JEPPIAAR
ENGINEERING COLLEGE

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

QUESTION BANK

EC3354 - SIGNALS AND SYSTEMS
(Regulation 2021)

III Semester ECE

<table>
<tr><th colspan="3">JEPPIAAR ENGINEERING COLLEGE</th></tr>
<tr><td>Vision of the Institute</td><td colspan="2">To build Jeppiaar Engineering College as an institution of academic excellence in technological and management education to become a world class University</td></tr>
<tr><td rowspan="4">Mission of the Institute</td><td>M1</td><td>To excel in teaching and learning, research and innovation by promoting the principles of scientific analysis and creative thinking</td></tr>
<tr><td>M2</td><td>To participate in the production, development and dissemination of knowledge and interact with national and international communities.</td></tr>
<tr><td>M3</td><td>To equip students with values, ethics and life skills needed to enrich their lives and enable them to meaningfully contribute to the progress of society</td></tr>
<tr><td>M4</td><td>To prepare students for higher studies and lifelong learning, enrich them with the practical and entrepreneurial skills necessary to excel as future professionals and contribute to Nation’s economy</td></tr>
<tr><th colspan="3">DEPARTMENT: ELECTRONICS AND COMMUNICATION ENGINEERING</th></tr>
<tr><td>Vision of the Department</td><td colspan="2">To become a centre of excellence to provide quality education and produce creative engineers in the field of Electronics and Communication Engineering to excel at international level.</td></tr>
<tr><td rowspan="4">Mission of the Department</td><td>M1</td><td>Inculcate creative thinking and zeal for research to excel in teaching-learning process</td></tr>
<tr><td>M2</td><td>Create and disseminate technical knowledge in collaboration with industries</td></tr>
<tr><td>M3</td><td>Provide ethical and value based education by promoting activities for the betterment of the society</td></tr>
<tr><td>M4</td><td>Encourage higher studies, employability skills, entrepreneurship and research to produce efficient professionals thereby adding value to the nation’s economy</td></tr>
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PROGRAM OUTCOMES (PO)	**PO 1**	**Engineering knowledge**: **Apply** the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
	PO 2	**Problem analysis**: **Identify, formulate, review** research literature, and **analyze** complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
	PO 3	**Design/development of solutions**: **Design solutions** for complex engineering problems and **design** system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
	PO 4	**Conduct investigations of complex problems**: **Use** research-based knowledge and research methods including **design** of experiments, **analysis** and **interpretation** of data, and **synthesis** of the information to provide valid conclusions.
	PO 5	**Modern tool usage**: **Create**, **select**, and **apply** appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
	PO 6	**The engineer and society**: **Apply** reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
	PO 7	**Environment and sustainability**: **Understand** the impact of the professional engineering solutions in societal and environmental contexts, and **demonstrate** the knowledge of, and need for sustainable development.
	PO 8	**Ethics**: **Apply** ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
	PO 9	**Individual and team work**: **Function effectively** as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
	PO 10	**Communication**: **Communicate effectively** on complex engineering activities with the engineering community and with society at large, such as, being able **to comprehend** and **write** effective reports and **design** documentation, **make** effective presentations, and **give** and **receive** clear instructions.
	PO 11	**Project management and finance**: **Demonstrate** knowledge and understanding of the engineering and management principles and **apply** these to one's own work, as a member and leader in a team, to **manage** projects and in multidisciplinary environments.
	PO 12	**Life-long learning**: **Recognize** the need for, and have the preparation and ability to **engage** in independent and life-long learning in the broadest context of technological change.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)	**PEO I**	Produce technically competent graduates with a solid foundation in the field of Electronics and Communication Engineering with the ability to analyze, design, develop, and implement electronic systems.
	PEO II	Motivate the students for choosing the successful career choices in both public and private sectors by imparting professional development activities.
	PEO III	Inculcate the ethical values, effective communication skills and develop the ability to integrate engineering skills to broader social needs to the students.
	PEO IV	Impart professional competence, desire for lifelong learning and leadership skills in the field of Electronics and Communication Engineering.
PROGRAM SPECIFIC OUTCOMES (PSOs)	**PSO 1**	Design, develop and analyze electronic systems through application of relevant electronics, mathematics and engineering principles.
	PSO 2	Design, develop and analyze communication systems through application of fundamentals from communication principles, signal processing, and RF System Design & Electromagnetics.
	PSO 3	Adapt to emerging electronics and communication technologies and develop innovative solutions for existing and newer problems.

EC3354 SIGNALS AND SYSTEMS L T P C

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OBJECTIVES:

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 6+6

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 42 systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.

UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 6+6

Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and properties

UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 6+6

Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 6+6

Baseband signal Sampling – Fourier Transform of discrete time signals (DTFT) – Properties of DTFT - Z Transform & Properties

UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 6+6

Impulse response – Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

CO1:determine if a given system is linear/causal/stable

CO2: determine the frequency components present in a deterministic signal

CO3:characterize continuous LTI systems in the time domain and frequency domain

CO4:characterize continuous LTI systems in the time domain and frequency domain

CO5:compute the output of an LTI system in the time and frequency domains

TEXT BOOK:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, ―Signals and Systems‖, Pearson, 2015.(Unit 1- V)

REFERENCES

1. B. P. Lathi, ―Principles of Linear Systems and Signals‖, Second Edition, Oxford, 2009.
2. R.E.Zeimer, W.H.Tranter and R.D.Fannin, ―Signals & Systems - Continuous and Discrete‖, Pearson, 2007.
3. John Alan Stuller, ―An Introduction to Signals and Systems‖, Thomson, 2007.

UNIT-I : [CLASSIFICATION OF SIGNALS AND SYSTEMS]

Part-A

1. **Define step function and delta function**

Ans:CT unit step function ,u(t) = 1 for $t \geq 0$
= 0 for t<0

DT unit step function,u(n) = 1 for $n \geq 0$
= 0 for n<0

CT delta function , $\delta(t)$ =1 for t=0
= 0 for $t \neq 0$

DT delta function , $\delta(n)$ =1 for n=0
= 0 for $n \neq 0$

2. **What is the period T of the signal x(t) =2 cos(n/4)?**

Ans: Here x(t) =2 cos(n/4)

Compare x(n) with A cos(2πfn).This gives $2\pi fn = (n/4)$

f=($1/8\pi$) which is not rational .Hence thie is not periodic signal

3. **What is the total energy of the discrete –time signal x(n) which takes the value of unity at n=-1,0 and 1?**

Energy of the signal is given as

$$E = \sum_{n=-\infty}^{\infty} |x(n)|^2 = \sum_{n=-1}^{+1} |x(n)|^2$$

$$= |x(-1)|^2 + |x(0)|^2 + |x(1)|^2$$

$$= 1+1+1 = 3$$

4. **What is an energy signal? Check whether or not the unit step signal is an energy signal**

Ans: The total energy of a signal x(t) is defined as

$$E = \lim_{T\to\infty} \int_{-T}^{+T} |x(t)|^2 \, dt \text{ Joules}$$

X(t) is an energy signal if and only if $0<E<\infty$,so that P=0

Unit step signal:

X(t)=u(t) is an unit step signal u(t) = 1 for $t \geq 0$
= 0 for t<0

$$E = \lim_{T\to\infty} \int_{-T}^{+T} |x(t)|^2 \, dt = \int_{0}^{\infty} 1.dt = [t] = \infty$$

$$p = \lim_{T\to\infty} (1/2T) \int_{-T}^{+T} |x(t)|^2 \, dt$$

$$p = \lim_{T\to\infty} (1/2T) \int_{0}^{+T} 1 \, dt = (1/2T)\,[T-0] = 1/2$$

It is an power signal

5. **Classify the following signal as a. periodic or non periodic and b. energy or power signal i.$e^{\alpha n}$,α >1 ii. $e^{-j2\pi ft}$**

Ans: a.Periodicity:

(i) $e^{\alpha n}$ is non periodic since it is exponential signal

(ii) $e^{-j2\pi ft}$ is periodic signal since it is phasor of frequency f.

b.Energy or power signal:

(i) since .$e^{\alpha n}$ is non periodic signal, let us calculate is energy,E= ∞

This dignal is neither energy nor power signal

(ii) $e^{-j2\pi ft}$ is periodic signal .Hence let us calculate its power is

$$p = \lim_{T\to\infty} (1/T) \int_{-(T/2)}^{+(T/2)} |x(t)|^2 \, dt$$

$$p = \lim_{T\to\infty} (1/T) \int_{-(T/2)}^{+(T/2)} |e^{-j2\pi ft}|^2 \, dt$$

$$p = \lim_{T\to\infty} (1/T) \int_{-(T/2)}^{+(T/2)} 1 \, dt = 1$$

Since power is finite, this is power signal

6. Is the signal x(t)=2 cos(3πt)+7 cos(9t) periodic?

Ans: Compare the given signal with, x(t) =A cos ( ) + B cos(2 $\pi f_2 t$)

$2\pi f_1 t = 3\pi t$ $\quad f_1 = (3/2)$ $\quad T_1 = (2/3)$

$2\pi f_2 t = 9t$ $\quad f_2 = (9/2\pi)$ $\quad T_2 = (2\pi/9)$

Therefore (T_1 / T_2) =[(2/3) / (2π /9)] = (3 / π) which is not ratio of Integers .Hence given signal is not periodic.

7. Define power signals

Ans: The average power of a signal x(t) is defined as

$$P = \lim_{T\to\infty} (1/2T) \int_{-T}^{+T} |x(t)|^2 \, dt$$

watts. X(t) is an power signal if and only if $0<P<\infty$

8. What do you mean by an even signal and an odd signal?

Ans: **Even signal**: A signal is said to be even signal if inversion of time axis does not change the amplitude that is condition for signal x(t) =x(-t) and x(n) =x(-n)

Odd signal :A signal is said to be even signal if inversion of time axis also Inverts amplitude of the signal that is condition for signal x(t) =-x(-t) and x(n) =-x(-n)

9. Draw the signal x(n)=u(n)-u(n-3)

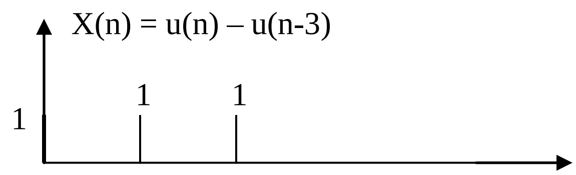
Ans:

u(n) = 1 for $n \geq 0$

= 0 for n <0

u(n-3) = 1 for $n \geq 3$

= 0 for n < 3



10. Represent a ramp signal in continuous time and discrete time, mathematically

Ans: CT ramp $r(t) = t\ ,t \geq 0$
$= 0\ ,t<0$

DT ramp $r(n) = n\ ,n\geq 0$
$= 0\ ,n<0$

11. Find the fundamental period of the signal $x(n) =\{3e^{j3\pi[n+(1/2)]}\} / 5$

Ans: Fundamental period $N =(2\pi/ \omega_0) =(2\pi/ 3\pi) = (2/3)$

12. Verify whether $x(t)=A\, e^{-\alpha t}\, u(t)$, $\alpha > 0$is an energy signal or not

Ans:

$$E = \lim_{T\to\infty} \int_{-T}^{+T} |x(t)|^2\, dt$$

$$E = A^2 \lim_{T\to\infty} \int_{-T}^{+T} | e^{-\alpha t} u(t)|^2\, dt$$

$$E = A^2 \lim_{T\to\infty} \int_{0}^{\infty} e^{-2\alpha t} |u(t)|^2\, dt = A^2/2$$

The given signal is an energy signal .If E is finite ,power is zero.

13. Show that the complex exponential signal $x(t)= e^{j\omega 0t}$ is periodic and that the fundamental period is $(2\pi/ \omega_0)$

Ans : The signal $x(t) = e^{j2\pi f_0 t}$, $\omega_0 = 2\pi f_0$, $f = = 2\pi/ \omega_0$

$T = (2\pi/ \omega_0)$

14. Find the fundamental period of the signal:

$x(n)= 2\cos(n\pi/4)+\sin(n\pi/8)-2\cos[(n\pi/2)+(\pi/6)]$

Ans:

The time period of $\cos(n\pi/4)$ is $N_1=(2\pi /\omega_0)m = (2\pi /(\pi/4))m=8m$ for $m=1$, $N_1 =8$

The time period of $\sin(n\pi/8)$ is $N_2=(2\pi /\omega_0)m = (2\pi /(\pi/8))m=16m$ for $m=1$, $N_2 =16$

The time period of $\cos[(n\pi/2)+(\pi/6)]$is $N_3=(2\pi /\omega_0)m = (2\pi /(\pi/2))m=4m$ for $m=1$, $N_3 =4$

$N=(N1/N2) =(8/16)$ & $(N2/N3)= 16/4$

15. Determine the power and RMS value of the signal $x(t) =e^{jat} \cos\omega_0 t$

Ans: $p= \lim_{T\to\infty} (1/2T) \int [e^{jat} \cos\omega_0 t]^2\, dt = \lim_{T\to\infty} (1/4T) \int (1+\cos\omega_0 t)\, dt$

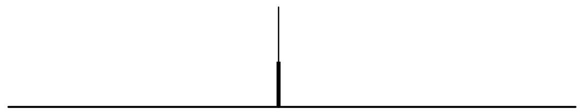
$P=(1/2)$ R.M.S value = 1/1.414

16.State Parseval theorem for discrete time signal

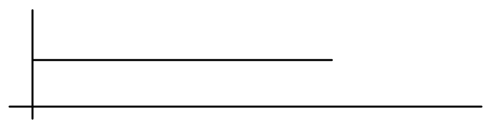
Ans: Parseval's relation for discrete time signals is given by

$$(1/N) \sum_{n=<N>} |x(n)|^2 = \sum_{k=<N} |a_k|^2$$

17. Draw the (a)Impulse (b)Step function for continuous time signal (δ(t),u(t))
Impulse function



Step function



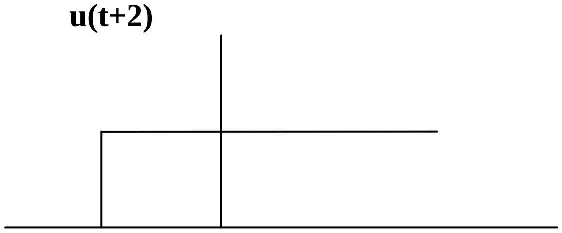
18.What is the periodicity of $x(t)=e^{j100\pi t+30}$?

Ans: Time period $T=(2\pi/\omega_0)$

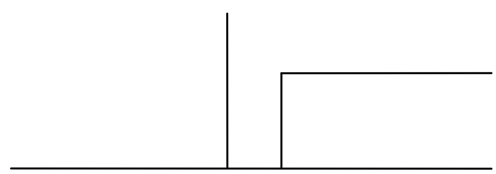
$T=2\pi / 100\pi = 1/50$.It is rational number. So it is periodic

19.Draw the waveforms u(t-2) and u(t+2)

u(t+2)



u(t-2)



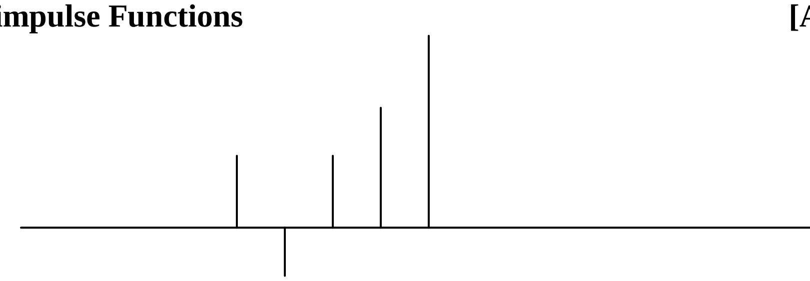
20.Determine whether the signal x(n)=cos(0.1πn) is periodic or not [Apr-2008]

Ans: Here x(t) = cos(**0.1πn**)

Compare x(n) with A cos(2πfn).This gives 2πfn = (**0.1πn**)

f=(0.1/2) which is rational .Hence this is periodic signal

21.Given x(n)={2,-1,2,3,4}.Represent x(n) as a linear combination of weighted shifted impulse Functions [Apr-2008]



22.Determine whether the signal $x(t)=2\cos 100\pi t+5\sin 50t$ is periodic[Apr-2008]

Ans: Compare the given signal with, $x(t) = A\cos(2\pi f_1 t) + B\cos(2\pi f_2 t)$

$2\pi f_1 t = \mathbf{100\pi t}$ $f_1 = (50)$ $T_1 = (1/50)$

$2\pi f_2 t = 50t$ $f_2 = (25/\pi)$ $T_2 = (\pi/25)$

Therefore (T_1 / T_2) =[(1/50) / (π /25)] = (1 /2 π) which is not ratio of Integers .Hence given signal is not periodic.

23.Find the even and odd part of $x(t)=(\sin t+1)^2$ [Apr-2008]

$x_e(t)=(1/2)[x(t)+x(-t)]$

$=(1/2)[(\sin t+1)^2+(-\sin t+1)^2]$

$x_o(t)=(1/2)[x(t)-x(-t)]$

$=(1/2)[(\sin t+1)^2-(-\sin t+1)^2]$

24. Is the system y(t)=y(t-1)+2 y(t-2) time invariant?

Ans:H[x(t-τ)] = y(t-τ)

L.H.S y(t-τ) = y(t-τ-1) +2 y(t-τ-2)

R.H.S y(t-τ) = y(t-τ-1) +(2) y(t-τ-2)

L.H.S=R.H.S.so this system is time invariant

25. Define linear time invariant system

Ans: A system is said to be linear as well as Time invariant called linear time invariant system

26. Define causality and stability of a system with an examples for each

Ans:

Causality: A system said to be causal if the output of the system at any time 't ' depends only on the present and past values of the inputs are called causal . A system said to be non causal if the output of the system at any time 't ' depends only on future values of the inputs are called non-causal . For examples : y(t) =x(t)+x(t-1) is a causal system but y(t) =x(t+1) is not

Stability: A system is stable ,if and only if every bounded input produces a bounded Output. Let the input signal x(t) is bounded (finite) i.e $|x(t)|<M_x<\infty$. Where Mx is a positive real number. If $|y(t)|<M_y<\infty$. i.e. y(t) is also bounded, then the system is BIBO stable. Otherwise ,it is unstable**.**

27. Determine whether the system described by the following input-output relationship is linear and causal y(t)=x(-t)

Ans: **LINEARITY:**

$H[\alpha_1 x_1(t)+\alpha_2 x_2(t)] = \alpha_1 y_1(t)+\alpha_2 y_2(t)$

L.H.S : $H[\alpha_1 x_1(t)+\alpha_2 x_2(t)] = \alpha_1 x_1(-t)+\alpha_2 x_2(-t)$

RHS: $\alpha_1 y_1(t)+\alpha_2 y_2(t) = \alpha_1 x_1(-t)+\alpha_2 x_2(-t)$

LHS =RHS

So the system is linear

CAUSALITY:

H[x(t-τ)] = y(t-τ)

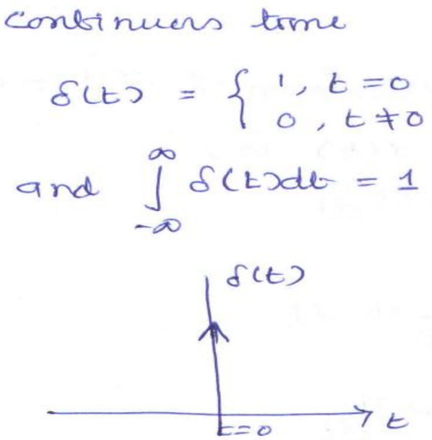
L.H.S H[x(t-τ)] = x[-(t-τ)] =x[-t+τ], R.H.S y(t-τ) = x[-t-τ]

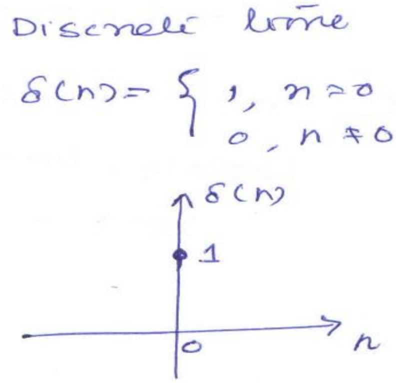
28. List the standard test signals.

1. step signal

2. ramp signal
3. delta signal
4. sinusoidal signal
5. exponential signal

29. Give the mathematical and graphical representation of a continuous time and discrete time unit impulse functions [NOV /DEC 16]





30. State the difference between causal and non causal system

[NOV /DEC 16]

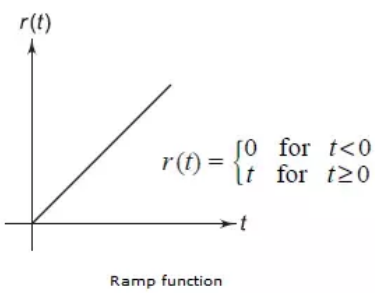
In causal system the output at any time depends on present input and past input

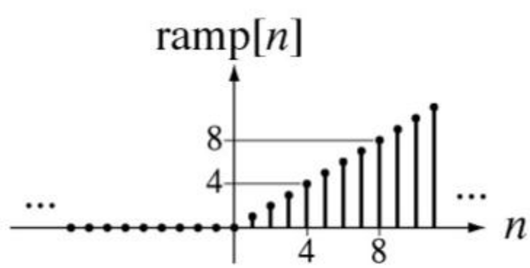
In causal system the output at any time depends on present input and past input and future input

31. Give the mathematical and graphical representation of a continuous time and discrete time unit ramp sequence

[NOV /DEC 18]

$$\text{ramp}[n] = \begin{Bmatrix} n, & n \geq 0 \\ 0, & n < 0 \end{Bmatrix}$$





32. Evaluate the following integral

$\int_{-1}^{1}(2t^2+3)\delta(t)dt$

Ans: Using the property of impulse signal $\int_{-1}^{1}(2t^2+3)\delta(t)dt$=3

33. Define signal.

Signal is a physical quantity that varies with time ,space or any other independent variable

34. Define systems.

System is a single device or group of devices interconnected that works on signal

35. List the classification of signals
    - Deterministic and random signals
    - Periodic and aperiodic signals
    - Even and odd signals
    - Energy and power signals
36. List the classifications of systems
    - Linear and non linear systems
    - Time variant and invariant system
    - Causal and non causal system
    - Stable and unstable system
    - Static and dynamic system
37. What is BIBO stable system?
    For a bounded input if the system produces a bounded output them the system is said to be bounded input bounded output(BIBO) stable system
38. Write the condition for a system to be LTI system.
    If the system obeys additivity and superposition principle and also if the system is time invariant then the system is called LTI system,
39. When a system is said to be memory less?
    If the output of the system depends only on the present input then the system is called memory less system.
40. Define deterministic signal.
    If the signal is completely defined by mathematical equation then the signal is called deterministic signal.
41. Define dynamic system.
    If the output of the system depend on past and or future input the system is called memory or dynamic system.
42. Define Linear System
    If the system satisfies the principle of additiveity and superposition then the system is said to be linear system.
43. Is the system y(t)=y(t+1)+2t y(t-2) time invariant?
    Ans:H[x(t-τ)] = y(t-τ)
    L.H.S y(t-τ) = y(t-τ-1) +2t y(t-τ-2)
    R.H.S y(t-τ) = y(t-τ-1) +(2t-τ) y(t-τ-2)
    L.H.S not equal R.H.S.so this system is time variant
44. Evaluate the following integral
    $\int_{-1}^{1}(2t+10)\delta(t)dt$
    Ans: Using the property of impulse signal $\int_{-1}^{1}(2t+10)\delta(t)dt$=10

45. Define Causal system
    system said to be causal if the output of the system at any time 't ' depends only on the present and past values of the inputs are called causal
46. Define non causal system
    A system said to be non causal if the output of the system at any time 't ' depends only on future values of the inputs are called non-causal
47. Define stable system
    A system is stable ,if and only if every bounded input produces a bounded Output

48. Define random signal

If the signal is not defined by mathematical equation then the signal is called random signal.

49. What is a periodic signal.

If the signal repeats for every time period T for all values of t then the signal is called periodic signal.

50. Define power signal.

If the average power of the signal is finite and non zero then the signal is called as power signal.The Energy of power signal is infinity.

PART B&C

1. **i) how are the signals classified? Explain. (nov/dec 2012)**

   ii) Determine whether the following signal is periodic. If periodic determine the fundamental period: $x(t) = 3\cos t + 4\cos\frac{t}{3}$.

   Ans: Refer signals and systems by Allan V. Oppenheim, page no:11

   iii) Give the equation and draw the waveform of discrete time real and complex exponential signals.

2. **i) Determine whether the following system is linear, time invariant, stable and invertible: (nov/dec 2016)**

   (1) $y(n) = x^2(n)$

   (2) $y(n) = x(-n)$

   Ans: Refer signals and systems by Allan V. Oppenheim, page no:44

   ii) Define LTI system. List the properties of LTI system and explain.

   Ans: Refer signals and systems by Allan V. Oppenheim, page no:44

3. **i) Write Elementary Continuous time signals in detail (nov/dec 2011)**

   Refer signals and systems by Allan V. Oppenheim, page no:1

   (ii) Determine the power and RMS value of the following signals

   x1(t)=5cos(50t+π/3)

   x2(t)=10cos5tcos10t

   Refer signals and systems by Allan V. Oppenheim, page no:5

4. **(i)Determine whether the following systems are linear or not**

   dy/dt+3ty(t)=t2x(t)

   y(n)=2x(n)+1/x(n-1) (nov/dec 2011)

   Refer signals and systems by Allan V. Oppenheim, page no:53

(ii) Determine whether the following systems are time invariant or not

Y(t)=tx(t) **(nov/dec 2011)**

Y(n)=x(2n)

Refer signals and systems by Allan V. Oppenheim, page no:50

5 . Find the energy of the discrete time signal $x(n) = (1/2)^n$, $n \geq 0$

$= 3^n$, $n<0$

Refer signals and systems by Allan V. Oppenheim, page no:5

6. (a) Given $x[n] = \{1, 4, \underset{\uparrow}{3}, -1, 2\}$. **Plot the following**

(i) $x[-n-1]$ (ii) $x\left[-\frac{n}{2}\right]$

(iii) $x[-2n+1]$ (iv) $x\left[-\frac{n}{2}+2\right]$

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7.

Given the input-output relationship of a continuous time system $y(t) = tx(-t)$. Determine whether the system is causal, stable, linear and time invariant.

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8.

Check whether the following signals are periodic/aperiodic signals.

(i) $x(t) = \cos 2t + \sin t/5$.

(ii) $x(n) = 3 + \cos \pi/2n + \cos 2n$.

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- Refer signals and systems by Allan V. Oppenheim, page no:1-11

9.

Check whether the following system is linear, causal time invariant and /or stable

(i) $y(n) = x(n) - x[n-1]$

(ii) $y(t) = \frac{d}{dt}x(t)$.

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10.(Given y(n)=n x(n) Determine the system is memoryless, causal, linear and time Invariant

- Refer signals and systems by Allan V. Oppenheim, page no:44 – 53

11.Prove that the power of energy signal is zero over infinite time and energy of the power signal is infinite over infinite time.

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12.Determine the value of power and energy for each of the signals

(1)$x_1(n)=e^{j[(\pi n/2)+(\pi/8)]}$ (2)$x_2(n)=(1/2)^n\, u(n)$

- Refer signals and systems by Allan V. Oppenheim, page no:5

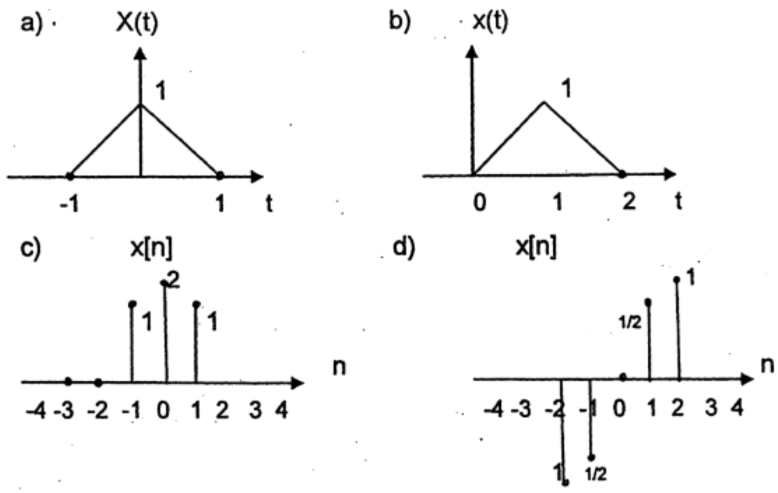
13.

a) Find the whether the signal is an energy signal or power signal.

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

ii) Draw the waveform for the signal $x(t) = r(t) - 2r(t-1) + r(t-2)$.

iii) For the given signal determine whether it is even, odd, or neither.



14.

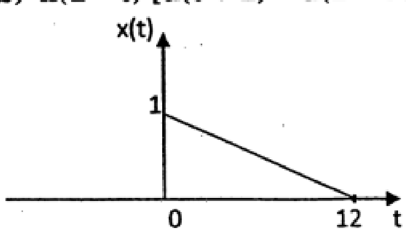
Determine whether the following system is Linear and Causal.

i) $y[n] = x[n].\, x[n-1]$ and $y[n] = \left(\frac{1}{3}\right)[x[n-1] + x[n] + x[n+1]]$.

ii) For x(t) indicate in figure sketch the following :

a) $x(1-t)\,[u(t+1) - u(t-2)]$

b) $x(1-t)\,[u(t+1) - u(2-3t)]$.



Refer signals and systems by Allan V. Oppenheim, page no:31,76**(nov/dec 2017)**

15.Explain the Classifications of signals in detail.

Refer signals and systems by Allan V. Oppenheim, page no:26

UNIT-II : [ANALYSIS OF CONTINUOUS TIME SIGNALS AND SYSTEMS]

PART-A

1. What do the Fourier series coefficient represent? Ans:Fourier series coefficient represent various frequencies present in the signal .It is nothing but spectrum of the signal

2. Define Fourier series

Ans: Let us consider a periodic signal x(t) with fundamental period T.If there exists a convergent series

$$\mathbf{x(t)} = \sum_{k=-\infty}^{+\infty} a_k e^{jk\omega_0 t}, \ \boldsymbol{\omega_0 = (2\pi / T)}$$

then the series is called Fourier series

3. Let x(t) =t,o<t<1 be a periodic signal with fundamental period T=1 and Fourier series coefficient a_k. Find the value of a_0.

Ans:

$a_0 = (1/T) \int x(t)\, dt = (1/1) \int t\, dt = [t^2/2] = (1/2)$

4. What is relationship between Fourier transform and Laplace transform

Ans: x(s) =x(jω) when s = jω .This means Fourier transform is same as Laplace transform when s = jω

5.State modulation property and convolution(time) property of Fourier transform

Ans: 1.Modulation property :-

$x(t) \cos(2\pi f_c t +) \leftrightarrow X(f-f_c) + X(f+f_c)$

2.Convoltion property:-

This property states that convolution in time doman corresponds to multiplication in frequency domain that is

$y(t)=x(t) \quad h(t) \leftrightarrow y(j\omega)= X(j\omega). H(j\omega)$

6.State Dirchlet's condition for Fourier series [Apr-2008]

Ans:(i) The function x(t) should be within the interval T_0

(ii) The function x(t) should have finite number of maxima and minima in the interval T_0

(iii) The function x(t) should have at the most finite number of discontinuities in the interval.

(i) The function should be absolutely integral

7. Define transfer function(or)system function in continuous time systems

Ans: Transfer function relates the transforms of input and output that is

H(f)=[Y(f)/X(f)],Using Fourier Transform (or) H(s) =[Y(S)/x(S)]

8. Write the Fourier transform pair for x(t)

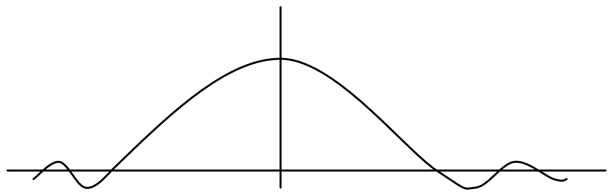
Ans:

Fourier transform : $X(j\omega) = \int_{-\infty}^{+\infty} x(t)\, e^{-j\omega t}\, dt$

Inverse Fourier transform : $x(t) = (1/2\pi) \int_{-\infty}^{+\infty} X(j\omega)\, e^{j\omega t}\, d\omega$

9. Draw the sinc function

Ans: $\text{sinc}(\lambda) = [\sin(\pi\lambda) / ((\pi\lambda)]$



10. Determine laplace transform of $x(t) = e^{-at} \sin(\omega t)\, u(t)$

Ans:

$$x(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt = \int_{0}^{\infty} e^{-at}\, 1/2j\, (e^{j\omega t} - e^{-j\omega t})\, e^{-st}\, dt = \omega / [(s+a)^2 + \omega^2]$$

11. What are the differences between Fourier series and Fourier transform?

Sl.no	**Fourier series**	**Fourier transform**
1	Fourier series is calculated for periodic signals	Fourier transform is calculated for non periodic signals as well as periodic signals
2	Three types of Fourier series such as trigonometric, polar and complex exponential	Fourier transform has no such types

12. Find the laplace transform of $x(t) = te^{-at}\, u(t)$,where a>0

Ans:

$$x(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt = \int_{0}^{\infty} e^{-at}\, e^{-st}\, dt = 1/s+a$$

$$L[te^{-at}\, u(t) = -(d/ds)x(s) = 1/(s+a)^2$$

13. Obtain the Fourier transform of $x(t) = e^{-at}\, u(t)$, a>0

Ans:

$$x(j\omega) = \int_{-\infty}^{\infty} x(t)\, e^{-j\omega t}\, dt = \int_{0}^{\infty} e^{-at}\, e^{-j\omega t}\, dt = 1/j\omega+a$$

14. State the initial and final value theorem of Laplace transforms

Ans:

The initial value $x(0) = \lim_{s\to\infty} s\,x(s)$

The final value theorem is $\lim_{t\to\infty} x(t) = \lim_{s\to 0} s\,x(s)$

15. Find the impulse response of the system given by H(S)=1/[S+9] Ans: H(S)=1/[S+9]

Taking inverse L.T $h(t) = e^{-9t}\,u(t)$

16. Determine the inverse Fourier transform of x(jω) = δ(ω)

Ans:

$$x(t) = (1/2\pi)\int_{-\infty}^{+\infty} X(j\omega)\, e^{j\omega t}\, d\omega$$

$$x(t) = (1/2\pi)\int_{-\infty}^{+\infty} \delta(\omega)\, e^{j\omega t}\, d\omega = (1/2\pi).1 = (1/2\pi)$$

17. Write the condition to be satisfied for the existence of Fourier transform of aperiodic signal

Ans: (i) The function x(t) should be within the interval T_0

(ii) The function x(t) should have finite number of maxima and minima in the interval T_0

(iii) The function x(t) should have at the most finite number of discontinuities in the interval.

(iv) The function should be absolutely integral

18. List out any four properties of Laplace transform used in signal analysis

Ans:1. Time shifting 2.Differentiation in Time 3.Convolution 4. Linearity

19. Define parseval's relation for continuous time periodic signals

Ans: If x(t) and x(jω) are Fourier transform pair, then

$$\int_{-\infty}^{\infty} |x(t)|^2\, dt = (1/2\pi)\int_{-\infty}^{\infty} |x(j\omega)|^2\, d\omega$$

20. Write the differentiation and integration property of Fourier transform

Ans: Differeniation : $(d/dt)\, x(t) \leftarrow\!\!-\!\!-\!\!\rightarrow j\omega\, X(j\omega)$

Integration:

$$\int_{-\infty}^{t} |x(\tau)|^2\, d\tau = (1/j\omega)\, x(j\omega) + \pi\, x(0)\delta(\omega)$$

21. Find the laplace transform for the signal $x(t) = -t\, e^{-2t}\, u(t)$

Ans:

$$x(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt = \int_{0}^{\infty} e^{-2t}\, e^{-st}\, dt = 1/s+2$$

$$L[te^{-2t}\, u(t) = -(d/ds)x(s) = 1/(s+2)^2$$

22. Find the Fourier Transform of $h(n) = \delta(n-n_0)$

Ans: Using time shifting property $x(j\omega) = e^{-j\omega n_0}$

23.Define the region of convergence of the laplace transform. (NOV 2012)

The range of σ for which the laplace transform converges is known as region of convergence (ROC)

24. List and draw the basic elements for the block diagram representation of the continuous time system.(NOV 2012)

Ans: Refer signals and systems by Allan V. Oppenheim, page no:7.95

25.What are the Dirichlet conditions of Fourier series? .(NOV 2015)

- The function x(t) should be single value within the interval To
- The function x(t) should have a finite number of discontinuities in the interval To
- The function x(t) should have a finite number of maxima and minima in the interval To
- The function x(t) should be absolutely integrable

26.State Convolution property of Fourier Transform.(NOV 2011)

The convolution theorem of Fourier Transform states that

If x1(t) <---------→X1(f)

And x2(t) <---------→X2(f)

Then x1(t)* x2(t) <---------→X1(f) X2(f)

27. Determine the inverse Fourier transform of x(jω) = δ(ω) .(NOV 2010)

$$x(t) = (1/2\pi) \int_{-\infty}^{+\infty} X(j\omega)\, e^{j\omega t}\, d\omega$$

$$x(t) = (1/2\pi) \int_{-\infty}^{+\infty} \delta(\omega)\, e^{j\omega t}\, d\omega = (1/2\pi).1 = (1/2\pi)$$

28.Define Fourier series

Ans:

Fourier series:

Let us consider a periodic signal x(t) with fundamental period T.If there exists a convergent series

$$\mathbf{x(t)} = \sum_{k=-\infty}^{+\infty} a_k e^{jk\omega_0 t}, \quad \boldsymbol{\omega_0 = (2\pi / T)}$$

then the series is called Fourier series

29.Find the inverse Fourier Transform of x(ω)=2πδ(ω)

Ans:

$$x(t) = (1/2\pi) \int_{-\infty}^{+\infty} X(j\omega)\, e^{j\omega t}\, d\omega$$

$$x(t) = (1/2\pi) \int_{-\infty}^{+\infty} \delta(\omega)\, e^{j\omega t}\, d\omega = (1/2\pi).1 = (1/2\pi)$$

$$\mathbf{F^{-1}[2\pi\delta(\omega)]=1}$$

30. State the conditions for the convergence of fourier series representation of continuour time periodic signals (NOV 2014)

- The function x(t) should be single value within the interval To
- The function x(t) should have a finite number of discontinuities in the interval To
- The function x(t) should have a finite number of maxima and minima in the interval To
- The function x(t) should be absolutely integrable

31. Find the ROC of Laplace transform of x(t)=u(t) (NOV 2014)

By definition of L.T

$$L[f(t)] = \int_{-\infty}^{\infty} f(t)\, e^{-st}\, dt$$

$$= \int_{-\infty}^{\infty} u(t)\, e^{-st}\, dt$$

$$= \int_{0}^{\infty} e^{-st}\, dt$$

$$= \left[\frac{e^{-st}}{-s}\right]_0^{\infty}$$

$$L[f(t)] = \frac{1}{s}$$

ROC: put $s = \sigma + j\omega$

$$L[f(t)] = \frac{1}{\sigma + j\omega}$$

real part is $Re(s) = \sigma > 0$

32. Give the relation between FT and LT **(NOV 2015)**

$$L[f(t)] = \int_{-\infty}^{\infty} f(t)\, e^{-st}\, dt$$

here $s = \sigma + j\omega$

$$L[f(t)] = \int_{-\infty}^{\infty} f(t)\, e^{-(\sigma + j\omega)t}\, dt$$

$$= \int_{-\infty}^{\infty} f(t)\, e^{-\sigma t}\, e^{-j\omega t}\, dt$$

$$= F\left[f(t)\, e^{-\sigma t} \right]$$

32. Find the Fourier series representation of the signal (1/3)cos2πft and determine the Fourier series coefficients [NOV /DEC 16]

$$x(t) = \frac{\cos 2\pi t}{3}$$

Using Eulers theorem,

$$x(t) = \frac{1}{3}\left[\frac{e^{j2\pi t} + e^{-j2\pi t}}{2} \right]$$

$$x(t) = \frac{1}{6} e^{j2\pi t} + \frac{1}{6} e^{-j2\pi t}$$

Comparing this with,

$$x(t) = \sum_{n=-\infty}^{\infty} C_n\, e^{-j2\pi nt/T_0}$$

$$C_1 = C_{-1} = \frac{1}{6}$$

33. Find the Laplace transform of $x(t)=e^{-at}u(t)$ [NOV /DEC 16]

$$X(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st} dt$$

$$= \int_{0}^{\infty} e^{-at} e^{-st} dt$$

$$= \int_{0}^{\infty} e^{-[s+a]t} dt$$

$$= \left[\frac{e^{-[s+a]t}}{-[s+a]} \right]_0^{\infty} = 0 - \frac{e^{0}}{-(s+a)}$$

$$X(s) = \frac{1}{s+a}$$

34. Find the Laplace transform of $x(t) = te^{at}\, u(t)$,where a>0

Ans:

$$x(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt = \int_{0}^{\infty} e^{at}\, e^{-st} dt = 1/s+a$$

$L[te^{-at}\, u(t) = -(d/ds)x(s) = 1/(s-a)^2$

35. Obtain the Fourier transform of $x(t)=e^{at}\, u(t)$,a>0

Ans:

$$x(j\omega) = \int_{-\infty}^{\infty} x(t)\, e^{-j\omega t}\, dt = \int_{0}^{\infty} e^{at}\, e^{-j\omega t} dt = 1/j\omega-a$$

36. **Find the Laplace transform of u(t)**

$$x(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt = \int_{0}^{\infty} 1e^{-st} dt = 1/s$$

37. **Find the Laplace transform of r(t)**

$$x(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt = \int_{0}^{\infty} te^{-st} dt = 1/s^2$$

38. **Find the Laplace transform of $u(t-t_0)$**

$$X(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt = \int_{to}^{\infty} e^{-st} dt = e^{st0}/s$$

39. **Find the Laplace transform of $r(t-t_0)$**

$$X(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt \quad = \quad \int_{t_0}^{\infty} (t - t_0) e^{-st} dt = e^{st0}/s^2$$

40. **Define sinc function**

Sinc function is defined as

$sinc(x)=(\sin\pi x)/\pi x$

41. Define Fourier transform

Fourier transform:

Let x(t) be a signal such that $-\infty<t<+\infty$ and x(t) is absolutely integrable then the Fourier Transform of x(t) is defined as

$$X(j\omega) = \int_{-\infty}^{+\infty} x(t)\, e^{-j\omega t}\, dt$$

42. Define the region of convergence of the laplace transform. (NOV 2012)

The range of σ for which the laplace transform converges is known as region of convergence (ROC)

43. **Find the Laplace transform of δ(t)**

$$X(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt \quad = \quad \int_{to}^{\infty} \delta(t) e^{-st} dt = 1$$

44. What are the methods for evaluating inverse Laplace transform?

- **Partial fraction expansion method**
- **Convolution integral method**

45. Find the Laplace transform of $x(t)=\sin^2 t\, u(t)$

$$X(s) = L\{x(t)\} = L\left\{\frac{1-\cos 2t}{2}\right\} = \frac{1}{2}\left\{\frac{1}{s} - \frac{s}{s^2+4}\right\} = \frac{2}{s(s^2+4)}$$

46. State the time scaling property of Laplace transform

If $L\{x(t)\}=X(s)$ then

$$L\{x(at)\} = \frac{1}{|a|} X\left(\frac{s}{a}\right)$$

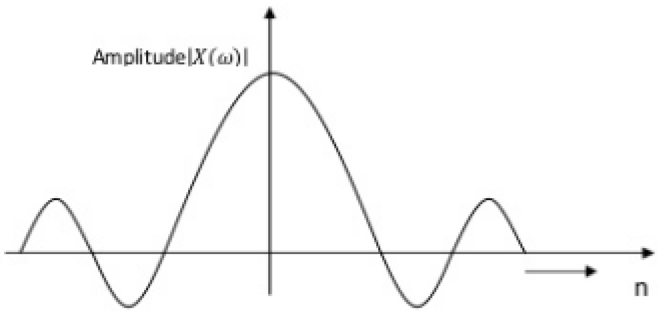
47. What is the Laplace transform of d.c signal of amplitude 1?

$$F^{-1}[\delta(\omega)] = \frac{1}{2\pi}\int_{-\infty}^{+\infty} x(t) e^{j\omega t} dt$$

$$= \frac{1}{2\pi}\int_{-\infty}^{+\infty} \delta(\omega) e^{j\omega t} dt = \frac{1}{2\pi}\delta(\omega) e^{j\omega t}\Big|\, \omega = 0$$

$$F^{-1}[\delta(\omega)] = \frac{1}{2\pi} \quad \text{Thus } FT[1] = [2\pi\delta(\omega)]$$

48. Draw the spectrum of CT rectangular pulse



49. Determine the Laplace ransform of x(t)=e^{-at}sinωtu(t)

$$= \frac{1}{2j} L\left\{e^{-(a-j\omega)t} - e^{-(a+j\omega)t}\right\}$$

$$= \frac{1}{2j}\left\{\frac{1}{s+(a-j\omega)} - \frac{1}{s+(a+j\omega)}\right\}$$

$$= \frac{\omega}{(s+a)^2+\omega^2}, \text{ ROC : Re(s) >-a}$$

50. Find the Fourier transform of e^{at}u(-t)

$$X(\omega) = \int_{-\infty}^{+\infty} x(t)\, e^{-j\omega t}\, dt$$

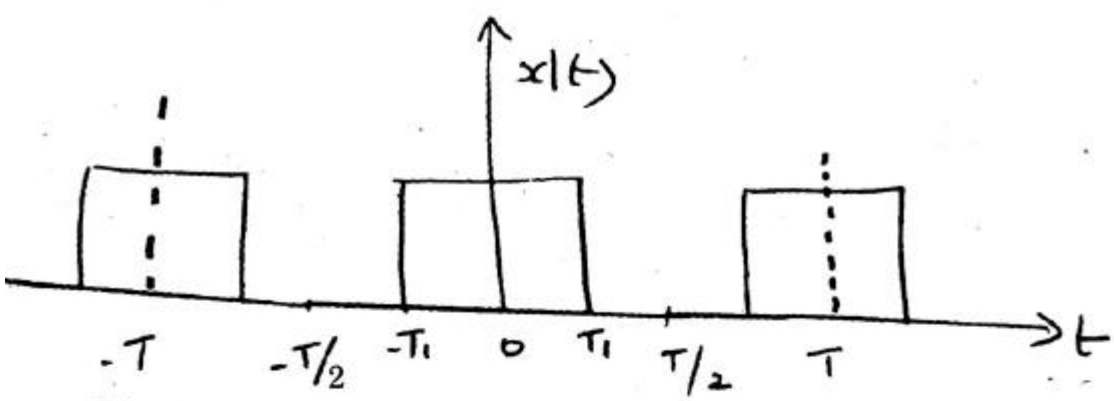
$$= \int_{-\infty}^{0} e^{at}\, e^{-j\omega t} dt$$

$$= \left(\frac{1}{s-a}\right)$$

PART B&C

1.

(a) Find the Fourier series coefficients of the following signal :



Plot the spectrum of the signal.

.

(nov/dec 2014)

Refer signals and systems by Allan V. Oppenheim, page no:186-195

2. (b) Find the spectrum of $x(t)=e^{-2|t|}$. Plot the spectrum of the signal.

(nov/dec 2014)

Refer signals and systems by Allan V. Oppenheim, page no:186-195

3. State and prove any 4 properties of FT (nov/dec 2015)

Refer signals and systems by Allan V. Oppenheim, page no:202-205

4.Find LT and its associated ROC for the signal (nov/dec 2015)

$$x(t) = te^{-2|t|}.$$

Refer signals and systems by Allan V. Oppenheim, page no:655

5. i) Determine the fourier transform for double exponential pulse whose function is given by $x(t)=e^{-2|t|}$ **Also draw its amplitude and phase spectra. (nov/dec 2012)**

Ans: Refer signals and systems by Allan V. Oppenheim, page no:296

ii) Obtain the inverse laplace transform of the function

$$X(s)=\frac{1}{s^2+3s+2},\ \text{ROC}: -2<\text{Re}\{s\}<-1.$$

(nov/dec 2012)

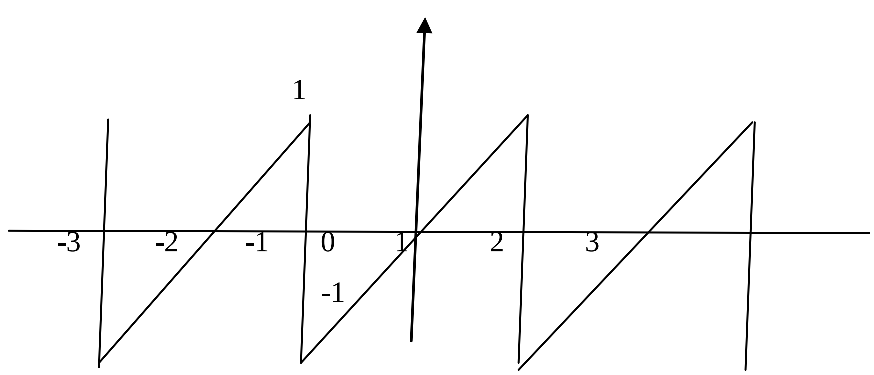
Ans: Refer signals and systems by Allan V. Oppenheim, page no:670

6. Determine the trigonometric Fourier series representation of the halfwave rectifier output (nov/dec 2012)

Refer signals and systems by Allan V. Oppenheim, page no:186-195

7.(i) Find the trigonometric Fourier series for the periodic signal x(t) shown in fig

x(t) **(nov/dec 2011)**



Refer signals and systems by Allan V. Oppenheim, page no:190

(ii) Find the Fourier transform of rectangular pulse. Sketch the signal and its Fourier Transform ` (nov/dec 2011)

Refer signals and systems by Allan V. Oppenheim, page no:290

8..(i) Determine the Laplace transform of the following signals

x1(t)=u(t-2) (nov/dec 2011)
x2(t)=t2e-2tu(t)

Refer signals and systems by Allan V. Oppenheim, page no:655

(ii) Determine the Laplace transform of the following signals

X(t)=sinπt,0<t<1 (nov/dec 2011)
0,otherwise

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9.Determine the Fourier series representation for x(t) = 2sin(2πt-3) + sin(6πt)

- Refer signals and systems by Allan V. Oppenheim, page no: 186-195

10. State and explain the following properties of Fourier transforms:
(a) Linearity (b) Differentiation and Integration property (c) Convolution property (d)Time shifting property

- Refer signals and systems by Allan V. Oppenheim, page no:202-205

11. Find the Laplace transform of $x(t) = e^{-b|t|}$ for b < 0 and b> 0
Refer signals and systems by Allan V. Oppenheim, page no:655

13. Find the Laplace transform of $x(t)=te^{-at}u(t)$

- Refer signals and systems by Allan V. Oppenheim, page no:655

14. Find the inverse Laplace transform of x(s)=1/[(s+1)(s+2)]
Refer signals and systems by Allan V. Oppenheim, page no:670

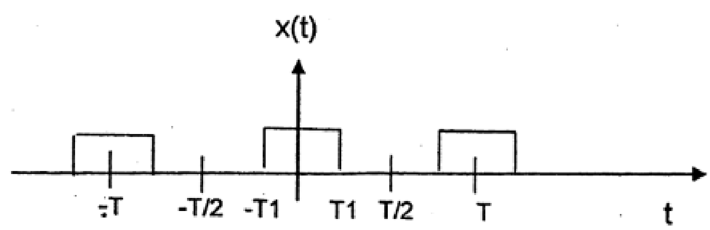
15. Find the inverse Laplace transform of $x(s)=[3s^2+8s+6]/[(s+2)(s^2+2s+1)]$

- Refer signals and systems by Allan V. Oppenheim, page no:670

16.

i) Find the Fourier transform of a rectangular pulse with width T and amplitude A.

ii) Determine the Fourier series coefficients of the following signal.



17

i) Determine the Fourier transform for double exponential pulse whose function is given by $x(t) = e^{-a|t|}, a > 0$. Also draw its amplitude and phase spectra.

ii) Obtain the inverse Laplace transform of the function

$$X(s) = \frac{1}{s^2 + 3s + 2}, \text{ ROC: } -2 < \text{Re}\{s\} < -1.$$

Refer signals and systems by Allan V. Oppenheim, page no:712,388**(nov/dec 2017)**

UNIT-III: LINEAR TIME INVARIANT –CONTINUOUS TIME SYSTEMS

PART-A

1.Check whether the system classified by $y(t) = e^{x(t)}$ is time invariant or not

Ans: $H[x(t-\tau)] = e^{x(t-\tau)}$

$y(t-\tau) = e^{x(t-\tau)}$, $H[x(t-\tau)] = y(t-\tau)$ .so it is time invariant

2. Find the initial and final value for $x(s) = [s+5]/[s^2+3s+2]$

Ans:

The initial value $x(0) = \lim_{s\to\infty} s\, x(s)$

$$= \lim_{s\to\infty} s\,[[s+5]/[s^2+3s+2]$$

$$= \lim_{s\to\infty} [s^2+5s]/[s^2+3s+2] = \lim_{s\to\infty} [(1)+(5/s)]/[(1)+(3/s)+(2/s^{2)}]$$

$=1$

The final value theorem is $\lim_{t\to\infty} x(t) = \lim_{s\to 0} s\, x(s)$

$$= \lim_{s\to 0} [s^2+5s]/[s^2+3s+2] = 0$$

3 A LTI system is characterized by the following differential equation [dy(t)/dt]+ay(t)=x(t).Find the frequency response of the system

Ans: $sy(s) - y(0) + ay(s) = x(s)$

$Y(s)[s+a] = x(s)$

$[Y(s)/x(s)] = 1(s+a)$

Transfer function $H(S) = 1/(s+a)$

Frequency response $H(j\omega) = 1/(j\omega + a)$

4.Determine the F.T of the following

$$\sum_{n=-\infty}^{\infty} \boldsymbol{\delta(t-n\tau)}$$

Ans:

$$x(j\omega) = \sum_{n=-\infty}^{\infty} \mathbf{2\pi a_n \delta}(\omega - n\omega_0)$$

$$\mathbf{a_k} = (1/T) \int_{(+T/2)}^{(-T/2)} \delta(t) e^{-jn\omega_0 t} dt = 1/T$$

$$x(j\omega) = (\mathbf{2\pi/T}) \sum_{n=-\infty}^{\infty} \mathbf{\delta}(\omega - n\omega_0)$$

5. Test whether the system y(t)=exp(x(t)) is linear or non-linear

Ans:

$H[\alpha_1 x_1(t)+ \alpha_2 x_2(t)] = \alpha_1 y_1(t)+ \alpha_2 y_2(t)$

L.H.S : $H[\alpha_1 x_1(t)+ \alpha_2 x_2(t)] = \exp(\alpha_1 x_1(t)+ \alpha_2 x_2(t))$

RHS: $\alpha_1 y_1(t)+ \alpha_2 y_2(t) = \alpha_1 \exp(x_1(t)+ \alpha_2 \exp(x_2 (t)$

LHS ≠RHS

So the system is non linear

6.Find the fourier transform of δ(t-2)

Ans: By using time shifting property $x(j\omega) = e^{-j\omega 2}$ since F.T[δ(t)]=1

7.Find the final value x(∞),given that x(s)=(s+5) /(s+3)

Ans: The final value theorem is $\lim_{t\to\infty} x(t) = \lim_{s\to 0} s\,x(s)$

$$= \lim_{s\to 0} [s^2+5s] /[s+3] = 0$$

8. State parsevals relation for continuous time aperiodic signal

Ans:Let $x_1(t)$ and $x_2(t)$ be signals with Forier transform $x_1(j\omega)$ and $x_2(j\omega)$ respectively.Then we have

$$\int_{-\infty}^{\infty} x_1(t)\, x_2(t)\, dt = \int_{-\infty}^{\infty} x_1(j\omega)\, x_2(j\omega)\, d\omega$$

9.Define Block diagram.

The block diagram representation gives pictorial form of the given system.

10.Find the laplace transform of u(t-2)

Ans:

$$x(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt = \int_{2}^{\infty} e^{-st\cdot} dt = [e^{-st}/-s] =e^{-2t}/s$$

11.If x(jω) is the Fourier transform of x(t),what is the Fourier transform of x(t-2) interms of x(jω)?

Ans:

$$x(j\omega) = \int_{-\infty}^{\infty} x(t)\, e^{-j\omega t}\, dt = \int_{-\infty}^{\infty} x(t-2)\, e^{-j\omega t\cdot} dt$$

12.Find the Laplace transform of x(t)=e^{-5t} u(t-1) and specify its region of convergenc

Ans:

$$x(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt = \int_{-\infty}^{\infty} \mathbf{e^{-5t}\, u(t-1)}\, e^{-st\cdot} dt$$

$$x(s) = \int_{1}^{\infty} \mathbf{e^{-5t}}\, e^{-st\cdot} dt =[e^{-(s+5)t}/-(s+5)] ==[e^{-(s+5)}/-(s+5)]$$

13.Find the Laplace transform and ROC of x(t)=t^{n} exp(-αt) u(t)

Ans:

$$x(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt \;=\; \int_{0}^{\infty} \mathbf{t^n}\, e^{-\alpha t}\, e^{-st.} dt = \mathbf{t^n} /(s+\boldsymbol{\alpha})$$

R.H.S $y(t-\tau) = x[-t-\tau]$

R.H.S $y(t-\tau) = x[-t-\tau]$

14.Find the transfer function of LTI system described by the differential equation $[d^2y(t)/dt^2] + 3\,[dy(t)/dt]+2y(t) =2\,[dx(t)/dt]-3\,x(t)$

Ans: $s^2y(s)+3sy(s)+2y(s)=2sx(s)-3x(s)$

$Y(s)[s^2+3s+2]=x(s)[2s-3]$

$[Y(s)/x(s)]=[2s-3] / [s^2+3s+2]$

$H(s)= [2s-3] / [s^2+3s+2]$

15.The input-output of a causal LTI system are related by the differential equation $[d^2y(t)/dt^2]+6[dy(t)/dt]+8y(t)=2x(t)$.Find the frequency response $H(j\omega)$ of the system

$s^2y(s)+6sy(s)+8y(s)=2x(s)$

$y(s)[s^2+6s+8]=2x(s)$

$y(s)/x(s)= 2/[s^2+6s+8]$

Transfer function:

$H(s)= 2/[s^2+6s+8]$

Frequency response $H(j\omega)=2/[(j\omega)^2+6\, j\omega+8]$

16.Find the impulse response h(t) for the systems described by the difference equation $[dy(t)/dt]+5y(t)=x(t)+2[dx(t)/dt]$

Ans: $sy(s)+5y(s)=x(s)+2sx(s)$

$Y(s)[s+5] =x(s)[1+2s]$

$Y(s)/x(s)=[2s+1]/[s+5]$

$H(s)=[2s+1]/[s+5]$

17.Define frequency response of continuous time systems

Ans: Frequency response of continuous time systems is defined as the ratio of the F.T of output to the F.T of input

$H(j\omega)=[y(j\omega) / x(j\omega)]$

18.List and draw the basic elements for the block diagram representation of the continuous time system. (nov 2012)

Ans: Refer signals and systems by Allan V. Oppenheim, page no:7.95

19.Check the causality of the system with impulse response $h(t) = e^{-t}\, u(t)$. **(nov 2012)**

Ans: Refer signals and systems by Allan V. Oppenheim, page no:4.19

20. Define causality and stability of a system with impulse response. (NOV 2010)

Causality: A system said to be causal if the output of the system at any time 't ' depends only on the present and past values of the inputs are called causal . A system said to be non causal if the output of the system at any time 't ' depends only on future values of the inputs are called non-causal .

For examples : y(t) =x(t)+x(t-1) is a causal system but y(t) =x(t+1) is not

Stability: A system is stable ,if and only if every bounded input produces a bounded Output. Let the input signal x(t) is bounded (finite) i.e $|x(t)|<Mx<\infty$.

21.What is the Laplace Transform of the function x(t)=u(t)-u(t-2)? (nov 2011)

$$X(s)=1/s(1-e^{-2s})$$

22.What are the transfer functions of the following? (nov 2011)

I. An ideal integrator

II. An ideal delay of T seconds

23.Draw the block diagram of the LTI system described by dy(t)/dt + y(t) = 0.1x(t) (nov 2014)

Refer signals and systems by Allan V. Oppenheim, page no: 695

24.What are the three elementary operations in block diagram representation of continuous time system. (nov 2013)

Refer signals and systems by Allan V. Oppenheim, page no: 695

25.Check whether the causal system with transfer function $H(s) = \frac{1}{S - 2}$ is stable. (nov 2013)

Refer signals and systems by Allan V. Oppenheim, page no:112-113

26.If x(jω) is the Fourier transform of x(t),what is the Fourier transform of x(t-2) interms of x(jω)? [Apr-2014]

Ans:

$$x(j\omega) = \int_{-\infty}^{\infty} x(t)\, e^{-j\omega t}\, dt = \int_{-\infty}^{\infty} x(t-2)\, e^{-j\omega t}\, dt$$

.

27.

Given the differential equation representation of a system, $\frac{d^2}{dt^2}y(t) + 2\frac{d}{dt}y(t) - 3y(t) = 2x(t)$. Find the frequency response $H(jr)$.

(nov 2015)

- Refer signals and systems by Allan V. Oppenheim, page no:693-698

28. Define transfer function

It is the ratio of Laplace transform of output to Laplace transform of input.

29. State the condition for Causality

A system is said to be causal if its output depends on present or past input.

30. Define inverse system

The output produced by the system is same as input x(t) then the system is inverse system.

31.Convolve the following signals u(t-1) and δ(t-1) [NOV /DEC 16]

$$x(t) * \delta(t-t_0) = x(t-t_0)$$

$$\therefore u(t-1) * \delta(t-1) = u(t-1-1)$$

$$= u(t-2)$$

32. Given $H(s) = \frac{s}{S^2+2s+1}$ .Find the differential equation representation of the system[NOV /DEC 16]

$$H(s) = \frac{Y(s)}{X(s)} = \frac{s}{s^2+2s+1}$$

$$Y(s)[s^2+2s+1] = X(s).s$$

$$s^2 Y(s) + 2s\, Y(s) + Y(s) = s \cdot X(s)$$

Taking inverse Laplace transform

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

33. **What are the transfer functions of the following? (nov 2011)**

An ideal integrator

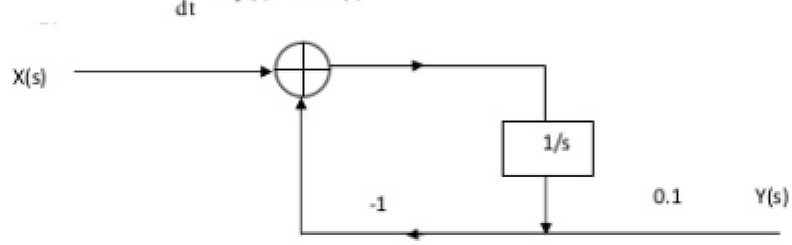
An ideal delay of T seconds

For integrator H(s)=1/s

For An ideal delay of T seconds H(s)=e^{-sT}

34. Draw the block diagram of the LTI system described by

$$\frac{dy(t)}{dt} + y(t) = 0.1x(t)$$



35. What are the properties of convolution
   - Commutative
   - Associative
   - Distributive
36. List the blocks used for block diagram representation
   - Scalar multipliers
   - Adders
   - Integrators.
37. State convolution integral

   Convolution of two signals is given by y(t)=x(t)*h(t)

   Where $x(t)*h(t)=\int_{-\infty}^{+\infty} x(\tau)h(t-\tau)\,d\tau$. This is known as convolution integral.
38. Define natural response

   Natural response is the response of the system with zero input, It depends on the initial state of the system.
39. Define forced response.

   forced response is the response of the system duo to the input alone when initial state of the system is zero.
40. Define complete response.

   The complete response of a LTI CT system is obtained by adding the natural response and forced response.
41. List the four steps to compute convolution integral.
   - Folding
   - Shifting
   - Multiplication
   - Integration
42. Define impulse response of a system.

   Impulse response of a system is defined as the output of a system when unit impulse signal is given as input.
43. What is the Laplace Transform of the function x(t)=u(t)-u(t-3)?

   $X(s)=1/s(1-e^{-3s})$
44. Find the transfer function of LTI system described by the differential equation

   $[d^2y(t)/dt^2] + 2\,[dy(t)/dt]+2y(t) =2\,[dx(t)/dt]-3\,x(t)$

   Ans: $s^2y(s)+2sy(s)+2y(s)=2sx(s)-3x(s)$

   $Y(s)[s^2+2s+2]=x(s)[2s-3]$

   $[Y(s)/x(s)]=[2s-3] / [s^2+2s+2\,]$

   $H(s)= [2s-3] / [s^2+2s+2\,]$
45. What are the different types of block diagram realization
   - Direct form I
   - Direct form II
   - Cascade
   - Parallel
46. What is the condition for the stability of a system

   For a system to be stable the poles of the transfer function must be in the left half of s plane.
47. When the LTI CT system is said to be dynamic?

If the output of the system is said to be dynamic if the out put depends on past input and or future input.

48. What is the advantage of Direct form II over direct form I ?

The number of integrators are reduced to half.

49.

Given $H(s) = \frac{s}{s^2+2s+1}$.Find the differential equation representation of the system.(Nov/Dec 2016)

$$\frac{Y(s)}{X(s)} = \frac{s}{s^2+2s+1}$$

$$sX(s) = s^2Y(s) + 2sY(s) + Y(s)$$

$$\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} + y(t) = \frac{dx(t)}{dt}$$

50.

Given the differential equation representation of a system $\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} - 3y(t) = 2\,x(t)$ .Find the Frequency response H(jω).(Nov/Dec 2015)

$$2X(s) = s^2Y(s) + 2sY(s) - 3Y(s)$$

$$H(j\omega) = \frac{s}{s^2+2s-3}$$

Part-B & C

1.

Convolve the following signals :

$$x(t) = e^{-2t}u(t-2)$$

$$h(t) = e^{-3t}u(t)$$

(nov/dec 2015)

Refer signals and systems by Allan V. Oppenheim, page no:382

2.

The input-output of a causal LTI system are related by the differential equation $\frac{d^2}{dt^2}y(t) + 6\frac{d}{dt}y(t) + 8y(t) = 2x(t)$.

(i) Find the impulse response $h(t)$

(ii) Find the response $y(t)$ of this system if $x(t) = u(t)$.

Hint : Use Fourier transform.

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3. Find the transfer function and impulse response of the system [NOV /DEC 16]

$2[d^2y(t)/dt^2]+3[dy(t)/dt]+4y(t)=2[dx(t)/dt]+x(t)$

- Refer signals and systems by Allan V. Oppenheim, page no:239

4.

An LTI system is represented by $\frac{d^2}{dt^2}y(t)+4\frac{d}{dt}y(t)+4y(t)=x(t)$ with initial conditions $y(\overline{0})=0; y'(\overline{0})=1$; Find the output of the system, when the input is $x|t|=e^{-t}u(t)$.

(nov/dec 2014)

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5. .Find whether the system with the impulse response $h(t)=(1/RC)e^{-t/RC}$ u(t) is BIBO stable

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6. The input-output relation of a system at initial rest is given by $[d^2y(t)/dt^2]+4[dy(t)/dt]+3\ y(t)=[dx(t)/dt]+2x(t)$ Using Laplace transform,find

(i) System transfer function (ii)Frequency response

(iii)Impulse response [Apr-2008]

- Refer signals and systems by Allan V. Oppenheim, page no:693-698

7. i) What is impulse response? Show that the response of an LTI system is convolution integral of its impulse response with input signal? (nov/dec 2012)

Ans: Refer signals and systems by Allan V. Oppenheim, page no:4.12

ii) Obtain the convolution of the following two signals: (nov/dec 2012)

$$x(t)=e^{2t}u(-t)$$
$$h(t)=u(t-3)$$

Ans: Refer signals and systems by Allan V. Oppenheim, page no:261

8.The input x(t) and output y(t) for a system satisfy the differential equation

$$\frac{d^2y(t)}{dt^2}+3\frac{dy(t)}{dt}+2y(t)=x(t).$$

i) **Compute the transfer function and impulse response.**
Ans: Refer signals and systems by Allan V. Oppenheim, page no:124

ii) **Draw direct form, cascade form and parallel form representations**
Ans: Refer signals and systems by Allan V. Oppenheim, page no:124 **(nov/dec 2012)**

9.Consider an LTI system with input $x(t)=e^{-t}$ u(t) and impulse response $h(t)=e^{-2t}$ u(t)

(i)Determine the Laplace transform of x(t) and h(t)

(ii)Using the convolution property, determine the Laplce transform y(s) of output y(t)

(iii)From the Laplace transform of y(t) as obtained in part(2),determine y(t)

(iv)Verify your result in part(2) by explicitly convolving x(t) and h(t) [Apr-2008]

- Refer signals and systems by Allan V. Oppenheim, page no:314

10. Solve $[^{d2}y(t)/d^{t2}]+4[dy(t)/dt]+4\ y(t)=[dx(t)/dt]+x(t)$ if the initial conditions are $y(0)=(9/4),[dy(0)/dt]=5$ if the input is e^{-3t} u(t)

- Refer signals and systems by Allan V. Oppenheim, page no:239

11. Check whether the following systems are stable and causal:

(1) $h(t) = e^{-2t} u(t-1)$ (2) $h(t) = e^{-4t} u(t+10)$ (3) $h(t) = te^{-t} u(t)$

Refer signals and systems by Allan V. Oppenheim, page no:112-113

12.

Using Laplace transform of x(t). Give the pole-zero plot and find ROC of the signal x(t). $x(t) = e^{-b|t|}$ **for both b>0 and b<0.**

.

Refer signals and systems by Allan V. Oppenheim, page no:116-119

13.

Find the condition for which Fourier transform exists for x(t). Find the Laplace transform of x(t) and its ROC. $x(t) = e^{-at} u(-t)$.

Refer signals and systems by Allan V. Oppenheim, page no:119-122

14.

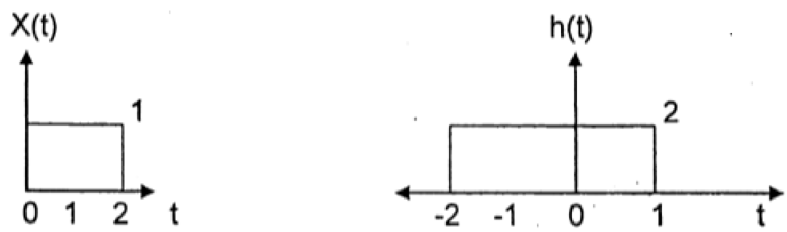
Using graphical method, find the output sequence y[n] of the LTI system whose response h[n] is given and input x[n] is given as follows.

x[n] = {0.5, 2} ; h[n] = {1, 1, 1}.

Refer signals and systems by Allan V. Oppenheim, page no:712,388**(nov/dec 2017)**

15.

Find the response y(t) of an LTI system whose x(t) and h(t) are shown in fig. (Using convolution integral).



Refer signals and systems by Allan V. Oppenheim, page no:715,

UNIT-IV : [ANALYSIS OF DISCRETE TIME SIGNALS]

PART-A

1.What is the z-transform of a^n u(n) ?

Ans:

$$x(z) = \sum_{n=-\infty}^{+\infty} x(n)\, z^{-n}$$

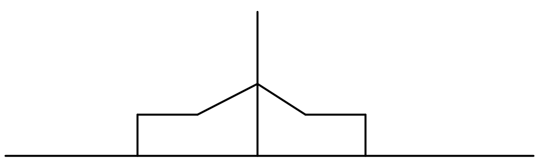
$$x(z) = \sum_{n=0}^{+\infty} a^n . z^{-n} = \sum_{n=0}^{+\infty} (az^{-1})^n = z/(z-a)$$

2. What is the relation between z-transform and Fourier transform of discrete time signal?

Ans: The z-transform x(z) reduces to the F.T $X(e^{j\omega})$ when the magnitude of the transform variable is unity[that is for $z = e^{j\omega}$] represented as

$$x(z) \text{ at } z= e^{j\omega} = X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x(n)\, e^{j\omega n}$$

3. A signal x(t) ,whose spectrum is shown in fig is sampled at a rate of 300 samples/sec.What is the spectrum of the sampled discrete time signal ?



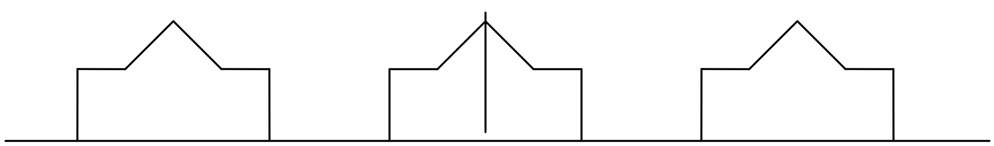
Ans: f_m = 100 hz

Nyquist rate = f_s =300 hz

Sampling frequency = f_s =300hz

$f_s > 2f_m$.Therefore no aliasing.

The spectrum of sampled signal repeats for every 300hz



4.Define Region of convergence w.r.t ,z-transform [Apr-2008]

Ans: The range of value of z for which the z-transform convergence is called ROC.

5. State initial value theorem of Z-transform

Ans: The initial value of the sequence is given is given as $x(0) = \lim_{z\to\infty} x(z)$

6. What are the different methods of evaluating inverse z-transform?

Ans: 1. Contour Integral 2.Power series 3.Partial fraction method

7. State sampling theorem

Ans: A band limited signal x(t) with $x(j\omega) = 0$ for $|\omega| > \omega_m$ can be uniquely determined from its samples x(nT),if the sampling frequency $f_s \geq 2f_m$,that is sampling frequency must be atleast twice the higher frequency present in the s signal.

8. State final value theorem of Z-transform

Ans: The final value of the sequence is given as, $X(\infty) = \lim_{z \to 1} (1-Z^{-1})\, x(z)$

9. Obtain Z-transform of x(n) = {1,2,3,4}

Ans:

$$x(z) = \sum_{n=-\infty}^{+\infty} x(n)\, z^{-n}$$

$$= \sum_{n=0}^{\infty} x(n)\, z^{-n}$$

$$= x(0)z^{0} + x(1)z^{-1} + x(2)z^{-2} + x(3)z^{-3} = 1+2z^{-1}+3z^{-2}+4z^{-3}$$

10. Define Z-transform

Ans: Two –sided (or) bilateral z-transform is given by

$$x(z) = \sum_{n=-\infty}^{+\infty} x(n)\, z^{-n}$$

One-sided(or) unilateral z-transform is given by

$$x(z) = \sum_{n=0}^{\infty} x(n)\, z^{-n}$$

11. What is meant by aliasing? How it is avoided?

Ans: When an analog signal x(t) is sampled as $f_s < 2Fm$,Fm is the maximum frequency in x(t) ,in the corresponding spectrum, high frequency interferes with low frequency and appears as low frequency. This phenomenon is called aliasing.

To avoid aliasing: i. Band limit the analog signal x(t) to f_M

ii . Sampling frequency must be $fs \geq 2f_M$ (Nyquist rate)

12. Find the z-transform of the given data sequence, x(n)=1, 0<n<10
= 0,otherwise ?

Ans: :

$$x(z) = \sum_{n=0}^{N-1} a^n z^{-n}$$

$$x(z) = \sum_{n=0}^{N-1} (az^{-1})^n$$

$$= 1+az^{-1}+a2z^{-2}+\ldots\ldots+a^{n-1} z^{-(N-1)}$$

[Note: $1+x^1+x^2+x^3+\ldots.+x^{N-1}=(1-x^N)/1-x)$]

$$=[1-(az^{-1})^N/ 1-az^{-1}] = (1/z^{N-1}) (z^N-a^N/z-a)]$$

13.What is the mathematical expression for the convolution property of

Z -transform?

Ans: $Z[x(n) * h(n)] = X(z)H(z)$

14. State any two properties of the ROC for the z-transform [Apr-2008]

Ans: 1.The ROC is concentric ring in the z-plane centered at the origin.

2. The ROC can not contain any poles.

15. Find the z-transform of δ(n-2)

Ans : By using time shifting property $x(z) = z^{-2}$ since $z[\delta(n)]=1$

16. Find the z-transform for $x(n) = a^{n-1} u(n-1)$

$$x(z) = \sum_{n=-\infty}^{+\infty} x(n) z^{-n}$$

$$x(z) = a^{-1} \sum_{n=1}^{+\infty} a^n . z^{-n} = a^{-1} \sum_{n=1}^{+\infty} (az^{-1})^n = a^{-1} [z/(z-a)-1]$$

17.List any two properties of z-transform

Ans: (1) linearity (2)Time shifting (3) convolution 4) Differentiation in time domain

18.What is the z-transform of u(n) and δ(n)?

Ans: (i) u(n):

$$x(z) = \sum_{n=-\infty}^{+\infty} x(n) z^{-n}$$

$$x(z) = \sum_{n=0}^{+\infty} 1 z^{-n} = \sum_{n=0}^{+\infty} (z^{-1})^n = z/(z-1)$$

(ii) δ(n) :

$$x(z) = \sum_{n=-\infty}^{+\infty} x(n) z^{-n}$$

$$x(z) = \sum_{n=0} \delta(n) z^{-n} = \delta(0) z^0 = 1 \qquad \text{since } \delta(0) = 1 \ \& \ z^0 = 1$$

19.Find the z-transform of x(n)=u(n)-u(n-3)

Ans:

$$x(z) = \sum_{n=-\infty}^{+\infty} x(n) z^{-n}$$

$$= \sum_{n=0}^{2} z^{-n} = 1 + z^{-1} + z^{-2}$$

20.Find the z-transform of the sequence x(n)={1,2,3,-1} and its ROC.

Ans:

$$x(z) = \sum^{+\infty} x(n) z^{-n}$$

$$n = -\infty$$

$$= \sum_{n=0}^{3} x(n)\, z^{-n}$$

$$= x(0) + x(1)z^{-1} + x(2)z^{-2} + x(3) z^{-3} = 1 + 2z^{-1} + 3z^{-2} - z^{-3}$$

21.For the analog signal x(t)=3 cos(50πt)+10 sin(300πt)-cos (100πt),what is the minimum sampling rate required to avoid aliasing? [Apr-2008]

Ans: f_1=25hz f_2=150hz f_3=50hz

Maximum frequency f_m=150hz

The required sampling frequency $fs > 2f_m$ =2x150=300 hz

22.Define DTFT and inverse DTFT (nov 2012)

$$\text{DTFT: } X(e^{j\omega}) = \sum_{n=-\infty} x(n)\, e^{-j\omega n}$$

$$\text{IDTFT : } x(n) = (1/2\pi) \int_{+\pi}^{+\pi} X(e^{j\omega})\, e^{j\omega n}\, d\omega$$

23.State the convolution property of the Z-transform (nov 2012)

Ans: x1(n)*x2(n)= X1(z).X2(z)

24.What is an anti aliasing filter? (nov 2011)

A filter that is used to reject high frequency signals before it is sampled to reduce the aliasing is called an anti aliasing filter.

25.State Parsevals relation for discrete time aperiodic signals (nov 2011)

Ans:Let x1(t) and x2(t) be signals with Fourier transform x1(jω) and x2(jω) respectively. Then we have

$$\int_{-\infty}^{\infty} x1(t)\, x2(t)\, dt = \int_{-\infty}^{\infty} x1(j\omega)\, x2(j\omega)\, d\omega$$

26. List the condition for existence of DTFT

In the definition of DTFT the summation is over infinite range of n. Hence for DTFT to exist the convergence of summation is necessary

27. Define sampling

Sampling frequency must be $fs \geq 2f_M$ (Nyquist rate)

28. (nov - 14)

Find the DTFT of $x(n) = \delta(n) + \delta(n-1)$

By definition of DTFT

$$X(\omega) = \sum_{n=-\infty}^{\infty} x(n)\, e^{-j\omega n}$$

$$= \sum_{n=-\infty}^{\infty} [\delta(n) + \delta(n-1)]\, e^{-j\omega n}$$

$$= \sum_{n=-\infty}^{\infty} \delta(n)\, e^{-j\omega n} + \sum_{n=-\infty}^{\infty} \delta(n-1)\, e^{-j\omega n}$$

$$= \sum_{n=0} e^{-j\omega n} + \sum_{n=1} e^{-j\omega n}$$

$$= 1 + e^{-j\omega}$$

29. State and prove folding property in ZT **(nov-14)**

If $x(n) \longleftrightarrow X(z)$ then $x(-n) \longleftrightarrow X(z^{-1})$

proof: $$X(z) = \sum_{n=-\infty}^{\infty} x(n)\, z^{-n}$$

$$= \sum_{n=-\infty}^{\infty} x(-n)\, z^{-n}$$

Let $-n = m$, $n \rightarrow -\infty$, $m = \infty$

$n \rightarrow \infty$, $m = -\infty$

$$X(z) = \sum_{m=\infty}^{-\infty} x(m)\, z^{m}$$

$$= \sum_{m=-\infty}^{\infty} x(m)\, (z^{-1})^{-m}$$

$$= X(z^{-1})$$

30. Find ZT and its associasted ROC **nov/dec 2015**

$$x[n] = \{1, -1, 2, \underset{\uparrow}{3}, 4\}.$$

By definition $X(z) = \sum_{n=-\infty}^{\infty} x(n) z^{-n}$

$$X(z) = \sum_{n=-3}^{1} x(n) z^{-n}$$

$$= x(-3) z^{3} + x(-2) z^{2} + x(-1) z^{1} + x(0) z^{0} + x(1) z^{-1}$$

$$= z^{3} - z^{2} + 2z + 3 + \frac{4}{z}$$

ROC is entire z plane except $z = 0$ & $z = \infty$

31. Find the Nyquist rate of the signal x(t)=sin200πt-cos100πt [NOV /DEC 16]

$x(t) = \sin 200\pi t - \cos 100\pi t$

Nyquist rate = 2 × Maximum frequency of the signal

$$\omega_s = 2\omega_m$$

$$= 2 \times 200\pi = 400\pi$$

32. Find the Z transform of the signal and its associated ROC x[n]={2,-1,3,0,2} [NOV /DEC 16]

z transform of x(n) is defined as

$$X(z) = \sum_{n=-\infty}^{\infty} x(n) z^{-n}$$

$$= \sum_{n=-2}^{2} x(n) z^{-n}$$

$$= x(-2) z^{2} + x(-1) z + x(0) + x(1) z^{-1} + x(2) z^{-2}$$

$$= 2z^{2} - z + 3 + 2z^{-2}$$

... and $z = \infty$

33. **.Define DTFT and inverse DTFT (nov 2012)**

DTFT: $X(e^{j\omega}) = \sum_{n=-\infty} x(n)\, e^{-j\omega n}$

IDTFT : $x(n) = (1/2\pi) \int_{+\pi}^{+\pi} X(e^{j\omega}) e^{j\omega n}\, d\omega$

34. **State the convolution property of the Z-transform (nov 2012)**

Ans: $x1(n)*x2(n)= X1(z).X2(z)$

35. **What is an anti aliasing filter? (nov 2011)**

A filter that is used to reject high frequency signals before it is sampled to reduce the aliasing is called an anti aliasing filter.

36. **State Parsevals relation for discrete time aperiodic signals (nov 2011)**

Ans:Let x1(t) and x2(t) be signals with Fourier transform x1(jω) and x2(jω) respectively. Then we have

$$\int_{-\infty}^{\infty} x1(t)\, x2(t)\, dt = \int_{-\infty}^{\infty} x1(j\omega)\, x2(j\omega)\, d\omega$$

37. **List the condition for existence of DTFT**

In the definition of DTFT the summation is over infinite range of n. Hence for DTFT to exist the convergence of summation is necessary

38. **State any two properties of the ROC for the z-transform [Apr-2008]**

Ans: 1.The ROC is concentric ring in the z-plane centered at the origin.

2. The ROC can not contain any poles.

39. **Find the z-transform of δ(n-3)**

Ans : By using time shifting property $x(z) = z^{-3}$ since $z[\delta(n)]=1$

40. **Find the z-transform for $x(n) = a^{n-2}\, u(n-2)$**

$$\mathbf{x(z)} = \sum_{n=-\infty}^{+\infty} \mathbf{x(n)\, z^{-n}}$$

$$\mathbf{x(z)} = \mathbf{a^{-2}} \sum_{n=2}^{+\infty} \mathbf{a^{n}.\, z^{-n}} = \mathbf{a^{-2}} \sum_{n=2}^{+\infty} (az^{-1})^{n} = a^{-2} [\, z/(z-a)-1]$$

41. **List any two properties of z-transform**

Ans: (1) linearity (2)Time shifting (3) convolution 4) Differentiation in time domain

42. **Find the z-transform of x(n)=u(n)-u(n-4)**

Ans:

$$x(z) = \sum_{n=-\infty}^{+\infty} x(n)\, z^{-n}$$

$$= \sum_{n=0}^{3} z^{-n} = 1 + z^{-1} + z^{-2} + z^{-3}$$

43. **List the condition for existence of Z transform**

In the definition of **Z transform** the summation is over infinite range of n. Hence for **Z transform** to exist the convergence of summation is necessary

44.

Find the DTFT of $x[n] = \delta(n) + \delta(n-1)$.(Nov/Dec 2014)

$$\delta(n) = \begin{cases} 1 : n = 0 \\ 0 : n \neq 0 \end{cases}$$

$$\delta(n-1) = \begin{cases} 1 : n = 1 \\ 0 : n \neq 1 \end{cases}$$

$$X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x(n)e^{-j\omega n} = \sum_{n=0}^{\infty} \delta(n)e^{-j\omega n} + \sum_{n=0}^{\infty} \delta(n-1)e^{-j\omega n}$$ Sub n=0 and n=1 in the first and

$$= 1 + e^{-j\omega}$$

Second terms

45. State and prove the time folding property of Z transform

Z{x[n]}=X(z) then $Z\{x[-n]\} = X(z^{-1})$

Proof

$$X(z) = \sum_{n=-\infty}^{\infty} x(n)z^{-n} \quad Z\{x[-n]\} = \sum_{n=-\infty}^{\infty} x(-n)z^{-n}$$

$$\text{Let } -n = p \quad Z\{x[-n]\} = \sum_{p=-\infty}^{\infty} x(p)(z^{-1})^{-p} = X(z^{-1})$$

46. Find thw inverse Z transform for z/z+0.1

$$x(n) = (-0.1)^n u(n) = \frac{z}{z+0.1}$$

$$x(n-1) = (-0.1)^{n-1} u(n-1) = \frac{1}{z+0.1}$$

47. Find the Z transform of impulse signal and unit step sequence

$$\text{Impulse} \quad X(z) = \sum_{n=-\infty}^{\infty} x(n)z^{-n} = \sum_{n=-\infty}^{\infty} \delta(n)z^{-n} = 1$$

$$\text{Unit Step } X(z) = \sum_{n=-\infty}^{\infty} u(n)z^{-n} = \sum_{n=0}^{\infty} 1 z^{-n} = \frac{z}{z-1}$$

48. Find the Z transform and its associated ROC for x(n)={1,-1,2,3,4}

$$X(z) = \sum_{n=-\infty}^{\infty} x(n) z^{-n}$$

$x(0)=5; x(-1)=2; x(-2)=-1; x(-3)=1; x(1)=4$

Substituting the sequence values we get

$X(z)= 2z^3 - z^2 + 2z + 3 + 4z^{-1}$

ROC: entire z-plane except z = 0 and z = ∞

49. Define sampling?
The Process of converting continuous time signal to discrete time signal is called sampling

50. What is aliasing?
If the fs<2fm ,the spectrum of successive samples overlap each other resulting in a condition called aliasing.

Part B&C

1. **State and explain sampling theorem both in time and frequency domain with necessary quantitative analysis and illustrations.** [NOV /DEC 16]
Refer signals and systems by Allan V. Oppenheim, page no:515

2. **State and prove any 2 properties of DTFT and ZT** [NOV /DEC 16]
Refer signals and systems by Allan V. Oppenheim, page no:748

3. **i) Find the Z-transform of the sequence** $x(n) = \cos(n\theta)\, u(n)$
Ans: Refer signals and systems by Allan V. Oppenheim, page no:741
(nov/dec 12)
ii) Determine the inverse Z-transform of the following expression using partial fraction expansion:

$$X(z) = \frac{1}{\left(1 - \frac{1}{3}z^{-1}\right)\left(1 - \frac{1}{6}z^{-1}\right)}, \quad \text{ROC}: |z| > \frac{1}{3}$$

Ans: Refer signals and systems by Allan V. Oppenheim, page no:757

4. **(nov/dec 14)**

Find inverse z-transform of $X(z) = \dfrac{z^{-1}}{1 - 0.25z^{-1} - 0.375z^{-2}}$.

For (i) ROC $|z| > 0.75$

(ii) ROC $|z| < 0.5$

Refer signals and systems by Allan V. Oppenheim, page no:757

5. **Find the z-transform of $x(n)= a^n \sin\omega_0 n\, u(n)$**

- Refer signals and systems by Allan V. Oppenheim, page no:741

6..Find the inverse z-transform of $x(z) = 1/[1-1.5z^{-1}+0.5z^{-2}]$ for ROC: 0.5<Z< 1

- Refer signals and systems by Allan V. Oppenheim, page no:757

7.Find the inverse Z-transform $X(Z) = [\, 1-(1/3)Z^{-1}] / [\, (1-Z^{-1})(\, 1+2Z^{-1})\,]$

- Refer signals and systems by Allan V. Oppenheim, page no:757

8. Find the Z-transform of the sequence $x(n) = (1/2)^n u(n) - (1/4)^n u(n-1)$

Refer signals and systems by Allan V. Oppenheim, page no:741

9.Obtain the inverse z-transform of the following:

a.$x(z) = [z+1] / [3z^2-4z+1]$

Refer signals and systems by Allan V. Oppenheim, page no:757

b. $x(z) = z^2 / [\, (z-0.25)(z-0.1)]$

- Refer signals and systems by Allan V. Oppenheim, page no:757

10.Using Final value theorem of z-transform, find the final value of the signal for which $Y(Z)=[2Z^{-1}] / [1-1.8Z^{-1}+0.8Z^{-2}]$

Refer signals and systems by Allan V. Oppenheim, page no:741

11

Find the Z transform and sketch the ROC of the following sequence $x[n] = 2^n u[n] + 3^n u(-n-1)$.

Refer signals and systems by Allan V. Oppenheim, page no:752

12.

Consider an analog signal $x(t) = 5 \cos 200\pi t$.

a) Determine the minimum sampling rate to avoid aliasing.

b) If sampling rate Fs = 400 Hz. What is the DT signal after sampling ?

Refer signals and systems by Allan V. Oppenheim, page no:792 **(nov/dec 2017)**

13.

Determine unit step response of the LTI system defined by $d^2y/dt^2 + 5dy/dt + 6y(t) = dx/dt + x(t)$.

Refer signals and systems by Allan V. Oppenheim, page no:797, **(nov/dec 2017)**

14.

Find the Inverse z-transform using partial fraction method.

$$X(z) = \frac{3-(5/6)z^{-1}}{\left(1-(1/4)z^{-1}\right)\left(1-(1/3)z^{-1}\right)} \qquad ;|z| > 1/3$$

Refer signals and systems by Allan V. Oppenheim, page no:,787**(nov/dec 2017)**

15. Using Partial Fraction, find the inverse Z transform. for which $Y(Z)=[2Z^{-1}] / [1-1.8Z^{-1}+0.8Z^{-2}]$

Refer signals and systems by Allan V. Oppenheim, page no:749

UNIT-V :[LINEAR TIME INVARIANT - DISCRETE TIME SYSTEMS]

PART-A

1. Is the output sequence of an LTI system finite or infinite when the input x(n) is finite? Justify your answer

Ans: If the impulse response of the system is infinite,then output sequence is infinite even though input is finite .For examples consider,

Input $x(n)=\delta(n)$ finite length ,impulse response $h(n)=a^n u(n)$ Infinite length

Output sequence $y(n)= h(n) * x(n)$

$= a^n u(n)* \delta(n) = a^n u(n)$

2. Write the general difference equation relating input and output of a system

Ans: The generalized difference equation is given as

$$y(n) = -\sum_{k=1}^{N} a_k\, y(n-k) + \sum_{k=0}^{M} b_k\, x(n-k).$$

Here y(n-k) are previous output and x(n-k) are present and previous inputs**.**

3. Write down the input-output relation of a LTI system in time and frequency domain

Ans: $y(n)=h(n)*x(n)$:Time domain

$Y(f) = H(f).X(f)$:Frequency domain

$y(s)=H(s).X(s)$: Frequency domain

4.Define impulse response of a LTI system

Ans: Impulse response of LTI system is denoted by h(n) .It is the response of the system to unit impulse input.

5. Consider an LTI system with difference equation $y(n)-(3/4)y(n-1)+(1/8)y(n-2)=2x(n)$.Find H(Z)

Ans: Taking z-transform on both side

$y(z) -(3/4)[z^{-1}y(z)+y(-1)+(1/8)[z^{-2}y(z)+z^{-1}y(-1)+y(-2)] =2x(z)$

$y(z) -(3/4)z^{-1}y(z)+(1/8)z^{-2}y(z) =2x(z)$

$y(z)[1-(3/4)z^{-1}+(1/8)z^{-2}]=2x(z)$

$H(Z)=[y(z)/x(z)] = 2/[1-(3/4)z^{-1}+(1/8)z^{-2}]$

$H(Z)= 2z^2/[z^2-(3/4)z+(1/8)]$

6. State the properties of convolution

Ans:1.Commutative property :$x(n)*h(n)=h(n)*x(n)$

2.Associative property : $[x(n)*h_1(n)]*h_2(n)=x(n)*[h_1(n)*h_2(n)]$

3. Distributive property: $[x(n)*h_1(n)]+[x(n)*h_2(n)]=x(n)*[h_1(n)+h_2(n)]$

7. Consider an LTI system with impulse $h(n)=\delta(n-n_0)$ for an input x(n).Find $y(e^{j\omega})$

Ans: Here $y(e^{j\omega})$is the spectrum of output.By convolution theorem we can

write, $Y(e^{j\omega})=H(e^{j\omega}).X(e^{j\omega})$ Here $H(e^{j\omega})=DTFT[\delta(n-n_0)] = e^{-j\omega n_0}$
Therefore $Y(e^{j\omega}) = e^{-j\omega n_0} x((e^{j\omega})$

8.Define eigen signal and give an example.

Ans: $H(S)= h(\tau) e^{-s\tau} d\tau$. H(S) is called transfer function.
Therefore $y(t)=H(S) e^{st}$ .Thus output is equal to input multiplied by system transfer function. Hence e^{st} is called eigen function and H(S) is called eigen value

9.Define DTFT pair (or)Write the analysis and synthesis equation of DTFT

Ans: DTFT :

$$X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x(n) e^{-j\omega n}$$

$$\text{IDTFT}: x(n) = (1/2\pi) \int_{+\pi}^{+\pi} X(e^{j\omega}) e^{j\omega n} d\omega$$

10.Determine the system function of the discrete system described by the difference equation y(n)-(1/2)y(n-1)+(1/4)y(n-2) = x(n) –x(n-1).

Ans: Taking z-transform both sides

$y(z) -(12)z^{-1}y(z)+(1/4)z^{-2}y(z) = x(z) - z^{-1}x(z)$

$y(z)[1-(1/2)z^{-1}+(1/4)z^{-2}] = x(z) [1-z^{-1}]$

$H(Z)=[y(z)/x(z)] =[1-z^{-1}] / [1-(1/2)z^{-1}+(1/4)z^{-2}]$

11.What is the linear convolution of the two signals{2,3,4} and {1,-2,1}

Ans:

		2	3	4
		1	-2	1
		2	3	4
	-4	-6	-8	
2	3	4		
2	**-1**	**0**	**-5**	**4**

Therfore y(n)={2,-1,0,-5,4}

12.What is the response of an LSI system with impulse response h(n)=δ(n)+2δ(n-1) for the input x(n)={1,2,3} ?

Ans: Here $h(n)=\delta(n)+2\delta(n-1)$ can be expressed as h(n) ={ 1,2}

	1	2	3
		1	2
	2	4	6
1	2	3	
1	4	7	6

13.Determine the transfer function of the system described by y(n)=a y(n-1) + x(n)

Ans: Taking z-transform on both side

$y(z) = az^{-1}y(z)+x(z)$

$y(z)[1 - az^{-1}] = x(z)$

$[y(z)/x(z)] = 1/[1 - az^{-1}]$

$H(Z) = Z/[Z-a]$

14.State the time shifting and frequency shifting properties of DTFT.

Ans: Time shifting: $DTFT[x(n-n_0)] = e^{-j\omega n0}\, x(e^{j\omega})$

Frequency shifting : $DTFT\, [e^{j\omega_0 n}\, x(n)\,] = x[e^{j(\omega-\omega_0)}]$

15.List out the different ways for interconnecting any two systems

Ans: 1. Associative property 2.Distributive property

16. State the conditions for causality and stability of system with impulse response h(n)

Ans: Causal : h(n) = 0 ,n<0

Stable : $\sum_{n=-\infty}^{+\infty} |h(n)|^2 < \infty$

17.State the linearity and periodicity properties of Discrete –Time Fourier Transform

Ans: Linearity : $DTFT[ax(n)+b\, y(n)\,]=a\, x(e^{j\omega})+b\, y(e^{j\omega})$

Periodicity : $x(e^{j\omega})$vis periodic with period 2π i.e $x[e^{j(\omega+2\pi)}] = x(e^{j\omega})$

18.Write the condition for the LTI system to be causal and stable

Ans: Causal : h(n) =0 for n < 0

Stable : $\sum_{n=-\infty}^{\infty} |h(n)|^2 < \infty$

19. State the properties needed for interconnecting any two systems

Ans (i) Distributive : $x(n)*[h_1(n)+h_2(n)]=xz(n)*h_1(n)+x(n)*h_2(n)$

(ii) Associative : $x(n)*(h_1(n)*h_2(n))=(x(n)*h_1(n))*h_2(n)$

20.Define discrete time Fourier transform?

Ans: DTFT :

$$X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x(n)\, e^{-j\omega n}$$

IDTFT :

$$x(n) = (1/2\pi) \int_{+\pi}^{+\pi} X(e^{j\omega})\, e^{j\omega n}\, d\omega$$

21.State and prove time shifting property of DTFT

Ans: Statement:Time shifting: DTFT[x(n-n_0] = $e^{-j\omega n}0$ x($e^{j\omega}$)

$$\textbf{Proof:} \quad F[x(n-n_0)] = \sum_{n=-\infty}^{\infty} x(n-n_0)\, e^{-j\omega n}$$

$$F[x(n-n_0)] = \sum_{P=-\infty}^{\infty} x(P) e^{-j\omega(P+n_0)}$$

$$= e^{-j\omega n_0} \sum_{P=-\infty}^{\infty} x(P) e^{-j\omega P}$$

$$= e^{-j\omega n_0} x(e^{j\omega})$$

22.Prove that for the causal LSI system the impulse response h[n]=0 ,for n<0

$$y(n) = \sum_{k=-\infty}^{\infty} h(k)\, x(n-k)$$

$$y(n) = \sum_{k=-\infty}^{-1} h(k)\, x(n-k) + \sum_{k=0}^{\infty} h(k)\, x(n-k)$$

$$= \ldots\ldots..h(-2)x(n+2)+h(-1)x(n+1)+h(0)x(n)+h(1)x(n-1)+\ldots\ldots\ldots..$$

$$y(n) = \sum_{k=0}^{\infty} h(k)\, x(n-k) \quad \text{so it is causal} \quad \mathbf{h[n]=0 \text{ ,for } n<0}$$

23.Compute discrete time Fourier transform of the signal x(n)=u(n-2)-u(n-6)

Ans: :

$$X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x(n)\, e^{-j\omega n}$$

$$X(e^{j\omega}) = \sum_{n=2}^{5} x(n)\, e^{-j\omega n}$$

$$= x(2)\, e^{-j\omega 2} + x(3)\, e^{-j\omega 3} + x(4)\, e^{-j\omega 4} + x(5)\, e^{-j\omega 5}$$

$$= e^{-j\omega 2} + e^{-j\omega 3} + e^{-j\omega 4} + e^{-j\omega 5}$$

24.Find the system response of x(n)=u(n) and h(n)=δ(n) +δ(n-1)

Ans:x(z)=1/(1-z^{-1}) H(z)=1+ z^{-1}

By using convolution property y(z)=x(z).H(z)

Y(z)=(1+ z^{-1}) /(1-z^{-1}) =(z+1) /(z-1)

25. Convolve the following two sequences: $x(n) = \{1, 1, 1, 1\}$ **and** $h(n) = \{3, 2\}$ **(nov 2012)**

Ans: Refer signals and systems by Allan V. Oppenheim, page no:476

26.A causal LTI system has impulse response h(n), for which the Z-transform is

$H(z) = \dfrac{1 + z^{-1}}{(1 - 0.5z^{-1})\,(1 + 0.25\,z^{-1})}$ **is the system stable? Explain. (nov 2012)**

Ans: Refer signals and systems by Allan V. Oppenheim, page no:547

27.What is the Z transform of the Sequence $x(n)=a^n u(n)$? (nov 2011)

$X(z)=z/(z-a)$

28.Define System function (nov 2011)

Transfer function relates the transforms of input and output that is

H(f)=[Y(f)/X(f)],Using Fourier Transform (or)

H(s) =[Y(S)/x(S)]

29. **nov/dec 2015**

Convolve the following signals

$x(n) = \{1, 1, 3\}$ & $h(n) = \{1, 4, -1\}$

h(n) / x(n)	1	4	-1
1	1	4	-1
1	1	4	-1
3	3	12	-3

$y(n) = \{1, 5, 6, 11, -3\}$

30. Give the impulse response of a linear time invariant h(n) = sin(πn).Check whether the system is stable or not **nov/dec 2014**

Condition for stability is

$$\sum_{n=-\infty}^{\infty} |h(n)| < \infty$$

$\sin \pi n = 0$ which is less than infinity

the given h(n) is absolutely stable

n value can be 0, 1, 2 ....

31. Convolve the following sequencex[n]={1,2,3],h[n]={1,1,2} [NOV /DEC16]

x(n) * h(n)

		1	2	3	
		1	1	2	
		2	4	6	
	1	2	3		
1	2	3			
1	3	7	7	6	

$x(n) * h(n) = \{1, 3, 7, 7, 6\}$

32. Given the system function H(z)=2+3z^{-1}+4z^{-3}-5z^{-4} Determine the impulse response h[n] [NOV 16]

Given $H(z) = 2 + 3z^{-1} + 4z^{-3} - 5z^{-4}$ — ①

By the definition of z transform

$H(z) = \sum_{n=-\infty}^{\infty} h(n) z^{-n} = \dots + h(0) + h(1)z^{-1} + h(2)z^{-2} + \dots$ — ②

Comparing ① and ②

$h(n) = \{\underset{\uparrow}{2}, 3, 0, 4, -5\}$

33. **Define transfer function**

It is the ratio of Z transform of output to Z transform of input.

34. **State the condition for Causality**

A system is said to be causal if its output depends on present or past input.

35. **Define inverse system**
    If the output produced by the system is same as input x(z) then the system is inverse system.
36. Distinguish between IIR and FIR system

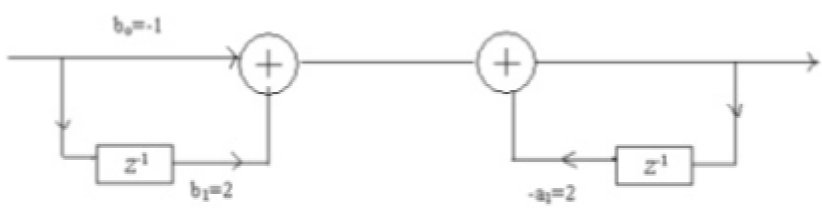
S.NO	FIR SYSTEM	IIR SYSTEM
1.	Length of impulse response is limited.	Length of impulse response is infinite.
2.	There is no feedback of output.	Feedback of output is taken.
3.	These systems are non recursive.	These systems are recursive.

37. Why direct form II structure is called canonic structure?
    The number of delay elements in the structure is equal to order ofthe difference equation or order of the transfer function.Hence it is called canonic structure.
38. Write the general equation relating input and output of a system.
    The generalized difference equation is given as,

$$y(n) = -\sum_{k=1}^{n} a_k y(n-k) + \sum_{k=0}^{m} b_k x(n-k)$$

39. Realize the following system y(n)=2y(n-1)+2x(n-1) in direct form I method

y(n)=2y(n-1)-x(n)+2x(n-1)



40. What is meant by recursive system
    When the output y(n) of the system depends upon the present and past inputs as well as past outputs,then the system is called recursive system.
41. What are the four steps to obtain convolution sum?
    - Folding
    - Shifting
    - Multiplication
    - Summation
42. List out the different methods to realise a DT system using block diagram
    Direct form I
    Direct form II
    Cascade
    Parallel

43. What are the properties of convolution
    - Commutative
    - Associative
    - Distributive

44. List the blocks used for block diagram representation
    - Scalar multipliers
    - Adders
    - unit delay elements

45. Define natural response

    Natural response is the response of the system with zero input, It depends on the initial state of the system.
46. Define forced response.

    forced response is the response of the system duo to the input alone when initial state of the system is zero.
47. Define complete response.

    The complete response of a LTI CT system is obtained by adding the natural response and forced response.
48. Find the convolution of the following sequence

    x(n)={1,2,1},h(n)={1,1,1}

    /e know

    $$z\{x(n)*h(n)\} = X(z)H(z)$$
    $$X(z) = (1 + 2z^{-1} + z^{-2})$$
    $$H(z) = (1 + z^{-1} + z^{-2})$$
    $$X(z)H(z) = 1 + 3z^{-1} + 4z^{-2} + 3z^{-3} + z^{-4}$$
    $$x(n)*h(n) = \{ \underset{\uparrow}{1}, 3, 4, 3, 1 \}$$
49. Find the convolution of the following sequence

    x(n)={1,2,3},h(n)={1,1,2}

    We know

    $$z\{x(n)*h(n)\} = X(z)H(z)$$
    $$X(z) = (1 + 2z^{-1} + 3z^{-2})$$
    $$H(z) = (1 + z^{-1} + 2z^{-2})$$
    $$X(z)H(z) = 1 + 3z^{-1} + 7z^{-2} + 7z^{-3} + 6z^{-4}$$
    $$x(n)*h(n) = \{ \underset{\uparrow}{1}, 3, 7, 7, 6 \}$$
50. Define convolution sum.

    Convolution sum is given by y(n)=x(n)*h(n)

    $$y[n] = \sum_{k=-\infty}^{+\infty} x[k].h[n-k]$$

PART B&C

1.

Compute $y(n) = x(n) * h(n)$

where $x(n) = (1/2)^{-n} u(n-2)$

$h(n) = u(n-2)$.

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2.

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) Find the transfer function of the system.

(ii) Find the impulse response of the system.

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3.

Convolve the following signals :

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

$$h[n] = u[n+2]$$

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4.Consider an LTI system with the system function H(Z)=1/[1-(1/4)$^{Z-1}$]. Find the difference equation

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5. i) Find the system function and the impulse response h(n) for a system ‘ described by the following input-output relationship

$$y(n) = \frac{1}{3} y(n-1) + 3x(n).$$

ii) An linear time invariant system is characterized by the system function

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

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

1. **The system is stable** **Nov/dec 12**
2. **The system is causal**
3. **The system is anti-causal**

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6. i) Derive the necessary and sufficient condition for BIBO stability of an LSI system

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ii) Draw the direct form, cascade form and parallel form block diagram of the following system function: **nov/dec 12**

$$H(z) = \frac{1}{\left(1+\frac{1}{2}z^{-1}\right)\left(1-\frac{1}{4}z^{-1}\right)}$$

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7.Find the output sequence y(n) of the system described by the equation y(n) =0.7y(n-1) –0.1y(n-2) +2x(n) –x(n-2) for the sequence x(n) = u(n)

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8a. Find the convolution of x(n) ={1,2,3,4,5} with h(n)={1,2,3,3,2,1}

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b. Find the impulse response of the discrete time system described by the difference equation y(n-2) –3 y(n-1) +2y(n) =x(n-1)

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9. Determine the impulse response and frequency of the system described by the difference equation y(n)-(1/6)y(n-1)-(1/6)y(n-2) =x(n-2)

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10. A causal discrete time LTI system is described by y(n) –(3/4)y(n-1)+(1/8)y(n-2) =x(n).Where x(n) and y(n) are the input and output of the system respectively(i) Determine the system function H(Z) (ii) Find the impulse response h(n) of the system [NOV /DEC 16]

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11.

Obtain the parallel realization of the system given by

$y(n) - 3y(n-1) + 2\,y(n-2) = x(n)$.

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12.

Determine the direct form II structure for the system given by difference equation

$$y(n) = \left(\frac{1}{2}\right)y(n-1) - \left(\frac{1}{4}\right)y(n-2) + x(n) + x(n-1).$$

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13.

Using the properties of inverse Z-transform solve :

i) $X(z) = \log(1 + az^{-1}); |z| > |a|$ and $X(z) = \dfrac{az^{-1}}{(1-az^{-1})^2}\ ; |z| > |a|$

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14.

Check whether the system function is causal or not

$$H(z) = \frac{1}{1-(1/2)z^{-1}} + \frac{1}{1-2z^{-1}} \quad ; |z| > 2$$

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15.

Consider a system with impulse response $H(s) = \frac{e^s}{S+1}; Re\{s\} > -1$. Check whether the system function is causal or not .

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