



Time Allotted : 3 Hours

Full Marks : 70

*The Figures in the margin indicate full marks.  
Candidate are required to give their answers in their own words as far as practicable*

**Group-A (Very Short Answer Type Question)**

1. Answer any ten of the following :

[ 1 × 10 = 10 ]

- (i) Convolution is
  - (a) commutative
  - (b) associative
  - (c) distributive
  - (d) All of the above
- (ii) The Fourier series of a real, even, periodic signal will contain only
  - (a) cosine terms
  - (b) sine terms
  - (c) even terms
  - (d) odd harmonics
- (iii) Z transform of  $\delta(n+2)$  is
  - (a)  $z$
  - (b)  $z^{-2}$
  - (c)  $z^2$
  - (d)  $z^{-1}$
- (iv) Spectral overlapping can be termed as
  - (a) aperture effect
  - (b) aliasing effect
  - (c) Gibbs phenomenon
  - (d) inter symbol interference
- (v) The power signal has
  - (a) finite power content but infinite energy content
  - (b) infinite power content and infinite energy content
  - (c) infinite power content and finite energy content
  - (d) finite power content and finite energy content
- (vi) Which of the following system, described by its impulse response  $h(n)$ , is causal?
  - (a)  $h(n) = u(n+1)$
  - (b)  $h(n) = u(n+3)$
  - (c)  $h(n) = u(n)$
  - (d)  $h(n) = u(-n)$
- (vii) The Fourier transform of unit step function is given by
  - (a)  $1/j2\pi f$
  - (b)  $j2\pi f$
  - (c)  $1/(1+j2\pi f)$
  - (d) None of the above
- (viii) Laplace transform of  $x(t) = \delta(t) - u(t)$  is
  - (a)  $(s-1)$
  - (b)  $(s-1)/s$
  - (c)  $s-(1/s)$
  - (d) none of the above
- (ix) Flat top sampling leads to
  - (a) aperture effect
  - (b) aliasing
  - (c) loss of signal
  - (d) loss of higher frequency component

- (x) What is width of the signal,  $x(t)=u(t)-u(t-3)$ ?
- 1 unit
  - 2 unit
  - 3 unit
  - 4 unit
- (xi) What will be the convolution of  $u(n)$  and  $\delta(n-3)$ ?
- $u(n)$
  - $u(n-1)$
  - $u(n-2)$
  - $u(n-3)$
- (xii) The frequency response of a system with  $h(n) = \delta(n) - \delta(n-1)$  will be
- $\delta(w) - \delta(w-1)$
  - $1 - \exp(jw)$
  - $u(w) - u(w-1)$
  - $1 - \exp(-jw)$

### Group-B (Short Answer Type Question)

Answer any three of the following :

[ 5 x 3 = 15 ]

- Impulse response of a system is given as  $h(n) = (1/2)^n u(n-1)$ . Comment on the stability and causality of the system. [5]
- Determine and sketch the magnitude and frequency response of the system given below:  
 $y(n) = (1/2)[x(n+1) - x(n-1)]$  [5]
- Evaluate  $y(t) = \exp(at) * \exp(bt)$  using the Laplace transform technique. [5]
- Explain the zero-order-hold Interpolation with the help of a proper diagram. [5]
- Consider an LTI system with frequency response  $H(w) = 1/(3+jw)$  for a particular input  $x(t)$ . The system produces the output,  $y(t) = \exp(-3t)u(t) - \exp(-4t)u(t)$ . Find out  $x(t)$ . [5]

### Group-C (Long Answer Type Question)

Answer any three of the following :

[ 15 x 3 = 45 ]

- (a) A system is described by the equation given below:  
 $y(n) = x(n) \cdot \cos(w_0 n)$   
Comment on the time invariability and causality of the system. [ 5 ]
- (b) Define power signal. Find out the power of the signal  $x(n) = A \cdot \exp(jw_0 n)$  where A is a constant. [ 2+3 ]
- (c) How can you represent any arbitrary signal  $x(t)$  into odd and even component? Give an example of an even signal with mathematical expression and sketch. [ 2+3 ]
- (a) Write down the sampling theorem. Draw a message signal, equivalent sampled signal and their spectrum. Mention one sampling method in brief. <https://www.makaut.com> [ 2+3+2 ]
- (b) Consider  $x_1(t) = \cos(20\pi t)$  and  $x_2(t) = \cos(100\pi t)$  which are sampled at  $F_s = 40$  Hz. Find out the corresponding discrete time signal. Is there any aliasing present in any of the discrete time signal? [ 4+2 ]
- (c) Find out the Nyquist sampling rate for  $\sin^2(200\pi t)$ . [ 2 ]
- (a) Find out the transfer function and the impulse response of a causal LTI system described by the differential equation: [ 5 ]

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

- (b) Calculate the z-transform of the signal  $x(n) = n a^n u(n)$ . [ 5 ]
- (c) Find out the inverse z-transform of the following: [ 5 ]

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

10. (a) State and prove the Parseval's theorem. ✓  
(b) If  $x(t)$  and the  $X(\omega)$  form a Fourier pair, then what will be the Fourier transform of  $x(-t)$ ?  
(i) when  $x(t)$  is odd signal  
(ii) when  $x(t)$  is even signal  
(c) Find out the inverse Fourier transform of the following:  
 $X(\omega) = 1/(a+j\omega)^2$   
(d) What is the difference between DTFT and DFT?
11. (a) Why DFT is used in signal processing? Comment on the periodicity of  $X(K)$  which is the DFT of  $x(n)$ .  
(b) Find out the DFT of a discrete time signal  $x(n) = \{1, 2, 3, 4\}$ .  
(c) Find out the magnitude and phase spectrum of  $x(n)$ . Sketch the spectrum.

\*\*\* END OF PAPER \*\*\*

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