EXAMPLE QUESTIONS and ANSWERS and NOTES

1- **If two LTI systems with impulse response h1 (t) and h2 (t) and are connected in parallel then output is given by…………………………..**

> The equivalent impulse response of two systems connected in parallel is the sum of individual impulse responses. It is represented as
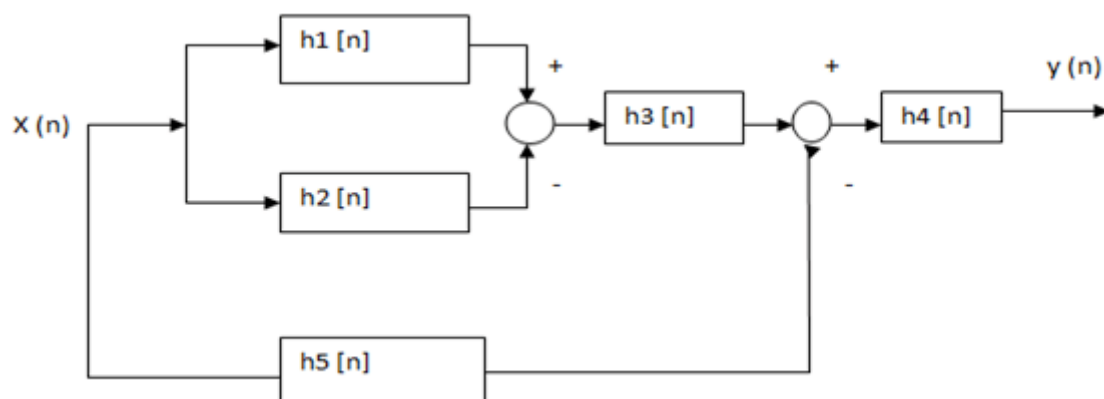> y(t) = x(t) * h1(t) + x(t) * h2(t) = x(t) * (h1(t) + h2(t)).

2-When two LTI systems with impulse responses ha (t) and hb (t) are cascaded then equivalent response is given by _____

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

h(t) = ha(t) * hb(t)

3-The overall response of the system given below

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].

4-The condition for memory-less system is given by

All memory-less LTI systems perform scalar multiplication on the input.

The LTI discrete-time system is said to be memory-less if and only if it satisfies the condition h[k]=cδ[k].

The LTI continious-time system is said to be memory-less if and only if it satisfies the condition h(t)=cδ(t)

5- The causal continuous system with impulse response should satisfy _____ equation.

To the continuous system to be causal, the impulse response should satisfy the equation

$h(t)=0, \quad t<0$

6- The impulse response of discrete-time signal is given by h [n] = u [n+3]. Whether the system is causal or not?

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.

7- The signal power of the periodic rectangular pulses of height 1 and width 1, is _____

Explanation: The signal power in the given signal using Parsevals's relation is

$$P = \frac{1}{t} \int_0^T x^2(t)\, dt$$
$$= \frac{1}{2} \int_0^1 1.dt$$
$$= 0.5 \text{ W.}$$

8- The signal power of the signal x (t) = 2sin 2t + 4sin 4t + 6cos 4t + 2cos 2t with period 0.5 is _____

Signal power = $0.5(2^2 + 4^2 + 6^2 + 2^2)$
= 0.5(4 + 16 + 36 + 4)
= 0.5(20 + 40) = 30 W.

9- A signal is a power signal if the signal has average power equal to

Answer: FINITE

A signal is said to be a power signal if and only if the average power of the signal is finite. In other words, we can say that a signal is a power signal if the energy of the signal is infinite, i.e., $E = \infty$.

10- A signal is an energy signal if the signal has average energy equal to _____

Answer FINITE

A signal is said to be an energy signal if and only if the average energy of the signal is finite. In other words, we can say that a signal is an energy signal if the average power of the signal is infinite, i.e., $P = \infty$.

11- Is the system characterized by the equation y (t) = ax (t) + b is linear?

The system is non-linear. The principle of homogeneity states that if for any input signal X (t), i.e. scaling any input signal scales the output signal by the same factor, then the signal X (t) is homogeneous. Because x (t) does not lead to y (t) = 0, which is a direct violation of the principle of homogeneity.

12- A band-limited signal with a maximum frequency of 5 kHz is to be sampled. According to the sampling theorem, the sampling frequency which is valid is _____

Explanation: Sampling frequency must be greater than or equal to maximum frequency

(f_s) min = 2 f_m

For this question (fs) min = 2 X 5 = 10 kHz

So, $f_s \geq$ 10 kHz.

The sampling frequency smaller than 10KHz is NOT valid.

14- Compute u (t) convolved with itself?

Explanation: By taking x (t) = u (t) and h (t) = u (t) and substituting in the integral

$$y(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)d\tau$$

On solving the given integral we get y (t) = t u (t).

15- Find the value of: h[n]*δ[n-1], where δ[n] being the delta function.

h[n-1]

Convolution of a function with a delta function shifts accordingly.

16- Find the value of h[n-1]*δ[n-3], δ[n] being the delta function.

h((n-1) – 3)= h(n-4)

17- If h1, h2 and h3 are cascaded, find the overall impulse response

h1 * h2 * h3

The resultant impulse response will be the convolution of all the subsequent impulse responses.

18- What is a unit impulse response?

Explanation: The impulse response is defined as the output of an LTI System due to a unit impulse signal input applied at time t=0 or n=0.

x(t)->y(t)

∂(t)->h(t)

Where ∂(t) is the unit impulse function and h(t) is the unit impulse response of a continuous time LTI system.

19-How are the convolution integral of signals represented?

x(t)*h(t).

We obtain the system output y(t) to an arbitrary input x(t) in terms of the input response h(t).

y(t)= ∫x(α)h(t-α) dα=x(t)*h(t).

20- How do you define convolution?

This is defined as-

y(t)= ∫x(α)h(t-α)dα=x(t)*h(t),

output y(t) to an arbitrary input x(t) in terms of the input response h(t).

This is defined as a weighted superposition of time shifted responses where the whole of the signals is taken into account i.e its full limits.

21- What are the Dirichlet's conditions?

Dirichlet's conditions are Conditions required for fourier series to converge. That is there are certain conditions that a signal must posses for its fourier series to converge at all points where the signal is continuous.

22- Dirichlet's condition possible in case of discrete signals. TRUE or FALSE

FALSE

Dirichlet's conditions is not possible in case of discrete signals. That is these are certain conditions that a signal must posses for its fourier series to converge at all points where the signal is continuous only.

23- What are the properties which are very important in case of LTI signals and systems?

Linearity and time invariance are the most important properties which are very important in case of LTI signals and systems as they even derive their name Linear time invariance from them. It is also because many physical properties possess these properties.

24- Continuous time convolution is done from negative infinity to positive infinity. TRUE or FALSE

TRUE

Convolution is a superposition theorem hence we have to consider the signals from negative to positive infinity. We start at t, at−∞ and slide it all the way to +∞. Wherever the two functions intersect, we find the integral of their product

25- It does not matter which one we shift, the input signal or the unit impulse response of a system during linear convolution in an integral. TRUE or FALSE?

TRUE

It does not matter which one we shift input or output. We start at t at −∞ and slide it all the way to +∞. Wherever the two functions intersect, we find the integral of their product.

26- A continuous time LTI system has memory only when _____

An LTI system is said to have a memory when its output at any time depends on the previous value of the input. This does not mean its value does not depend on present values. It depends both on past and present values according to the situation.

27- Which of the following system is memoryless?

a) h(t)=0, t ≠0

b) h(t)=x(t-1)

c) h(t)=0, t=0

d) h(t)=kx(t+2)

A continuous-time LTI system is memoryless when h(t)=0,t ≠0. Such memoryless system has the form h(t)=kx(t), for some constant k has the impulse response h(t) = k∂(t).

The answer is A

28- A continuous time LTI system is causal only when _____

An LTI system is said to be causal when its output at any time depends on the previous and present value of the input. That is its value does not depend only on past values.

29- An important property for causality of the system is _____

a) Initial rest

b) Final rest

c) It is memoryless

d) It is unstable

A causal system follows what is called initial rest concept. That is if the input of the system is 0 upto some point in time than the output of the system should also be zero upto that time

Answer is A

30- Which of the following system is causal?

a) $y[n] = 2[n] - 3[n+1]$

b) $y[n] = 2[n] + 3$

c) $y[n] = 2[n-7] - 3[n+1]$

d) $y[n] = 2[n]*3[n+1]$

An LTI system is said to be causal only when its output at any time depends on the previous or present value of the input. A causal system cannot depend on the future values of the input.

Answer is B