UNIT I -CLASSIFICATION OF SIGNALS AND SYSTEMS
PART A

1. What are the major classifications ofsignals?

Signals are classified as Continuous Time (CT) and Discrete Time(DT) signals.
Both CT and DT signals are further classified as
Deterministic and Random signals, Even and Odd signals, Energy and Power signals, Periodic and Aperiodic signals

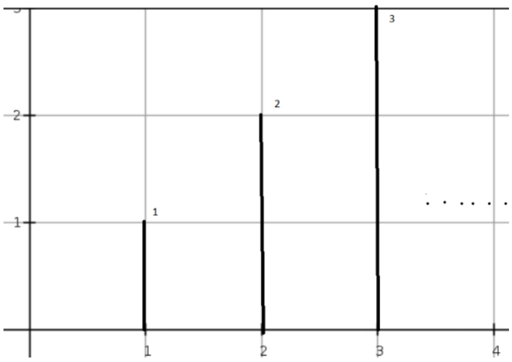
2. With suitable examples distinguish a deterministic signal from a random signal. Define a random signal.(Nov2019)

Deterministic signal: A signal which can be modeled (represented) by a mathematical equation.
Example: cosine signal
Random signal:A signal which cannot be modeled by a mathematical equation is called random signal. **Example:**Speech Signal

3. Define energy signal and power signal.(May2015)

A signal x(t) is said to be energy signal if , Energyisfinite i.e. $0 < E < \infty$andaverage power is zero i.e. P=0 Where E =energy and P = Averagepower
A signal x(t) is said to be power signal if powerisfinite i.e $0 < P < \infty$and energy is infinitei.e.
$E = \infty$where E =energy and P = Averagepower

4. Givethemathematicaland graphicalrepresentationoframpsequence.(Dec2018)



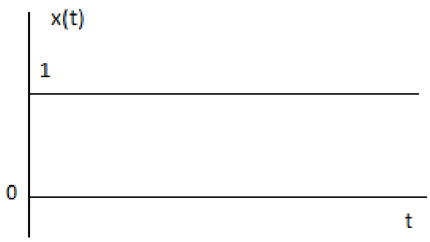
r[n] = n for n≥0

5. Evaluate the integral $\int_{-1}^{1}(2t^2+3)\delta(t)dt$. (Dec2018)

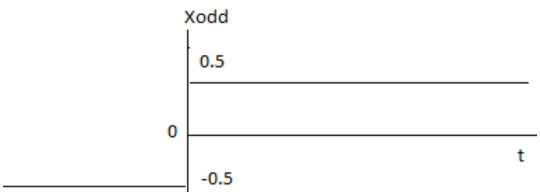
Weknowthat, $\int_{-\infty}^{\infty} \emptyset(t)\delta(t-t_0)dt = \emptyset(t_0)$

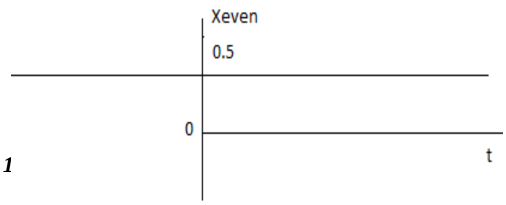
Therefore t_0=0 and Answer=$2(0)^2+3=3$

6. Find the even and odd part of the signal?(Apr2019)



Odd part of the signal x(t)=x(t)-x(-t)/2 Even part of the signal x(t)=x(t)+x(-t)/2





7.State two properties of unit impulse function. (Dec2014)

Shiftingproperty:

signal with shifted impulse simply shifts the signal.

$$\int_{-\infty}^{\infty} x(t)\delta(t-t_o)dt = x(t_o)$$

δ(t) is the limit of graphs of area 1, the area under its graph is 1.δ(t)peak response at origin.

8.D**efine symmetric and anti-symmetric signal. Symmetric signal:** It is a even signal, A signal$x(-t)=x(t)$.

$x(t)$ is said to be symmetric signalif

Example:$x(t) = A\cos\omega t$

Anti symmetric signal:

A signal $x(t)$ is said to be anti-symmetric signal if

$x(-t) = -x(t)$ .Example: $x(t) = A\sin \omega t$

8.Verifywhether $x(t) = Ae^{-at}u(t)$, $a > 0$ **is an energy signal or not.**

$x(t) = Ae^{-at}u(t)$, $a > 0$:

$$Energy = \lim_{T\to\infty} \int_{-T}^{T} |x(t)|^2 dt = \lim_{T\to\infty} \int_{0}^{T} |Ae^{-at}|^2 dt = \lim_{T\to\infty} \left[A^2 \frac{e^{-2at}}{-2a} \right]_0^T = \frac{A^2}{2a} \; Joules$$

$$power = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} |x(t)|^2 dt = \lim_{T\to\infty} \frac{1}{2T} \left[A^2 \frac{e^{-2at}}{-2a} \right]_0^T = 0 \; Watts$$

Energy is finite, Power is zero. The signal is energy signal

9. Determine the power and RMS value of thesignal $x(t) = e^{jat}\cos\omega_o t$.

$$power = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} |e^{jat}\cos\omega_0 t|^2 dt = \lim_{T\to\infty} \frac{1}{4T} \int_{-T}^{T} (1+\cos 2\omega_0 t)\, dt \qquad since\; |e^{jat}| = 1$$

$$= \lim_{T\to\infty} \frac{1}{4T}(2T) = \frac{1}{2} watt \qquad ;RMSvalue = \sqrt{\frac{1}{2}}$$

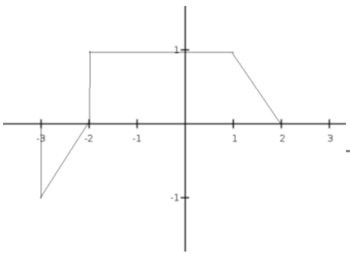
10.Find theaveragepowerofthesignal$u(n)-u(n-N)$.

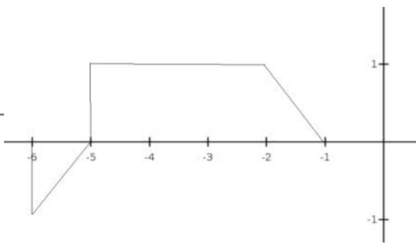
Average power of a DT signal x(n) is

$$Power = \lim_{N\to\infty} \frac{1}{(2N+1)} \sum_{n=-N}^{N} |x(n)|^2 = \lim_{N\to\infty} \frac{1}{(2N+1)} \sum_{n=0}^{N} (1)^2 = 0 watt$$

12. Plot x(3-5t) (May 2018)

i)x(t) **ii)x(t+3)**





13. Distinguishstaticsystemfromdynamicsystem.

Static system: Static system is a system with no memory or energy storage element. Output of a static system at any specific time depends on the input at that particular time.

Dynamic system:

Dynamic systems have memory or energy storage elements. Output of a dynamic system at any specific time depends on the inputs at that specific time and at other times.

14. Define a time invariantsystem.

A system is said to be time invariant if its input-output characteristics do not change with time.

Let $y(t) = F[x(t)]$; F *denotes some transformation (operation) on* $x(t)$;x(t)-input, y(t)- output

Let $y(t, t_o)$ denote the output due to delayed input $x(t-t_0)$i.e, $y(t, t_0) = F[x(t - t_0)]$

let $y(t - t_0)$ be the output delayed by t_0 if $y(t - t_0) = y(t, t_0)$ then the system is time invariant

15. Define a continuous time LTI system. Give the conditions for a system to be LTI system.(Dec2013)

A continuous time system which posses two properties i) linearity (Obeys superposition principle) ii) Time invariance(Input –output characteristics do not vary with time) is a CT LTI system.

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

$y(t) = x(-t)$ $\rightarrow$ *input–outputrelationship* $y(t)$=*output* & $x(t)$ =*input*

Checking for linearity:

For an input $x_1(t)$, theoutput $y_1(t)$ is, $y_1(t) = x_1(-t)$

For an input $x_2(t)$, theoutput $y_2(t)$ is, $y_2(t) = x_2(-t)$

For an input $a\,x_1(t) + b\,x_2(t)$, the output $y_3(t)$is, $y_3(t) = a\,x_1(-t) + b\,x_2(-t)$

$y_3(t) = a\; y_1(t) + b\,y_2(t)$ The system obeys superposition principle. Therefore the system is linear

Checking for causality:

For $t = -1$, $y(-1) = x(1)$ For negative values of time ‘t’, the output depends on the future input. Therefore the system is non-causal.

17. Computetheaverageenergyandpowerofthesignalx(t)=r(t)-(r-2)(May2018)

$$\text{Energy} = \int_{-\infty}^{+\infty} |x(t)|^2 dt = \int_0^2 t^2\, dt + \int_2^{+\infty} 2dt = \infty$$

$$\text{Power} = \lim_{T\to\infty}\left(\frac{1}{2T}\right)\int_{-T}^{+T} |x(t)|^2 dt = \lim_{T\to\infty}\left(\frac{1}{2T}\right)\left\{\int_0^2 |t|^2 dt + \int_2^T 4dt\right\} = 2W$$

Energy is infinite, Power is 2W. The signal is power signal

18. Check whether the following system is static (or) dynamic and causal (or) non-causal:$y(n) = x(2n)$(Dec 2012)

For a given ‘n’ the output depends on the future input. Therefore the system is non-causal. The system is a dynamic system.

19. Verify whether the system described by the equation is linear and time invariant. y(t)=x(t²)

Linearity:

$y(t)=x(t^2)$; $y(t)=F[x(t)]=x(t^2)$

For an input $x_1(t)$, $y_1(t)=F[x_1(t)]=x_1(t^2)$

For an input $x_2(t)$, $y_2(t)=F[x_2(t)]=x_2(t^2)$

Weighted sum of outputs is given by $ay_1(t)+by_2(t)=ax_1(t^2)+bx_2(t^2)$

Output due to weighted sum of inputs is $y_3(t)=F[ax_1(t)+bx_2(t)]=[ax_1(t^2)+bx_2(t^2)]$

Therefore, the system is linear.

Time invariance:

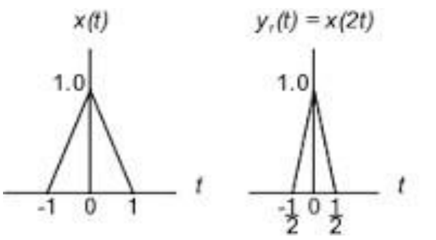
$y(t)=x(t^2)$, $y(t)=F[x(t)]=x(t^2)$

If the input is delayed by k units of time then the output is , $y(t,k)=F[x(t-k)]=x((t-k)^2)$

Output delayed by k units of time is, $y(t-k)=x(t^2-k)$, $y(t,k)\neq y(t-k)$

Therefore, the system is time –variant.

20. Sketch the following signal $y(t)=x(2t)$ (May2014)



21. StatetheDifferencebetweenCausalandnon-causalsystem(Nov2016)

Causal System: A system is said to be causal if the present output depends on present input and past input.

Non-Causal System: A system is said to be Non-causal if the present output depends on future input.

22. Check whether the following system is Time Invariant/ Time variant and also causal/ non-causal: Y(t)=X(t/3). (Nov2017)

A system is said to be time invariant if its input-output characteristics do not change with time.

Let Y(t)=X(t/3); *F denotes some transformation (operation) on x(t)* ;x(t)-input, y(t)- output

Let $y(t,t_o)$denotetheoutputduetodelayedinputX(t/3-t_0) i.e, $y(t,t_0)=F[x(t-t_0)]$

let $y(t-t_0)$ be the output delayedbyt_0 if $y(t-t_0)=y(t,t_0)$ then the system is time invariant

23. Determineif thesignal X[n]=sin($\frac{6\pi n}{7}+1$)givenbelowisperiodic.Ifyes,givesits fundamental period. If not, state why it is aperiodic. (Nov2017)

For given problem $w=\frac{6\pi}{7}=2\pi f$

$f=\frac{3}{7}=\frac{k}{N}$, *periodic signal with fundamental period* $N=7$

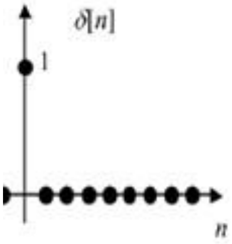
24. Define a Linear systems? (Apr2017)

A system is said to be linear, it should satisfy superposition principle i.e additivity and Homogeneity property.

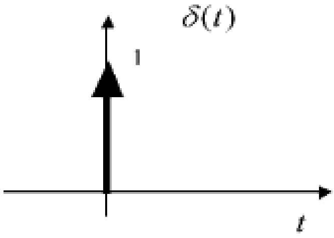
$$F(a_1x_1(t)+a_2x_2(t))=a_1y_1(t)+a_2y_2(t)$$

$x_1(t), x_2(t)$ *are input signals* $y_1(t), y_2(t)$ *are output signals*

25. Give the mathematical and graphical representation of a continuous time and discrete time unit impulse functions.(Nov2016)

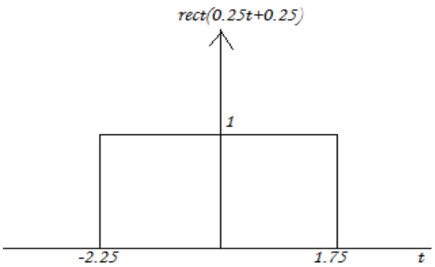


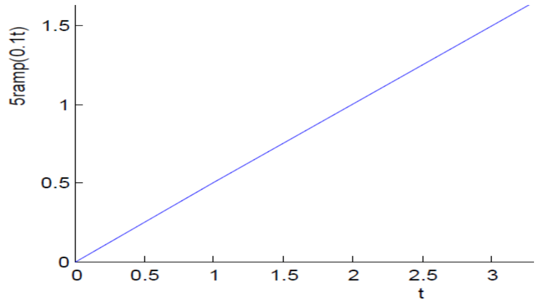
$$\delta(n) = \begin{cases} 1 & n = 0 \\ 0 & n \neq 0 \end{cases}$$



$$\delta(t) = \begin{cases} 1 & t = 0 \\ 0 & t \neq 0 \end{cases}$$

26. Sketch thefollowingsignals: $\mathrm{rect}\left(\frac{t+1}{4}\right)$; $5\mathrm{ramp}(0.1t)$ (May2016)





27. Fine the summationof $x(n) = \sum_{n=-\infty}^{+\infty} \delta(n-1)\sin 2n$ **(May2017)**

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

x(n) = Sin2=0.0348

28. Determine whether the given discrete time sequence is periodic or not. If the sequence is periodic, find the fundamental period. x(n)=cos(n/8)+cos(nπ/8) **.(Apr 2019)**

N1=2π/(1/8)=16π:N2=2π/(π/8)=16. Since N1 and N2 cannot be represented as ratio of integers the given signal isaperiodic.

29. Determine whetherthesignal $x(t) = \sin\sqrt{2}t$ is periodic or not.(Nov2019)

To find the fundamentalperiodT=2π/ω=2π/ $\sqrt{2}$=$\sqrt{2}$π

Since this cannot be expressed as ratio of integers. Therefore, the given signal is not periodic.

30. DetermineaveragepowerP$_\infty$forthesignalx(t)=2cos(t).(Nov2020)

The general form is Acos2πft.

2πft = t ; f=1/2π ; 1/T=1/2π; T=2π

Power:

$$P = \lim_{T\to\infty} \frac{1}{T}\int_0^T |x(t)|^2 dt$$

$$P = \lim_{T\to\infty} \frac{1}{2\pi}\int_0^{2\pi} |2cost|^2 dt$$

$$P = \lim_{T\to\infty} \frac{1}{2\pi}\int_0^{2\pi} 4cos^2t\ dt$$

$$P = \lim_{T\to\infty} \frac{2}{\pi}\int_0^{2\pi} cos^2t\ dt$$

$$P = \lim_{T\to\infty} \frac{2}{\pi}\int_0^{2\pi} \left(\frac{1 + cos2t}{2}\right) dt$$

$$P = \lim_{T\to\infty} \frac{1}{\pi}\int_0^{2\pi} (1 + cos2t)\, dt$$

$$P = \lim_{T\to\infty} \frac{1}{\pi}\left\{\int_0^{2\pi} tdt + \int_0^{2\pi} cos2tdt\right\}$$

$$P = \lim_{T\to\infty} \frac{1}{\pi} |t|_0^{2\pi}$$

In the above equation cosine waves are integrated over full cycles. Therefore the integration will be zero.

$$P = \lim_{T\to\infty} \frac{1}{\pi}(2\pi)$$

P=2W

31. Express discrete time unit impulse signal in terms of discrete time unit step signal and express discrete time unit step signal in terms of discrete time unit impulse signal. (Nov2020)

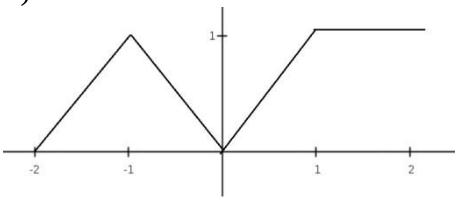
$\delta[n]=u[n]-u[n-1]$

$$u[n] = \sum_{k=0}^{\infty} \delta[n-k]$$

PART B(C204.1)

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

ii)Determine and sketch the odd and even part of the following signal



iii)Acontinuoussystemisgivenby$y(t) = \int_{-\infty}^{2t} x(t)dt$isLinear/Timeinvariant/static/causal. **(May 2018)**

2.(i)Acontinuoussystemisgivenby$y(t) = \begin{cases} 0 & \text{for } x \geq 0 \\ x(t) + x(t-2) & \text{for } x(t) < 0 \end{cases}$checkwhether the system is Linear/Timeinvariant/static/causal.

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

(iii)Find whether the signal is periodic or not.

$x(t) = e^{j(2\pi/3)^n} + e^{j\left(\frac{3\pi}{4}\right)n}$ **(May2018)**

3.i) Define an energy and power signal

ii)Determine whether the following signals are energy or power and calculate their energy or power.**(May 2013)**

(i) $x(n)=\left[\frac{1}{2}\right]^n u(n)$ (ii) $x(t) = rect\left[\frac{t}{T_o}\right]$ (iii)$x(t) = \cos^2(\Omega_0 t)$

4. Determine whether the discretetime system y(n)=x(n)cos(ωn) is(i)memoryless **(ii)** Stable (iii) causal(iv) linear (v)time invariant.**(Dec2013)**

5.i)Determinewhetherthesignalx(t)=sin20πt+sin5πtisperiodicandifitisperiodicfindthe fundamental period**(Dec2013)**

ii) Discuss various forms of real &complex exponential signals with graphical representations**(Dec2013)**

iii) Statetheprecedenceruleforcombinedtimescalingandtimeshiftingoperation.

6. Checkwhetherthesystemislinear,causal,timeinvariantandorstable**(Apr/Dec2019)**

i)y(n)= nx(n) ii) y(n)=x(n)-x(n-1) iii) $y(t)= \frac{d}{dt}x(t)$

7. (i) Given $x(t) = \frac{1}{6}(t+2) \quad -2 \le t \le 4 \; otherwise \; 0$ Sketch (1)x(t) (2) x(t+1) (3) x(2t) (4)x(t/2).

(ii) Determine whether the discrete time sequence

$x[n] = \sin\left(\frac{3\pi}{7}n + \frac{\pi}{4}\right) + \cos\left(\frac{\pi}{3}\right)$ is periodic ornot. **(May2014)**

8. Check the following systems are linear, stable

(i) $y(t) = e^{x(t)}$ (ii) y(n)=x(n-1). **(May2014)**

11. Given x(n)=[1,4,3,-1,2]. Plot the following signals **(Dec2015)**

$i)\, x(n-1) \quad ii)\, x\left(\frac{-n}{2}\right) \quad iii)\, x(-2n+1) \quad iv)\, x\left(\frac{-n}{2}+2\right)$

9. Given the input-output relationship of a continuous time system y(t)=tx(-t). Determine whether the systemis linear, causal ,time invariant and stable **(Dec2015)**

11. i)Draw the waveforms represented by the following step functions.

$f_1(t)=2u(t-1)$, $f_2(t)=-2u(t-2)$, $f(t)= f_1(t)+ f_2(t)$, $f(t)= f_1(t)- f_2(t)$.

ii)Determine the energy and power of the given signal x(t)=tu(t).

iii)Check whether the system is linear or not $y(t)=x^2(t)$. **(Apr 2019)**

10.i)Checkifx(t)=4cos(3πt+π/4)+2cos(4πt)isperiodic. **(May2015)**

ii) For the system y(n) = log[x(n)], Check for linearity, causality, time invariance and stability.

11. (i) Find whether the following signals are periodic or aperiodic. If periodic find the fundamentalperiodandfundamentalfrequency

$$x_1(t) = \sin 2\pi t + \cos \pi t \quad , x_2(n) = \sin\left(\frac{n\pi}{3}\right)\cos\left(\frac{n\pi}{5}\right)$$ **(May2016)**

(ii) Find whether the following signals are power or energy signals. Determine power and energy of the signals.

$x(t) = 5\cos\left(17\pi t + \frac{\pi}{4}\right) + 2\sin\left(19\pi t + \frac{\pi}{3}\right) \quad , x(n) = (0.5)^n\, u(n)$ **(May 2016)**

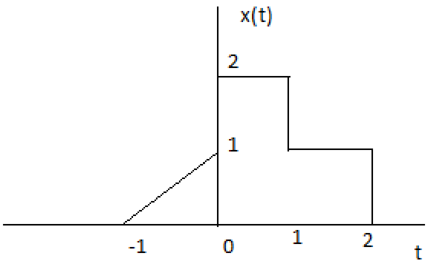
12. Find whether the following systems are time invariant, linear, stable, Memoryless and causal y(t)=t x(t-1). **(Dec2018)**

13. Determinewhetherthesystemislinear,TimeInvariant,Causalandmemoryless

$y(t) = \frac{1}{2}\int_{-\infty}^{t} x(z)\,dz$ **(Dec2016)**

14.A discrete time signal is given as x[n]={1,2,1,2,1,2,1}Plot the following signals i)x[n -1] ii)x[n/2] iii)x[n/2-1] iv)x[-n/2-1] v)x[2n] **(Dec 2018/2019)**

15.i) A continuous time signal x(t) is shown in figure below, sketch and label each of the following signals. x(t-2),x(2t+3) and x(-t+1)



ii) Determine the energy and power of the given signal x[n]=cos(πn/4) **(Apr 2019)**

16. (i)Findoutwhetherthefollowingsignalsareperiodicornot.Ifperiodic,findtheperiod Determinewhether

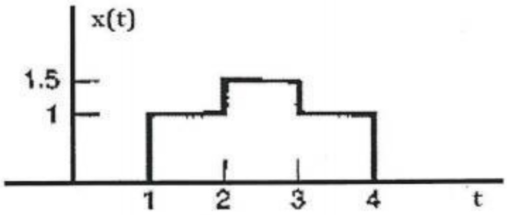
$x(t) = 2\cos(10t+1) - 1\sin(4t-1)$, $x(n) = \cos(0.1\pi n)$ **(May 2017)**

(ii) Find out whether the following signals are energy or power signal or neither powernor energy. Determine power or energy as the case may be for the signal $x(t) = u(t) + 5u(t-1) - 2u(t-2)$

17. Determine whether the following given systems are Linear, Causal, Time invariant and dynamic **(May2017)**

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

(ii) $y_1(n) = x(n^2) + x(n)$
(iii) $y_2(n) = log_{10} x(n)$
18. i)Considerthesystemdescribedbytheinputoutputrelation,y(t)=[cos(3t)]x(t).Here x(t)standsforinputandy(t)foroutput.Statewithjustificationwhetherthesystemislinear and/or timeinvariant.
ii) Consider the system described by the input output relation, y(t) = [cos (3t)]x(t). Here x(t) standsforinputandy(t)foroutput.Statewithjustificationwhetherthesystemislinearand/or timeinvariant.
iii) State whether the LTI system described by impulse response h[n]= $(1/4)^n$u[-n] is causal and stable with justification.**(Nov2020)**
19. i)Forthesignalx(t)showninFigure,sketch
$x\left(2-\frac{t}{2}\right)$
ii) Sketchtheevenandoddpartofthesignalx(t)showninFigure.



iii) Let x[n]=u[n+4];h[n]=δ[n]-δ[n-2]. Sketch the convolution of x[n] and h[n]. **(Nov 2020)**

UNIT II-ANALYSIS OF CONTINUOUSTIME SIGNALS (C204.2)
PART-A

1. State the conditions for convergence of Fourier series.(May2017)
The Fourier Series exists only when the function x(t) satisfies the following three conditions:
a) Thefunctionx(t)haveonlyafinitenumberof maximaandminima.
b) Thefunctionx(t)haveafinitenumberofdiscontinuities.
c) $x(t)$ is absolutelyintegrable.

i.e, $\int_0^T |x(t)|\, dt < \infty$

2. State Dirichlet's conditions for Fourier Transform.(May 2018/Dec2018)
The Fourier transform does not exist for all aperiodic functions. The conditions for x(t) to have Fourier transform are:
a) x(t)isabsolutelyintegrableover(−∞,∞)

ie., $\int_{-\infty}^{\infty} |x(t)|\, dt < \infty$

b) x(t)hasfinitenumberofdiscontinuitiesandafinitenumberofmaximaandminimain every finite timeinterval.

3. GivetheFouriertransformandInverseFouriertransformpairequation.
$X(j\Omega) = F[x(t)]$ and $x(t) = F^{-1}[X(j\Omega)]$

$$X(j\Omega) = \int_{-\infty}^{\infty} x(t) e^{-j\Omega t} dt \qquad \text{for all } \Omega$$

$$x(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} X(j\Omega) e^{j\Omega t} d\Omega \qquad \text{for all } t$$

4. If X(jΩ) is the Fourier transform of the signal x(t), what is the Fourier transformof the signal x(3t) in terms X(jΩ)? (Dec2018)
According to the property of Fourier of transform
$x(at) \xrightarrow{FT} \frac{1}{|a|} X\left(\frac{j\Omega}{a}\right)$ Therefore $x(3t) \xrightarrow{FT} \frac{1}{3} X\left(\frac{j\Omega}{3}\right)$

5. State convolution (time) property of Fouriertransform.

$F[x(t)]=X(j\Omega)$; $F[h(t)]=H(j\Omega)$

$F[x(t) * h(t)]=X(j\Omega)H(j\Omega)$

6. What is the Fourier transform of $x(t)=e^{-at}u(t)$?(Dec2017)

$$X(j\Omega)=\int_{-\infty}^{\infty}x(t)e^{-j\Omega t}dt=\int_{0}^{\infty}e^{-at}e^{-j\Omega t}dt=\left[-\frac{e^{-(a+j\Omega)t}}{(a+j\Omega)}\right]_0^{\infty}=\frac{1}{(j\Omega+a)}$$

7. What is the Inverse Fourier transformof $X(j\Omega)=\frac{1}{(a+j\Omega)^2}$?

$x(t)=t\,e^{-at}\,u(t)$

8. Find the Fourier transform of the impulsesignal.

$x(t)=\delta(t)$; $X(j\Omega)=\int_{-\infty}^{\infty}\delta(t)\,e^{-j\Omega t}\,dt=1$

9. Determine Laplace transformofx(t)=e^{-at}sin(Ωt)u(t).

$$L[\sin(\Omega t)u(t)]=\frac{\Omega}{s^2+\Omega^2}$$

$$X(S)=L[e^{-at}\sin(\Omega t)u(t)]=\frac{\Omega}{(s+a)^2+\Omega^2}$$

10. Find the ROC of the Laplace transform ofx(t)=u(t).(Nov2014)

$X(s)=\frac{1}{(s+1)}$; $\text{Re}\{s\}>-1$

The ROC of u(t) isRe{s}>-1.

11. What is the inverse Laplace transformof $\frac{1}{(s+2)}$; $\text{Re}\{s\}<-2$

Inverse Laplace transform of $\frac{1}{(s+2)}$; $\text{Re}\{s\}<-2$ is, $-e^{-2t}u(-t)$

12. What is the inverse Laplace transformof $\frac{1}{(s+1)}$; $\text{Re}\{s\}>-1$

Inverse Laplace transform of $\frac{1}{(s+1)}$; $\text{Re}\{s\}>-1$ is, $e^{-t}u(t)$

13. Define ROC of Laplace transform.(Dec2012)

Laplace transform of x(t) is given by the following formula

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

The range of values of 's' for which the integral in the equation converges is referred to as the region of convergence(ROC).

14. What is the Laplace transform of (i) u(t) (ii) t u(t) ? Also specify theROC.

(i) Laplacetransformofu(t)=$\int_{0}^{\infty}e^{-st}dt=\left[-\frac{e^{-st}}{s}\right]_0^{\infty}=\frac{1}{s}$ ROC: $\text{Re}\{s\}>0$

(ii) Laplace transform of tu(t) $= \int_0^\infty t e^{-st} dt = \left[-\frac{te^{-st}}{s} - \frac{e^{-st}}{s^2} \right]_0^\infty$

$= \frac{1}{s^2}$ $\quad ROC: \ \mathrm{Re}\{s\} > 0$

15. Determine the Laplace transform and ROC for the signal $y(t) = -e^{at}u(-t)$ **.**

$$Y(s) = \int_{-\infty}^{\infty} -e^{-at} u(-t)\, e^{-st}\, dt = -\int_{-\infty}^{0} e^{-(s-a)t} dt = \frac{1}{(s-a)} \qquad ROC: \ \mathrm{Re}\{s\} < a$$

16. Determine the Laplace transform and ROC of x(t)=u(t-5).(May2012)

$x(t) \xleftrightarrow{LT} X(s) \quad ; x(t-a) \xleftrightarrow{LT} e^{-as} X(s)$

Laplace Transform of $u(t-5) = e^{-5s} L[u(t)] = e^{-5s} \times \frac{1}{s}$

$L[u(t-5)] = \frac{e^{-5s}}{s} \qquad ROC: \ \mathrm{Re}\{s\} > 0$

17. What is the unilateral Laplace transform of $\frac{d}{dt}x(t)$ **?**

$\frac{dx(t)}{dt} \xleftrightarrow{unilateral\ LT} sX(s) - x(0^-)$

18. State the convolution (in time) property of Laplace transform.

$x(t) \xleftrightarrow{LT} X(s); h(t) \xleftrightarrow{LT} H(s)$

$x(t) * h(t) \xleftrightarrow{LT} X(s)H(s)$

19. State the time scaling property of Laplace transform.(May2013)

$x(t) \xleftrightarrow{LT} X(s) \qquad ROC: R$

$x(at) \xleftrightarrow{LT} \frac{1}{|a|} X\left(\frac{s}{a}\right) \qquad ROC: \frac{R}{|a|}$

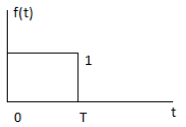
20. State initial value theorem and final value theorem of Laplace transform.

$L[x(t)] = X(s)$

Initial Value theorem: $\lim_{t \to 0} x(t) = \lim_{s \to \infty} sX(s)$

Final Value theorem: $\lim_{t \to \infty} x(t) = \lim_{s \to 0} sX(s)$

21. Find the Laplace transform of the following signal. (Apr2019)



$$X(s) = \int_{-\infty}^{\infty} x(t) e^{-st} dt = \int_0^T e^{-st} dt = \frac{1 - e^{-sT}}{s}$$

22. Give synthesis and analysis equations of CT Fourier transform.(Dec2012)

$X(j\Omega) = F[x(t)] \quad and \quad x(t) = F^{-1}[X(j\Omega)]$

$X(j\Omega) = \int_{-\infty}^{\infty} x(t)\, e^{-j\Omega t} dt$ for all $\Omega \rightarrow$ analysis equation

$x(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} X(j\Omega) e^{j\Omega t} d\Omega$ for all $t \rightarrow$ synthesis equation

23. Consider a periodic signal x(t) with fundamental frequency 2π and a_0=1,a_{-1}=1/4,a_2=a_{-2}=1/2,a_3,a_{-3}=1/3.Expressx(t)ingeneralFourierseriesformula.(May2018)

$$x(t) = \sum_{k=-\infty}^{\infty} a_k e^{jk\Omega_o t}$$

from the given problem $\Omega_o = 2\pi$

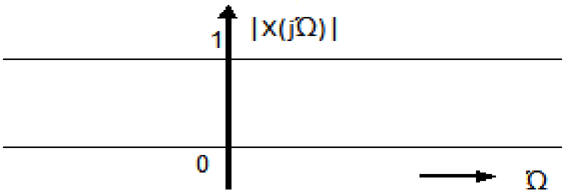
From the given equation, $x(t) = \frac{1}{3}e^{-j6\pi t} + \frac{1}{2}e^{-j4\pi t} + 1 + \frac{1}{2}e^{j4\pi t} + \frac{1}{3}e^{j6\pi t}$

24. WhatistheFouriertransformofaDCsignalofamplitude1?(May2013)

$x(t) = 1$

$$X(j\Omega) = \int_{-\infty}^{\infty} 1.\, e^{-j\Omega t}\, dt = 1$$

$|X(j\Omega)| = 1$ *for all* Ω *angle*$(X(j\Omega)) = 0$ *for all* Ω



25. Give the Laplace Transform of $x(t) = 3e^{-2t}\, u(t) - 2e^{-t}\, u(t)$with ROC. (May 2016)

$$L(x(t)) = X(s) = \int_{-\infty}^{\infty} x(t)e^{-st}dt \quad , L(e^{-at}u(t)) = \frac{1}{S+a}$$

$$L(x(t)) = X(S) = \frac{3}{S+2} - \frac{2}{S+1} = \frac{S-1}{(S^2+2S+2)} \quad Re\{S\} > -1$$

26. What is the Laplace transform and Fourier Transform of δ(t) ? (Apr2015)

$$L(x(t)) = X(S) = \int_{-\infty}^{\infty} \delta(t)e^{-St}dt = 1$$

$$F(x(t)) = X(j\Omega) = \int_{-\infty}^{\infty} x(t)e^{-j\Omega t}dt = 1$$

27. State Gibb's Phenonmenon.(Nov2019)

The Gibbs phenomenon is an overshoot (or "ringing") of Fourier series and other Eigenfunction series occurring at simple discontinuities. Gibbs phenomenon occurs due to the non- uniform convergence of the Fourier series at a discontinuity. Thus, the frequency response so obtained contains ripples in the frequency domain.

28. State any two properties of ROC of Laplace transform X(S) of a signal x(t).(May2014)

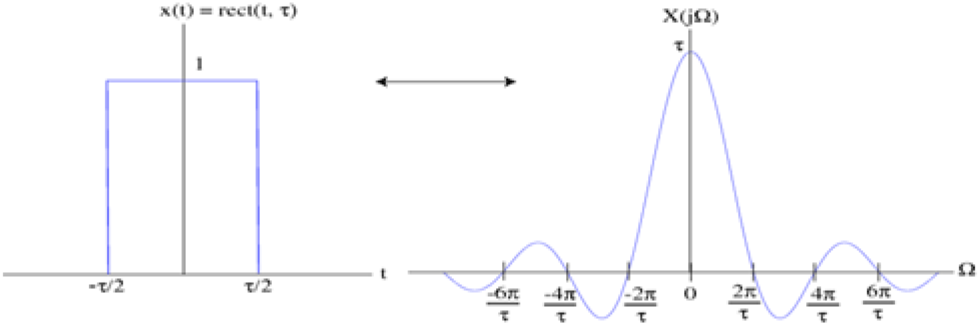
i) Ifx(t)isabsolutelyintegrableandoffiniteduration,thentheROCistheentires-plane (the Laplacetransformintegralisfinite,i.e.,X(S)exists,forany s.

ii) TheROCofX(S)consistsofstripsparalleltothejω-axisinthes-plane.

iii) Ifx(t)is right sided andRe(s)=σis in the ROC, then any s to the right of σ (i.e., Re(s)>σ) is also in the ROC, i.e., ROC is a right sided halfplane.

iv) If x(t) is left sided and Re(S)= σ is in the ROC, then any $s$to the left of σ (i.e., Re(S)<σ) is also in the ROC, i.e., ROC is a leftsided half plane.

29. Draw the Spectrum of CT Rectangular Pulse?(Apr2015)



30. What is the inverse Fourier transform of (i) $e^{-j2\pi f t_0}$ (ii) $\delta(f - f_o)$ (May 2016)

(i)$\delta(t - t_0)$ (ii)$\frac{1}{2\pi} e^{jf_0 t}$

31. Find the Fourier coefficients of the signal.(Apr/Dec2019)

$$x(t) = 1 + \sin\left(\frac{\pi}{2}\right)t$$

Linear combination of harmonically related complex exponential of the form

$$x(t) = \sum_{k=-\infty}^{\infty} a_k e^{jk\Omega_0 t}$$

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

On comparing the above equations $a_0=1, a_1=1/2j, a_{-1}=-1/2j$

32. Find the Laplace transform of $x(t) = e^{-at}\, u(t$(Dec2016)

$$L(x(t)) = X(S) = \int_{-\infty}^{\infty} x(t) e^{-St} dt\,,$$

$$X(S) = \int_0^{\infty} e^{-at} e^{-st} dt = \int_0^{\infty} e^{-(S+a)t} dt = \left[\frac{e^{-(S+a)t}}{-(S+a)}\right]_0^{\infty} = \left[\frac{e^{-\infty}}{-(S+a)} + \frac{1}{S+a}\right]$$

$$= \frac{1}{S+a} \quad Re\{s\} > -a$$

33. Find the Laplace transform of following impulse response h(t),h(t)= te^{-t} u(t). (Dec2017)

$$L(h(t)) = H(S) = \int_{-\infty}^{\infty} h(t) e^{-St} dt$$

The Laplace transform of the given signal is $H(s)=1/(s+1)^2$

34. StateParseval'stheoremforcontinuoustimeaperiodicsignal(Dec2020)

$$\int_{-\infty}^{\infty} |x(t)|^2 dt = \frac{1}{2\pi} \int_{-\infty}^{\infty} |X(j\Omega)|^2 d\Omega$$

35. DetermineFouriertransformforunitstepsignal.(Nov2020)

sgn(t)=2u(t)-1

$$u(t) = \frac{1}{2}\{1 + sgn(t)\}$$

Taking Fourier transform on both sides,

$$FT\{u(t)\} = \frac{1}{2}\{FT\{1\} + FT\{sgn(t)\}\}$$

$$FT\{u(t)\} = \frac{1}{2}\left[2\pi\delta(\omega) + \frac{2}{j\omega}\right]$$

$$FT\{u(t)\} = \left[\pi\delta(\omega) + \frac{1}{j\omega}\right]$$

36. DeterminetheLaplacetransformforthesignalx(t)=e^{-4t}u(t)(Nov2020)

$$L(x(t)) = X(S) = \int_{-\infty}^{\infty} x(t)e^{-St}dt\ ,$$

$$X(S) = \int_0^{\infty} e^{-4t}e^{-st}\, dt = \int_0^{\infty} e^{-t(s+4)}dt = \frac{e^{-t(s+4)}}{-(s+4)}$$

$$= \frac{1}{S+4}$$

ROC:Re{s}>-4

PART B (C204.2)

1. i) Find the Fourier transform of thesignal $x(t) = \begin{cases} 1, & |t| < T_1 \\ 0. & |t| > T_1 \end{cases}$

ii) Find the Laplace transform of the signal x(t)=e^{-2}tu(t)+e^{-t}cos(3t)u(t)**(May 2018)**

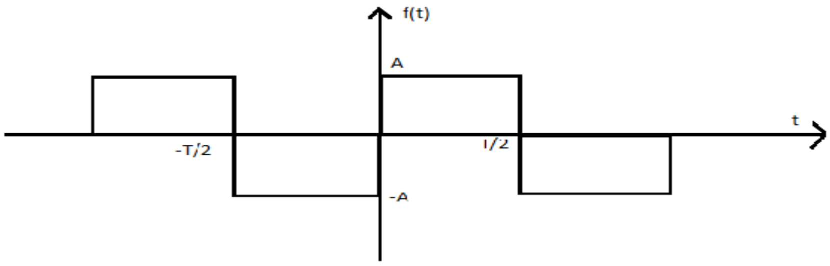
2. i)Using the properties of Fourier transform find X(jω) and sketch itsmagnitudespectrum $x(t) = e^{-a|t|}u(t): a > 0$, δ(t-5) **(Dec 2018/Apr2019)**

3. Find the inverse Laplace transform of $X(s) = \frac{3s^2+8s+6}{(s+2)(s^2+2s+1)}$**(May2018)**

4. i)DeterminetheFouriertransformrepresentationofthehalfwaverectifieroutput.

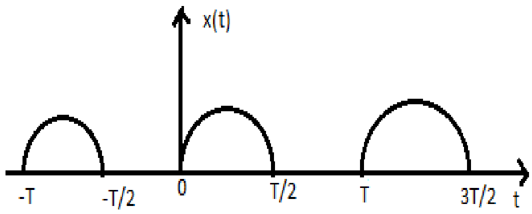
ii) Write the properties of ROC of Laplace transform. **(May 2013)**

5. i)FindtheexponentialFourierseriesof thewaveform.**(Dec2013)**



6. i)Find the Laplace transform ofthesignal $x(t) = e^{-a|t|}$ and it ROC and also indicatewhether the Fourier transform exists.**(Dec2020)**

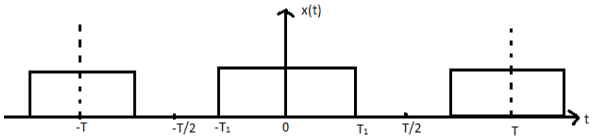
7. Find the Fourier series coefficients of thesignal shown below.**(May 2014)**



8. Find the inverse Laplace transform of $X(S) = \frac{1}{(S+3)(S+5)}$for the ROC's(i)-5<Re{s}<3

(ii) Re{s}>3

9. FindtheFourierseriescoefficientsofthefollowingsignal.**(Nov2020)**



10. Find thespectrumof $x(t) = e^{-2|t|}$.Plotthespectrumofthesignal.**(Dec2014)**

11. State and prove any four properties of Fourier Transform**(Dec2015)**

12. FindtheLaplacetransformanditsassociatedROCforthesignal $x(t) = te^{-2|t|}$**(Dec2015)**

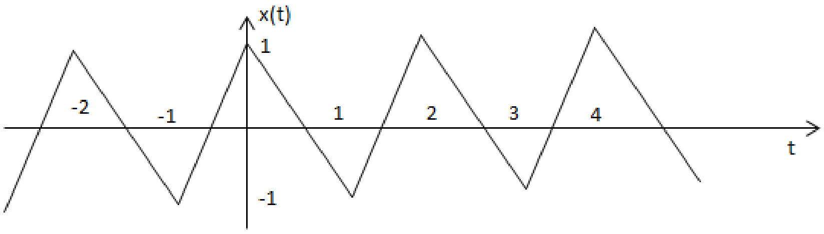
13. i)DeterminetheFourierseriesexpansionforaperiodicrampsignalwithunitamplitudeand a period T(10)

ii) Find the Fourier transform of $x(t) = te^{-at}u(t)$**(May2015)**

14. i) If $x(t) \leftrightarrow X(j\Omega)$, then using time shifting property show that $x(t+T) + x(t-T) \leftrightarrow 2cos\Omega T\ X(j\Omega)$

ii) Find the inverse Laplace transform of $X(S) = \dfrac{8S+10}{(S+1)(S+2)^3}$ **(May 2015)**

15. ObtaintheFourierseriescoefficients&plotthespectrumforgivenwaveform**(May2016)**



16. (i)Frombasicformula,determinetheFouriertransformofthegiven signals.Obtain magnitudeandphasespectraofthegivensignals.**(May2016)**

a) $x(t) = te^{-at}\ u(t)\quad a > 0$

b) $x(t) = e^{-a|t|}\quad a > 0$

(ii) State and prove Rayleigh's Energy theorem. **(May 2016)**

17. Find theFouriertransformofthe Signal$x(t) = cos\ \Omega_o t\ u(t)$**(Dec2016)**

18. Stateandprovethemultiplication&convolutionpropertyofFourierTransform.**(Dec2016)**

19. SpecifyallpossibleROC'sforthefunctionX(s)givenbelow.Andalsofindx(t)ineachcase **(Nov 2019)**

$$X(s) = \frac{4s}{(s+2)(s+4)}$$

20. 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. **(Dec 2017/Dec2019)**

ii) Obtain the inverse Laplace transform of the function.

$$x(S)=\frac{1}{s^2+3s+2}$$, ROC: -2<Re{s}<-1. **(Dec 2017)**

21. Obtain the trigonometric Fourier co-efficient and write the quadrature form of full wave rectified sine wave. **(May 2017/Apr2019)**

22. DeterminetheinverseLaplacetransformofthefollowing**(May2017)**

$$X(s)= \frac{1-2s^2-14s}{s(s+3)(s+4)}$$

$$X(s)= \frac{2s^2+10s+7}{(s+1)(s^2+3s+2)}$$

23. i)ConsidertheperiodicsignalDerivetheexpression fortheFourierseriescoefficient$a_m$of the complex exponential$e^{jm\omega_0 t}$.

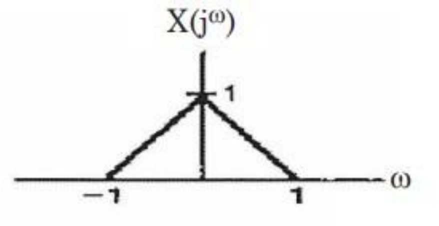
$$x(t) = \sum_{k=-\infty}^{\infty} a_k e^{jk\omega_0 t}$$

ii) Let

$$x(t) = \delta(t) - \frac{2}{3}e^{-2t}u(t) + \frac{1}{3}e^{-4t}u(t)$$

Determine Laplace transform for the signal x(t). Plot pole zero and mark region of convergence **(Nov 2020)**

24. Consider a signal x(t) with X(jω) shown in Figure Let p(t) = sin(t).sin(2t). Determine the Fouriertransformforthesignaly(t)generatedbytheproductofx(t)andp(t)givenbyy(t)= x(t).p(t).SketchthespectrumY(jω)**(PartC-Nov2020)**



25. Given x[n] has Fourier transform $X(e^{j\omega n})$ Express Fourier transform for the following signals**(Part C- Nov2020)**

i) $x_1[n]=x[2-n]+x[-2-n]$

ii)) $x_2[n]=(n-1)^2x[n]$

UNIT III-LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS (C204.3)

PARTA

1. What is the overall impulse response h(t), when two systems with impulse responses $h_1(t) = e^{-2t}u(t)$ and $h_2(t)=\delta(t-1)$ are in series? (Dec2018)

Over all impulse response h(t) of two LTI systems with impulse responses $h_1(t)$ and $h_2(t)$ connected in cascade(series) is the convolution of the individual impulse responses.

Overall impulse response is $h(t) = h_1(t) * h_2(t)$

Given $h(t)= e^{-2t}u(t)*\delta(t-1)$

According to the property ofDiracdelta $x(t)*\delta(t-t_0)=x(t-t_0)$

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

2. What is the overall impulse response h(t) when two systems with impulse responses $h_1(t)$ and $h_2(t)$ are in parallel? (Nov2019)

Overall impulse response h(t) = sum of the individual impulse responses.

$h(t) = h_1(t) + h_2(t)$

3. Whatarethedrawbacksofrepresentingasystemusingitstransferfunction?

(a) Thetransferfunctiondescribesonlythezerostateresponseofasystem.

(b) It describes only the relationship between the input and output of a system, but doesnot provideanyinformationregardingtheinternalstateofasystem.

(c) It is limited to single input and single outputsystems.

(d) It is applicable only for LTIsystems.

4. Checkwhethergivensystemiscausalandstable.$h(t)=e^{-4t}u(t+10)$.(Apr2019)

If the system is absolutely summable then the system isstable.

$$h(t) = \int_{-10}^{\infty} e^{-4t}\, dt = \frac{e^{40}}{4} = \text{Summable}$$

Sincetheh(t)isnotequalto0fort<0thesystemisnoncausal.

5. If the system $H(s) = 4 - \frac{3}{s+2}$ $Re(s) > -2$, find the impulse response h(t).(Dec2018)

$h(t)=4\delta(t)-3e^{-2t}u(t)$

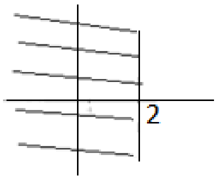
6. Determine the frequency response of the systemhaving impulse response $h(t) = \delta(t) - 2e^{-2t}u(t)$ **.**

Frequency response = Fourier transform of impulse response.

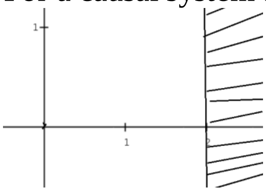
$$F\left[h(t)\right] = H(j\Omega) = 1 - \frac{2}{(j\Omega + 2)} = \frac{j\Omega}{(j\Omega + 2)}$$

7. The pole and zero of a function is given by Poles (-3+4j),(2+j),(2-j),(-3-4j) zeros(-5+2j),(-5-2j),(-2),(+3)PlottheROCwhenthesystemiscausalandstable.(May2018)

A stable system must include jω axis in its ROC



For a causal system the function should be right hand sided

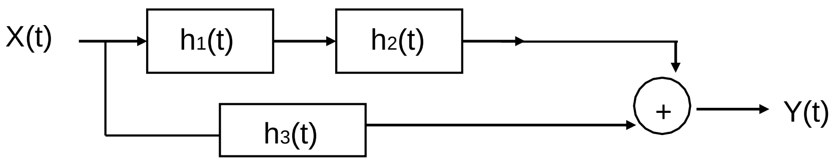


8. The impulse response h(n) is given below. Check the system is stable / causal h(n)=(1/3)^{n}u(n)(May2018)

This system is absolutely summable. Therefore the system is stable.

Since the h(n)=0 for n<0 the system is causal

9. Find the overall impulse response h(t) of the systemshown.



Overallimpulseresponse $= h(t) = \left[h_1(t) * h_2(t)\right] + h_3(t)$

10. What is the overall impulse response h(t) when two systems with impulseresponses h$_1$(t)= $\delta(t)$ **and h$_2$(t)** $= e^{-t}u(t)$ **are in series?**

Over all impulse response h(t) of two LTI systems with impulse responses h $_1$(t) and h$_2$(t) connected in cascade(series) is the convolution of the individual impulse responses.

Overall impulseresponseis $h(t) = h_1(t) * h_2(t)$

in 's'domain $H(s) = H_1(s)H_2(s)$

$$H_1(s) = L\left[\delta(t)\right] = 1 \quad \& H_2(s) = \frac{1}{(s+1)} : \ H(s) = 1 \times \frac{1}{(s+1)} = \frac{1}{(s+1)} : h(t) = L^{-1}\left[H(s)\right] = e^{-t}u(t)$$

11. Check the stability of the CT system whose impulse response is $h(t) = e^{-3t}u(t)$**.**

$$h(t) = e^{-3t}u(t); H(s) = L\left[h(t)\right] = \frac{1}{(s+3)} = \textit{transfer function}$$

Pole is at s= - 3 which is on the left half of S-plane. Therefore the system is stable.

12. Compare the hardware requirements of Direct form I and Direct form II realization.

Direct form II structures require lesser number of integrators.

13. Define the convolution integral.(May2017)

$y(t)=h(\tau)*x(\tau); y(t)= \int_{-\infty}^{\infty} h(\tau)\, x(t-\tau)\, d\tau$; *where*, $h(t)$ =*impulse response*, $x(t)$ =*input*

14. What is the condition for a LTI system tobe stable?(May2013)

The poles of the LTI system should be on the left half of S-plane.

15. What are the three elementary operations in block diagram representation of CT system.(Dec2013)

(i) Summing, (ii) Scalar multiplication,(iii)Integration.

16. Check whether the systemis stable $H(S) = \frac{1}{S-2}$ **transfer function(Dec2013)**

Pole is at s= 2 which is on the right half of S-plane. Therefore the system is unstable.

17. State the necessary and sufficient condition for an LTI continuous time system tobe causal. (May2014)

An LTI continuous time system is causal if and only if its impulse response is zero for negative values of t.

18. Find the differential equation relating the input and output of a CT system represented by(May2014).

$$H(j\Omega) = \frac{Y(j\Omega)}{X(j\Omega)} = \frac{4}{(j\Omega)^2 + 8j\Omega + 4}$$

On cross multiplying, By taking inverse Fourier transform corresponding differential equation $\frac{d^2y(t)}{dt^2} + 8\frac{dy(t)}{dt} + 4y(t) = 4.x(t)$

19. The input output relationship is given by the following equation system. Find H(s) for the following system. (Nov2019)

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

Take Laplace transform on both sides,

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

$H(s)=Y(s)/X(s)=s/(s^2+s+2)$

20.Find y(n)=x(n-1)*δ(n+2).(Dec2014)

From $x(n)*\delta(n-n_0)=x(n_0)$

y(n)=x(n-1+2)=x(n+1)

21. Given the differential equation representation ofa system $\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} - 3y(t) = 2.x(t)$ **Find the frequency response H(jΩ) (Dec2015).**

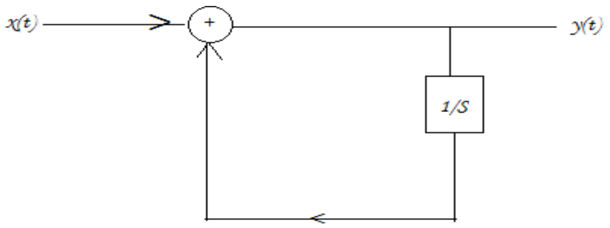
$$H(j\Omega) = \frac{Y(j\Omega)}{X(j\Omega)} = \frac{2}{((j\Omega)^2 + 2j\Omega - 3)}$$

22. Find whether the following system whose impulse response is given is causaland stable $h(t) = e^{-2t}u(t-1)$**. (May 2016)**

$$H(S) = \int_{1}^{\infty} e^{-2t}e^{-St}dt = \left(\frac{e^{-t(S+2)}}{-(S+2)}\right)_1^{\infty} = \frac{e^{-(S+2)}}{(S+2)} \quad Re\{S\} > -2$$

The given system is causal and stable because poles are located in the left half of S plane i.e poles are having negative real parts.
For causal system ROC is right half of right most pole for stability ROC must includes the jΩ axis.

23. Realizetheblockdiagramrepresentingthesystem$H(S)=\frac{S}{S+1}$.(May2016)



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24. Convolve the signals $u(t-1)$ and $\delta(t-1)$(Dec2016)
The convolution of a signal with shifted impulse simply shifts the signal.
$u(t-1)*\delta(t-1)=u(t-2)$
Proof: $L(x(t)*h(t))=X(S)H(S)=Y(S)$

$$L(u(t-1))=\frac{e^{-S}}{S}, L(\delta(t-1))=e^{-S}, i.e\ L(u(t-1)*\delta(t-1))=\frac{e^{-2S}}{S}, L^{-1}\left(\frac{e^{-2S}}{S}\right)=u(t-2)$$

25. Given $H(S)=\frac{S}{S^2+2S+1}$Find the differential equation of the system.(Dec2016)

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

By taking inverse Laplace transform the corresponding differential equation

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

26. will there be two different signals having same laplace transform? Give anexample. How do you differentiate these two signals? (Dec2017)
For example Laplace transform of given signals are same but ROC will differ

$$x(t)=-e^{-at}u(-t), X(s)=\frac{1}{s+a}\ \mathrm{Re}(s)<-a,\quad x(t)=e^{-at}u(t), X(s)=\frac{1}{s+a}\mathrm{Re}(s)>-a$$

27. consider an LTI system with transfer function H(s) is given byH(s)= $\frac{1}{(s+1)(s+3)}$

Re(s)>3; determine h(t). (Dec 2017)
By applying partial fraction,

$$\frac{1}{(s+1)(s+3)}=\frac{A}{s+1}+\frac{B}{s+3}=\frac{A(s+3)+B(s+1)}{(s+1)(s+3)}$$

.

$$1=A(s+3)+B(s+1),\quad s=-1 \text{ in the equation } A=\frac{1}{2}\ ,s=-3\ ;\ B=\frac{-1}{2}$$

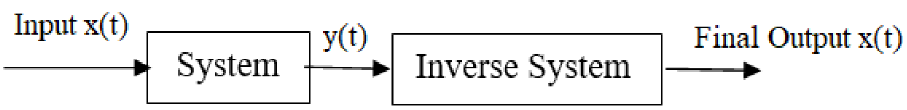
$$H(s)=\frac{\frac{1}{2}}{s+1}+\frac{\frac{-1}{2}}{s+3} \text{ by taking inverse laplace } L^{-1}(H(s))=h(t)=\frac{1}{2}(e^{-t}-e^{-3t})u(t)$$

28. Givenh(t),whatisthestepresponseofaCTLTIsystems(May2017)
Step response in terms of impulse response is nothing but integral of Impulse response with respect to time.

$y(t)=h(\tau)*x(\tau); y(t)= \int_{-\infty}^{\infty} h(\tau)x(t-\tau)d\tau; where, h(t)=impulse response,$ $x(t)=input=u(t)$

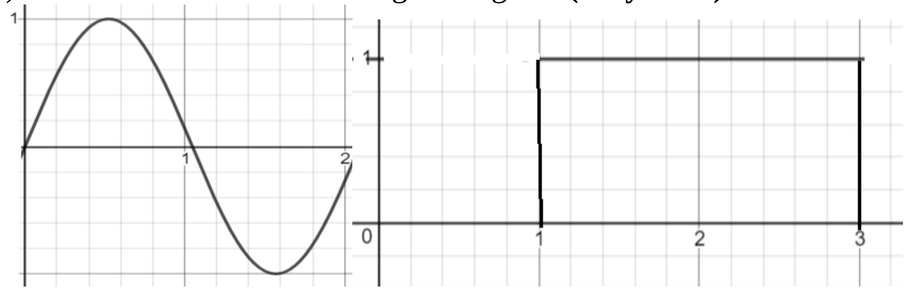
29. Define an invertible continuous time system. (Nov2020)

A system is said to be invertible if there is unique output for every unique input.



PART B (C204.3,C204.4)

1.i) Find the convolution for the given signals.**(May 2018)**



2. Findtheoutputy(t)ofthesystemH(s)=1/(s+2);Re{s}>-2fortheinputx(t)=e^{-3t}u(t) **(Dec 2018)**

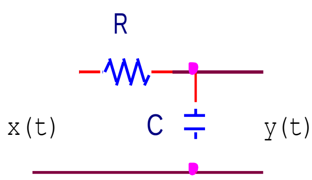
3. Determine the impulse response h(t) of the systemgiven by the differential equation **(May 2018)**

$$\frac{d^2y(t)}{dt^2}+5\frac{dy(t)}{dt}+4y(t)=\frac{dx(t)}{d(t)}$$

4. AcausalLTIsystemsatisfiesthelineardifferentialequation $\frac{d^2y(t)}{dt^2}+7\frac{dy(t)}{dt}+12y(t)=\frac{dx(t)}{dt}+2x(t)$Find the frequency response and output y(t) for the input x(t)=e^{-2t}u(t).**(Dec 2018)**

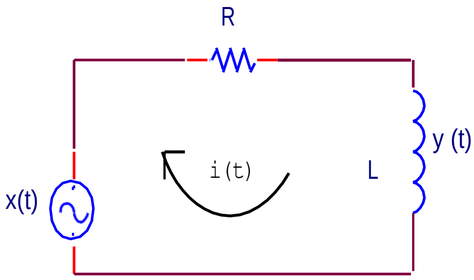
5. DeterminetheoutputresponseofRCLowpassnetworkshowninfigureduetoinput **(Dec2014)**

$x(t)=te^{-\frac{t}{RC}}$ by convolution.



6. Usingconvolutionintegral,determinetheresponseofaCTLTIsystemy(t)giveninput $x(t)=e^{-\alpha t}u(t)$andimpulseresponse h(t)= $e^{-\beta t}$ u(t),|α|<1,|β|<1.**(May2014)**

7. Findthefrequencyresponseofthesystemshownbelow:**(May2014)**



8. Convolve the following signals: x(t) = e^{-2t}u(t-2) , h(t) = e^{-3t}u(t)**(Dec2015)**

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

i) Find the impulse responseh(t)

ii) Findtheresponsey(t)of thissystemifx(t)=u(t) **(Dec2015)**

10. i. Solve the differential equation (D^2+ 3D+2)y(t) = Dx(t) using the input x(t) = 10 e^{-3t} and with initial condition y(0^+) =2 and y·(0^+)=3 **(May2015)**

ii). Draw the block diagram representation for H(s) = (4s+28) / (s^2+6s +5)

11. i)ForaLTIsystemwithH(s)=(s+5)/(s^2+4s+3)findthedifferentialequation.Findthe systemoutputy(t)totheoutputx(t)=e^{-2t}u(t)

ii) Using graphical method convolve x(t) = x(t) = e^{-2t}u(t) with h(t) =u(t+2) **(May 2015)**

12.(i)Usinggraphicalconvolution,Findtheresponseofthesystemwhoseimpulseresponse is $h(t) = e^{-2t}u(t) for\ an\ input\ x(t) = \begin{cases} A, & for\ \ 0 \le t \le 2 \\ 0, & otherwise \end{cases}$ **(May2016)**

(ii) Realize the followingin Direct Form –II

$\frac{d^3y(t)}{dt^3} + 4\frac{d^2y(t)}{dt^2} + 7\frac{dy(t)}{dt} + 8y(t) = 5\frac{d^2x(t)}{dt^2} + 4\frac{dx(t)}{dt} + 7x(t)$**(May2016)**

13. (i) An LTI system is defined by differentialequation $\frac{d^2y(t)}{dt^2} - 4\frac{dy(t)}{dt} + 5y(t) = 5x(t)$ Findtheresponseofthesystemy(t)foraninput$x(t) = u(t)$,iftheinitialconditionsare $y(0) = 1; \frac{dy(t)}{dt}\Big|_{t=0} = 2$**(May2016)**

(ii) Determine Frequency response and impulse response for the system described by the followingdifferenceequation.$\frac{dy(t)}{dt} + 3y(t) = x(t)$**(May2016)**

14. Convolve the following signals $x(t) = e^{-3t}u(t) \quad and\ h(t) = u(t+3)$.**(Dec2016)**

15. A system is described by the differential equation $\frac{d^2}{dt^2}y(t) + 6\frac{d}{dt}y(t) + 8y(t) = \frac{d}{dt}x(t) + x(t)$. Find the transfer function and the output signal $y(t) for\ x(t) = \delta(t)$.**(Dec2016)**

16. Convolvethefollowingsignalsx(t)=u(t)andh(t)=u(t)-u(t-2).**(Nov2019)**

17. FindtheconditionforwhichFouriertransformexistsforx(t).FindtheLaplacetransform of x(t) andits ROC. $x(t) = e^{-at}u(-t)$.**(Dec 2017)**

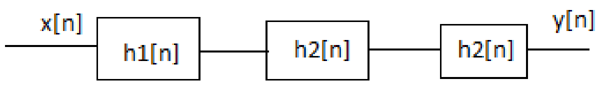
18. UsingLaplacetransformdeterminetheresponsefthesystemdescribedbytheequation $\frac{d^2}{dt^2}y(t) + 5\frac{d}{dt}y(t) + 4y(t) = \frac{d}{dt}x(t)$ withinitialcondition $y(0) = 0; \frac{dy(t)}{dt}\Big|_{t=0} = 1$ forthe input $x(t) = e^{-2t}u(t)$**(May2017)**

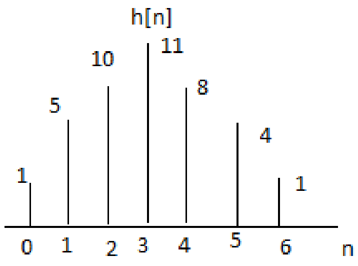
19. A causal LTI system having frequency responseis $H(j\Omega) = \frac{1}{j\Omega+3}$ producing an output $y(t) = e^{-3t}u(t) - e^{-4t}u(t)$ for a particular input x(t).Determine x(t). **(May 2017)**

20. Realize the given systems inparallelform **(May2017)**

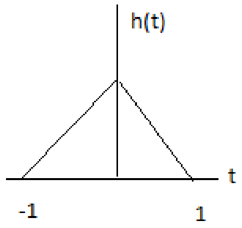
$$H(s) = \frac{s(s+2)}{(s^3+8s^2+19s+12)}$$

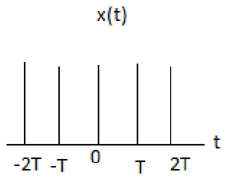
21. i) Consider the cascade interconnection of three signal stage causal LTI system with impulse response h1[n],h2[n],h3[n] shown below. The impulse response h2[n]=u[n]-u[n-2].The overall response h[n] is also given below.Find the impulse response h1[n] and the response y[n] given x[n]=δ[n]-δ[n-1].**(Apr2019)**





ii) Let h(t) be a triangular pulse and let x(t) be the impulse train. Determine and sketch y(t) for the following values of T (i) T=4 (ii) T=2 (iii) T=1 (iv) T=3/2





22. i) Find the convolution between x[n] and h[n] , where $x[n] = \alpha^n u[n]; 0 < \alpha < 1$, h[n]=u[n]

ii)Find the convolution of x(t) and h(t) **(Apr 2019)**

$x(t) = \begin{cases} 2 & \text{for} -2 \le t \le 2 \\ 0 & \text{otherwise} \end{cases}$ $h(t) = \begin{cases} 4 & \text{for } 0 \le t \le 2 \\ 0 & \text{otherwise} \end{cases}$

23. ConsideranLTIsystemdescribedbydifferentialequation.**(Nov2020)**

$$\frac{d^2(t)}{dt^2} + 5\frac{dy(t)}{dt} + 4y(t) = \frac{dx(t)}{dt} + 2x(t)$$

Here x(t) and y(t) are the input and output of the system respectively.

i) DeterminethetransferfunctionH(s)ofthesystem,ifthesystemiscausalandstable.

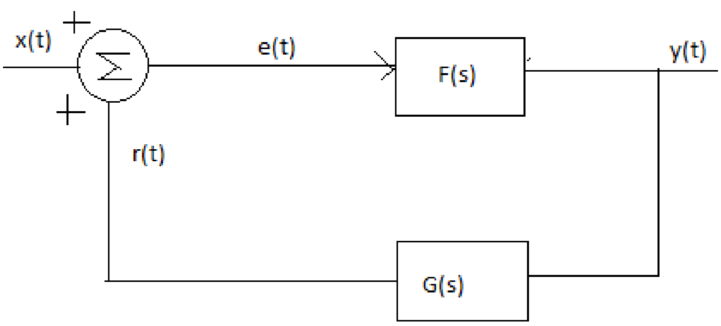
ii) Consideringthesystemtobecausalandstable,iftheinputisdefinedasx(t)=e^{-3t}u(t), Determine the responsey(t).

24.(i)Suppose that the signal $e^{j\omega t}$ is applied to the excitation to a linear, time invariant system that has an impulse response h(t). By using the convolution integral Show that the resulting output is H(ω) $e^{j\omega t}$ where

$$H(\omega) = \int_{-\infty}^{\infty} h(\tau) e^{j\omega\tau} d\tau$$

(ii) Assume the first order differential equation $\frac{dy(t)}{dt} + ay(t) = x(t)$ if x(t)= $e^{j\omega t}$ then y(t)= H(ω)$e^{j\omega t}$.BysubstitutingthedifferentialequationdetermineH(ω).**(Apr2019)**

25. Thefeedbackinterconnectionoftwocausalsubsystemswithsystemfunction F(s)and G(s)isshownbelow.FindtheoverallsystemfunctionH(s)forthisfeedbacksystem.**(Nov 2019)**



26. Letx(t)=u(t-2)-u(t-5)andh(t)=e^{-5t}.Computetheconvolutiony(t)=x(t)*h(t)andsketchthe signal y(t). **(Nov2020)**

UNIT IV-ANALYSIS OF DISCRETE TIME SIGNALS (C204.4)

PARTA

1. State sampling theorem.(Apr2019)

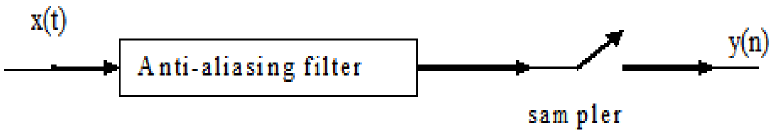
A continuous time (CT) can be completely represented in its samples and recovered back if the sampling frequency $F_s \geq 2F_m$.

F_s=*sampling frequency*

F_m=*highest frequencycomponent presentin the signal*

2. What is an antialiasingfilter?(May2014)

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



3. Write the relationship between DTFT and Z transform. (Apr2019)

DTFT isdefinedas$X[e^{j\omega}] = \sum_{n=-\infty}^{n=+\infty} x[n]e^{-j\omega n}$

DTFT interms of Ztransform

$$X(z) = \sum_{n=-\infty}^{\infty} x[n]z^{-n} \Big| \text{where } z = e^{j\omega}$$

4. Define Nyquistrate.

A continuous time (CT) can be completely represented in its samples and recovered back if the sampling

$F_s \geq 2F_m$.Fs sampling frequency, Fm Maximum Frequency. The limiting sampling rate

$F_s = 2F_m$ is called as Nyquist sampling rate.

5. Find the DTFT of the signal x[n]=(1/3)ⁿu(n)(May2018)

$$DTFT\left(a^n u(n)\right) = \frac{1}{1 - ae^{-j\omega}}$$

Therefore $DTFT\left(\frac{1}{3}u(n)\right) = \frac{1}{1-\frac{1}{3}e^{-j\omega}}$

6. For the analog signal(t)=3cos(50πt)+10sin(300πt)-cos(100πt), What is the minimum sampling rate required to avoid aliasing?(Nov 2020)

$$\cos(50\pi t) \Rightarrow \quad \Omega_1 = 50\pi \quad F_1 = \frac{50\pi}{2\pi} = 25\ Hz$$

$$\sin(300\pi t) \Rightarrow \Omega_2 = 300\pi \quad F_2 = \frac{300\pi}{2\pi} = 150\ Hz$$

$$\cos(100\pi t) \Rightarrow \Omega_3 = 100\pi \quad F_3 = \frac{100\pi}{2\pi} = 50Hz$$

Highest frequency = 150 Hz = Fm

Minimum sampling rate = Nyquist rate = 2Fm = 300 Hz

7. State the linearity and periodicity properties of Discrete-Time FourierTransform.

Linearity:

$$x_1(n) \xleftrightarrow{DTFT} X_1(e^{j\omega}); x_2(n) \xleftrightarrow{DTFT} X_2(e^{j\omega})$$

$$ax_1(n)+bx_2(n) \xleftrightarrow{DTFT} aX_1(e^{j\omega}) + bX_2(e^{j\omega})$$ where a, b are constants.

Periodicity:

DTFT is periodic with period 2 π

$$x(n) \xleftrightarrow{DTFT} X(e^{j\omega})$$

$$X(e^{j(\omega+2k\pi)}) = X(e^{j\omega})$$ where 'k' is an integer.

8. A continuous time signal has the following real Fourier transform X(jΩ)={1,|Ω|≤10π Find the Nyquist rate.(Dec2018)

Given :2πf=10π; fmax=5Hz; fsampling=2fmax=10Hz

9.Compute the discrete time Fourier transform of thesignal $x(n) = u(n-2) - u(n-6)$.

$$u(n-2) \xleftrightarrow{DTFT} \frac{e^{-j2\omega}}{1-e^{-j\omega}}; \quad u(n-6) \xleftrightarrow{DTFT} \frac{e^{-j\omega 6}}{1-e^{-j\omega}}; \quad X(e^{j\omega}) = \frac{e^{-j2\omega}}{1-e^{-j\omega}} - \frac{e^{-j6\omega}}{1-e^{-j\omega}}$$

10. The DTFT of a discrete time signal x(n) is given as $X(e^{j\omega})=2e^{2j\omega}+3+4e^{-4j\omega}-2e^{-2j\omega}$ (Dec2018)

DTFT is definedas $X[e^{j\omega}] = \sum_{n=-\infty}^{n=+\infty} x[n]e^{-j\omega n}$

Therefore by comparing the coefficients x(-2)=2,x(-1)=0,x(0)=3, x(1)=0,x(2)=-2,x(3)=0,x(4)=4

11.DefineunilateralandbilateralZ-transforms.(Dec2013)

$$X(Z) = \sum_{n=0}^{\infty} x(n)z^{-n} \text{-Unilateral ZT} ; \quad X(Z) = \sum_{n=-\infty}^{\infty} x(n)z^{-n} \text{- Bilateral ZT}$$

12. State the convolution property ofthe z-transform.

$$x_1(n) \xleftrightarrow{z} X_1(z) ; \; x_2(n) \xleftrightarrow{z} X_2(z); \quad x_1(n) * x_2(n) \xleftrightarrow{z} X_1(z)X_2(z)$$

13. What is the z transform ofδ(n+k)?(May2013)

Using time shifting property of z-transform,

$$X(z) = z^k[z - transform of\ \delta(n)] \quad = z^k$$

14. What isaliasing?(May2013)

When sampling rate is less than the Nyquist rate, high frequency fold in and appear as low frequency. The superimposition of the high frequency behavior on to the low f requency is known as aliasing or frequency folding.

15.Statethefinalvaluetheoremofz-transform.

For causal signal, $x(n)$; $x(n) \xleftrightarrow{z^+} X^+(z)$

If poles of $X^+(z)$ are within the unit circle in z-plane, then $x(\infty) = \lim_{z\to 1}(z-1)\,X^+(z)$

16. State and prove the time folding property of Z-transform. (Dec2014)
Statement:x(-n)=X(z⁻¹)

Proof: $z\{x(-n)\} = \sum_{n=-\infty}^{\infty} x(-n)(z^{-n}) = \sum_{n=-\infty}^{\infty} x(-n)(z^{-1})^{-n} = X(z^{-1})$

17.State the multiplication propertyofDTFT. (May2014)

Multiplicationproperty:

$y(n) = x_1(n)x_2(n)$then

$$Y(e^{j\omega}) = \frac{1}{2\pi}\int_{2\pi} X_1(e^{j\theta})X_2(e^{j(\omega-\theta)})\,d\theta$$

18. For the analog signal(t)=sin(200πt)+3sin²(120πt), What is the minimum sampling rate required to avoid aliasing? (Apr15)

$\sin(200\pi t) \Rightarrow \Omega_1 = 200\pi \quad F_1 = \frac{200\pi}{2\pi} = 100\ Hz$

$\sin^2(120\pi t) \Rightarrow \left(\frac{1-\cos(240\pi t)}{2}\right) \quad \Omega_2 = 240\pi \quad F_2 = \frac{240\pi}{2\pi} = 120Hz$

Highest frequency = 120 Hz = F_m

Minimum sampling rate = Nyquist rate = $2F_m$ = 240 Hz

19. Find the Z-Transform of the signalx[n]=cos(nωT)u(n)(May2018)

$$X(z) = \frac{z^2 - z\cos(\omega T)}{z^2 - 2z\cos(\omega T) + 1}, |z| > 1$$

20. WritetheconditionsforexistenceofDTFT.(May2016)

1. Thus, the absolute summability of $x[n]$ is a sufficient condition for the existence of the DTFT$X(e^{jw})$
2. TheDTFT $X(e^{jw})$ofx[n]isacontinuousfunctionofω
3. Itisalsoaperiodicfunctionofωwithaperiod2π

21.Find the final value of the given $X(Z) = \frac{1}{1+2Z^{-1}-3Z^{-2}}$**(May 2016)**

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

From final value theorem $\lim_{Z\to 1}(Z-1)X(Z) = x(\infty) = \lim_{Z\to 1}(Z-1)\frac{Z^2}{(Z+3)(Z-1)} = \frac{1}{4}$

22. Find the Nyquist rate ofthe signal $x(t) = sin200\pi t - cos100\pi t$**(Dec 2016)**

$\Omega_1 = 200\pi = 2\pi F_1, F_1 = 100\ Hz\ \&\ \Omega_2 = 100\pi = 2\pi F_2, F_2 = 50\ Hz$

$Nyquist\ Rate = F_N = 2F_{max} = 2(100) = 200Hz$

23. ListtheRocPropertiesofZ-transform.(Dec2017)

If x(n) is a causal finite sequence then the ROC is the entire z-plane except at z = 0.

If x(n) is a anti causal sequence of finite duration then the ROC is the entire z-plane except at z = ∞.

ROC cannot contain any poles.

If x(n) is a finite duration two sided sequence the ROC is entire z-plane except at z = 0 and z = ∞.

24. Find the Z-transform of the signal & its associated ROC $x[n] = \left\{2, -1, \underset{\uparrow}{3}, 0, 2\right\}$**(Dec 2016)**

$$X(Z) = \sum_{n=-2}^{2} x(n)Z^{-n} = x(-2)Z^2 + x(-1)Z^1 + x(0)Z^0 + x(1)Z^{-1} + x(2)Z^{-2}$$

$$X(Z) = 2Z^2 - Z^1 + 3 + 2Z^{-2}\ ROC\ is\ entire\ Z\ plane\ Except\ Z = 0\ and\ Z = \infty$$

25. Find the Z-transform of a sequence x[n]=cos(nωT) u[n]. (Dec2017)

cos(nωT) u[n]=$\cos(n\omega T)\,u(n) = \left(\frac{e^{jnwT} + e^{-jnwt}}{2}\right) u(n)$

$$X(z) = \sum_{n=-\infty}^{\infty} x(n)z^{-n} = \sum_{n=-\infty}^{n=\infty} \cos(n\omega T)\,u(n)z^{-n} = \sum_{n=-\infty}^{\infty} \left(\frac{e^{jnwT} + e^{-jnwt}}{2}\right) u(n)z^{-n}$$

$$= \sum_{n=0}^{\infty}\left(\frac{e^{jnwT}+e^{-jnwt}}{2}\right)z^{-n} = \frac{1}{2}\left(\frac{1}{1-e^{j\omega T}z^{-1}}+\frac{1}{1-e^{-j\omega T}z^{-1}}\right)$$

$$X(z) = \frac{1}{2}\left(\frac{1-e^{-j\omega T}z^{-1}+1-e^{j\omega T}z^{-1}}{(1-e^{j\omega T}z^{-1})(1-e^{-j\omega T}z^{-1})}\right) = \frac{1}{2}\left(\frac{2(1-\cos(\omega T))}{1-2\cos(\omega T)z^{-1}+z^{-2}}\right)$$

$$X(z) = \left(\frac{1-\cos(\omega T)}{1-2\cos(\omega T)z^{-1}+z^{-2}}\right)|z| >$$

26. What is the Z transform of a unit step sequence (May2017)

$$X(z) = \sum_{n=-\infty}^{\infty} x(n)z^{-n} = \sum_{n=-\infty}^{\infty} u(n)z^{-n} = \sum_{n=0}^{\infty} z^{-n} = 1+z^{-1}+z^{-2}+z^{-3}+z^{-4}+---$$

–

$$X(z) = \frac{1}{1-z^{-1}}|z| > 1$$

27. Find x(∞) ofthe given signal for with the Z transform is given by $X(Z) = \frac{Z+1}{3(Z-1)(Z+0.9)}$ (May2017)

$$X(Z) = \frac{Z+1}{3(Z-1)(Z+0.9)}$$

From final value theorem

$$\lim_{Z\to 1}(Z-1)X(Z) = x(\infty) = \lim_{Z\to 1}(Z-1)\frac{Z+1}{3(Z-1)(Z+0.9)} = \frac{2}{5.7} = 0.3508$$

28. Find the Z-transform and its associated ROC for the signal.x[n]=δ[n+1]+2δ[n]-3δ[n-2] (Nov2019)

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

29. Find the Fourier transform for the discrete time signal x[n]= δ[n]+ δ[n-1]+ δ[n+1] and draw its spectrum.(Nov2020)

DTFT{δ[n]}=1

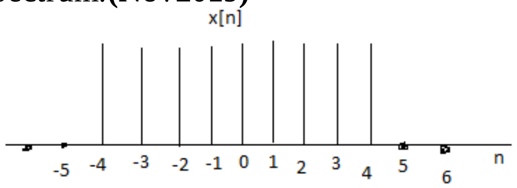
Applying the Shifting property

$\mathrm{DTFT}\{x[n-n_0]\} = e^{-j\Omega n_0}X(\Omega)$

$\mathrm{DTFT}\{x[n]\}=1+e^{-j\Omega}+e^{j\Omega}$

PART B (C204.4)

1. Find the DTFT of the rectangular pulse sequence shown below and also plot the spectrum.**(Nov2019)**



2. i) Determine the sequence x(n) from the following function using Partial fraction expansion.**(May2018)**

$$X(z)= \frac{1}{1-1.5z^{-1}+0.5z^{-2}} \quad ROC\ is\ |z| > 1$$

ii) Find the DTFT of the signal $x(n) = u(n-2)$

3. i)DeterminetheZtransformof $x(n)=\sin(\omega_o n)u(n)$**(Dec2018)**

ii) Determine the inverse Z transform of

$$X(Z) = \frac{1}{1-1.5z^{-1}+0.5z^{-2}} \quad |Z|> 1$$

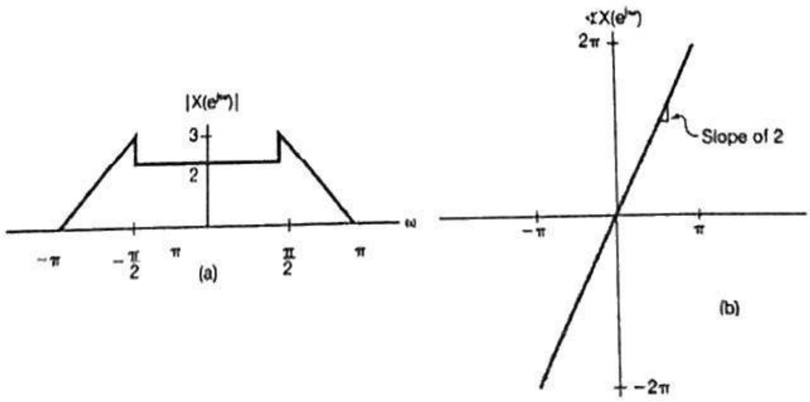
4. State and prove the properties of DFT.**(May2018)**

5. i)DeterminetheDiscretetimeFouriertransformof$x(n)=a^{|n|}$,|a|<1.**(Dec2013)**

ii) Find the z-transform and ROC of the sequence $x(n)= r^n\cos(n\theta)u(n)$.

6. (i) Find the inverse Laplace transform of $s+4/(2s^2+5s+3)$;ROC:Re{s}>-1

(ii)Consider an LTI system with impulse response $h[n]=\alpha^n u[n]$, $|\alpha< 1|$ and $x[n]= \beta^n u[n]$, $|\beta<1|$. Find the response of the LTI system. **(Apr 2019)**
7. Stateandprovesamplingtheoremforabandlimitedsignal.**(Dec2014)**
8. Find inverse Z-transformof
$X(Z)=\frac{Z^{-1}}{(1-0.25Z^{-1}-0.375Z^{-2})}$ Z | | >0.75 $|Z|< 0.5$ **(Dec2014)**
9. Using convolution property of DTFTof $X(e^{jw})=\frac{1}{(1-\alpha e^{-jw})^2}$ $|\alpha|<1$**(May2014)**
10. Find the inverse Z-transformof $X(Z)=\frac{Z^2}{(Z-0.5)(Z-1)^2}$ $|Z|>1$ **(May2014)**
11. LetX($e^{j\omega}$)betheFouriertransformofthesequencex[n].Determinex[n]forthefollowing sequencesusingDTFTproperties
(i) $X(e^{j(\omega-\omega_0)})$ (ii)$X^*(e^{j(\omega)})$ (iii) $jd/d\omega X(e^{j\omega})$ (iv) $1/2\pi X_1(e^{j\omega})\otimes X_2(e^{j\omega})$**(Dec 2018)**
12. StateandproveanytwopropertiesofDTFTandanytwopropertiesofZ-Transform. **(Dec2015)**
13. i)Acontinuoustimesinusoidcos(2πft+θ)issampledataratef$_s$=1000Hz.Determine the resulting signal samples if the input signal frequency f is 400 Hz and 1000 Hz respectively **(May2015)**
ii) Prove the following DTFT Properties a) nx(n) <-> j d X(Ω)/dΩ b) x(n) $e^{j\Omega_c n}$ <-> **X(Ω-Ω$_c$)**
14.i)Find the DTFT of $x(n) = (1/2)^{n-1}u(n-1)$
ii) Using suitable z transform properties find X(z) if $x(n) =(n-2)(1/3)^{n-2}u(n-2)$
iii) Find the z transform of $x(n) = \alpha^{|n|}$ $0<\alpha <1$.**(May 2015)**
15.(i) State and prove sampling theorem.
(ii) What is aliasing? Explain the steps to be taken to avoid aliasing **(May 2016)**
16.(i)Consider adiscrete time LTI system with impulse response $h(n)=(1/2)^n u[n]$. Use FourierTransformtofindtheresponseofthesystemtotheinput$x[n]=(3/4)^n u[n]$
(ii)A difference equation of the system is given as y(n)-y(n-1)+(1/4)y(n-2)=x(n)+1 /4x(n-1)-1/8x(n-2)**.** Determine the transfer function of the inverse system. Check whether the inverse system is causal and stable. **(Apr 2019)**
17.(i) Discuss the effects of under sampling a signal using necessary diagrams. **(Dec 2016)**
(ii)FindtheZtransformof$x[n] = a^n u[n] - b^n u[-n-1]$andspecifyit'sROC.
(Dec 2016)
18.(i) Give the relationship between DTFT and Z transform.**(Dec 2016)**
(ii)State & prove the time shifting property & time reversal property of Z-transform.
(Dec 2016)
19. i)Findthez-transformandsketchtheROCofthefollowingsequence$x[n]=2^n u[n]+3^n u[n-1]$.
ii) consider an analog signal x(t)= 5cos 200πt.
a) Determinetheminimumsamplingratetoavoidaliasing.
b) IfsamplingrateF$_s$=400Hz.WhatistheDTsignalaftersampling?**(Dec2017)**
20. i)DetermineunitstepresponseoftheLTIsystemdefinedby$d^2y/dt^2+5dy/dt+6y(t)=dx/dt+x(t)$.
ii) Find the Inverse z-transform using partial fraction method.
$X(z)=\frac{3-(5/6)z^{-1}}{(1-(1/4)z^{-1})(1-(1/3)z^{-1})}$;|z|>1/3**(Dec 2017)**
21. StateandprovethefollowingpropertiesofDTFT**(May2017)**
(i)Differentiation in frequency
(ii)Convolution in frequency domain
22. Consider the sequence $x(n)$whose Fourier transform $X(e^{j\omega})$is depictedfor $-\pi \le \omega \le \pi$in the figure below. Determine whether or not , in the time domain, $x(n)$is periodic,real,even,and/oroffiniteenergy.



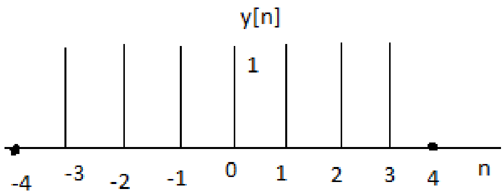
(i) Whatisthetransferfunctionandtheimpulseresponseoflowpass RCcircuit?

(ii) Findthenecessaryandsufficientconditionontheimpulseresponse $h(n)$

Suchthatforanyinput$x(n)$ $max\{|x(n)|\} \geq \max\{|y(n)|\}$where $y(n) = x(n) * h(n)$

23. Given the z Transform of the sequence x[n] as X(z)=z/z-1 Find the Z transform of the followingsignalsintermsofx(z)usingpropertiesofztransformi)x[n-1]ii)x[-n]iii)α^nx[n] iv)nx[n] **(Nov2019)**

24. Consider the signaly[n]



(i)Find a signal x[n] such that even{x[n]}= y[n] for n≥0 and odd{x[n]}=y[n] for n<0.
(ii)Suppose that even {w[n]}=y[n] for all n. Also assume that w[n]=0 for n<0. Find w[n].**(Part C Apr 2019)**

25. i)Determine DTFT of the signalx[n]

$$x[n] = \begin{cases} 1, & |n| < N_1 \\ 0, & |n| > N_1 \end{cases}$$

Sketch it spectrum for N_1=4.

Consider a signal x[n]= 5(1/3)^{n}u[n]-3(1/4)^{n}u[n] , determine its z-transform X[z] and mark its ROC. **(Nov 2020)**

26.i)Determinethez-transformforthesignalx[n]=(1/2)^{n}sin(π/8n)u[n]andmarkitsROC.

ii) Determine the Fourier transform for the signal x[n] = u[n – 3] – u[n – 7]. **(Nov 2020)**

UNIT V-LINEAR TIME INVARIANT DISCRETE TIME SYSTEMS (C204.3,C204.4)PARTA

1. Find the system function for the given difference equationy(n)=0.5y(n-1)+x(n).

Taking Z transform of the equation,

$$Y(z) - 0.5z^{-1}Y(z) = X(z)$$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{1}{1 - 0.5z^{-1}}$$

2. What is a F I Rsystem?

FIR-Finite Impulse Response system. Impulse response of the system is of finite duration. General form of difference equation describing the system is

$$y(n) = \sum_{k=0}^{M} b_k x(n-k)$$

3.What is an IIRsystem?

IIR-infinite impulse response system. Impulse response of the system is of infinite duration. General form of difference equation describing the system is:

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

4.The input x(n)={1,2,3,4} and output y(n)={0,1,2,3,4}.Find the impulse response h(n) of the LTI system.(Dec2018)

According to the property of z-transform

$$x(n)©h(n) = y(n) \xrightarrow{Z-Tranform} X(z)H(z) = Y(z)$$

H(z)=Y(z)/X(z); $Y(z)=z^{-1}+2z^{-2}+3z^{-3}+4z^{-4}$ and $X(z)=1+2z^{-1}+3z^{-2}+4z^{-3}$

Dividing H(z)= $(z^{-1}+2z^{-2}+3z^{-3}+4z^{-4})/(1+2z^{-1}+3z^{-2}+4z^{-3})= z^{-1}$

Oncomparingwithstandardz-transformequationh(n)={0,1}

5. Given the system function $H(z)=z^{-1}/(z^{-2}+2z^{-1}+4)$. Find the difference equation of the system.(Dec2018)

We know that $H(z)=Y(z)/X(z)= z^{-1}/(z^{-2}+2z^{-1}+4)$

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

Taking Inverse z-transform y(n-2)+2y(n-1)+4y(n)=x(n-1)

6. Is the discrete time system described by the difference equation y(n) = x(-n) causal?(May2013)

When n= -1 y(n)=x(-(-1))=x(1) - Future value **;** Therefore the system is non-causal.

7. X(ω) is the DTFT of x(n), what is the DTFT of $x^*(-n)$?(May2013)

From complex conjugation and time reversal property $x^*(-n) = X(-\omega)$

8. A Causal LTI system hasimpulse response $h(n)$ **, for which the z-transformis** $H(z) = \frac{1+z^{-1}}{(1-0.5z^{-1})(1+0.25z^{-1})}$**. Is the system stable? Explain. (Dec 2012)**

Poles are at z = 0.5 and at z = -0.25. The poles lie within the unit circle in z-plane. Therefore the system is stable.

9. Determine the Z-transform of the following signals. Note that the two have samealgebraic equation and only differ in ROC: $x_1[n]=(1/2)^n u(n)$ and $x_2[n]=-(1/2)^n u[-n-1]$.(Apr2019)

Z transform for both the functions are z/z-2. The ROC for $x_1[n]$=Re{z}>1/2, for $x_2[n]$=Re{z}<1/2

10. In terms of ROC, state the condition for an LTI system discrete time system to be causal and stable.(Nov2020)

A discrete LTI system with rational system function H(z) is causal if and only if the ROC is the exterior of the circle of the outer most pole and stable if and only if all of the poles of H(z) lies inside the unit circle.

11. Find x(∞) if X(z)=z+1/3(z-1)(z+0.9) (May 2018)

$x(\infty)=\lim_{z\to 1} [z-1]X(z)$

x(∞)=0.35

12. Find the transfer function of the system described by the equation y(n-2)-3y(n-1)+2y(n)=x(n-1)

Taking z-transform of the equation,

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

13. Whatarethedrawbacksoftransferfunctionrepresentationofthesystem?

(i)The transfer function describes only the zero state response of a system.(ii) It describes only the relationship between the input and output of a system, but does not provide any information regarding the internal state of a system. (iii) It is limited to single-input single-output systems.(iv) It is applicable only for linear time-invariant systems.

14. What is the necessary and sufficient condition for a DT LTI system to be stable, what is the necessary and sufficient condition on impulse response for stability of a causal LTIsystem?

Necessaryandsufficientcondition:ROCofsystemfunctionmustincludeunitcircle,ALTI causalsystemissaidtobestableif andonlyifPolesofsystemfunctionH(z)mustliewithin the unit circle in z -plane.

15. Check whether the system is causaland stable.(Dec2013)

$$H(Z)= \frac{1}{1-\frac{1}{2}Z^{-1}} + \frac{1}{1-2Z^{-1}} = \frac{(1-2Z^{-1})+(1-\frac{1}{2}Z^{-1})}{(1-1/2Z^{-1})(1-2Z^{-1})}$$

Poles at Z=1/2, Z=2 .The system is causal-Output does not depend on future I/P

The system is unstable since the poles lie outside the unit circle.

16. Given the impulse response of a linear time invariant system as h(n)=sinπn, Check whether the system is stable or not.(Apr2019)

Sinπn=0 for n=…-2,-1,0,1,2…. Hence h(n) is absolutely summable and the system is stable.

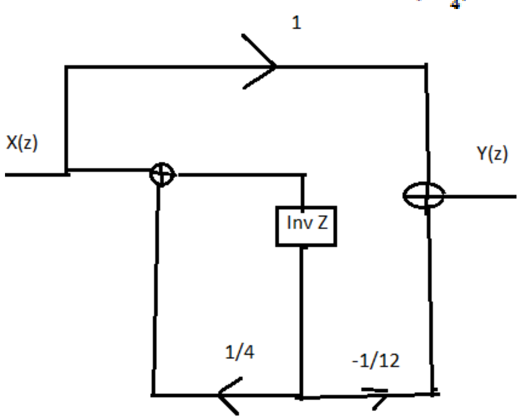
17. UsingZ-Transformcheckwhetherthefollowingsystemisstable.(May2014)

$$H(Z)= \frac{Z}{Z-\frac{1}{2}} + \frac{Z}{Z-3}, \quad \frac{1}{2} < |Z| < 3$$

Here the ROC of system function includes the unit circle.So the given system is stable.

18. Implementthesysteminparallelform. $\frac{1}{\left(1+\frac{1}{2}z^{-1}\right)\left(1-\frac{1}{4}z^{-1}\right)}$ **(May2018)**

Simplifying we get $X(z) = 1 - \frac{1}{12(z-\frac{1}{4})}$



19. DistinguishBetweenRecursiveandNonRecursiveSystem?(May2017)

A recursive system is a system in which present output depends on previous output and input, Non recursive system is a system in which present output depends on previous input.

Recursive: $y(n) = -\sum_{k=1}^{N} a_k y(n-k) +$

M

$\sum \quad b\ k=0^{k}$ $x(n$
$-k)$

Non Recursive: $y(n) = \sum_{k=0}^{M} b_k \, x(n-k)$

IIR filter is example for Recursive system, FIR filter is example for Non Recursive system

20. From discrete convolution sum, find the step response in terms of h(n).(May2016)

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

21. Determinewhetherthefollowingsystemisrecursivesystemandjustifyyouranswer. y[n]=2x[n]+3x[n-1]-2x[n-2] (Nov2019)

The given system is a non recursive system since the outputdepends on previous input only

22. Convolve the following sequences $x[n] = [1,2,3]$ $h[n] = [1,1,2]$(Nov2019)

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

linear convolution y(n) = (1,4,8,8,3)

circular convolution between x[n]and h[n]is $\begin{bmatrix}1 & 3 & 2\\2 & 1 & 3\\3 & 2 & 1\end{bmatrix}\begin{bmatrix}1\\1\\2\end{bmatrix} = \begin{bmatrix}1+3+4\\2+1+6\\3+2+2\end{bmatrix} = \begin{bmatrix}8\\9\\7\end{bmatrix}$

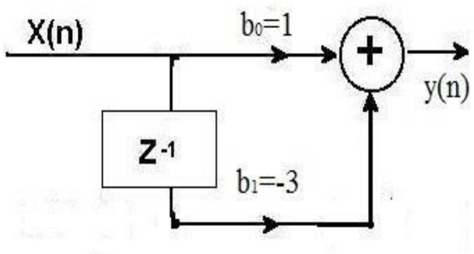
23. Given the system function $H(Z) = 2 + 3Z^{-1} + 4Z^{-3} - 5Z^{-4}$. Determine the impulse response h(n).(Dec2016)

$h(n) = 2\delta(n) + 3\delta(n-1) + 4\delta(n-3) - 5\delta(n-4), h(n) = (2,3,0,4,-5)$

24. Write the condition for stability of a DT-LTI system respect to the position of poles.(Dec2017)

DT-LTI is said to be stable if the ROC of system function includes the unit circle.

25. Realizethedifferenceequationy[n]=x[n]-3x[n-1]indirectformI.(Dec2017)



26. Determine Z-transform of unit impulse signal δ[n] and sketch itsROC.

$$X(z) = \sum_{n=0}^{\infty} x[n]z^{-n}$$

$$X(z) = \sum_{n=0}^{\infty} \delta[n]z^{-n}$$

$$\delta[n] = \begin{Bmatrix}1 \; for \; n = 0\\0 \; for \; n \neq 0\end{Bmatrix}$$

Therefore ZT{δ[n]}=1 ROC: Entire Z-Plane.

PART B (C204.5)

1. Consider thesystem $H(z) = \frac{0.2z}{(z+0.4)(z-0.2)}$; ROC $|z| > 0.4$

i) Findtheimpulseresponseofthesystem.

ii) Is DTFT exists for the system. If sohow?

iii) Find the DTFT. **(May2018)**

2. Drawthecascadeformofthefollowingsystemfunction

y(n)-1/4y(n-1)-1/8y(n-2)=x(n)+3x(n-1)+2x(n-2)**(May 2018)**

3.Givenh(n)={-2(1/3)^n+3(1/2)^n}u(n).FindH(z)andstepresponseofthesystem.**(Dec2018)**

4. A causal DT LTI system is given by y[n-2]-7/10y[n-1]+1/10y[n]=x[n]. Find whether systemisstableornotusingpolezeroplot.**(Dec2018)**

5. Compute convolution sum of the following sequences. x[n]=α^nu[n];h[n]=u[n-1] **(Nov 2019)**

6. i)Determinethetransferfunctionand impulseresponseforthecausalLTIsystem describedbythedifferenceequationusingz-transform

$$y(n) - \frac{1}{4}y(n-1) - \frac{3}{8}y(n-2) = -x(n) + 2x(n-1).$$

7. Given theimpulseresponseofadiscretetimeLTIsystemh[n]=-2(1/3)^{n}u(n)+3(1/2)^{n}u(n) (i)FindH(z)(ii)Findthedifferenceequationofthesystem(iii)Findthestepresponse ofthe system**(May2018)**

8. The I/O relation is given by y[n]-1/4y[n-1]=x[n].Find y[n] if $X(e^{j\omega}) = \frac{1}{1-\frac{1}{2}e^{-j\omega}}$**(Dec2018)**

9. ConsideranLTIsystemwithimpulseresponseh[n]=α^nu[n]andtheinputtothissystem is x(n) =β^n u(n) with |α| & |β| <1. Determine the response y[n]. i) When α = β and ii) When α ≠ β using DTFT. **(Apr2019)**

10. Let y(n)=x(n)*h(n) where x(n)=(1/3)nu(n) and h(n)=(1/5)nu(n) Find Y(z) using property andalsofindy(n)usingpartialfractionmethod.**(Dec2018)**

11. Let y[n]=x[n]*h[n] where x[n]=(1/3)^{n}u[n] and h[n]=(1/5)^{n}u[n].Find y(z) by using the convolutionpropertyofztransformandalsofindy(n)usingpartialfractionmethod.

(Dec 2018)

12. A causal system has input $x(n)$ and output $y(n)$.Find the

(i)System function $H(Z)$

(ii) Impulse response $h(n)$

(iii)Frequency response $H(e^{jw})$

$x(n) = \delta(n) + \frac{1}{6}\delta(n-1) - \frac{1}{6}\delta(n-2), h(n) = \delta(n) - \frac{2}{3}\delta(n-1)$.**(Dec 2016)**

13. i)Obtaintheparallelrealizationofthesystemgivenbyy(n)-3y(n-1)+2y(n-2)=x(n).

ii) Determine the direct form II structure for the system given by difference equation

y(n)= (-3/8)y(n-1)+(3/32)y(n-2)+(1/64)y(n-3)+x(n)+3x(n-1)+2x(n-2) **(Apr 2019)**

14. Usingthepropertiesof inverseZ-transformsolve:**(Dec2017)**

i) X(z)= log (1+az^{-1}); |z|>|a| and X(z)= $\frac{az^{-1}}{(1-az^{-1})^2}$; |z|>|a|

ii) Checkwhetherthesystemfunctioniscausalornot

H(zs)= $\frac{1}{1-(1/2)z^{-1}} + \frac{1}{1-2z^{-1}}$;|z|>2

iii) ConsiderasystemwithimpulseresponseH(s)=e^s/s+1;Re{s}>-1.Checkwhetherthe systemfunctioniscausalornot.

15. Perform Convolution to find the response of the systems $h_1[n]$and $h_2[n]$f or the given inputsequence $x_1[n]$ and $x_2[n]$

(1) $x_1[n] = \{1,-1,2,3\}$,$h_1[n] = \{1,-2,3,-1\}$

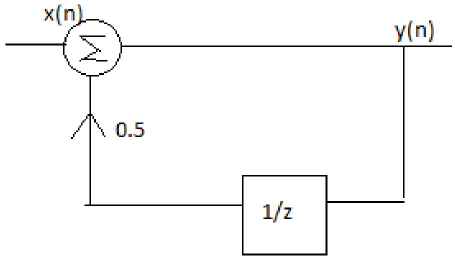
(2) $x_2[n] = \{1,2,3,2\}$,$h_2[n] = \{1,2,2\}$**(May2017)**

16. For a causal LTI system the input x(n) and output y(n) are related throughdifference equation $y(n) - \frac{1}{6}y(n-1) - \frac{1}{6}y(n-2) = x(n)$ Determine the frequency response H(e^{jw}) and the impulse response h(n) of the system. **(May 2017)**

17. Determinethesteadystateresponseforthesystemwithimpulseresponse$h[n] = [j\ 0.5]^n$foran input $x[n] = \cos(\pi n)\, u(n)$**(May2017)**

18. ConsideraDTLTIsystemisgivenbyH(z)=z/z-0.5,|z|>0.5Findthestepresponseofthe system. **(Nov2019)**

19. Consider the discrete LTI system shown below. Find the frequency response and the impulseresponseofthesystem.Andalsosketchthemagnituderesponse.**(PartCNov2019)**



20. i)ADiscretetimeLTIsystemprovidesresponsey[n]=0.4^nu[n]forinputx[n]=0.2^nu[n]. DeterminefrequencyresponseH($e^{j\omega}$)ofthesystem.

ii) Consider second order LTI system described by

$$H(z) = \frac{1}{\left(1 - \frac{1}{2}z^{-1}\right)\left(1 - \frac{1}{3}z^{-1}\right)}$$

Determine the impulse response if the system is causal. **(Nov 2020)**

21. Determineandplottheconvolutionofx[n]andh[n]definedby**(Nov2020)**

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

and h[n]=u[n+3]