $-3 \leq n \leq 3$.	5+5	1	3
5.	Find the convolution sum of the following sequences: $x[n] = (a)^n u[n]$, and $h[n] = (b)^n u[n]$ for the following two cases: i) a=b=1/2, ii) a=1/2 and b=1/3.	4+6	1	3

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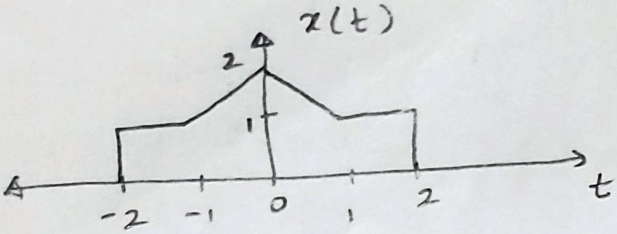
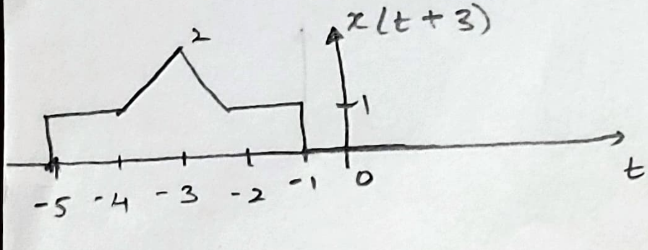
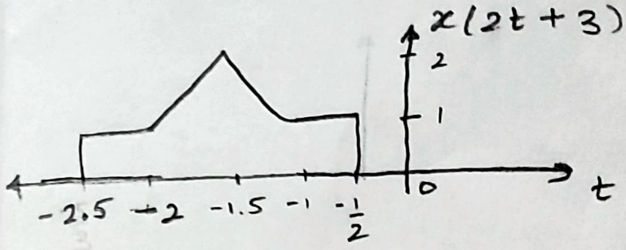
C2 - CAT-1

1)

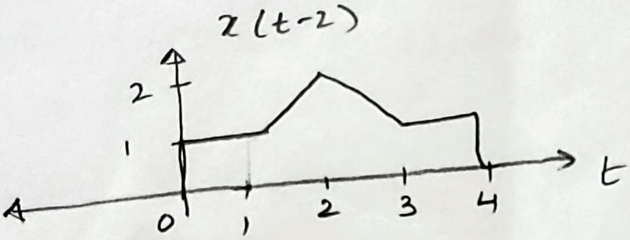


(i) $x(2t+3) \rightarrow x(t+3) \rightarrow x(2t+3)$

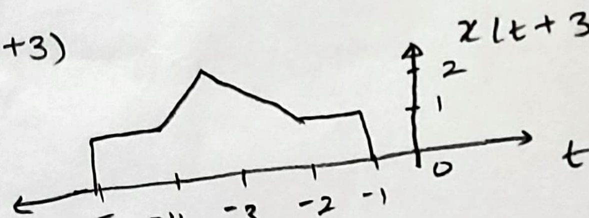




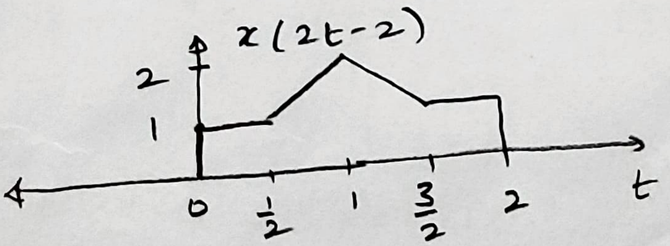
(ii) $x(t-2)$

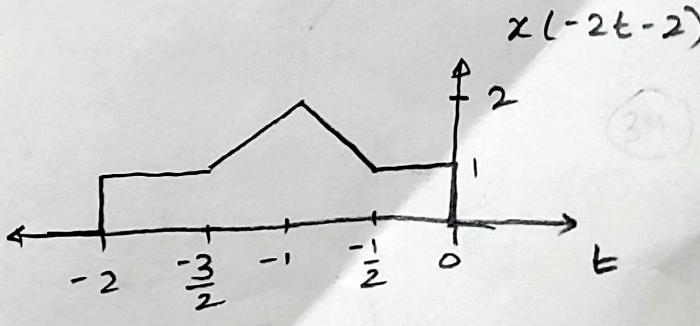


(iii) $x(t+3)$



(iv) $x(-2t-2) \rightarrow x(t-2) \rightarrow x(2t-2) \rightarrow x(-2t-2)$





2)

(a) $x[n] = \cos\left(\frac{\pi}{2}n\right)\cos\left(\frac{\pi}{4}n\right) = \frac{1}{2}\left[\cos\left(\frac{3\pi}{4}n\right) + \cos\left(\frac{\pi}{4}n\right)\right]$

$\frac{\omega_1}{2\pi} = \frac{3\pi}{4 \times 2\pi} = \frac{3}{8}$ $\quad N_1 = 8$

$N = LCM(8,8) = 8$ periodic

$\frac{\omega_2}{2\pi} = \frac{\pi}{4 \times 2\pi} = \frac{1}{8}$ $\quad N_2 = 8$

(b) (i) $x[n] = e^{j\left(\frac{\pi}{2}n + \frac{\pi}{8}\right)}$ $|x[n]| = 1$

$$E_\infty = \sum_{n=-\infty}^{\infty} |x[n]|^2 = \infty$$

$$P_\infty = \lim_{N \to \infty} \frac{1}{2N+1} \sum_{n=-N}^{N} |x[n]|^2 = 1$$ Power Signal.

(ii) $x[n] = (-0.5)^n u[n]$ $E_\infty = \frac{4}{3}$ $P_\infty = 0$ Energy Signal

3) (a) $y(t) = (\cos 3t)\, x(t)$

ML, Causal

$x_1(t) \rightarrow y_1(t) = (\cos 3t)\, x_1(t)$ $x_3(t) = a x_1(t) + b x_2(t)$

$x_2(t) \rightarrow y_2(t) = (\cos 3t)\, x_2(t)$

$x_3(t) \rightarrow y_3(t) = (\cos 3t)\, x_3(t)$ Linear

$= (\cos 3t)\left[a x_1(t) + b x_2(t)\right] = a y_1(t) + b y_2(t)$

$y(t-t_0) = \left[\cos 3(t-t_0)\right] x(t-t_0)$ Not Same

$y_{t_0}(t) = (\cos 3t)\, x(t-t_0)$ Time Variant

$|x(t)| < \infty \ \forall t$ $|\cos 3t| < \infty \ \forall t$ then $|y(t)| < \infty \ \forall t$

Stable

(b) $y(n) = x[-n]$

Memory, Non Causal $y[1] = x[-1]$

$y[-1] = x[1]$

$x_1(n) \rightarrow y_1[n] = x_1[-n]$ Linear

$x_2[n] \rightarrow y_2[n] = x_2[-n]$

$x_3[n] \rightarrow y_3[n] = x_3[-n] = a x_1[-n] + b x_2[-n]$

$= a y_1[n] + b y_2[n]$

$y[n-n_0] = x[-n+n_0]$ $\neq$ same Time Variant

$y_{n_0}(n) = x[-n-n_0]$

$|x[n]| < \infty \ \forall n$ then $|x[-n]| < \infty \ \forall n$ Stable

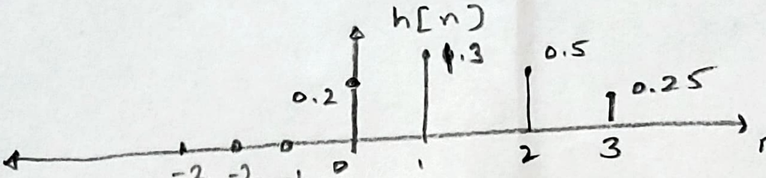
4) $h[n] = \{[h_1[n] * h_2[n]] + h_3[n]\} * h_4[n]$

$h_1[n] * h_2[n] = \delta[n-1] * \left(\frac{1}{2}\right)^n u[n] = \left(\frac{1}{2}\right)^{n-1} u[n-1]$

$h_1[n] * h_2[n] + h_3[n] = \left(\frac{1}{2}\right)^{n-1} u[n-1] + 0.2\,\delta[n] + 0.3\,\delta[n-1]$

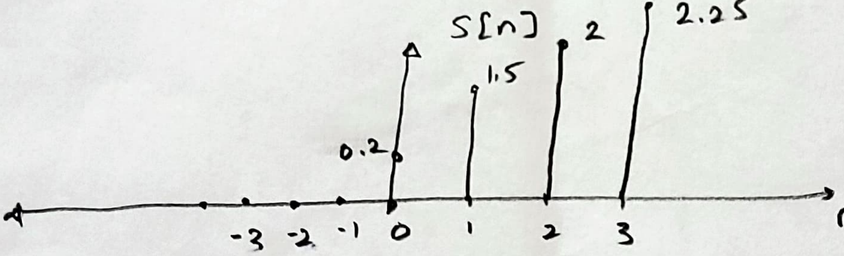
$h[n] = \left[\left(\frac{1}{2}\right)^{n-1} u[n-1] + 0.2\,\delta[n] + 0.3\,\delta[n-1]\right] * \delta[n]$

$= 0.2\,\delta[n] + 0.3\,\delta[n-1] + \left(\frac{1}{2}\right)^{n-1} u(n-1)$

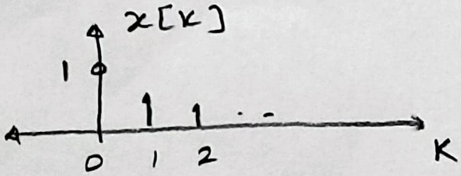


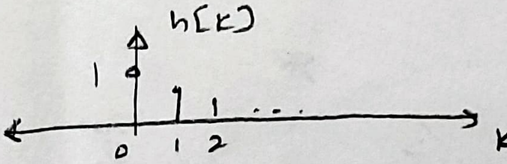
$s[n] = \sum_{k=-\infty}^{n} h[k]$

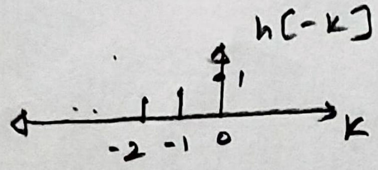
$n<0$ $s[n] = 0$, $s[0] = 0.2$, $s[1] = 1.5$, $s[2] = 2$, $s[3] = 2.25$

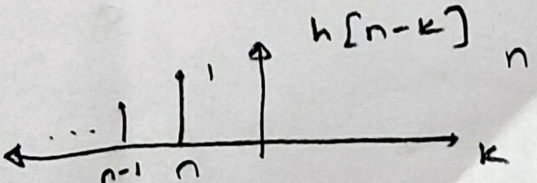


5) $x(n) = a^n u[n]$, $h[n] = b^n u[n]$

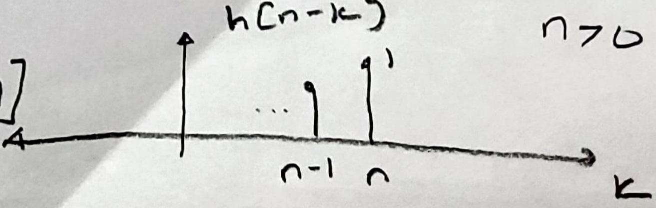








$n<0$ $y(n) = 0$ [No overlap b/w $x[k]$ & $h[n-k]$]



$n \geq 0$ $y[n] = \sum_{k=0}^{n} a^k b^{n-k} = b^n \sum_{k=0}^{n} \left(\frac{a}{b}\right)^k$

$n \geq 0$ $\quad y[n] = \dfrac{b^n\left(1-\left(\frac{a}{b}\right)^{n+1}\right)}{1-\frac{a}{b}} = \dfrac{b^{n+1}-a^{n+1}}{b-a}$

$$y[n] = \left(\frac{b^{n+1}-a^{n+1}}{b-a}\right)u[n]$$

$a = \frac{1}{2}$, $b = \frac{1}{3}$ $\qquad \frac{1}{3} - \frac{1}{2} = \frac{-1}{6}$

$$y[n] = \frac{\left(\frac{1}{3}\right)^{n+1} - \left(\frac{1}{2}\right)^{n+1}}{(-1/6)}u[n] = 6\left[\left(\frac{1}{2}\right)^{n+1} - \left(\frac{1}{3}\right)^{n+1}\right]u[n]$$

$a = b = \frac{1}{2}$

$y[n]$ $\quad y[n] = \sum_{k=0}^{n} a^k a^{n-k} = a^n \sum_{k=0}^{n} = (n+1)a^n$

$n \geq 0$

$$y[n] = (n+1)\left(\frac{1}{2}\right)^n u[n]$$