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**Signals & Systems (18EC44)**

**Multiple choice questions & solutions**

**MODULE 1:**

**Introduction and Classification of signals, operations on signals, Systems**

**1.** A signal is a physical quantity which does not vary with \_\_\_\_\_\_\_\_\_\_\_\_
a) Time
b) Space
c) Independent Variables
**d) Dependent Variables**
**Explanation:** A signal is a physical quantity which varies with time, space or any other independent variables. Therefore, it does not vary with dependent variables.

**2.** Most of the signals found in nature are \_\_\_\_\_\_\_\_\_
a) Continuous-time and discrete-time
b) Continuous-time and digital
c) Digital and Analog
**d) Analog and Continuous-time**

**Explanation:** Signals naturally are continuous-time signals. These are also known as analog signals. Continuous-time or analog signals are defined for all values of time t.

**3.** Which one of the following is not a characteristic of a deterministic signal?
a) Exhibits no uncertainty
b) Instantaneous value can be accurately predicted
**c) Exhibits uncertainty**
d) Can be represented by a mathematical equation
**Explanation:** Deterministic signal is one which exhibits no uncertainty and its instantaneous value can be accurately predicted from its mathematical equation. Therefore, a deterministic signal doesn’t exhibit uncertainty. However, a random is always uncertain.

**4.** Determine the fundamental period of the following signal: sin(60πt).
a) 1/60 sec
**b) 1/30 sec**c) 1/20 sec
d) 1/10 sec

**Explanation:** Consider the equation: sinΩ0t. Comparing this equation with the one given in the question: sin60t
⇒ Ω0=60π


**5.** Sum of two periodic signals is a periodic signal when the ratio of their time period is
**a) A rational number**b) An irrational number
c) A complex number
d) An integer

**Explanation:** Sum of two periodic signals is a periodic signal only when the ratio of their time period is a rational number or it is the ratio of two integers. For e.g., T1/T2 = 5/7 → Periodic; T1/T2 = 5 → Aperiodic.

**6.** Determine the Time period of: x(t)=3cos(20t+5)+sin(8t-3).
a) 1/10 sec
b) 1/20 sec
**c) 2/5 sec**
d) 2/4 sec

**Explanation:**


**7.** What is the even component of a discrete-time signal?


Answer: b
Explanation:


**8.** Determine the odd component of the signal: x(t)=cos t+sin t.
a) sin t
b) 2sin t
**c) cos t**
d) 2cos t

**Explanation:**



**9.** For an energy signal \_\_\_\_\_\_\_\_\_\_
a) E=0
b) P= ∞
c) E= ∞
**d) P=0**

**Explanation**: A signal is called an energy signal if the energy satisfies 0<E< ∞ and power P=0.

**10.** Determine the power of the signal: x(t) = cos(t).
**a) 1/2**b) 1
c) 3/2
d) 2
Explanation:



**11.** A signal is anti-causal if \_\_\_\_\_\_\_\_\_\_\_\_\_\_
a) x(t) = 0 for t = 0
b) x(t) = 1 for t < 0
c) x(t) = 1 for t > 0
**d) x(t) = 0 for t > 0
Explanation:** A signal is said to be anti-causal when x(t) = 0 for t > 0.

**12.** The type of systems which are characterized by input and the output quantized at certain levels are called as
a) analog
**b) discrete**c) continuous
d) digital
**Explanation:** Discrete systems have their input and output values restricted to enter some quantised/discretized levels.

**13.** The type of systems which are characterized by input and the output capable of taking any value in a particular set of values are called as
a) analog
b) discrete
c) digital
**d) continuous**
**Explanation:** Continuous systems have a restriction on the basis of the upper bound and lower bound, but within this set, the input and output can assume any value. Thus, there are infinite values attainable in this system

parameters are continuous in nature. Data is stored in the form of discretized bits on CDs.

**14.** A system which is linear is said to obey the rules of
a) scaling
b) additivity
**c) both scaling and additivity**
d) homogeneity
**Explanation:** A system is said to be additive and scalable in order to be classified as a linear system.

**15.** A time invariant system is a system whose output
a) increases with a delay in input
b) decreases with a delay in input
**c) remains same with a delay in input**
d) vanishes with a delay in input

**Explanation:** A time invariant system’s output should be directly related to the time of the output. There should be no scaling, i.e. y(t) = f(x(t)).

**16.** All real time systems concerned with the concept of causality are
a) non causal
**b) causal**
c) neither causal nor non causal
d) memoryless
**Explanation:** All real time systems are causal, since they cannot have perception of the future, and only depend on their memory.

**17.** A system is said to be defined as non causal, when
a) the output at the present depends on the input at an earlier time
b) the output at the present does not depend on the factor of time at all
c) the output at the present depends on the input at the current time
**d) the output at the present depends on the input at a time instant in the future**
**Explanation:** A non causal system’s output is said to depend on the input at a time in the future.

**18.** When we take up design of systems, ideally how do we define the stability of a system?
a) A system is stable, if a bounded input gives a bounded output, for some values of the input
b) A system is unstable, if a bounded input gives a bounded output, for all values of the input
**c) A system is stable, if a bounded input gives a bounded output, for all values of the input**d) A system is unstable, if a bounded input gives a bounded output, for some values of the input

**Explanation:** For designing a system, it should be kept in mind that the system does not blow out for a finite input. Thus, every finite input should give a finite output.

**19.** All causal systems must have the component of
**a) memory**b) time invariance
c) stability
d) linearity
**Explanation:** Causal systems depend on the functional value at an earlier time, compelling the system to possess memory.

**20.** If x (-t) = -x (t) then the signal is said to be \_\_\_\_\_\_\_\_\_\_\_\_\_
a) Even signal
**b) Odd signal**
c) Periodic signal
d) Non periodic signal
**Explanation:** Signals is said to be odd if it is anti- symmetry over the time origin. And it is given by the equation x (-t) = -x (t).

**21.** Which of the following is true for complex-valued function?
**a) X (-t) = x\*(t)**
b) X (-t) = x(t)
c) X (-t) = – x(t)
d) X (-t) = x\*(-t)
**Explanation:** Complex-valued function is said to be conjugate symmetry if its real part is even and imaginary part is odd and it is shown by the equation x(-t) = x\*(t).

**22.** When x(t ) is said to be non periodic signal?
a) If the equation x (t) = x (t + T) is satisfied for all values of T
b) If the equation x (t) = x (t + T) is satisfied for only one value of T
**c) If the equation x (t) = x (t + T) is satisfied for no values of T**d) If the equation x (t) = x (t + T) is satisfied for only odd values of T
**Explanation:** A signal x (t) is said to be non periodic signal if it does not satisfy the equation x(t) = x(t + T). And it is periodic if it satisfies the equation for all values of T = T0, 2T0, 3T0…

**23.** Fundamental frequency x[n] is given by \_\_\_\_\_\_\_\_\_\_\_
**a) Omega = 2\*pi /N**b) Omega = 2\*pi\*N
c) Omega = 4\*pi \*2N
d) Omega = pi / N
**Explanation:** Fundamental frequency is the smallest value of N which satisfies the equation
Omega = 2\*pi/ N, Where N is a positive integer.

**24.** Noise generated by an amplifier of radio is an example for?
a) Discrete signal
b) Deterministic signal
**c) Random signal**d) Periodic signal
**Explanation:** Random signal is the one which there is uncertainty before its actual occurrence. Noise is a best example for random signal.

**25.** Energy signal has zero average power and power signal has zero energy.
a) True
**b) False**
**Explanation:** Energy and power signals are mutually exclusive. Energy signal has zero average power and power signal has infinite energy.

**26.** What is the fundamental frequency of discrete –time wave shown in fig a?


a) π/6
**b) π/3**c) 2π/8
d) π
**Explanation:** mega = 2\* π / N. In the given example the number of samples in one period is N = 6. By substituting the value of N =6 in the above equation then we get fundamental frequency as π/3.

**27.** Which of the following is an example of amplitude scaling?
a) Electronic amplifier
b) Electronic attenuator
**c) Both amplifier and attenuator**d) Adder

**Explanation:** Amplitude scaling refers to multiplication of a constant with the given signal. It is given by y (t) = a x (t). It can be both increase in amplitude or decrease in amplitude.

**28.** Which of the following is an example of physical device which adds the signals?
a) Radio
**b) Audio mixer**c) Frequency divider
d) Subtractor

**Explanation:** Audio mixer is a device which combines music and voice signals. It is given by
Y (t) = x1 (t) + x2 (t).

**29.** AM radio signal is an example for \_\_\_\_\_\_\_\_\_\_
a) y (t) = a x (t)
b) y (t) = x1 (t) + x2 (t)
**c) y (t) = x1 (t) \* x2 (t)**d) y (t) = -x(t)
**Explanation:** AM radio signal is an example for y (t) = x1 (t) \* x2 (t) where, x1 (t) consists of an audio signal plus a dc component and x2 (t) is a sinusoidal signal called carrier wave.

**30.** Which of the passive component performs differentiation operation?
a) Resistor
b) Capacitor
**c) Inductor**
d) Amplifier
**Explanation:** Inductor performs differentiation. It is given by y (t) = L d/dt i(t) where, I (t) denotes current flowing through an inductor of inductance L.

**31.** Which of the component performs integration operation?
a) Resistor
d) Diode
**c) Capacitor**
d) Inductor
**Explanation:** Capacitor performs integration. V (t) developed across capacitor is given by
v (t) = (1/C)\* ∫t-∞ i (∂).d∂, I (t) is the current flowing through a capacitor of capacitance C.

**32.** Time scaling is an operation performed on \_\_\_\_\_\_\_
a) Dependent variable
**b) Independent variable**c) Both dependent and independent variable
d) Neither dependent nor independent variable
**Explanation:** Time scaling is an example for operations performed on independent variable time. It is given by y (t) = x (at).

**33.** Y (t) = x (2t) is \_\_\_\_\_\_\_\_
**a) Compressed signal**b) Expanded signal
c) Shifted signal
d) Amplitude scaled signal by a factor of 2
**Explanation:** By comparing the given equation with y (t) = x (at) we get a=2. If a>1 then it is compressed version of x (t).

**34.** Y (t) = x (t/5) is \_\_\_\_\_\_\_
a) Compressed signal
**b) Expanded signal**c) Time shifted signal
d) Amplitude scaled signal by factor 1/5
**Explanation:** y (t) = x (at), comparing this with the given expression we get a = 1/5. If 0<a<1 then it is expanded (stretched) version of x (t).

**35.** In discrete signal, if y [n] = x [k\*n] and k>1 then \_\_\_\_\_\_
**a) Some samples are lost from x [n]**b) Some samples are added to x [n]
c) It has no effect on samples
d) Samples will be increased with factor k
**Explanation:** For discrete time signal y [n] = x [k\*n] and k>1, it will be compressed signal and some samples will be lost. The samples lost will not violate the rules of sampling theorem.

**Elementary Signals**

**1.** The general form of real exponential signal is\_\_\_\_\_\_\_\_
**a) x (t) = beat**
b) x (t) = (b+1)eat
c) x (t) = b (at)
d) x (t) = be (a+1)t
**Explanation:** x (t) = beat is the most general way of representing the exponential signals where both b and a are real parameters.

**2.** In the equation x (t) = beat if a < 0, then it is called \_\_\_\_\_\_
a) Growing exponential
**b) Decaying exponential**c) Complex exponential
d) Both Growing and Decaying exponential
**Explanation:** If a > 0 in x (t) = beat it is called growing exponential and if <0 it is called decaying exponential. Hence Decaying exponential is correct.

**3.** The time period of continuous-time sinusoidal signal is given by \_\_\_\_\_
**a) T = 2π / w**
b) T = 2π / 3w
c) T = π / w
d) T = π / 2w
**Explanation:** X (t) = A cos (wt+φ) is the continuous-time sinusoidal signal and its period is given by
T = 2π / w where w is the frequency in radians per second.

**4.** Euler’s identity ejθ is expanded as \_\_\_\_\_
**a) cos θ + j sin θ**
b) cos θ – j sin θ
c) cos θ + j sin 2θ
d) cos⁡ 2θ+j sinθ
**Explanation:** The complex exponential ejθ is expanded as cos θ + j sin θ and is called Euler’s identity with cos θ as real part sin θ as imaginary part.

**5.** Exponentially damped sinusoidal signal is \_\_\_\_\_\_
a) Periodic
**b) Non periodic**c) Insufficient information
d) Maybe periodic
**Explanation:** Exponentially damped sinusoidal signal of any kind is not periodic as it does not satisfy the periodicity condition.

**6.** If    describes x [n] as superposition of two step functions.

**a) x [n] = u [n] – u [n-5].**
b) x [n] = u [n] + u [n-5].
c) x [n] = u [n-5] – u [n].
d) x [n] = u [n-5] + u [n].

**Explanation:** x [n] will be of amplitude for the interval 0 to 4 and zero otherwise. It can be obtained by the equation x [n] = u [n] – u [n-5].

**7.** Discrete-time version of unit impulse is defined as \_\_\_\_\_\_


**Answer: a**
**Explanation:** Unit impulse is an elementary signal with zero amplitude everywhere except at n = 0.

**8.** Which of the following is not true about unit impulse function?


**Answer: d
Explanation:** One option gives the definition of discrete-time version of impulse function, other options gives continuous-time representation of impulse function.

**9.** The step function u (t) is integral of \_\_\_\_\_\_\_ with respect to time t.
a) Ramp function
**b) Impulse function**
c) Sinusoidal function
d) Exponential function
**Explanation:** Step function is an integral of impulse function and conversely, impulse is the derivative of step function u (t).

**10.** The area under the pulse defines \_\_\_\_\_ of the impulse.
**a) Strength**
b) Energy
c) Power
d) Duration
**Explanation:** The area under the pulse defines strength of the impulse and the strength of the impulse is denoted by the label next to the arrow.

**11.** Unit impulse ∂(t) is \_\_\_\_\_ of time t.
a) Odd function
**b) Even function**c) Neither even nor odd function
d) Odd function of even amplitude
**Explanation:** For an impulse function, ∂(-t)= ∂(t). Hence unit impulse is an even function of time t.

**12.** Shifting property of impulse ∂(t) is given by \_\_\_\_\_\_


**Answer: a
Explanation:** X (t) be a function and the product of x (t) with time shifted delta function ∂(t – to) gives x(to), this is referred to as shifting property of impulse function.

**13.** ∂(at) = 1⁄a ∂(t), this property of unit impulse is called \_\_\_\_\_\_
a) Time shifting property
**b) Time scaling property**
c) Amplitude scaling property
d) Time reversal property

**Explanation:** Impulse function exhibits shifting property, time scaling property. And time scaling property is given by∂(at) = 1⁄a ∂(t).

**14.** Which of the following is not true about the ramp function?
a) 
b) r (t) = t u (t)
c) Ramp function with unit slope is integral of unit step
d) Integral of unit step is a ramp function of unit slope

**Answer: d
Explanation:** The impulse function is derivative of the step function. In the same way the integral of step function is a ramp function of unit slope.
∫u(t) = r(t).

**MODULE-2: Time domain representation of LTI Systems**

**1.** Impulse response is the output of \_\_\_\_\_\_ system due to impulse input applied at time=0?
a) Linear
b) Time varying
c) Time invariant
**d) Linear and time invariant**

**Explanation:** Impulse response is the output of LTI system due to impulse input applied at time = 0 or n=0. Behaviour of an LTI system is characterised by the impulse response.

**2.** Which of the following is correct regarding to impulse signal?
**a) x[n]δ[n] = x[0]δ[n]**b) x[n]δ[n] = δ[n]
c) x[n]δ[n] = x[n]
d) x[n]δ[n] = x[0]
**Explanation:** When the input x[n] is multiplied with an impulse signal, the result will be impulse signal with magnitude of x[n] at that time.

**3.** Weighted superposition of time-shifted impulse responses is termed as \_\_\_\_\_\_\_ for discrete-time signals.
a) Convolution integral
b) Convolution multiple
**c) Convolution sum**
d) Convolution

**Explanation:** Weighted superposition of time-shifted impulse responses is called convolution sum for discrete-time signals and convolution integral for continuous-time signals.

**4.** Find the convolution sum of sequences x1[n] = (1, 2, 3) and x2[n] = (2, 1, 4).
**a) {2, 5, 12, 11, 12}**
b) {2, 12, 5, 11, 12}
c) {2, 11, 5, 12, 12}
d) {-2, 5,-12, 11, 12}

**Explanation:** x1[n] = δ(n)+2δ(n-1)+3δ(n-2) and x2[n] = 2δ(n)+δ(n-1)+4δ(n-2)
Y[n] = x1[n]\*x2[n] by performing convolution operation on x1[n] and x2[n] we get the sequence as {2, 5, 12, 11, 12}.

**5.** The convolution sum is given by \_\_\_\_\_ equation.


**Answer: a
Explanation:** By the definition of convolution sum we can write the equation as
x[n]\*h[n] = ∑∞k=-∞ x[k]h[n-k].

**6.** When the sequences x1 [n] = u [n] and x2 [n] = u [n-3], the output of LTI system is given as \_\_\_\_\_
a) y[n] = n-2, n>3
**b) y[n] = n-2, n≥3**c) y[n] = n+2, n>3
d) y[n] = n-2, n≤3

**Explanation:** The output y[n] =∑∞k=-∞u(k)u(n-k-3), by solving the above summation either by graphically or by direct summation we get .

**7.** The impulse response h (t) of an LTI system is given by e-2t u(t) . What is the step response?
**a) y(t) = 1⁄2 (1 – e-2t) u (t)**
b) y(t) = 1⁄2 (1 – e-2t)
c) y(t) = (1- e-2t) u (t)
d) y(t) = 1⁄2 (e-2t) u (t)

**Explanation:** Given x (t) = u (t) and h (t) = e-2t.u(t). By using convolution integral

We get output y (t) as y(t) = 1⁄2 (1 – e-2t) u (t).

**8.** Convolve the signals e-2t u(t)\* e-3t u(t). Determine the output?
**a) y(t) = (e-2t – e-3t)u(t)**b) y(t) = (e-2t – e-3t)
c) y(t) = (e-3t – e-2t)u(t)
d) y(t) = (e-t – e-3t)u(t)

**Explanation:** By solving the convolution integral
, we get output as y(t) = (e-2t – e-3t)u(t).

**MODULE 3:**

**System interconnection and properties of impulse response**

1. If two LTI systems with impulse response h1 (t) and h2 (t) and are connected in parallel then output is given by \_\_\_\_\_\_
**a) y(t) = x(t) \*(h1(t) + h2(t))**b) y(t) = x(t) + (h1(t) + h2(t))
c) y(t) = x(t) \* (h1(t) h2(t))
d) y(t) = (x(t) \* h1(t)) + h2(t)
**Explanation:** The equivalent impulse response of two systems connected in parallel is the sum of individual impulse responses. It is represented as
y(t) = x(t) \* h1(t) + x(t) \* h2(t) = x(t) \* (h1(t) + h2(t)).

**2.** When two LTI systems with impulse responses ha (t) and hb (t) are cascaded then equivalent response is given by \_\_\_\_\_\_
a) h(t) = ha(t) + hb(t)
b) h(t) = ha(t) – hb(t)
c) h(t) = ha(t) hb(t)
**d) h(t) = ha(t) \* hb(t)**

**Explanation:** The equivalent impulse response of two systems connected in series (cascaded) is given by convolution of individual impulse responses.

**3.** What is this property of impulse response is called \_\_\_\_\_\_\_\_\_\_\_
h1(t) \* h2(t) = h2(t) \* h1(t)
a) Associative property
**b) Commutative property**c) Distributive property
d) Closure law

**Explanation:** Impulse response exhibits commutative property and it is given mathematically by the equation
h1(t) \* h2(t) = h2(t) \* h1(t).

**4.** The overall impulse response of the system is given by \_\_\_\_\_\_

**a) h(t) = [(h1(t) + h2(t)) \* h3(t))] – h4(t)**b) y(t) = x(t) \* (h1(t) + h2(t)\*h3(t)) – h4(t)
c) h(t) = (h1(t) + h2(t) \* h3(t)) + h4(t) \* x(t)
d) h(t) = (h1(t) h2(t) \* h3(t)) – h4(t)

**Explanation:** In the above given system h1 (t) and h2 (t) are connected in parallel hence it is h1 (t) +h2 (t) which is cascaded to h3 (t) and its equivalent is connected in parallel with h4 (t). Hence the equivalent impulse response is given by h(t) = (h1(t) + h2(t) \* h3(t)) – h4(t).

**5.** The overall impulse response of the system is given by \_\_\_\_\_\_

a) h[n] = (h1[n]-h2[n])\*h3[n]+h5[n]\*h4[n]
b) h[n] = (((h1[n]-h2[n])\*h3[n])+h5[n])\*h4[n]
**c) h[n] = (((h1[n]-h2[n])\*h3[n])-h5[n])\*h4[n]**d) h[n] = (((h1[n]-h2[n])\*-h3[n])-h5[n])\*h4[n]

**Explanation:** Here in the above system h1 [n] and h2 [n] are connected in parallel and given by h1 [n] – h2 [n], this is cascaded with h3 [n] and given by (h1 [n] – h2 [n]) \* h3 [n], this is again connected in parallel with h5 [n] and its equivalent is cascaded with h4 [n]. The equivalent response is given by h[n] = (((h1[n]-h2[n])\*h3[n])-h5[n])\*h4[n].

**6.** The condition for memory-less system is given by \_\_\_\_\_
**a) h[k] = c δ[k]**b) h[k] = c δ[n-k]
c) h[k] = c h[k]δ[k]
d) h[k] = c h[n-k]δ[k]

**Explanation:** The LTI discrete-time system is said to be memory-less if and only if it satisfies the condition h[k]=cδ[k]. All memory-less LTI systems perform scalar multiplication on the input.

**7.** The causal continuous system with impulse response should satisfy \_\_\_\_ equation.
**a) h(t)=0,t<0**b) h(t)=0,t>0
c) h(t)≠0,t<0
d) h(t)≠0,t≤0

**Explanation:** To the continuous system to be causal, the impulse response should satisfy the equation h(t)=0,t<0 and convolution integral is given by y(t)=∫0∞ h(τ)x(t-τ)dτ.

**8.** Which of the following is true for discrete-time stable systems?


**Answer: a
Explanation:** If the condition ∑∞k=-∞|h[k]|<∞ is satisfied by an LTI system then it is said to be stable and for continuous time signal the condition is given by integral
∫∞-∞ |h(τ)|dτ<∞.

**9.** The impulse response of discrete-time signal is given by h [n] = u [n+3]. Whether the system is causal or not?
a) Causal
**b) Non-causal**
c) Insufficient information
d) The system cannot be classified

**Explanation:** The given impulse response h [n] = u [n+3] is not causal because of the term u[n+3] which implies it is non zero for n= -1, -2, -3.

**Fourier Series**

**1.** What are fourier coefficients?
a) The terms that are present in a fourier series
b) The terms that are obtained through fourier series
**c) The terms which consist of the fourier series along with their sine or cosine values**d) The terms which are of resemblance to fourier transform in a fourier series are called fourier series coefficients

**Explanation:** The terms which consist of the fourier series along with their sine or cosine values are called fourier coefficients. Fourier coefficients are present in both exponential and trigonometric fourier series.

**2.** Which are the fourier coefficients in the following?
**a) a0, an and bn**
b) an
c) bn
d) an and bn

**Explanation:** These are the fourier coefficients in a trigonometric fourier series.
a0 = 1/T∫x(t)dt
an = 2/T∫x(t)cos(nwt)dt
bn = 2/T∫x(t)sin(nwt)dt

**3.** The fourier series coefficients of the signal are carried from –T/2 to T/2.
**a) True**
b) False
**Explanation:** Yes, the coefficients evaluation can be done from –T/2 to T/2. It is done for the simplification of the signal.

**4.** What is the polar form of the fourier series?
**a) x(t) = c0 + ∑cncos(nwt+ϕn)**
b) x(t) = c0 + ∑cncos(ϕn)
c) x(t) = ∑cncos(nwt+ϕn)
d) x(t) = c0+ ∑cos(nwt+ϕn)

**Explanation:** x(t) = c0 + ∑cncos(nwt+ϕn), is the polar form of the fourier series.
C0=a0 and cn = √a2n+ b2n for n≥1
And ϕn = tan-1 bn/an .

**5.** What is a line spectrum?
a) Plot showing magnitudes of waveforms are called line spectrum
**b) Plot showing each of harmonic amplitudes in the wave is called line spectrum**
c) Plot showing each of harmonic amplitudes in the wave is called line spectrum
d) Plot showing each of harmonic amplitudes called line spectrum

**Explanation:** The plot showing each of harmonic amplitudes in the wave is called line spectrum. The line rapidly decreases for waves with rapidly convergent series.

**6.** What is the disadvantage of exponential Fourier series?
a) It is tough to calculate
b) It is not easily visualized
**c) It cannot be easily visualized as sinusoids**d) It is hard for manipulation
**Explanation:** The major disadvantage of exponential Fourier series is that it cannot be easily visualized as sinusoids. Moreover, it is easier to calculate and easy for manipulation leave aside the disadvantage.

**7**. Fourier series uses which domain representation of signals?
a) Time domain representation
**b) Frequency domain representation**
c) Both combined
d) Neither depends on the situation
**Explanation:** Fourier series uses frequency domain representation of signals. X(t)=1/T∑Xnejnwt. Here, the X(t) is the signal and Xn = 1/T∫x(t)e-jwtn.

**8.** How does Fourier series make it easier to represent periodic signals?
**a) Harmonically related**b) Periodically related
c) Sinusoidally related
d) Exponentially related

**Explanation:** Fourier series makes it easier to represent periodic signals as it is a mathematical tool that allows the representation of any periodic signals as the sum of harmonically related sinusoids.

**9.** How do we represent a pairing of a periodic signal with its fourier series coefficients in case of continuous time fourier series?
**a) x(t) ↔ Xn**
b) x(t) ↔ Xn+1
c) x(t) ↔ X
d) x(n) ↔ Xn

**Explanation:** In case of continuous time fourier series, for simplicity, we represent a pairing of a periodic signal with its fourier series coefficients as,
x(t) ↔ Xn
here, x(t) is the signal and Xn is the fourier series coefficient.

**10.** What are the properties of continuous time fourier series?
a) Linearity, time shifting
b) Linearity, time shifting, frequency shifting
c) Linearity, time shifting, frequency shifting, time reversal, time scaling, periodic convolution
**d) Linearity, time shifting, frequency shifting, time reversal, time scaling, periodic convolution, multiplication, differentiation**

**Explanation:** Linearity, time shifting, frequency shifting, time reversal, time scaling, periodic convolution, multiplication, differentiation are some of the properties followed by continuous time fourier series. Integration and conjugation are also followed by continuous time fourier series.

**11.** If x(t) and y(t) are two periodic signals with coefficients Xn and Yn then the linearity is represented as?
**a) ax(t) + by(t) = aXn + bYn**b) ax (t) + by(t) = Xn + bYn
c) ax(t) + by(t) = aXn + Yn
d) ax(t) + by(t) = Xn + Yn

**Explanation:** ax(t) + by(t) = aXn + bYn, x(t) and y(t) are two periodic signals with coefficients Xn and Yn.

**12.** How is time shifting represented in case of periodic signal?
a) If x(t) is shifted to t0, Xn is shifted to t0
b) x(t-t0), Yn = Xn e-njwt0
**c) Xn = x(t-t0), Yn = Xn e-njwt0**d) Xn = x(-t0), Yn = Xn e-njwt0

**Explanation**: If x(t) and y(t) are two periodic signals with coefficients Xn and Yn, then if a signal is shifted to t0, then the property says,
Xn = x(t-t0), Yn = Xne-njwt0

**13.** What is the frequency shifting property of continuous time fourier series?
a) Multiplication in the time domain by a real sinusoid
**b) Multiplication in the time domain by a complex sinusoid**c) Multiplication in the time domain by a sinusoid
d) Addition in the time domain by a complex sinusoid

**Explanation:** If x(t) and y(t) are two periodic signals with coefficients Xn and Yn,
Then y(t)= ejmwtx(t)↔Yn=Xn-m.
Hence, we can see that a frequency shift corresponds to multiplication in the time domain by complex sinusoid whose frequency is equal to the time shift.

**14.** What is the time reversal property of fourier series coefficients?
**a) Time reversal of the corresponding sequence of fourier series**
b) Time reversal of the last term of fourier series
c) Time reversal of the corresponding term of fourier series
d) Time reversal of the corresponding sequence

**Explanation:** x(t)↔ Xn
Y(t) = x(-t)↔Yn=X-n.
That is the time reversal property of fourier series coefficients is time reversal of the corresponding sequence of fourier series.

**MODULE 4:**

**Fourier Transform**

**1.** Which of the following is the Analysis equation of Fourier Transform?
a) F(ω)=∫∞−∞f(t)ejωtdt
b) F(ω)=∫∞0f(t)e−jωtdt
c) F(ω)=∫∞0f(t)ejωtdt
**d) F(ω)=∫∞−∞f(t)e−jωtdt**

**Explanation:** For converting time domain to frequency domain, we use analysis equation. The Analysis equation of Fourier Transform is F(ω)=∫∞−∞f(t)e−jωtdt.

**2.** Choose the correct synthesis equation.
a) f(t)=12π∫∞−∞F(ω)e−jωtdω
**b) f(t)=12π∫∞−∞F(ω)ejωtdω**c) f(t)=12π∫∞0F(ω)e−jωtdω
d) f(t)=12π∫∞0F(ω)ejωtdω
**Explanation:** Synthesis equation converts from frequency domain to time domain. The synthesis equation of fourier transform is f(t)=12π∫∞−∞F(ω)ejωtdω.

**3.** Find the fourier transform of an exponential signal f(t) = e-at u(t), a>0.
**a) 1a+jω**b) 1a−jω
c) 1−a+jω
d) 1−a−jω

**Explanation:** Given f(t)= e-at u(t)
We know that u(t)={01t<0t>0
Fourier transform,
F(ω)=∫∞−∞f(t)e−jωtdt=∫∞−∞e−atu(t)e−jωtdt=∫∞0e−(a+jω)tdt
F(ω) = 1a+jω, a>0.

**4.** Find the fourier transform of the function f(t) = e-a|t|, a>0.
a) 2aa2−ω2
**b) 2aa2+ω2**
c) 2aω2−a2
d) aa2+ω2

**Explanation:** The given two-sided exponential function f(t) = e-a|t|, a>0 can be expressed as
f(t)={e−ateatt≥0t≤0
The Fourier transform is
F(ω)=∫∞−∞f(t)e−jωtdt=∫0−∞f(t)e−jωtdt+∫∞0f(t)e−jωtdt
F(ω)=1a+jω+1a−jω=2aa2+ω2.

**5.** Find the fourier transform of the unit step function.
a) πδ(ω) + 1/ω
**b) πδ(ω) + 1/jω**
c) πδ(ω) – 1/jω
d) δ(ω) + 1/jω

**Explanation:** We know that sgn(t) = 2u(t) – 1.
u(t) = 12[sgn(t)+1] Its Fourier transform is F[u(t)] = 12 F[sgn(t)] + 12 F[1]
As the Fourier transforms F[1] = 2πδ(ω) and [sgn(t)] = 2jω, hence
F[u(t)] = πδ(ω) + 1jω.

**6.** The Fourier transform of a function x(t) is X(ω). What will be the Fourier transform of dX(t)/dt?
a) X(f) jf
**b) j 2πfX(f)**
c) dX(f)dt
d) jf X(f)
**Explanation:** We know that x(t) = 12π∫∞−∞X(ω)ejωtdω
ddtx(t)=12π∫∞−∞X(ω)ddtejωtdω=12πjωX(ω)∫∞−∞ejωtdω
= jω X(ω) = j2πfX(f).

**7.** Find the Fourier transform of jπt.
a) sinc(ω)
b) sa(ω)
c) δ(ω)
**d) sgn(ω)**

**Explanation:** Let x(t) = sgn(t)
The Fourier transform of sgn(t) is X(ω) = F[sgn(t)] = 2jω
Replacing ω with t
–> X(t) = 2jt
As per duality property X(t) ↔ 2πx(-ω), we have
F[2jt] = 2πsgn(-ω) = -2πsgn(ω)
2jt ↔ -2πsgn(ω)
2πt ↔ sgn(ω).

**8.** Find the Fourier transform of f(t)=te-at u(t).
a) 1/(a−jω)2
**b) 1/(a+jω)2**
c) a/(a−jω)2
d) ω/(a−jω)2
**Explanation:** Using frequency differentiation property, tx(t)↔jddωX(ω)
F[te−atu(t)]=jddωF[te−atu(t)]=jddω1a+jω=j−1(j)(a+jω)2=1(a+jω)2
te−atu(t)↔1(a+jω)2.

**9.** Find the Fourier transform of ejω0t.
a) δ(ω + ω0)
b) 2πδ(ω + ω0)
c) δ(ω – ω0)
**d) 2πδ(ω – ω0)**

**Explanation:** We know that F[1] = 2πδ(ω)
By using the frequency shifting property, ejω0t x(t) ↔ X(ω – ω0)
We have F[ejω0t] = F[ejω0t (1)] = 2πδ(ω – ω0).

**10.** Find the Fourier transform of u(-t).
a) πδ(ω) + 1ω
b) πδ(ω) + 1jω
**c) πδ(ω) – 1jω**d) δ(ω) + 1jω
Explanation: We know that F[u(t)] = πδ(ω) + 1jω
Using time reversal property, x(-t) ↔ X(-ω)
We have F[u(-t)] = πδ(ω) – 1jω.

**11.** Find the inverse Fourier transform of δ(ω).
a) 12π
b) 2π
c) 1π
**d) π
Explanation:** We know that x(t) = 12π∫∞−∞X(ω)ejωtdω= 12π∫∞−∞δ(ω)ejωtdω=12π.

**12.** Find the inverse Fourier transform of u(ω).
**a) 12δ(t)+j2πt**b) 12δ(t)–j2πt
c) δ(t) + j2πt
d) δ(t) – j2πt

**Explanation:** We know that u(ω) = 12[1+sgn(ω)].
Applying linearity property,
u(ω) = -1 [12]+F−1[12sgn(ω)]
u(ω) = 12δ(t)+j2πt.

**13.** Find the inverse Fourier transform of ej2t.
**a) 2πδ(ω-2)**b) πδ(ω-2)
c) πδ(ω+2)
d) 2πδ(ω+2)

**Explanation:** We know that ejω0 t ↔ 2πδ(ω-ω0)
∴ ej2t ↔ 2πδ(ω-2).

**Module 5:**

**Z-Transform**

**1.** When do DTFT and ZT are equal?
a) When σ = 0
**b) When r = 1**c) When σ = 1
d) When r = 0

**Explanation:** Discrete Time Fourier Transform, X(e-jω) = ∑∞n=−∞x(n)e−jωn

Z-Transform, X(Z) = ∑∞n=−∞x(n)z−n, z = r ejω When r=1, z = ejω and hence DTFT and ZT are equal.

**2.** Find the Z-transform of δ(n+3).
a) z
b) z2
c) 1
**d) z3**

**Explanation:** Given x(n) = δ(n+3)
We know that δ(n+3) = {10n=−3otherwise
X(Z) = ∑n=−∞∞x(n)z−n=∑n=−∞∞δ(n+3)z−n = z3.

**3.** Find the Z-transform of an u(n);a>0.
**a) z/z−a**
b) z/z+a
c) 1/1−az
d) 1/1+az

**Explanation:** Given x(n) = an u(n)
We know that u(n)={10n≥0n<0
X(Z) = ∑n=−∞∞x(n)z−n=∑n=−∞∞anu(n)z−n
= ∑n=0∞an(1)z−n=∑n=0∞(az−1)n=(1−az−1)−1
= 11−az−1=zz−a.

**4.** Find the Z-transform of u(-n).
**a) 1/1−z**
b) 1/1+z
c) z/1−z
d) z/1+z

**Explanation:** Given x(n) = u(-n)
Z[x(n)] = X(Z) = ∑∞n=−∞x(n)z−n=∑∞n=−∞u(−n)z−n=∑0n=−∞(1)z−n
=∑∞n=0zn=11−z.

**5.** The z-transform of δ[n-k]>0 is \_\_\_\_\_\_\_\_\_\_
a) Zk, Z>0
b) Z-k, Z>0
c) Zk, Z≠0
**d) Z-k, Z≠0**

**6.** The z-transform of δ[n+k]>0 is \_\_\_\_\_\_\_\_\_\_
a) Z-k, Z≠0
b) Zk, Z≠0
c) Z-k, all Z
**d) Zk, all Z**

**7.** The z-transform of {3,0,0,0,0,6,1,-4} (1 as the reference variable) is \_\_\_\_\_\_\_\_\_\_\_
a) 3z5 + 6 + z-1 – 4z-2, 0≤|z|<∞
**b) 3z5 + 6 + z-1 – 4z-2, 0<|z|<∞**
c) 3z5 + 6 + z – 4z-2 0<|z|<∞
d) 3z5 + 6 + z-1 – 4z-2, 0≤|z|<∞

**Explanation:** Performing z-transform on x (n+n0), we get zn0 X (z)
Now, x[n] = 3δ[n+5] + 6δ[n] + δ[n-1] – 4δ[n-2]
So, X (z) = 3z5 + 6 + z-1 – 4z-2, 0<|z|<∞.

**8.** The z-transform of x[n]= {2,4,5,7,0,1} (5 as the reference variable) is \_\_\_\_\_\_\_\_\_\_\_
a) 2z2 + 4z + 5 +7z + z3, z≠∞
b) 2z-2 + 4z-1 + 5 + 7z + z3, z≠∞
c) 2z-2 + 4z-1 + 5 + 7z + z3, 0<|z|<∞
**d) 2z2 + 4z + 5 + 7z-1 + z3, 0<|z|<∞**

**Explanation:** Performing z-transform on x (n+n0), we get zn0 X (z)
Now, x[n] = 2δ[n+2] + 4δ[n+1] + 5δ[n] + 7δ[n-1] + δ[n-3]
So, X (z) = 2z2 + 4z + 5 + 7z-1 + z3, 0<|z|<∞.

**9.** The z-transform of 3n u[-n-1] is \_\_\_\_\_\_\_\_\_\_\_
a) z3−z, |Z|>3
**b) z3−z, |Z|<3**
c) 33−z, |Z|>3
d) 33−z, |Z|<3

**Explanation:** X (z) = ∑−1n=−∞(3z−1)n
= ∑∞n=1(z13)n
= 13z1−13z, |z|<3
= z3−z.

**10.** Find the Z-transform of the causal sequence x(n) = {1,0,-2,3,5,4}. (1 as the reference variable)
**a) 1 – 2z-2 + 3z-3 + 5z-4 + 4z-5**
b) 1 – 2z2 + 3z3 + 5z4 + 4z5
c) z-1 – 2z2 + 3z3 + 5z4 + 4z5
d) z – 2z3 + 3z4 + 5z5 + 4z6

**Explanation:** Given sequence values are :
x(0)=1, x(1)=0, x(2)=-2, x(3)=3, x(4)=5, x(5)=4.
We know that
X(Z)=∑n=−∞∞x(n)z−n
X(Z) = x(0) + x(1) z-1 + x(2) z-2 + x(3) z-3 + x(4) z-4 + x(5) z-5
X(Z) = 1 – 2z-2 + 3z-3 + 5z-4 + 4z-5.

**11.** Find the Z-transform of the anticausal sequence x(n) = {4,2,3,-1,-2,1}. (1 as the reference variable)
**a) 4z5 + 2z4 + 3z3 – z2 – 2z + 1**b) 4z-5 + 2z-4 + 3z-3 -z-2 – 2z-1 + 1
c) -4z5 – 2z4 – 3z3 + z2 + 2z – 1
d) -4z-5 – 2z-4 – 3z-3 + z-2 + 2z-1 – 1

**Explanation:** Given sequence values are :
x(-5)=4, x(-4)=2, x(-3)=3, x(-2)=-1, x(-1)=-2, x(0)=1
We know that
X(Z)=∑n=−∞∞x(n)z−n
X(Z) = x(-5) z5 + x(-4) z4 + x(-3) z3 + x(-2) z2 + x(-1)z + x(0)
X(Z) = 4z5 + 2z4 + 3z3 – z2 – 2z + 1.

**12.** Find the Z-transform of x(n) = u(-n-2).
a) z2z−1
**b) z21−z**c) z21+z
d) z22−z

**Explanation:** Given x(n) = u(-n-2)
Time shifting property of Z-transform states that
If x(n) ↔ X(z), then x(n-m) ↔ z-m X(z)
Z[u(-n-2)] = Z{u[-(n+2)]}=z2 Z[u(-n)] = z21−z.

**13.** Find the Z-transform of x(n) = n2 u(n).
a) z(z−1)(z−1)3
**b) z(z+1)(z−1)3**c) z(z+1)(z+1)3
d) z(z−1)(z+1)3

**Explanation:** Given x(n) = n2 u(n)
We know that X(z) = Z[x(n)] = Z[u(n)] = z1−z
The multiplication of n or differentiation in z-domain property of Z-transform states that
If x(n) ↔ X(z), then nk x(n) ↔ (-1)k zk dkX(z)dzk
Z[n2 u(n)] = z2 d2X(z)dz2=z2d2dz2[z1−z]=z(z+1)(z−1)3.

**14.** Find the Z-transform of x(n) = 2n u(n-2).
a) zz−2
b) zz+2
c) zz(z−2)
**d) 4z(z−2)**

**Explanation:** Given x(n) = 2n u(n-2)
Time shifting property of Z-transform states that
If x(n) ↔ X(z), then x(n-m) ↔ z-m X(z)
Z[u(n-2)] = z-2 Z[u(n)] = z−2zz−1=1z(z−1)
The multiplication by an exponential sequence property of Z-transform states that
If x(n) ↔ X(z), then an x(n) ↔ X(z/a)
Z[2n u(n-2)] = Z[u(n-2)]|z=(z/2) = [1z(z−1)]z=(z/2)
=1(z/2)[(z/2)−1]=4z(z−2).

**15.** Find the Z-transform of x(n) = n[an u(n)].
a) zz(z−a)
b) azz(z−a)
c) azz(z+a)
**d) az(z−a)2**

**Explanation:** Given x(n) = n[an u(n)]
We know that an u(n) ↔ zz−a
Time differentiation property states that
If x(n) ↔ X(z), then nx(n) ↔ -z dX(z)dz
Z[x(n)] = Z{n[an u(n)]} = -z dX(z)dz=−zddz[zz−a]=az(z−a)2.