SRM VALLIAMMAI ENGINEERING OLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

III SEMESTER

1906001 - SIGNALS AND SYSTEMS

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UNIT I

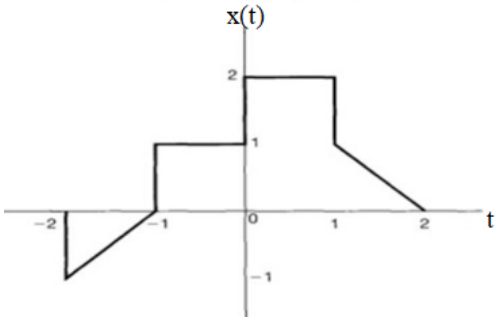
CLASSIFICATION OF SIGNALS AND SYSTEMS

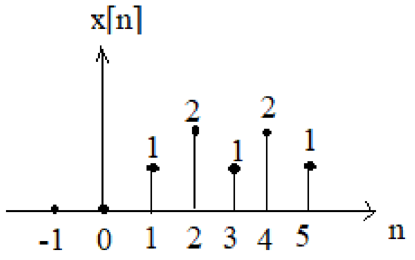
Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_ Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.

PART A

Q.No	Questions	BT Level	Competence
1.	Distinguish between continuous and discrete time signal.	BTL 2	Understanding
2.	List the elementary continuous time signals.	BTL 1	Remembering
3.	Define symmetric and anti-symmetric signals.	BTL 1	Remembering
4.	Sketch the signal $x[n] = u[n] - u[n-5]$.	BTL 1	Remembering
5.	Draw the signal $u(t-2) - u(t-5)$.	BTL 1	Remembering
6.	Find the periodicity of $\cos(0.1\pi n)$.	BTL 3	Applying
7.	Write the conditions for a system to be an LTI System.	BTL 1	Remembering
8.	When the system is said to be memoryless? Give example.	BTL 2	Understanding
9.	Estimate whether the following system is Time Invariant/Time variant and also causal/non causal: $y(t) = x(\frac{t}{3})$.	BTL 2	Understanding
10.	The system is described by $y[n] = x[2n]$. Classify it as static or dynamic and also causal or non-causal system.	BTL 2	Understanding
11.	Verify the periodicity of the discrete time signal $\sin[3n]$.	BTL 3	Applying
12.	Express the relationship among the impulse signal and step signal.	BTL 3	Applying
13.	Compare energy and power signals.	BTL 4	Analyzing
14.	Check whether the signal $x(n) = \sin(\frac{6\pi n}{7} + 1)$ is periodic. If periodic what is its fundamental period 'T'?	BTL 4	Analyzing
15.	Find the even and odd components of the signal $x(t) = e^{jt}$	BTL 3	Applying
16.	Distinguish between odd and even signals.	BTL 4	Analyzing
17.	What is the energy and power of a unit step signal?	BTL 1	Remembering
18.	Find whether the signal is causal or not. $y(n) = u(n+3) - u(n-2)$.	BTL 3	Applying
19.	Write the conditions for the system to be BIBO Stability.	BTL 3	Applying
20.	Determine whether the given system described by the equation is linear or not. $y(n) = nx(n)$.	BTL 4	Analyzing
21.	Mention the mathematical and graphical representation of discrete type ramp sequence.	BTL 2	Understanding

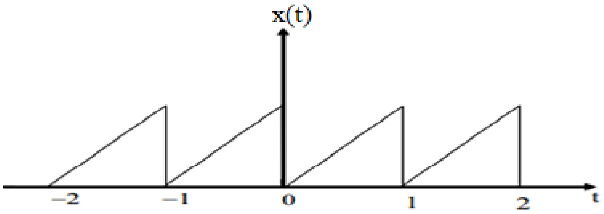
22.	Classify two types of time scaling with example.	**BTL 4**	**Analyzing**
23.	Given the input-output relationship of a discrete time systems *y(n)= cos[x(n)]*. *Check* whether the system is stable.	**BTL 4**	**Analyzing**
24.	Outline the properties of linear system.	**BTL 2**	**Understanding**
PART-B (13 MARKS)			
1.	(i) Write about elementary Continuous time Signals in detail. (7) (ii) Find whether the following signal is periodic. If periodic determine the fundamental period. (6) (a) $x(t) = e^{j\frac{2\pi}{3}n} + e^{j\frac{3\pi}{4}n}$ (b) $x(t) = 3\cos(4t) + 2\sin(\pi t)$	**BTL 1**	**Remembering**
2.	(i) Identify whether the following systems are linear or not. (8) (a) $y(t) = x^2(t)$ (b) $\mathrm{y[n]} = 3x[n] + \frac{1}{x[n-1]}$ (ii) Derive the odd and even components of the following signals. (a) $x(t) = \sin(t) + 2\sin(t) + 2\sin^2(t)\cos(t)$ (5)	**BTL 1**	**Remembering**
3.	(i) Examine whether the following systems are time invariant or not. (a) $y(t) = e^{x(t)}$ (b) $y[n] = x(n) + nx(n-1)$ (7) (ii) What is the power and RMS value of the signal. (6) (a) $x(t) = Acos(\Omega_0 t + \theta)$ (b) $x(t) = \cos(t)$	**BTL 1**	**Remembering**
4.	(i) Identify whether the following systems are linear or not. (a) $\frac{dy}{dt} + 3ty(t) = t^2 x(t)$ (4) (b) $\frac{dy}{dt} + 2y(t) = x(t)\frac{dx(t)}{dt}$ (3) (ii) Examine whether the following system are time invariant or not (a)$\mathrm{y}(t) = x(-t)$ (3) (b)$\mathrm{y}(n) = x(n^2)$ (3)	**BTL 1**	**Remembering**
5.	(i) Check whether the following signals are periodic or not. (6) (a) $x(t) = 2\cos(10t + 1) - \sin(4t - 1)$ (b) $x(t) = u(t) - u(t - 10)$ (ii) Estimate the fundamental period T for the following continuous time signals. (3+4) (a) $y(t) = 20\cos(10\pi t + {}^{\pi}/_{6})$ (b) $x(t) = 3\cos(17\pi t + {}^{\pi}/_{3})$+2$\sin(19\pi t - {}^{\pi}/_{3})$	**BTL 2**	**Understanding**
6.	(i) A Continuous time signal x(t) is shown in figure below, Sketch and label each of the following signals (a)x(t-1) (b) x(2-t) (c) x(t)[$\delta(t + \frac{3}{2})$ - $\delta(t - \frac{3}{2})$] (d) x(2t+1) (8)	**BTL 2**	**Understanding**

	 { (ii) Estimate the energy and power of the given signal (5) x[n]= $cos\ [\frac{\pi}{4}n]$		
7.	Examine whether the following signals are energy signals or power signals (a) $y(t) = \left(\frac{1}{3}\right)^n\ u[n]$ (4) (b) $x(t) = tu(t)$ (4) (c) $x(t) = (1 + e^{-5t})$ (5)	**BTL 2**	**Understanding**
8.	(i) Sketch the following signals (8) (a) $-2u(t-1)$ (b) $3r(t-1)$ (c) $-2r(t)$ (d) $r(-t+2)$ Where u(t) and r(t) are unit step and unit ramp signal respectively. (ii) Determine the power and R.M.S value of the following signal (5) $y(t) = 10\sin(50\pi t + {}^{\pi}/_{4})$+ $16\sin(100t + {}^{\pi}/_{3})$	**BTL 3**	**Applying**
9.	(i) Find whether the following systems are dynamic or not (a) $y(t) = x(t-2)$ (2) (b) $y(n) = x(n+2)$ (2) (c) $y(t) = x^2(t)$ (2) (ii) Check whether the following systems are casual or not (a) $y(n) = x(n) + \frac{1}{x(n-1)}$ (3) (b) $y(n) = x(-n)$ (2) (c) $y(n) = x(n^2)$ (2)	**BTL 3**	**Applying**
10.	(i) Analyze whether the following systems are linear or not. (a) $y(t) = e^{x(t)}$ (5) (b) $y(t) = t^2x(t)$ (4) (ii) Examine whether the following systems are time invariant or not. (a) $y(n) = x(-n)$ (2) (b) $y(n) = x(n+1) + x(n) + x(n-1)$ (2)	**BTL 4**	**Analyzing**

11.	The input-output relation of a full wave rectifier is given by $y(t) = \|x(t)\|$. Analyze whether the full wave rectifier is (a) Linear (3) (b) Time-invariant (3) (c) Stable (3) (d) Memoryless (2) (e) Causal. (2)	**BTL 4**	**Analyzing**
12.	Identify whether the following systems are static or dynamic, linear or nonlinear, and time invariant or time variant. (i) y(n) = x(n) - x(n-1) (7) (i) y(t)=$\frac{d}{dt}x(t)$ (6)	**BTL 4**	**Analyzing**
13.	(i)Examine the fundamental period T of the continuous time signal $x(t) = 3\cos(60\pi t)+2\sin(50\pi t)$ (5) (ii)Sketch the waveforms represented by the following functions. (8) $f_1(t) = 2u(t-1)$ $f_2(t) = -2u(t-2)$ $f(t) = f_1(t) + f_2(t)$ $f(t) = f_1(t) - f_2(t)$	**BTL 3**	**Applying**
14.	A discrete time signal x[n] is shown below.  Sketch and label carefully each of the following signals. (i) $x[n-2]$ (2) (ii) $x[n+1]$ (2) (iii) $x[-n]$ (2) (iv) $x[-n+1]$ (2) (v) $x[2n]$ (2) (vi) $x[-2n+1]$ (3)	**BTL 3**	**Applying**
15.	Derive the relation between the following signals (i) unit ramp and unit step signals (7) (ii) unit step and unit impulse signals (6)	**BTL 2**	**Understanding**
16.	Check periodicity of the following signal and also determine the fundamental period, if they are periodic. (i) $x(n) = cos(\pi n/5)sin(^{\pi n}/_3)$. (4) (ii) $cos100\pi t + sin50\pi t$ (4) (iii) $x(n) = sin(\frac{6\pi n}{7} + 1)$ (5)	**BTL 3**	**Applying**

17.	Classify the following signals as energy, power signals or neither and find the corresponding value. (i) $x(t) = e^{-2t}\, u(t)$ (4) (ii) $x(n) = -(0.5)^{n}\, u(n)$ (5) (iii) $x(t) = e^{j(3t + \pi/4)}$ (4)	**BTL 4**	**Analyzing**
	PART-C (15 MARKS)		
1.	Plot the graphical response for the following signals. (i) u(-t+2) (3) (ii) r(-t+3) (4) (iii) $2\delta(n+2) + \delta(n) - 2\delta(n-1) + 3\delta(n-3)$ (4) (iv) u(n+2)u(-n+3) (4) where u(t), r(t), $\delta(n)$, and u(n) represent continuous time unit step, continuous unit time ramp, discrete time impulse and discrete time unit step functions respectively.	**BTL 3**	**Applying**
2.	(i) Prove the following: (a) Energy of the power signal is infinite over infinite time. (5) (b) Power of the energy signal is zero. (5) (ii) Examine the energy and power of the following signal (5) $x(n)= e^{j\left(\frac{\pi}{2}n+\frac{\pi}{8}\right)}$	**BTL 3**	**Applying**
3.	Check and classify whether the following systems are static/dynamic, linear/non-linear, time- invariant or time-variant, and causal or non-causal. (i) $y(n) = 2x(n) + \frac{1}{x(n-1)}$ (7) (ii) $y(n) = x^2(n) + \frac{1}{x^2(n-1)}$ (8)	**BTL 2**	**Understanding**
4.	Analyze the properties such as linearity, causality, time invariance and dynamicity of the given systems. (i) $\frac{d^2y(t)}{dt^2} + 3t\frac{dy(t)}{dt} + y(t) = x(t)$ (5) (ii) $y(n) = x(n)x(n-1)$ (5) (iii) $y(n) = \log\lvert x(n)\rvert$ (5)	**BTL 4**	**Analyzing**
5.	(i) Define signals and systems with examples. (4) (ii) Explain different classification of signals and systems with examples. (11)	**BTL 1**	**Remembering**

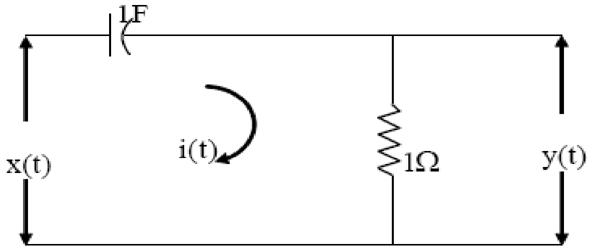
UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS			
Fourier series for periodic signals - Fourier Transform – Inverse Fourier Transform - properties- Laplace Transforms - Inverse Laplace Transform and properties			
PART A			
Q. No	**Questions**	**BT Level**	**Competence**
1.	Define Parseval's relation for CT periodic signals.	**BTL 1**	**Remembering**
2.	Write the equations for trigonometric & exponential Fourier series.	**BTL 1**	**Remembering**
3.	State the Dirichlet's conditions of Fourier series.	**BTL 1**	**Remembering**
4.	Solve for the complex Fourier series representation of $x(t) = \sin \omega_0 t$.	**BTL 2**	**Understanding**
5.	Express the Fourier series representation of the signal $x(t) = \cos(\frac{2\pi}{3} t)$	**BTL 2**	**Understanding**
6.	Distinguish between Fourier series and Fourier transform.	**BTL 2**	**Understanding**
7.	What is the Fourier transform of the signal, $x(t)=e^{-at}u(t)$?	**BTL 1**	**Remembering**
8.	Obtain the Fourier Series coefficients of the signal, x(t)=4(cos t) (sin 4t)	**BTL 3**	**Applying**
9.	Examine the Fourier transform of $x(t)= 6\sin^2 2t$.	**BTL 3**	**Applying**
10.	Mention the significance of Fourier series representation.	**BTL 1**	**Remembering**
11.	Using Fourier transform property, determine the Fourier transform of x(t) = x(4t – 8).	**BTL 2**	**Understanding**
12.	Find the Fourier transform of the signal x(t) = δ(t) also sketch the magnitude and phase spectrum.	**BTL 2**	**Understanding**
13.	The function x(t) is defined as, x(t) =u(t)-u(t-2). Calculate X(s).	**BTL 3**	**Applying**
14.	Determine the Laplace transform of $x(t) = 2e^{-2t}u(t)+4e^{-4t}u(t)$ and analyze its ROC.	**BTL 4**	**Analyzing**
15.	Solve the Laplace transform of δ(t) and u(t).	**BTL 3**	**Applying**
16.	Analyze the Relationship between Laplace Transform and Fourier Transform.	**BTL 4**	**Analyzing**
17.	Interpret the significance of ROC of the Laplace Transform.	**BTL 4**	**Analyzing**
18.	Compute x(t), from given X(s), $X(s)= \frac{1}{s(s+2)}$.	**BTL 3**	**Applying**
19.	Find the Laplace Transform of the signal $x(t) =-te^{-2t} u(t)$.	**BTL 3**	**Applying**
20.	Write the differentiation and integration property of Laplace transform.	**BTL 1**	**Remembering**
21.	Differentiate between Fourier series and Fourier transform.	**BTL 2**	**Understanding**
22.	Write the analysis and synthesis equations of Fourier transform.	**BTL 4**	**Analyzing**
23.	Calculate the initial and final value of the function $x(s) = \frac{1}{s^2+5s-2}$.	**BTL 4**	**Analyzing**
24.	Analyze the various mathematical tools to be used for continuous time signals.	**BTL 4**	**Analyzing**

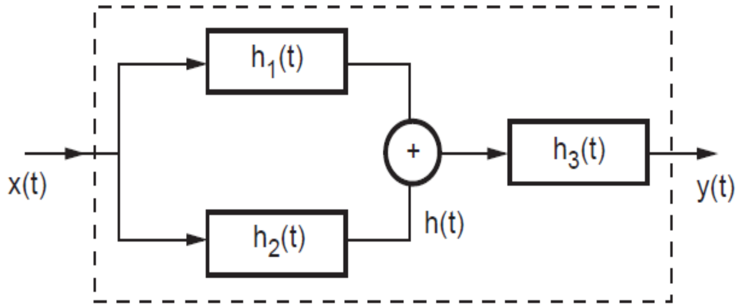
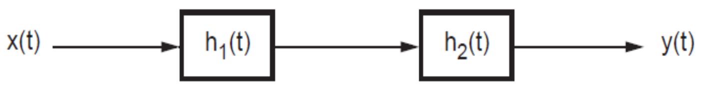
	PART-B (13 MARKS)		
1.	Realize the Fourier transform of each of the following signals and sketch the magnitude and phase as a function of frequency, including both positive and negative frequencies (i) $\delta(t+1)+\delta(t-1)$ (ii) $e^{-at}u(t)$, α-real and positive (7+6)	**BTL 2**	**Understanding**
2.	(i) Find the Fourier transform of $x(t)=e^{-at}u(-t)$ (6) (ii) Determine the Fourier series representation of the signal $x(t) = 2+\cos(4t) + \sin(6t)$ (7)	**BTL 2**	**Understanding**
3.	Examine the trigonometric Fourier series over the interval (-1, 1) for the signal $x(t) = t^2$. (13)	**BTL 4**	**Analyzing**
4.	Obtain the exponential Fourier series for the periodic signal x(t) = t; 0 < t < 1 and it repeats for every one second. (13) 	**BTL 3**	**Applying**
5.	Determine the Fourier transform of $x(t) = e^{-2\|t\|}u(t)$ and plot the Fourier spectrum. (13)	**BTL 2**	**Understanding**
6.	(i) Write the properties of CT Fourier Transform. (6) (ii) Describe about the Trigonometric Fourier series for the full wave rectified sine wave. (7)	**BTL 1**	**Remembering**
7.	(i) Estimate the Fourier Transform of $x(t) = 1-e^{-\|t\|}\cos\omega_0 t$. (7) (ii) Derive the Fourier Transform of Rectangular pulse and sketch the signal. (6)	**BTL 2**	**Understanding**
8.	Using Partial fraction expansion find inverse Fourier transform for the following, (i) $X(j\Omega)=\frac{5j\Omega+12}{(j\Omega)^2+5(j\Omega)+6}$ (7) (ii) $X(j\Omega)=\frac{1+2j\Omega}{(j\Omega+2)^2}$ (6)	**BTL 3**	**Applying**
9.	(i) Derive the Laplace Transform and ROC of the signal $x(t)=e^{-3t}u(t)+e^{-2t}u(t)$ (7) (ii) State and prove the convolution property of Laplace transform. (6)	**BTL 1**	**Remembering**
10.	(i) Solve the inverse Laplace transform of $x(s) = \frac{(s+3)}{(s+1)(s+2)^2}$. (7) (ii) Calculate the initial value and final value of signal x(t) whose Laplace Transform is $x(s) = \frac{s+5}{s^2+3s+2}$. (6)	**BTL 3**	**Applying**
11.	(i) Find the inverse Laplace Transform of, $x(s) = \frac{3}{s^2(s+1)}$. (7) (ii) Solve for the Laplace Transform of, $x(t) = t^2e^{-2t}u(t)$. (6)	**BTL 1**	**Remembering**

12.	Analyze the inverse Laplace transform of x(s) = $\frac{4}{(s+2)(s+4)}$ with reference to the following ROCs. (i)Re(s) < -4 (ii) Re(s) > -2 (iii) -2 > Re(s) > -4. (13)	BTL 4	Analyzing
13.	Evaluate the Laplace transform, ROC, Pole location for the following signals. (6+7) (i) $x(t) = e^{-b\|t\|}$ (ii) $x(t)=e^{-at}u(t)+ e^{-bt}u(-t)$	BTL 4	Analyzing
14.	For the Laplace transform of, $$x(t) = \begin{cases} e^{t} sin2t, & t \leq 0, \\ 0 & t > 0 \end{cases}$$ Find the location of its poles and plot it. Also identify its Region of Convergence. (13)	BTL 2	Understanding
15.	Compute the Fourier transform for the following signals x(t) = $\boldsymbol{e^{-at} u(t)}$ and plot the Fourier spectrum. (13)	BTL 4	Analyzing
16.	Obtain the Laplace transform of the following (i) $e^{-at}\, sin\omega t$ (7) (ii) $\boldsymbol{e^{-at}\, cos\omega t}$ (6)	BTL 3	Applying
17.	State and prove the following properties of Laplace transform. (i) Linearity (3) (ii) Time shifting (3) (iii) Time scaling (3) (iv) Differentiation in time domain (4)	BTL 1	Remembering
PART-C (15 MARKS)			
1.	(i) Determine the Fourier transform of $$x(t) = \begin{cases} \frac{1}{2}[1 - \|t\|] & for \quad -1 \leq t \leq 1 \\ 0 & otherwise \end{cases}$$ (12) (ii) Find the Fourier transform of x(t) = cos $\boldsymbol{\omega}_c$t. (3)	BTL 3	Applying
2.	(i) Find the Fourier transform of $x(t) = e^{-2t}$ cos3t u(t). (5) (ii)Obtain the Trigonometric Fourier series representation of half wave rectified Sine wave. (10)	BTL 1	Remembering
3.	Compute the Laplace transform and associated region of convergence and pole-zero plot for each of the following function. (i) $x(t) = e^{-4t}u(t) + e^{-5t}(sin5t)\, u(t)$ (8) (ii) $x(t) = \|t\|\, e^{-2\|t\|}$ **(7)**	BTL 3	Applying
4.	Examine the inverse Laplace transform of the following functions (i) x(s) = $\frac{1}{s^2+3s+2}$ $ROC: -2 < Re(s) < -1$ (7) **(ii) x(s) =** $\boldsymbol{\frac{1}{(s+5)(s-3)}}$ $\boldsymbol{ROC: -5 < Re(s) < 3}$, Re(s)>3 (8)	BTL 4	Analyzing
5.	Estimate the initial and final values of the following functions (i) x(s) = $\frac{2s+3}{s^2+5s+6}$ (7) **(ii) x(s) =** $\boldsymbol{\frac{2s^2+3}{s^2+5s-16}}$ (8)	BTL 2	Understanding

UNIT III LINEAR TIME INVARIANT- CONTINUOUS TIME SYSTEMS			
Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.			
PART A			
Q.No	**Questions**	**BT Level**	**Domain**
1.	Write the condition for LTI system to be stable and causal.	**BTL 1**	**Remembering**
2.	Given the differential equation representation of the system $\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} - 3y(t) = 2\,x(t)$. Examine the frequency response.	**BTL 3**	**Applying**
3.	Identify the differential equation relating the input and output a CT system represented by $H(j\Omega) = \frac{1}{(j\Omega)^2+8(j\Omega)+1}$	**BTL 1**	**Remembering**
4.	Given the input x(t) =u(t) and h(t) = δ(t-1). Find the response y(t).	**BTL 1**	**Remembering**
5.	List the properties for convolution integral.	**BTL 1**	**Remembering**
6.	The input - output relationship of the system is described as, $\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = \frac{dx}{dt}$. Find the system function H(s) of the system.	**BTL 1**	**Remembering**
7.	Summarize impulse response of an LTI system.	**BTL 2**	**Understanding**
8.	Given H(s) = $\frac{1}{s^2+2s+1}$. Express the differential equation representation of the system.	**BTL 2**	**Understanding**
9.	Estimate whether the causal system with transfer function $H(s) = \frac{1}{s-2}$ is stable.	**BTL 2**	**Understanding**
10.	Find the unit step response of a CT LTI system for the given $h(t) = e^{-2t}u(t)$.	**BTL 2**	**Understanding**
11.	If the system function $H(s) = 4 - \frac{3}{s+2}$; Re(s)>-2, analyze the impulse response h(t)	**BTL 4**	**Analyzing**
12.	Calculate the unit step response of the system given by $h(t) = (\frac{1}{RC})\, e^{-\frac{t}{RC}}\, u(t)$.	**BTL 3**	**Applying**
13.	Solve the impulse response of the system given by $H(s) = 1/(s+9)$.	**BTL 1**	**Remembering**
14.	Write the expression of convolution integral.	**BTL 3**	**Applying**
15.	What is the impulse responses of two systems $h_1(t)$ and $h_2(t)$ when connected in cascade?	**BTL 4**	**Analyzing**
16.	Two systems with impulse response $h_1(t) = e^{-at}\,u(t)$ and $h_2(t) = u(t-1)$ are connected in parallel. What is the overall impulse response h(t) of the system?	**BTL 4**	**Analyzing**

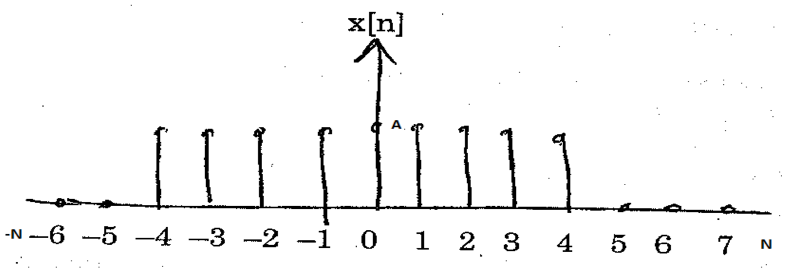
17.	Examine the causality of the system with response $h(t)= e^{-t} u(t)$.	**BTL 4**	**Analyzing**
18.	Determine the transfer function of the system with the impulse response, $h(t) = \delta(t) + e^{-3t} u(t) + 2e^{-t} u(t)$.	**BTL 3**	**Applying**
19.	Write the N^{th} order differential equation for an LTI continuous time system.	**BTL 2**	**Understanding**
20.	Combine the following signals using Convolution. $u(t-1)$ and $\delta(t-1)$.	**BTL 3**	**Applying**
21.	What are the drawbacks of representing a system using its transfer function?	**BTL 4**	**Analyzing**
22.	Check whether given system is causal and stable. $h(t)=e^{-4t} u(t+10)$.	**BTL 2**	**Understanding**
23.	Given $\boldsymbol{H(s) = \frac{s^2}{s^2+2s+1}}$, Determine the differential equation of the system.	**BTL 4**	**Analyzing**
24.	Mention the three elementary operation in block diagram representation of CT Systems.	**BTL 1**	**Remembering**
	PART B (13 Marks)		
1.	Examine the Convolution of following signals. $x(t)= u(t)$ and $h(t)= e^{-at} u(t)$, $\|a\| > 0$ (13)	**BTL 1**	**Remembering**
2.	(i) Define convolution Integral and describe its equation. (6) (ii) A stable LTI system is characterized by the differential equation $d^2y(t)/dt^2 + 4dy(t)/dt + 3y(t) = dx(t)/dt + 2x(t)$. Derive its frequency response & impulse response using Fourier transform. (7)	**BTL 1**	**Remembering**
3.	(i) Identify the impulse response h(t) of the system given by the differential equation $d^2y(t)/dt^2 + 3dy(t)/dt + 2y(t) = x(t)$ with all initial conditions to be zero. (7) (ii) Describe the unit step response of the first order system governed by the equation $\frac{\mathbf{dy(t)}}{\mathbf{dt}} + \boldsymbol{0.5y(t) = x(t)}$ with zero initial conditions. (6)	**BTL 1**	**Remembering**
4.	Find the output expression of the system described by the differential equation $d^2y(t)/dt^2+ 6dy(t)/dt +8y(t) = dx(t)/dt+ x(t)$, when the input signal is $x(t) =u(t)$ and the initial conditions are $y(0^+)=1, dy(0^+)/dt =1$. (13)	**BTL 1**	**Remembering**
5.	The system produces the output $y(t) = e^{-t}u(t)$ for an input $x(t) =e^{-2t}u(t)$. Estimate its frequency response and impulse response. (13)	**BTL 2**	**Understanding**
6.	(i) The impulse response of the system is $e^{-4t}u(t)$ and the output response is $[1-e^{-4t}] u(t)$. Estimate the input x(t). (6) (ii) Using Laplace transform, obtain the impulse response of an LTI system described by the differential equation. $d^2y(t)/dt^2 - dy(t)/dt - 2y(t) = x(t)$. (7)	**BTL 2**	**Understanding**

7.	(i) Express the transfer function of the system for the impulse response $h(t)= \delta(t) + e^{-3t}u(t) + 2e^{-t}u(t)$ (6) (ii) Find the output of the system shown in figure for the input $e^{-2t}\,u(t)$ using Laplace transform. (7) 	**BTL 2**	**Understanding**
8.	Examine the convolution y(t) of the given signals. (i) x(t)=cost u(t), h(t)=u(t) (7) (ii) x(t)=u(t), $h(t)=\frac{R}{L}e^{-tR/L}u(t)$ (6)	**BTL 3**	**Applying**
9.	(i) Using graphical method, determine the output y[t] for the LTI system with impulse response h[t] = u(t-3) and input x[t]= u(t+1). (7) (ii) Find the step response of the system $h(t) = e^{-4t}\,u(t)$. (6)	**BTL 3**	**Applying**
10.	The input-output of a causal LTI system is related by the differential equation $d^2y(t)/dt^2 + 6dy(t)/dt + 8y(t)= 2x(t)$. (i) Determine the impulse response of h(t). (7) (ii) Analyze the response y(t) of the system if x(t)=u(t) using Fourier Transform. (6)	**BTL 4**	**Analyzing**
11.	Estimate the output response (y(t)) of the following systems (h(t)) for the given input (x(t)). (i) $x(t) = u(t), h(t) = 2\,e^{-3t}u(t)$ (6) (ii) $x(t) = e^{-t}u(t), h(t) = e^{-2t}u(t)$ (7)	**BTL 3**	**Applying**
12.	Examine the impulse response and step response of the system $\boldsymbol{H(s)} = \frac{s+4}{s^2+5s+6}$ (13)	**BTL 4**	**Analyzing**
13.	A system is described by the differential equation $d^2y(t)/dt^2 + 5\,dy(t)/dt + 6y(t) = dx(t)/dt + x(t)$, $dy(0^-)/dt = 3$, $y(0) = 1$, $x(t) = u(t)$. Find the transfer function and output signal y(t). (13)	**BTL 1**	**Remembering**
14.	The LTI system, initially at rest is described by the differential equation $d^2y/dt^2 + 3\,dy/dt + 2y = dx/dt + 3x$. Estimate the system function H(s) and impulse response h(t). (13)	**BTL 3**	**Applying**
15.	Draw the direct form-I and II implementation of the system described by the following differential equation $dy(t)/dt + 5y(t) = 3\,x(t)$. (13)	**BTL 2**	**Understanding**
16.	An LTI system is represented by $\frac{d^2y(t)}{d^2t} + 4\frac{dy(t)}{dt} + 4\,y(t)$ = x(t) with initial conditions $y(0^-) = 0$; $y'(0^-) = 1$.Determine the output of the system when the input is $x(t) = e^{-t}\,u(t)$. (13)	**BTL 4**	**Analyzing**

17.	Examine the overall impulse response of the following system shown below. Here $h_1(t) = e^{-2t} u(t)$ $h_2(t) = \boldsymbol{\delta}(t) - \boldsymbol{\delta}(t-1)$ $h_3(t)= \boldsymbol{\delta}(t)$ Also find the output of the system for the input x(t) = u(t) using convolution integral.  (13)	**BTL 4**	**Analyzing**
PART-C (15 MARKS)			
1.	Determine the response y(t) of a continuous time system using Laplace transform with transfer function $H(s) = \frac{1}{(s+2)(s+3)}$ for an input $x(t)= e^{-t} u(t)$. (15)	**BTL 3**	**Applying**
2.	A system is described by the differential equation $d^2y(t)/dt^2 + 6dy(t)/dt + 8y(t) = dx(t)/dt + x(t)$. Find the transfer function and the output signal y(t) for x(t) = δ(t). (15)	**BTL 2**	**Understanding**
3.	A causal LTI system having a frequency response $H(j\Omega) = \frac{1}{j\Omega+3}$ is producing an output $y(t) = e^{-3t}u(t) - e^{-4t}u(t)$ for a particular input x(t). Determine the value x(t). (15)	**BTL 4**	**Analyzing**
4.	A continuous time LTI system is represented by the following differential equation. $\frac{d^2}{dt^2}y(t) + 3\frac{d}{dt}y(t) + 2y(t) = 2x(t)$. Find the impulse response of the system using Fourier transform. (15)	**BTL 1**	**Remembering**
5.	The system shown below is formed by connecting two systems in cascade. The impulse responses of the systems are given by $h_1(t)$ and $h_2(t)$ respectively $h_1(t) = e^{-2t} u(t)$, $h_2(t) = 2e^{-t} u(t)$. Find the overall impulse response of the system. Determine if the overall system is BIBO stable  **(15)**	**BTL 2**	**Understanding**

UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS			
Baseband signal Sampling – Fourier Transform of discrete time signals (DTFT) - Inverse DTFT- Properties of DTFT - Z Transform Inverse Z Transform - & Properties.			
1.	State Sampling theorem.	**BTL 1**	**Remembering**
2.	Find the DTFT of x(n)= δ(n)+ δ(n-1).	**BTL 1**	**Remembering**
3.	What is the main condition to avoid aliasing?	**BTL 1**	**Remembering**
4.	Write the condition for existence of DTFT.	**BTL 1**	**Remembering**
5.	Define DTFT and Inverse DTFT.	**BTL 1**	**Remembering**
6.	Outline the time folding property of Z-transform.	**BTL 1**	**Remembering**
7.	If $X(\boldsymbol{\omega})$ is the DTFT of x(n), find the DTFT of x(n-k)?	**BTL 2**	**Understanding**
8.	Write the expression for one sided Z-transform and two sided Z transform.	**BTL 2**	**Understanding**
9.	Solve for the the Nyquist rate of the signal x(t)=cos200πt + sin400πt.	**BTL 2**	**Understanding**
10.	List the methods of obtaining inverse Z transform.	**BTL 2**	**Understanding**
11.	Find the DTFT of u(n).	**BTL 2**	**Understanding**
12.	Summarize the initial value theorem of Z-transform.	**BTL 2**	**Understanding**
13.	Find the Z transform of x(n)= {1,2,3,4}.	**BTL 3**	**Applying**
14.	Point out the Parseval's relation for discrete time aperiodic signals.	**BTL 3**	**Applying**
15.	Express the multiplication property of DTFT.	**BTL 3**	**Applying**
16.	Infer about the convolution property of Z-transform.	**BTL 3**	**Applying**
17.	Formulate the Z- transform and its associated ROC for the signal x[n]= 3δ[n+2]+2δ[n]+δ[n-1]- δ[n-2].	**BTL 3**	**Applying**
18.	Determine the inverse Fourier transform of $X(\omega) = 1+ e^{-j\omega} + 2e^{-4j\omega}$.	**BTL 3**	**Applying**
19.	Examine the Z transform of sequence $x(n)=a^n u(n)$ and its ROC.	**BTL 4**	**Analyzing**
20.	Determine the z-transform of δ(n+K).	**BTL 4**	**Analyzing**
21.	Write the relationship between Z-transform and Fourier transform.	**BTL 4**	**Analyzing**
22.	Determine the Z-transform of x(n)= δ[n]- 0.95 δ[n-6].	**BTL 4**	**Analyzing**
23.	Obtain the inverse Z- transform of $X(z) = \frac{1}{z-a}$ for |z|>|a|.	**BTL 4**	**Analyzing**
24.	A signal having a spectrum ranging from near to 50 KHz is to be sampled and converted to discrete form. What is the number of samples per second that must be taken to ensure recovery?	**BTL 4**	**Analyzing**
PART –B (13 Marks)			
1.	(i) Consider an analog signal x(t) = 4sin100πt. (a) Find the minimum sampling rate to avoid aliasing . (4) (b) If sampling rate Fs =400Hz, what is the discrete time signal after sampling? (5) (ii) State the initial and final value theorem of Z- Transform (4)	**BTL 1**	**Remembering**

2.	(i) List any four properties of DTFT. (8) (ii) Derive the transfer function of a zero order hold and explain. (5)	**BTL 1**	**Remembering**
3.	(i) Solve for the Nyquist rate and the Nyquist interval for the signal $x(t)= \frac{1}{4}\pi \cos(5000\pi t)\cos(2000\pi t)$. (10) (ii) State and prove the Parseval's theorem for DTFT. (3)	**BTL 1**	**Remembering**
4.	(i) State and Prove the sampling theorem and explain how the original signal can be reconstructed from the sampled version with necessary illustrations. (8) (ii) Describe the effects of under sampling and the steps to eliminate aliasing. (5)	**BTL 1**	**Remembering**
5.	State and explain the following properties of Z transform (i) Time and frequency convolution property. (8) (ii) Parseval's theorem. (5)	**BTL 2**	**Understanding**
6.	(i) Summarize the properties of ROC. (7) (ii) Explain the contour integration method and find x(n) using this method for $\boldsymbol{X(Z) = \frac{Z}{(Z-1)3}}$. (6)	**BTL 2**	**Understanding**
7.	(i) Use convolution method to determine the inverse Z-transform of $X(Z) = \frac{Z^2}{(Z-2)(Z-3)}$. (10) (ii)Find the inverse Z-transform for the following sequences. $X(Z)= 3Z^2+Z+2-3Z^{-1}+2Z^{-2}$ (3)	**BTL 2**	**Understanding**
8.	(i) Examine the convolution of two signals $x_1(n) = (1/2)^n u(n)$ and $x_2(n) = (1/4)^n u(n)$ using DTFT. (7) (ii) Find the DTFT of $x(n) = 2 (3)^n u(-n)$. (6)	**BTL 3**	**Applying**
9.	(i) Determine the Z transform and ROC of x(n) = u(-n) - u(n-3). (7) (ii) Relate DTFT and Z transform with necessary explanations. (6)	**BTL 3**	**Applying**
10.	Find the Z transform and analyze the ROC of the following sequences: (i) $x(n) = \sin(\omega_0 n)\, u(n)$ (7) (ii) $x(n) = -a^n u(-n-1)$ Also specify its ROC (6)	**BTL 4**	**Analyzing**
11.	State and prove the following DTFT properties : (i) Time shifting property (5) (ii) Differentiation in the frequency domain (8)	**BTL 1**	**Remembering**
12.	(i) Analyze the Z-transform and ROC of $x[n] = 2^n u(n)+3^n u(-n-1)$. (7) (ii) Explain the Z-transform of the sequences x(n)= n u(n). (6)	**BTL 4**	**Analyzing**
13.	(i) Deduce the initial value of $X(Z) = \frac{Z+2}{(Z+1)(Z+3)}$ (6) (ii)Solve for the Z-transform of $x(n) = (2/3)^n u(n)+(-1/2)^n u(n)$. (7)	**BTL 4**	**Analyzing**
14.	Consider the analog signal $x(t) = 2\cos 2000\pi t + 5\sin 4000\pi t + 12\cos 2000\pi t$. (i) Obtain the Nyquist sampling rate. (6) (ii) If the analog signal is sampled at Fs = 5000Hz, formulate the discrete time signal obtained by sampling. (7)	**BTL 4**	**Analyzing**
15.	Find the Z-transform and ROC of the following signals: (i) $x(n) = a^n u(n)$ (5) (ii) $x(n) = a^{n-2} u(n-2)$ (8)	**BTL 3**	**Applying**

16.	(i) Distinguish between Continuous Time Fourier Transform & Discrete Time Fourier Transform. (3) (ii) Find the DTFT of $x(n) = (½)^n$ and plot its magnitude and phase spectrum. (10)	**BTL 2**	**Understanding**
17.	Find the inverse Z- transform of $\frac{z^{-1}}{3-4Z^{-1}+Z^{-2}}$ using Partial fraction method. (13)	**BTL 3**	**Applying**
	PART-C (15 MARKS)		
1.	(i) Deduce the DTFT of the rectangular pulse sequence shown below and also plot the spectrum. (10)  (ii) Determine the DTFT of the signal $x(n)= 2 (3)^n u(-n)$ (5)	**BTL 4**	**Analyzing**
2.	(i) Formulate the Z transform and prepare the pole zero plot with ROC for $x(n) = (0.5)^n u(n) – (1/3)^n u(n)$. (10) (ii) Evaluate the z- transform and ROC of $x(n) = a^{\|n\|}$; $\|a\|<1$ (5)	**BTL 3**	**Applying**
3.	Using Long division method , determine the inverse Z- transform of $\frac{1+Z^{-1}}{1+z^{-1}+z^{-2}}$. When **(i)** x (n) is causal (8) **(ii)** x (n) is anticausal. (7)	**BTL 3**	**Applying**
4.	(i) Determine the Z transform of the sequence $x[n] = a^n u[n] + b^n u[-n-1]$ and find ROC. (8) (ii) Estimate the Z- transform of the sequence x(n)= u(n)-u(n-3) and plot ROC. (7)	**BTL 2**	**Understanding**
5.	Find the inverse Z- transform of $X(Z) = \frac{Z}{(Z-1)(Z-2)(Z-3)}$ using partial fraction method for (i) ROC : $\|Z\| > 3$ (5) (ii) ROC: $3 > \|Z\| > 2$ (5) (iii) ROC: $\|Z\| < 1$ (5)	**BTL 1**	**Remembering**

UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS			
Impulse response -Convolution sum- Difference equations -Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.			
PART A			
Q. No	**Questions**	**BT Level**	**Competence**
1.	Define the non-recursive and recursive systems.	**BTL 1**	**Remembering**
2.	State the condition for an LTI discrete time system to be causal and stable in terms of ROC.	**BTL 1**	**Remembering**
3.	What is the overall impulse response h(n) when two systems $h_1(n)$ and h_2 (n) are in parallel and are in series?	**BTL 1**	**Remembering**
4.	Find the stability of the system whose impulse response is $h(n)=2^n u(n)$	**BTL 1**	**Remembering**
5.	Write the convolution sum with its equation $x_1(n)$ & $x_2(n)$ as two input sequence.	**BTL 1**	**Remembering**
6.	Mention the condition for stability in Z-domain?	**BTL 1**	**Remembering**
7.	Find the impulse response of a linear time invariant system as h(n)=sin πn. Express whether the system is stable or not.	**BTL 2**	**Understanding**
8.	Is the discrete time system described by the difference equation y(n) = x(-n) is causal?	**BTL 2**	**Understanding**
9.	Find out the range of values of the parameter 'a' for which the linear time invariant system with impulse response $h(n) = a^n u(n)$ is stable.	**BTL 2**	**Understanding**
10.	Analyze whether the following system is a recursive system or not and justify your answer y[n] = 2x[n] + 3x[n-1] – 2x[n-2].	**BTL 4**	**Analyzing**
11.	Determine the convolution of the following signals: x[n] = {1, 2, 3}, h[n] = {1,2}.	**BTL 3**	**Applying**
12.	Compute the convolution of the input signal {1,2} and its impulse response {1,1} using Z transform.	**BTL 3**	**Applying**
13.	Solve for the initial values of the given function $X(z) = (1+z^{-1}) / (1-0.25z^{-2})$	**BTL 2**	**Understanding**
14.	Check whether the system with system function $H(z) = \frac{1}{1-0.5z^{-1}} + \frac{1}{1-2z^{-1}}$ with ROC $\|z\| < 0.5$ is causal and stable.	**BTL 2**	**Understanding**
15.	Using Z-transform inspect if the LTI system given by H (z) = z/(z-1) is stable or not.	**BTL 4**	**Analyzing**
16.	Determine the system function of the discrete time system described by the difference equation, y(n) = 0.5y(n-1) + x(n).	**BTL 3**	**Applying**

17.	Examine the convolution of (a) $x(n) * \delta(n)$ (b) $x(n) * [h_1(n) + h_2(n)]$.	**BTL 4**	**Analyzing**
18.	Estimate the final values of the given function $X(z) = (1+z^{-1}) / (1-0.25z^{-2})$	**BTL 3**	**Applying**
19.	The input x(n) and output y(n) of a discrete time LTI system is given by x(n) = {1,2,3,4} and y(n) = {0,1,2,3,4}. Find the impulse response due to these functions.	**BTL 3**	**Applying**
20.	Determine the overall impulse response h(n) when two systems $h_1(n) = u(n)$ and $h_2(n) = \delta(n) + 2\,\delta(n-1)$ are in series.	**BTL 4**	**Analyzing**
21.	Given the system function $H(z) = z^{-1}/(z^{-2}+2z^{-1}+4)$. Find the difference equation of the system.	**BTL 2**	**Understanding**
22.	Determine Z-transform of unit impulse signal δ[n] and sketch its ROC	**BTL 4**	**Analyzing**
23.	Find the transfer function of the system described by the equation y(n-2)-3y(n- 1) + 2y(n) = x(n-1)	**BTL 3**	**Applying**
24.	Realize the difference equation y[n] = x[n] - 3x[n-1] in direct form I.	**BTL 4**	**Analyzing**
PART –B (13 Marks)			
1.	The input output relationship of a discrete system is given by y(n) – (¼)y(n-1) = x(n). Find the response y(n) if the Fourier transform of the input x(n) is given by $X(e^{j\omega}) = 1/ [1-(1/2)\, e^{-j\omega}]$. (13)	**BTL 1**	**Remembering**
2.	(i) Write the properties of convolution sum. (4) (ii) List the methods to compute the convolution sum along with steps. (4) (iii) Find the linear convolution of x(n)={1, 2, 3, 4, 5, 6, 7} with h(n)={2, 4, 6, 8} (5)	**BTL 1**	**Remembering**
3.	Determine the linear convolution of x(n) = {1,1,1,1} and h(n)= {2,2} using graphical representation. (13)	**BTL 1**	**Remembering**
4.	Find the impulse response, frequency response, magnitude response and phase response of the second order system $\boldsymbol{y(n) - y(n-1) + \frac{3}{16}\, y(n-2) = x(n) - \frac{1}{2}\, x(n-1)}$ (13)	**BTL 1**	**Remembering**
5.	The LTI discrete time system y(n)=(3/2)y(n-1)-(1/2)y(n-2)+x(n)+x(n-1) is given an input x(n) = u(n). (i) Determine the transfer function of the system. (7) (ii) Express the impulse response of the system. (6)	**BTL 2**	**Understanding**
6.	Determine the impulse and step response of the system described by the following difference equation y(n)+(1/ 3) y(n-1) = x(n). (13)	**BTL 2**	**Understanding**

7.	Obtain the system function and output response y(n) of a linear time invariant discrete time system specified by the equation $y(n) - \frac{3}{2}y(n-1) + \frac{1}{2}y(n-2) = 2x(n) + \frac{3}{2}\boldsymbol{x(n-1)}$. (13)	**BTL 2**	**Understanding**
8.	(i) Determine the impulse response of the discrete time system described by the difference equation y(n-2) - 3y(n-1) + 2y(n) = x(n-1). (8) (ii) Find the autocorrelation of {1,2,1,3}. (5)	**BTL 3**	**Applying**
9.	Analyze the system response described by the difference equation y(n) - 2y(n-1) -3y(n-2) = x(n) when the input signal $x(n)=2^n u(n)$ with initial conditions y(-1)=1, y(-2) = 0. (13)	**BTL 4**	**Analyzing**
10.	Explain the convolution between the signals, $x[n] = \alpha^n u[n]$ and h[n] = u [n-1]. (13)	**BTL 4**	**Analyzing**
11.	Consider a DT LTI system whose system function H(Z) is given by $H(Z) = \frac{z}{(z-0.5)}$: |z| > 0.5. Find the step response of the system. (13)	**BTL 3**	**Applying**
12.	Determine the impulse response for cascade of two LTI systems having impulse responses $\boldsymbol{h_1}(n)=\left(\frac{1}{3}\right)^n u(n)$ and $\boldsymbol{h_2}(n)=\left(\frac{1}{9}\right)^n u(n)$. (13)	**BTL 3**	**Applying**
13.	The input output relationship of a discrete system is given by y(n) – (¼)y(n-1) = x(n). Analyze the response y(n) if the Fourier transform of the input x(n) is given by $X(e^{j\omega})=1/[1-(1/2)e^{-j\omega}]$. (13)	**BTL 4**	**Analyzing**
14.	Determine the system function H(z) in the pole-zero pattern for the following systems and also check their stability. (i) y(n-2) - (7/10) y(n-1) + (1/10) y(n) = x(n). (7) (ii) y(n)=1.8y(n-1)-0.72y(n-2) + x(n)+0.5x(n-1). (6)	**BTL 3**	**Applying**
15.	(i)Compute y(n) = x(n)* h(n) where $x(n) = (1/2)^{-n} u(n-2)$ and h(n) = u(n-2) . (7) (ii)Find the convolution sum between x(n) = {1,4,3,2) and h(n) = {1,3,2,1}. (6)	**BTL 2**	**Understanding**
16.	A discrete time causal system has a transfer function H(z) as, $H(z) = \frac{1-z^{-1}}{1-0.2z^{-1}-0.15z^{-2}}$ (i) Determine the difference equation of the system. (5) (ii) Show pole-zero diagram and hence find magnitude at $\boldsymbol{\omega}= 0$ and $\boldsymbol{\omega}= \pi$. (4) (iii) Find the impulse response of the system. (4)	**BTL 4**	**Analyzing**
17.	LTI discrete time system y(n) = 3/2 y(n-1)-1/2 y(n-2) + x(n) + x(n-1) is given by an input x(n)= u(n). (i)Find the transfer function of the system. (7) (ii)Find the impulse response of the system. (6)	**BTL 4**	**Analyzing**

PART-C (15 MARKS)			
1.	Determine and sketch the magnitude and the phase response of $y(n) = \frac{1}{2}x(n) + \frac{1}{2}x(n-1)$ (15)	**BTL 1**	**Remembering**
2.	Consider a causal and stable LTI system whose input x(n) and output y(n) are related through the second order difference equation y(n)-(1/6) y(n-1)- (1/6) y(n-2) = x(n). Determine (i) Frequency response of the system. (5) (ii) Impulse response of the system. (5) (iii) The system output for the input $(1/4)^n$ u(n). (5)	**BTL 4**	**Analyzing**
3.	A system is described by the difference equation $y(n) - \left[\frac{1}{2}\right] y(n-1) = 5x(n)$. Identify and Determine the solution, when the $x(n) = \left[\frac{1}{5}\right]^n u(n)$ and the initial condition is given by y(-1) =1, using z transform. (15)	**BTL 2**	**Understanding**
4.	(i) Find the response of the causal system y(n) – y(n-1) = x(n) + x(n-1) to the input x(n)=u(n). Also test its stability. (10) (ii) Prove that a system having system function H(z) is stable, if and only if all poles of H(z) are inside the unit circle. (5)	**BTL 3**	**Applying**
5.	Compute the response of the system y(n) = 0.7 y(n-1)-0.12 y(n-2) + x(n-1) + x(n-2) to the input x(n) = nu(n). Is the system stable? (15)	**BTL 4**	**Analyzing**