INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**SIGNALS AND SYSTEMS**
Course Code	:	**A30406**
Class	:	II B. Tech I Semester
Branch	:	ECE
Year	:	2016 -2017
Course Coordinator	:	Ms. L Shruthi, Assistant Professor
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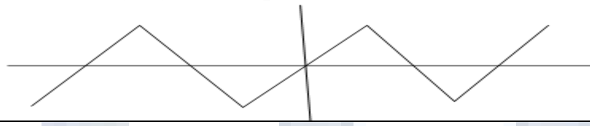
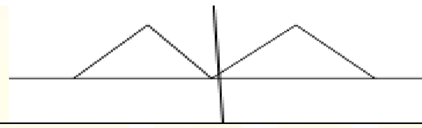
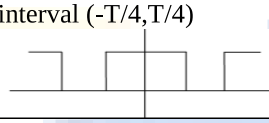
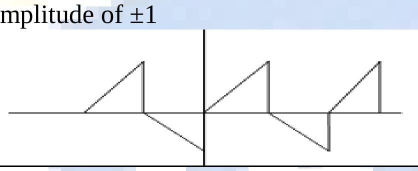
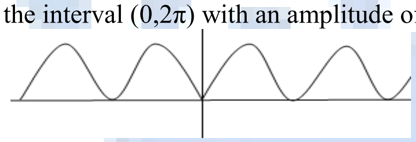
OBJECTIVES

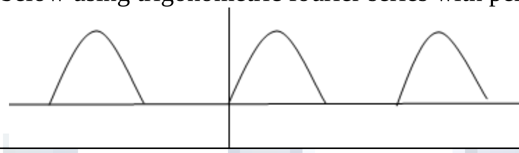
To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.

In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learner's learning process.

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
	UNIT-I Signal Analysis and Fourier Series		
	GROUP - A (SHORT ANSWER QUESTIONS)		
1	Define Signal.	Remember	1
2	Define system.	Understand	1
3	What are the major classifications of the signal?	Understand	1
4	Define discrete time signals and classify them	Remember	1
5	Define continuous time signals and classify them.	Understand	1
6	Condition for minimum mean square error?	Remember	1
7	Define discrete time unit step &unit impulse.	Understand	2
8	Define continuous time unit step and unit impulse.	Remember	2
9	Define periodic signal and nonperiodic signal.	Remember	2
10	Define unit ramp signal.	Understand	2
11	Define energy and power signals?	Understand	2
12	Define even and odd signal?	Remember	2
13	Define unit ramp function?	Remember	2
14	Define the Parseval's Theorem?	Remember	2
15	Define continuous time complex exponential signal?	Remember	2
16	What is continuous time real exponential signal?	Understand	2
17	What is continuous time growing exponential signal?	Remember	2
18	Find whether the signal given by x (n) = 5cos (6n) is periodic	Apply	2

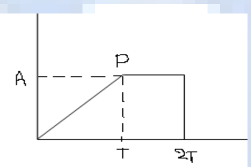
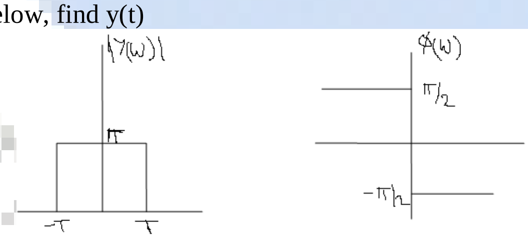
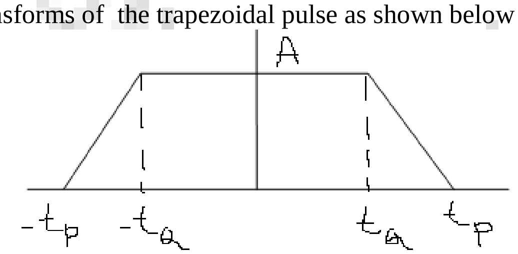
S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
19	Write down the exponential form of the Fourier series representation of a Periodic signal?	Apply	5
20	Write down the trigonometric form of the fourier series representation of a Periodic signal?	Apply	5
21	Write short notes on Dirichlet's conditions for fourier series.	Understand	5
22	State Time Shifting property in relation to fourier series.	Understand	5
23	Obtain Fourier Series Coefficients for $x(n) = sinw_0n$	Remember	5
24	What are the types of Fourier series?	Remember	5
GROUP - II (LONG ANSWER QUESTIONS)			
1	Prove that the functions Øm(t) and Øn(t) where Øk(t) =(1/√T)(cos kwt+sinkwt); T=2π/w are orthogonal over the period(0,T)	Understand	1
2	Prove that sin nwt and cos mwt are orthogonal to each other for all integers m,n	Apply	1
3	Prove that the complex exponential signals are orthogonal functions $x(t)=e^{jnwt}$ and $y(t)=e^{jmwt}$ let the interval be(t_0, t_0+T)	Apply	1
4	Discuss how an unknown function f(t) can be expressed using infinite mutually orthogonal functions. Hence show the representation of a waveform f(t) using trigonometric fourier series.	Apply	1
5	A rectangular function is defined as $$f(t) = \begin{cases} A, & 0 < t < \pi/2 \\ -A, & \frac{\pi}{2} < t < 3\pi/2 \\ A, & \frac{3\pi}{2} < t < 2\pi \end{cases}$$ Approximate the above function by A cos t between the intervals (0,2π) such that the mean square error is minimum.	Apply	1
6	A rectangular function is defined as $$f(t) = \begin{cases} 1, & 0 < t < \pi \\ -1, & \pi < t < 2\pi \end{cases}$$ Approximate the above function by a single sinusoid sint between the intervals(0,2π) , Apply the mean square error in this approximation.	Remember	1
7	Show that f(t) is orthogonal to signals cost, cos2t, cos3t, … cosnt for all integer values of n, n≠0, over the interval (0,2π) if $$f(t) = \begin{cases} 1, & 0 < t < \pi \\ -1, & \pi < t < 2\pi \end{cases}$$	Apply	1
8	Explain the analogy of vectors and signals in terms of orthogonality and evaluation of constant.	Remember	1
9	Consider the complex valued exponential signal x(t)= A $e^{\alpha t+jwt}$, a>0. Apply the real and imaginary components of x(t) for the following cases i) α is real, α=α1 ii) α is imaginary, α=jw iii) α is complex, α=α+jw	Apply	1
10	Sketch the following signals i) $\pi\left(\frac{t-1}{2}\right) + \pi(t-1)$ ii) f(t)=3u(t)+tu(t)-(t-1)u(t-1)-5u(t-2)	Understand	1
11	Apply the following integrals i) $\int_0^5 \delta(t)\sin 2\pi t\, dt$ ii) $\int_{-\alpha}^{\alpha} e^{-\alpha t^2}\,\delta(t-10)dt$	Apply	1
12	Determine whether each of the following sequences are periodic or not, if periodic determine the fundamental period. i) x(n)= sin(6πn/7) ii) y(n)= sin(n/8)	Remember	2
13	Write a short note on exponential fourier spectrum	Apply	2
14	Derive the polar fourier series from the exponential fourier series representation and hence prove that Dn=2 |Cn|	Apply	2
15	With regard to fourier series representation, justify the following statement a) odd functions have only sine terms	Remember	5

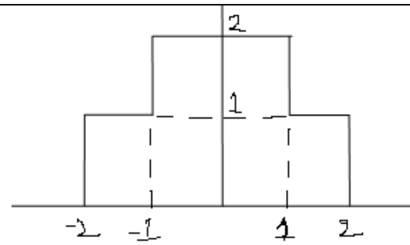
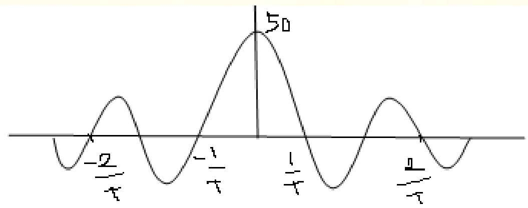
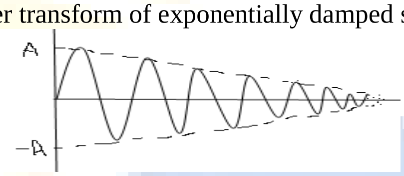
S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
	b) even functions have no sine terms c) functions with half-wave symmetry have only odd harmonics		
16	Find the fourier series expansion of the periodic triangular wave shown below for the interval (0,T) with amplitude of ‘A’ 	Apply	5
17	Determine the fourier series of the function shown below for the interval (0,T) with amplitude of ‘A’ 	Understand	5
18	Obtain the fourier series representation of an impulse train given by $x(t) = \sum_{n=-\alpha}^{\alpha} \delta(t - nT)$	Apply	5
19	Determine the fourier series expansion of the square wave function as $f(t) = \begin{cases} 1, & -1/2 < t < 1/2 \\ -1, & ½ < t < 3/2 \end{cases}$	Remember	5
20	Obtain the trigonometric fourier series for the periodic rectangular waveform as shown below for the interval (-T/4,T/4) 	Apply	5
21	Assume that T=2, determine the fourier series expansion of the signal shown below with amplitude of ±1 	Apply	5
22	Find the exponential fourier series for the fullwave rectified sinewave as shown below for the interval (0,2π) with an amplitude of ‘A’ 	Remember	5
23	The complex exponential representation of a signal x(t) over the interval (0,T) is $x(t) = \sum_{n=-\infty}^{\infty} \left[\frac{3}{4+(n\pi)^2}\right] e^{jn\pi t}$ i) what is the numerical value of T? ii) if one of the components of x(t) is A cos 3πt, determine the value of A iii) determine the minimum number of terms which must me retained in the representation of x(t) in order to include 99.9% of the energy in the interval	Apply	5
	GROUP - III (ANALYTICAL THINKING QUESTIONS)		
1	Approximate a square wave function with n orthogonal set sin(nwt), over the same period(0,T)	Apply	1
2	Plot amplitude and power spectrum of the periodic halfwave rectified	Apply	1

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
	function shown below using trigonometric fourier series with period T=2 		
3	Find the fourier series of the following function $$f(t)=\begin{cases} A, & -\delta/2 < t < \delta/2 \\ 0, & \frac{\delta}{2} < t < (T-\frac{\delta}{2}) \end{cases}$$	Understand	2
4	Consider three continuous time periodic signals whose fourier series representations are as follows i) $x_1(t)=\sum_{k=0}^{100}\left(\frac{1}{2}\right)^k e^{jk\frac{2\pi}{50}t}$ ii) $x_2(t)=\sum_{k=-100}^{100}\cos(k\pi)\, e^{jk\frac{2\pi}{50}t}$ iii) $x_3(t)=\sum_{k=-100}^{100} j\sin\left(\frac{k\pi}{2}\right) e^{jk\frac{2\pi}{50}t}$ use fourier series properties to help answer the following questions a) Which of the three signals is/are real valued? b) Which of the three signals is/are even?	Apply	5
5	Suppose we are given the following information about a signal x(n) 1. x(n) is a real and even signal 2. x(n) has period N=10 and fourier coefficients a_k 3. $a_{11}=5$ 4. $\frac{1}{10}\sum_{n=0}^{9}\lvert x(n)\rvert^2=50$ Show that x(n)= A cos(Bn+C), and specify values constants A,B,C	Understand	2

UNIT-II
Fourier Transforms and Sampling
GROUP - A (SHORT ANSWER QUESTIONS)

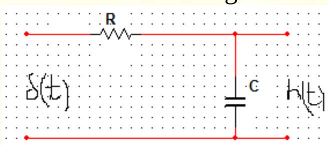
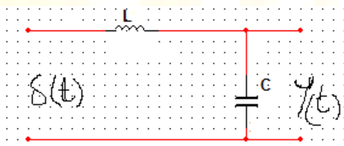
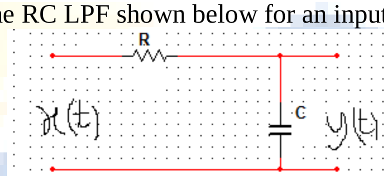
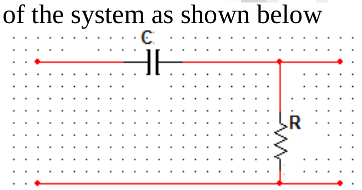
1	Define Fourier transform pair.	Remember	5
2	Find the fourier transform of x(t)=sin(wt)	Understand	5
3	Explain how aperiodic signals can be represented by fourier transform.	Remember	5
4	Explain how periodic signals can be represented by fourier transform.	Remember	5
5	State Convolution property of Fourier Transform.	Remember	5
6	Find the fourier transform of x(t)=cos(wt)	Apply	5
7	Find the fourier transform of sgn function	Apply	5
8	Find the Fourier transform of $x(t)=e^{j2\pi ft}$	Apply	5
9	State properties of fourier transform.	Understand	5
10	State Parseval's relation for continuous time fourier transforms.	Apply	5
11	The Fourier transform (FT) of a function x (t) is X (w). What is the FT of dx(t)/ dt	Remember	5
12	What is the Fourier transform of a rectangular pulse existing between t = − T / 2 to t = T / 2	Understand	5
13	What is the Fourier transform of a signal $x(t)=e^{2t}u(-t)$	Apply	5
14	What are the difference between Fourier series and Fourier transform?	Apply	5
15	Explain time shifting property of fourier transform	Apply	6
16	Why CT signals are represented by samples.	Remember	6
17	What is meant by sampling?	Apply	6
18	State Sampling theorem.	Understand	6
19	What is meant by aliasing?	Apply	6
20	What are the effects aliasing?	Apply	6
21	What are all the blocks are used to represent the CT signals by its samples?	Remember	6
22	Mention the types of sampling.	Remember	6

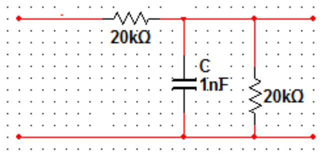
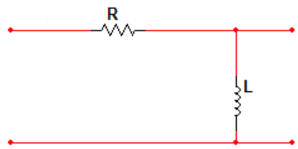
S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
23	Define Nyquist's rate.	Apply	6
24	What is the condition for avoid the aliasing effect?	Apply	6
25	What is an antialiasing filter?	Apply	6
26	What is the Nyquist's Frequency for the signal $x(t) = 3\cos 50t + 10\sin 300t - \cos 100t$?	Understand	6
27	What is the period of the signal $x(t) = 10\sin 12t + 4\cos 18t$	Apply	6
28	Define Nyquist's interval	Remember	6
29	Define sampling of band pass signals.	Understand	6
30	What is the Nyquist's Frequency for the signal $x(t) = 3\cos 100t + 10\sin 30t - \cos 50t$?	Apply	6
GROUP - II (LONG ANSWER QUESTIONS)			
1	Distinguish between the exponential form of the fourier series and fourier transform. What is the nature of the 'transform pair' in the above two cases	Remember	5
2	Find the fourier transform of the following a) real exponential, $x(t)= e^{-at}\, u(t), a>0$ b) rectangular pulse, $x(t) = \begin{cases} 1, & -T \le t \le T \\ 0, & \|t\| > T \end{cases}$ c) $x(t)= e^{at}\, u(-t), a>0$	Apply	5
3	a) Find the fourier transform of a gate function $\prod(t) = \begin{cases} 1, & \|t\| < 1/2 \\ 0, & \|t\| > 1/2 \end{cases}$ b) Find the fourier transform of x(t)=1	Apply	5
4	Find the fourier transforms of a) cos wt u(t) b) sin wt u(t) c) cos (wt+Ø) d) e^{jwt}	Remember	5
5	Find the fourier transforms of a normalized Gaussian pulse	Understand	5
6	Find the fourier transforms of a Triangular pulse	Apply	5
7	Find the fourier transforms of signal $x(t)=e^{-A\|t\|}\, sgn(t)$	Apply	5
8	Find the fourier transforms of signal x(t) 	Apply	5
9	The magnitude |Y(w)| and phase Ø(w) of the fourier transform of a signal y(t) are shown in below, find y(t) 	Remember	5
10	Find the fourier transforms of the trapezoidal pulse as shown below 	Apply	5
11	Find the fourier transforms of signal x(t) as shown below	Understand	5

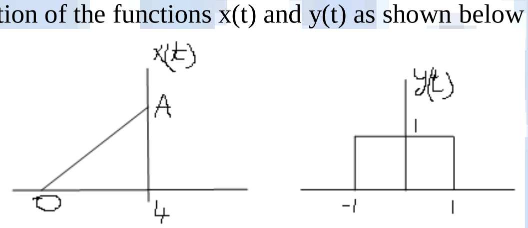
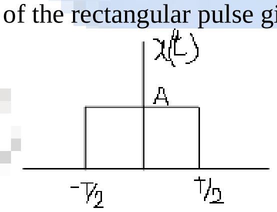
S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
			
12	Determine the fourier transforms of the sinc function as shown below 	Apply	5
13	Find the fourier transform of square wave with period T=4, amplitude of ‘A’	Apply	5
14	Determine the fourier transform of exponentially damped sinusoidal signal 	Apply	5
15	Find the fourier transform of periodic pulse train with period T=T/2, with amplitude of ‘A’	Remember	5
16	Find the fourier transform of e^{-at} sin wt u(t)	Apply	5
17	Find the continuous magnitude and phase spectra of a single pulse $$x(t) = \begin{cases} A, & (-a,0) \\ 0, & \forall\, t \\ -A, & (0,a) \end{cases}$$	Understand	5
18	Consider the signal $x(t) = \left(\frac{\sin 50\pi t}{\pi t}\right)^2$ which is to be sampled with a sampling frequency of ω_s=150π to obtain a signal g(t) with fourier transform G(jw). Determine the maximum value of w_0 for which it is guaranteed that G(jw)=75X(jw) for $\|w\| \leq w_0$, where X(jw) is F.T of x(t)	Apply	6
19	A signal x(t)=2cos 400πt+6 cos 640πt is ideally sampled at f_s=500Hz, if the sampled signal is passed through an ideal LPF with a cut off frequency of 400Hz, what frequency components will appear in the output.	Apply	6
20	Determine the Nyquist’s rate and interval corresponding to each of the following signals i) $x(t) = \frac{\sin 4000\pi t}{\pi t}$ ii) x(t) =1+cos 2000πt+sin 4000πt	Apply	6
21	The signal x(t)=cos 5πt+0.3 cos 10πt is instantaneously sampled. Determine the maximum interval of the sample	Remember	6
22	The signal x(t)=cos 5πt+0.3 cos 10πt is instantaneously sampled. The interval between the samples is T_s a) Find the maximum allowable value for T_s b) If the sampling signal is $S(t) = \sum_{k=-\alpha}^{\alpha} \delta(t-0.1k)$, the sampled signal v_s(t)= v(t).S(t) consists of a train of impulses, each with a different strength $v_s(t) = \sum_{k=-\alpha}^{\alpha} I_k \delta(t-0.1k)$, find I_0, I_1, I_2	Apply	6

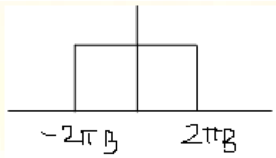
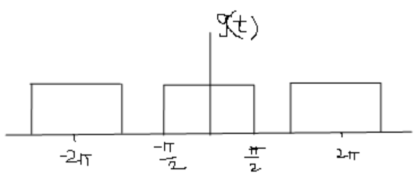
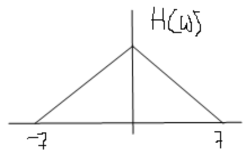
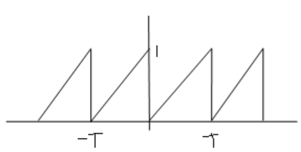
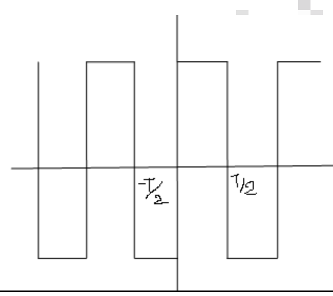
S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
	c) To reconstruct the signal $v_s(t)$ is passed through a rectangular LPF. Find the minimum filter bandwidth to reconstruct the signal without distortion		
23	For the analog signal x(t)=3 cos 100πt a) Determine the minimum sampling rate to avoid aliasing b) Suppose that the signal is sampled at the rate, f_s=200Hz, what is the discrete time signal obtained after sampling c) Suppose that the signal is sampled at the rate, f_s=75Hz, what is the discrete time signal obtained after sampling d) What is the frequency $0<f< f_s/2$ of a sinusoid that yields samples identical to those obtained in (c) above	Understand	6
24	Show that a band limited signal of finite energy which has no frequency components higher than f_m Hz is completely described by specifying values of the signals at instants of time separated by 1/2 f_m seconds. Also show that if the instantaneous values of the signal are separated at intervals larger than 1/2 f_m seconds, they fail to describe the signal. A band pass signal has spectral range extending from 20kHz to 80kHz; find the acceptable range of sampling frequency f_s.	Apply	6
25	A flat-top sampling system samples s signal of maximum frequency 1kHz with 2.5 Hz sampling frequency. The duration of the pulse is 0.2s. Compute the amplitude distortion due to aperture effect at the highest signal frequency. Also determine the equalization characteristic.	Apply	6
	GROUP - III (ANALYTICAL THINKING QUESTIONS)		
1	Suppose that a signal x(t) has fourier transform X(jw). Now consider another signal g(t) whose shape is the same as the shape of X(jw); that is g(t)= X(jt) a) show that the fourier transform G(jw) of g(t) has the same shape as 2πx(-t); that is, show that G(jw)=2πx(-w) b) using the fact that $F\{\delta(t+B)\}=e^{jBw}$ In conjuction with the result from part (a), show that $F\{e^{jBt}\}=2\pi\delta(w-B)$	Remember	5
2	Use properties of the fourier transform to show by induction that the fourier transform of $x(t)=\frac{t^{n-1}}{(n-1)!}\, e^{-at}\, u(t), a>0$ is $\frac{1}{(a+jw)^n}$	Apply	5
3	Let $g_1(t)=\{[\cos wt]x(t)\}*h(t)$ and $g_2(t)=\{[\sin wt]x(t)\}*h(t)$ where $x(t)=\sum_{k=-\infty}^{\infty} a_k\, e^{jk100t}$ is a real valued periodic signal and h(t) is the impulse response of a stable LTI system. a) specify a value for w and any necessary constraints on H(jw) to ensure that $g_1(t)= Re\{a_5\}$ and $g_2(t)= Im\{a_5\}$ b) give an example of h(t) such that H(jw) satisfies the constraints you specified in part (a).	Remember	5
4	Suppose x[n] has a fourier transform that is zero for π/3≤|w|≤π. Show that $x[n]=\sum_{k=-\infty}^{\infty} x[3k]\left(\frac{\sin\left(\frac{\pi}{3}(n-3k)\right)}{\frac{\pi}{3}(n-3k)}\right)$	Understand	5
5	If $x[n]=\cos\left(\frac{\pi}{4}n+\emptyset\right)$ with $0\le\emptyset\le 2\pi$ and $g[n]=x[n]\sum_{k=-\infty}^{\infty}\delta[n-4k]$, what additional constraints must be imposed on Ø to ensure that $g[n]*\left(\frac{\sin\frac{\pi}{4}n}{\frac{\pi}{4}n}\right)=x[n]$?	Apply	5
	UNIT-III		

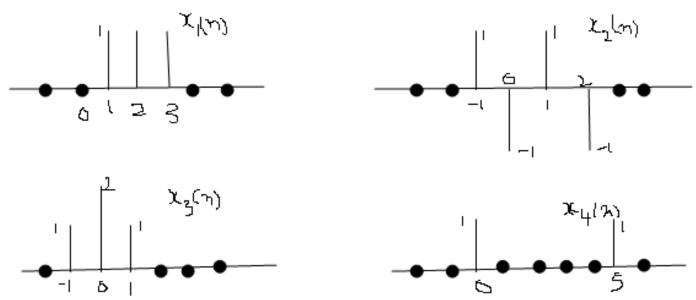
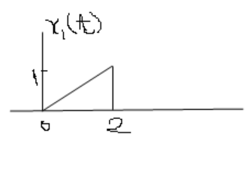
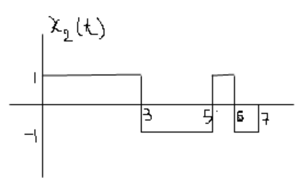
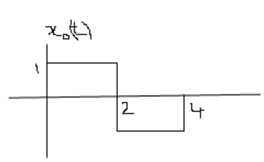
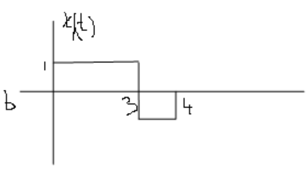
S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
	Signal transmission through linear systems		
	GROUP - A (SHORT ANSWER QUESTIONS)		
1	What are the Conditions for a System to be LTI System?	Remember	3
2	Define time invariant and time varying systems.	Understand	3
3	Is the system describe by the equation y(t) = x(2t) Time invariant or not? Why?	Understand	3
4	What is the period T of the signal x(t) = 2cos (n/4)?	Remember	3
5	Is the system y(t) = y(t-1) + 2t y(t-2) time invariant ?	Understand	3
6	Is the discrete time system describe by the equation y (n) = x(-n) causal or non causal ?Why?	Remember	3
7	What is the periodicity of x(t) = $e^{j100\Pi t}$?	Understand	3
8	What is the impulse response of two LTI systems connected in parallel	Apply	3
9	Define LTI CT systems	Apply	3
10	What is the condition of LTI system to be stable?	Understand	3
11	What are the tools used for analysis of LTI CT systems?	Understand	3
12	When the LTICT system is said to be dynamic?	Remember	3
13	When the LTICT system is said to be causal?	Remember	3
14	When the LTICT system is said to be stable?	Remember	3
15	Define impulse response of continuous system	Remember	3
16	Find the unit step response of the system given by h (t)= 1/RC $e^{-t/RC}$ u(t)	Understand	3
17	What is the impulse response of the system y(t)= x(t-to)	Remember	3
18	Define eigenvalue and eigen function of LTI-CT system.	Understand	3
19	The impulse response of the LTI-CT system is given as h(t) = e^{-t} u(t). Determine transfer function and check whether the system is causal and stable series?	Remember	3
20	Define impulse response of a linear time invariant system.	Understand	3
21	Write down the input-output relation of LTI system in time and frequency domain.	Remember	3
22	Define transfer function in CT systems.	Understand	3
23	What is the relationship between input and output of an LTI system?	Apply	3
24	Write down the convolution integral to find the output of the CT systems	Apply	4
25	Give the system impulse response h(t). State the conditions for stability and causality.	Understand	4
26	List and draw the basic elements for the bloc diagram representation of the CT systems.	Understand	4
27	What are the three elementary operations in block diagram representation of CT system	Remember	4
	GROUP - II (LONG ANSWER QUESTIONS)		
1	Determine whether the following input-output equations are linear or non linear. a) $y(t)=x^2(t)$ b) $y(t)=x(t^2)$ c) $y(t)=t^2x(t-1)$ d) y(t)=x(t) cos 50πt	Understand	3
2	Find whether the following system are static or dynamic a) $y(t)= x(t^2)$ b) $y(t)=e^{x(t)}$ c) $y(t) = \int_{\tau=0}^{\infty} x(t-\tau)d\tau$	Apply	3
3	Find whether the following systems are causal or non-causal a) y(t)=x(-t) b) y(t)=x(t+10)+x(t) c) y(t)=x(sin(t)) d) y(t)=x(t) sin(t+1)	Apply	3
4	Determine whether the following systems are time-varying or time-invariant a) y(t)=tx(t) b) $y(t)=t^2$ x(t-1) c) $y(t)=a[x(t)]^2+bx(t)$ d) y(t)=x(t) cos 50πt	Apply	3
5	Show that the following systems are LTI systems	Apply	3

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
	a) y(t)=x(t/4) b) $y(t) = \begin{cases} x(t) + x(t-4), & t \geq 0 \\ 0, & t < 0 \end{cases}$		
6	Find whether the following systems are stable or unstable a) $y(t)=e^{x(t)}$; $\lvert x(t)\rvert<10$ b) y(t)=(t+10) u(t)	Apply	3
7	Find the impulse response of a system characterized by the differential equations a) $\tau\left[\frac{dy(t)}{dt}\right] + y(t) = x(t); \quad -\infty < t < \infty$ b) $\tau\left[\frac{d^2y(t)}{dt^2}\right] + y(t) = x(t); \quad -\infty < t < \infty$ Where x(t) is the input and y(t) is the output	Apply	3
8	Test whether the system described in the figure is BIBO stable or not 	Understand	4
9	Test whether the given LC LPF is BIBO stable or not 	Apply	4
10	Find the voltage of the RC LPF shown below for an input voltage of te^{-at} 	Apply	4
11	The impulse response of a continuous time system is expressed as $h(t) = \frac{1}{RC} e^{-\frac{t}{RC}} u(t)$ find the frequency response and plot the magnitude and phase plots	Understand	4
12	A system produces an output of $y(t)= e^{-t}$ u(t) for an input of $x(t)= e^{-2t}$ u(t). Determine the impulse response and frequency response of the system	Apply	4
13	The input voltage to an RC circuit is given as $x(t)=te^{-t/RC}$ u(t) and the impulse response of this circuit is given as $h(t)=(1/RC)\, e^{-t/RC}$ u(t). Determine the output y(t)	Apply	4
14	For a system excited by $x(t)=e^{-2t}$ u(t), the impulse response is $h(t)=e^{-t}$ u(t)+e^{2t} u(-t), find the output y(t) for this system	Apply	4
15	Consider a causal LTI system with frequency response $H(w) = \frac{1}{3+jw}$ For a particular input x(t), the system is observed to produce the output, $y(t)=e^{-3t}$ u(t)-e^{-4t} u(t), find the input x(t)?	Understand	4
16	The transfer function of the LPF is given by $H(w) = \begin{cases} (1 + k\cos wT)e^{-jw\tau}; & \lvert w\rvert < 2\pi B \\ 0; & \lvert w\rvert > 2\pi B \end{cases}$ Determine the output y(t) when a pulse x(t) band limited in B is applied at input	Understand	4
17	Find the impulse response of the system as shown below  Find the transfer function. What would be its frequency response? Sketch the	Apply	4

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
	response.		
18	Determine the maximum bandwidth of signals that can be transmitted through the low pass RC filter as shown below, if over this bandwidth, the gain variation is to be within 10% and the phase variation is to be within 7% of the ideal characteristics. 	Apply	4
19	There are several possible ways of estimating an essential bandwidth of non-band limited signal. For a low pass signal, for example, the essential bandwidth may be chosen as a frequency where the amplitude spectrum of the signal decays to k% of its peak value. The choice of k depends on the nature of application. Choosing k=5, determine the essential bandwidth of $g(t)= e^{-at}\, u(t)$.	Apply	4
20	Find the impulse response to the RL filter as shown below 	Understand	4
21	Consider a stable LTI system characterized by the differential equation $$\frac{d^2y(t)}{dt^2} + 4\frac{d\,y(t)}{dt} + 3\,y(t) = \frac{d\,x(t)}{dt} + 2\,x(t)$$ Find its impulse response and transfer function	Understand	4
GROUP - III (ANALYTICAL THINKING QUESTIONS)			
1	Consider the signal $x[n]= \alpha^n u[n]$ a) sketch the signal $g[n]= x[n]- \alpha\, x[n-1]$ b) use the result of part (a) in conjuction with properties of convolution in order to determine a sequence h[n] such that $x[n] * h[n]= (1/2)^n \{u[n+2]- u[n-2]\}$	Remember	3
2	Consider an LTI system S and a signal $x(t)=2e^{-3t}\, u(t-1)$. If $x(t) \rightarrow y(t)$ and $\frac{dx(t)}{dt} \rightarrow -3y(t) + e^{-2t}\, u(t)$. determine the impulse response h(t) of S.	Remember	3
3	Determine whether each of the following statements concerning LTI systems is true or false. Justify your answers. a) if h(t) is the impulse response of an LTI system and h(t) is periodic and nonzero, the system is unstable. b) the inverse od causal LTI system is always causal c) if $\lvert h[n]\rvert \leq K$ for each n, where K is a given number, then the LTI system with h[n] as its impulse response is stable.	Remember	4
4	Consider an LTI system with impulse response h[n] that is not absolutely summable; that is, $$\sum_{k=-\infty}^{\infty} \lvert h[k]\rvert = \infty$$ a) suppose that the input to its system is $$x[n] = \begin{cases} 0, & if\ h[-n] = 0 \\ \frac{h[-n]}{\lvert h[-n]\rvert}, & if\ h[-n] = 0 \end{cases}$$ Does this input signal represent a bounded input? Is so, what is the smallest number B such that $\lvert x[n]\rvert \leq n$ for all n? b) calculate the output at n=0 for this particular choice of input. does the result prove the contention that absolute summability is a necessary condition for stability.	Apply	4

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
5	Consider a discrete time LTI system with unit sample response $h[n]=(n+1)\,\alpha^n u[n]$, where $\lvert\alpha\rvert<1$. Show that the step response of the system is $s[n]=\left[\frac{1}{(\alpha-1)^2}-\frac{\alpha}{(\alpha-1)^2}\alpha^n+\frac{\alpha}{(\alpha-1)}(n+1)\alpha^n\right]u[n]$	Apply	4
	UNIT-IV **Convolution and correlation of signals**		
	GROUP - A (SHORT ANSWER QUESTIONS)		
1	What are the properties of convolution?	Understand	5
2	Explain about Auto correlation?	Remember	5
3	State the Cross correlation?	Understand	5
4	Properties of Auto correlation	Understand	5
5	Determine the convolution of the signals X(n)={2,-1,3,2} & h(n)={1,-1,1,1}	Apply	5
6	Define convolution integral.	Understand	5
7	List the properties of convolution integral.	Understand	5
8	State commutative property of convolution.	Apply	5
9	Find the convolution of two sequences x(n)={1,1,1,1} and h(n)={2,2}?	Apply	5
10	What is the overall impulse response h(n) when two system with impulse response h1(n)and h2(n) are connected in parallel in series?	Apply	5
11	What is the necessary and sufficient condition on impulse response for stability?	Understand	5
12	What are the steps involved in calculating convolution sum?	Remember	5
13	Find the convolution of x1(t) and x2(t) , x1(t)= t u(t),x2=u(t) 14.	Understand	5
14	Find linear convolution of x(n)={1,2,3,4,5,6} with y(n)={2,-4,6,-8}	Remember	5
15	Find the circular convolution of x1(n)={1,2,0,1} X2(n)={2,2,1,1}	Apply	5
	GROUP - II (LONG ANSWER QUESTIONS)		
1	Determine the convolution of two functions $x(t)=a\,e^{-at}$; $y(t)=u(t)$	Apply	4
2	Find the convolution of the functions x(t) and y(t) as shown below 	Apply	4
3	Find the convolution of the rectangular pulse given below with itself 	Understand	4
4	Determine the energy and power for the following signals and hence determine whether the signal id energy or power signal i) $x(t)=e^{-3t}$ ii) $x(t)=e^{-3\lvert t\rvert}$ iii) $x(t)=e^{-10t}u(t)$ iv) $x(t)=A\,e^{j2\pi at}$	Understand	4
5	Verify Parseval's theorem for the energy signal $x(t)=e^{-at}u(t)$, a>0	Apply	4
6	Find the power for the following signals i) A cos wt ii) a+f(t), a is a constant and f(t) is a power signal with zero mean	Apply	4
7	Find the autocorrelation, power, RMS value and sketch the PSD for the signal x(t)=(A+ sin 100t) cos 200t	Apply	4

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
8	Determine the energy spectral density (ESD) of a gate function of width τ and amplitude A.	Understand	4
9	A signal e^{-3t} u(t) is passed through an ideal LPF with cut-off frequency of 1 rad/s i) Test whether the input is an energy signal ii) Find the input and output energy	Understand	4
10	A function f(t) has a PSD of S(w). Find the PSD of i) integral of f(t) and ii) time derivative of f(t)	Apply	4
11	A power signal g(t) has a PSD $S_g(w)=N/A^2$, $-2\pi B \le w \le 2\pi B$, shown in figure  below, where A and N are constants.	Apply	4
12	The periodic signal g(t) is passed through a filter with transfer function H(w) shown in figure below. Determine the PSD and RMS value of the input signal. Assume the period is 2π.  	Apply	4
13	A filter has an input $x(t)=e^{-2t}$ u(t) and transfer function, H(w)=1/(1+jw). Find the ESD of the output?	Understand	4
14	The auto correlation function of signal is given below i) $R(\tau) = e^{-\tau^2/2\sigma^2}$ ii) $R(\tau) = e^{-2a\|\tau\|}$ Determine the PSD and the normalized average power content of the signal	Understand	4
15	Determine the auto and cross correlation and PSDand ESD of the following signal x(t)=Asin(wt+Ø)	Apply	4
16	Find the convolution of the two continuous-time functions x(t)= 3 cos2t for all t and $y(t)=e^{-\|t\|} = \begin{cases} e^{t}; t < 0 \\ e^{-t}; t \ge 0 \end{cases}$	Apply	4
17	State and prove the properties of auto correlation function	Apply	4
18	Prove that for a signal, auto correlation and PSD form a fourier transform pair	Understand	4
19	Show that the relation between correlation and convolution	Understand	4
20	Find out the cross correlation function of the following two periodic wave forms  	Apply	4
21	Find the power spectral density of a periodic signal?	Apply	4

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
22	Derive the Parseval’s theorem from the frequency convolution property	Understand	4
	GROUP - III (ANALYTICAL THINKING QUESTIONS)		
1	Suppose that the signal x(t)= u(t+0.5)-u(t-0.5) and the signal h(t)= e^{jwt} a) Determine a value of w which ensures that y(0)=0, where y(t)=x(t)*h(t) b) Is your answer to the previous part unique?	Apply	4
2	a) If x(t)=0, |t|>T_1 and h(t)=0, |t|>T_2 then x(t)*h(t)=0, |t|>T_3 for some positive number T_3. Express T_3 in terms of T_1 and T_2 b) Consider a discrete-time LTI system with the property that if the input x[n]=0 for all n≥10, then the output y[n]=0 for all n≥15. What condition must h[n], the impulse response of the system, satisfy for this to be true?	Remember	4
3	a) compute the auto correlation sequences for the signals $x_1[n]$, $x_2[n]$, $x_3[n]$, $x_4[n]$ as shown below b) compute the cross-correlation sequences $Ø_{xi\ xj}[n]$, i≠j, i,j=1,2,3,4 	Apply	4
4	a) compute the auto correlation function for each of the two signals $x_1(t)$ and $x_2(t)$ as shown in fig-a b) let x(t) be a given signal, and assume that x(t) is of finite duration—i.e., that x(t)=0 for t<0 and t>T. Find the impulse response of an LTI system so that $Ø_{xx}(t-T)$ is the output if x(t) is the input c) The system determined in fig-b is a matched filter for the signal x(t). Let x(t) be as in fig-b, and let y(t) denote the response to x(t) of an LTI system with real impulse response h(t). Assume that h(t)=0 for t<0 and for t>T. show that the choice for h(t) that maximizes y(T), subject to the constraint that $\int_0^T h^2(t)dt = M;\ a\ fixed\ positive\ number$  fig-a   fig-b 	Apply	4
5	a) Find the PSD of the integral of a function f(t) b) Find the PSD of the derivative of a function f(t)	Understand	4
	UNIT-V		

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
Laplace transforms and z transforms			
GROUP - A (SHORT ANSWER QUESTIONS)			
1	What is the use of Laplace transform?	Understand	5
2	What are the types of laplace transform?	Remember	5
3	Define Bilateral and unilateral laplace transform.	Understand	5
4	Define inverse laplace transform.	Remember	5
5	State the linearity property for laplace transform.	Apply	5
6	Region of convergence of the laplace transform	Understand	5
7	State the time shifting property for laplace transform	Understand	5
8	What is pole zero plot.	Apply	5
9	State initial value theorem and final value theorem for laplace transform	Apply	5
10	State Convolution property of the Laplace transform	Apply	5
11.	What is region of Convergence?	Understand	5
12.	What are the Properties of ROC?	Remember	5
13.	The unilateral Laplace transform of $f(t)$ is $1/s^2+s+1$. What is the unilateral Laplace transform of $tf(t)$	Understand	5
14.	Find the Laplace Transforms of the function f(t)u(t),where f(t) is periodic with period T, is A(s) times the L.T. of its first period.	Remember	5
15.	In what range should Re(s) remain so that the L.T. of the function $e^{(a+2)t+5}$ exists?	Apply	5
16.	Define Z transform.	Understand	5
17.	What are the two types of Z transform?	Understand	5
18.	Define unilateral Z transform.	Apply	5
19.	What is the time shifting property of Z transform.	Apply	5
20	What is the differentiation property in Z domain	Apply	5
21	State convolution property of Z transform.	Understand	5
22	State the methods to find inverse Z transform.	Remember	5
23	State multiplication property in relation to Z transform.	Understand	5
24	State parseval's relation for Z transform.	Remember	5
25	What is the relationship between Z transform and fourier	Apply	5
26	Define one sided Z transform and two sided Z transform.	Understand	5
27	What is the Z-transform of sequence $x(n)=a^n u(n)$?	Understand	5
28	What is the linearity property of Z transform	Apply	5
29	What is the correlation property of z transform	Apply	5
30	The final value of $x(t)=(2+e^{-3t})\,u(t)$ is obviously $x(\infty)=2$. Show that this final value can be found with the final value theorem.	Understand	5
GROUP - II (LONG ANSWER QUESTIONS)			
1.	Determine the function of time x(t) for each of the following Laplace transforms and their associated region of convergence i) $\frac{(s+1)^2}{s^2-s+1}\ Re\{s\} > 1/2$ ii) $\frac{s^2-s+1}{(s+1)^2}\ Re\{s\} > -1$	Understand	5
2.	Consider the following signals, find Laplace transform and region of convergence for each signal a) $e^{-2t}u(t) + e^{-3t}u(t)$ b) $e^{-4t}u(t) + e^{-5t}\sin 5t\, u(t)$	Apply	5
3.	State the properties of Laplace transform	Understand	5
4.	Determine the function of time x(t) for each of the following Laplace transforms a) $\frac{1}{s^2+9}; Re\{s\} > 0$ b) $\frac{s}{s^2+9}; Re\{s\} < 0$ c) $\frac{s+1}{(s+1)^2+9}; Re\{s\} < -1$	Remember	5
5.	Determine the Laplace transform and associated region of convergence for each of the following functions of time i) $x(t) = 1;\ 0 \le t \le 1$ ii) $x(t)=\begin{cases} t; & \\ 2-t; & 1 \le t \le 2 \end{cases}$ iii) x(t)= cos	Apply	5

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
	wt		
6.	Properties of ROC of Laplace transforms	Understand	5
7.	Find the Laplace Transforms of the following functions a) exponential function b) unit step function c) hyperbolic sine & cosine d) damped sine function e) damped hyperbolic cosine & sine f) power 'n'	Understand	5
8.	Find the inverse Laplace transform of the functions i) Y(s)= $\frac{10s}{(s+2)^2\,(s+8)}$ ii) Y(s)= $\frac{10s}{(s+2)^3\,(s+8)}$	Apply	5
9.	Find the inverse Laplace transform of the functions i) Y(s)=$\frac{2s^2+6s+6}{(s+2)(s^2+2s+2)}$ ii) Y(s)= $\frac{s^4+5s^3+12s^2+7s+15}{(s+2)(s^2+1)^2}$	Apply	5
10.	A certain function f(t) is known to have a transform F(s)=$\frac{6s^2+8s+5}{s(2s^2+6s+5)}$, find f(t) find also values of f(t) at t=0 and t=∞	Apply	5
11.	Find x(t) if X(s)=$\frac{1}{(s^2+a^2)^2}$ using convolution	Understand	5
12.	For an initially inert system, the impulse response is ($e^{-2t}+e^{-t}$) u(t). find the excitation to produce an output of t. e^{-2t} u(t)	Remember	5
13.	Find the Laplace transform of the following function , x(t)= (1/t) $\sin^2$ wt	Understand	5
14.	Obtain the inverse Laplace transform of the function $ln\left\{\frac{s+a}{s+b}\right\}$	Remember	5
15.	Find the Laplace Transform of cos wt and sin wt using frequency shifting property	Apply	5
16	Determine the Laplace transform and associated region of convergence and pole-zero plot for the following function of time. x(t)= e^{-2t} u(t) + e^{3t} u(t)	Understand	5
17	Find the z-transform of the following sequences i) x[n]= a^{-n} u[-n-1] ii) x[n]= u[-n] iii) x[n]= $-a^n$ u[-n-1]	Understand	5
18	A finite series sequence x[n] is defined as x[n]={5,3,-2,0,4,-3}.find X[z] and its ROC.	Apply	5
19	Find the z-transform of the following i) x[n]= cos nw. u[n] ii) x[n]= a^n sin nw. u[n] iii) x[n]= a^n u [n]	Apply	5
20	Find the z-transform and ROC of the following sequences i) x[n]=[4(5n)-3(4n)] u(n) ii) $(1/3)^n$ u[-n] iii) $(1/3)^n$ [u[-n]-u[n-8]]	Apply	5
21	Constraints on ROC for various classes of signals?	Understand	5
22	Using the power series expansion technique, find the inverse z-transform of the following X(z): i) X(z)= $\frac{z}{2z^2-3z+1}$; |z|<1/2 ii) X(z)= $\frac{z}{2z^2-3z+1}$; |z|>1	Remember	5
23	Find the inverse Z-transform of X(z)= $\frac{z}{z(z-1)(z-2)^2}$; |z|>2 using partial fraction	Understand	5
24	Find inverse z-transform of X(z) using long division method X(z)= $\frac{2+3z^{-1}}{(1+z^{-1})(1+0.25z^{-1}-\frac{(z-2)}{8})}$	Remember	5
25	Properties of Z-transforms?	Apply	5
26	Find the inverse z-transform of X(z)= $\frac{(z-1)^2}{z^2-0.1z-0.56}$	Understand	5
	GROUP - III (ANALYTICAL THINKING QUESTIONS)		
1	Let h(t) be the impulse response of a causal and stable LTI system with a rational system function	Remember	5

S. No	QUESTION	Blooms Taxonomy Level	Course Outcome
	a) is the system with impulse response d h(t)/dt guaranteed to be causal and stable? b) is the system with impulse response $\int_{-\infty}^{t} h(\tau)d\tau$ guaranteed to be causal and unstable?		
2	Let x(t) be the sampled signal specified as $x(t)=\sum_{n=0}^{\infty} e^{-nT}\delta(t-nT),\ where\ T>0$ a) determine X(s), including its region of convergence b) sketch the pole-zero plot for X(s) c) Use geometric interpretation of the pole-zero plot to argue that X(jw) is periodic.	Understand	5
3	Consider an even sequence x[n] with rational z-transform X(z) a) from the definition of the z-transform, show that X(z)=X(1/z) b) from your results in part (a), show that if a pole (zero) of X(z) occurs at $z=z_0$ then a pole(zero) must also occur at $z=1/z_0$ c) verify the result in part(b) for each of the following sequences: (1) δ[n+1]+δ[n-1] (2) δ[n+1]-(5/2)δ[n]+δ[n-1]	Remember	5
4	The following is known about a discrete-time LTI system with input x[n] and output y[n]: 1) if $x[n] = (-2)^n$ for all n, then y[n]=0 for all n 2) if $x[n] = (1/2)^n u[n]$ for all n, then y[n] for all n is of the form $y[n]=\delta[n]+a(1/4)^n u[n]$ where a is a constant 3) Determine the value of the constant a. 4) Determine the response y[n] if the input x[n]=1 for all n.	Apply	5
5	By first differentiating X(z) and using the appropriate properties of the z-transform determine the sequence for which the z-transform is each of the following a) X(z) = log (1-2z); |z|<1/2 b) $X(z)= \log (1-1/2z^{-1})$; |z|>1/2	Understand	5

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