CS/B.TECH/ECE/EVEN/SEM-6/EC-602/2015-16

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Paper Code : EC-602

DIGITAL SIGNAL PROCESSING

Time Allotted : 3 Hours   *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) The digital system in $y[n] = x[n^2]$ is

      a) Linear and causal

      b) Linear and non-causal

      c) Non-linear and causal

      d) Non-linear and non-causal.

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   ii) The Z-transform of $u[n-1]$ is

      a) $\dfrac{1}{(1-Z^{-1})}$ b) $\dfrac{Z}{1-Z^{-1}}$

      c) $\dfrac{1}{[Z(1-Z^{-1})]}$ d) $(1+Z^{-1})$.

   iii) If $x[n] = \{1,0,0,1\}$, the DFT value of $X(0)$ is

      a) 2   b) $1+j$

      c) 0   d) $1-j$.

   iv) Infinite memory system is also known as

      a) FIR system   b) IIR system

      c) Digital system   d) Analog system.

   v) $\left(\dfrac{1}{2}\right)^n u[n]$ is

      a) energy signal   b) power signal

      c) both (a) and (b)   d) none of these.

   vi) The convolution of $u[n]$ with $u[n-4]$ at $n=5$ is

      a) 5   b) 2

      c) 1   d) 0.

vii) The value of twiddle factor W_8^4 is

a) 5

b) 2

c) 1

d) 0.

viii) Zero padding a signal

a) reduces aliasing

b) increases time resolution

c) increases frequency resolution

d) has no effect.

ix) If $x[n]$ is a sequence of L samples and of M samples, the circular convolution of $x[n]$ and $h[n]$ contains

a) $\max(L, M)$ samples

b) $(L + M - 1)$ samples

c) $(L + M - 2)$ samples

d) $(L + M)$ samples.

x) Overlap save method is used to find

a) circular convolution

b) linear convolution

c) DFT

d) Z-transform.

xi) Number of multiplications in FFT algorithm is

a) $n \log(n)$

b) $(n/2) * \log(n)$

c) $(n/2) * \log(n/2)$

d) $n \log(n/2)$

xii) If F_{si} is the minimum sampling rate, F_{max} is the highest frequency available in the analog signal, then Nyquist rate is

a) $F_{si} = 2F_{max}$

b) $F_{si} = F_{max}$

c) $F_{si} > 2F_{max}$

d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.　　$3 \times 5 = 15$

2. A discrete time LTI system with impulse response $h[n] = \{1,1,1\}$ is excited by a sequence $x[n] = \{4,3,2,1\}$. Determine the output $y[n]$ of the system.

3. State and prove final value theorem for Z-transform.

$2 + 3$

4. What do you mean by even and odd component of a signal ? Show that the energy of a real valued energy signal is equal to the sum of the energies of its even and odd components. 2 + 3

5. Find out the DFT of $x[n] = \{2,1,2,1\}$.

6. Find the Fourier transform of the signal $X(n) = 3^n u(-n) - 3^{-n} u(n)$.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) What is the basic difference between s-plane and z-plane ? How is the mapping done from s-plane to z-plane ? 2 + 3

b) Find the inverse Z-transform of

$$X(Z) = \frac{z(z+1)}{(z-1)(z-3)}, \text{ROC} : |Z| > 3, \text{ using}$$

i) Partial fraction expansion method

ii) Residue method

iii) Convolution method. 10

8. a) Find the circular convolution of $x[n] = \{1,2,3,1\}$ with $h[n] = \{1,1,1\}$ using concentric circle method. 5

b) Why the result of circular convolution is not same as linear convolution ? Give an idea how to get the result of linear convolution using circular convolution. 3 + 4

c) What is the physical significance of convolution sum ? 3

9. Determine the impulse response of the system with $x(n)$ as input and $y(n)$ as output shown in figure below. Impulse responses of the subsystems are $h_1(n) = \left\{\frac{1}{2}, \frac{1}{4}, \frac{1}{2}\right\}$, $h_2(n) = h_3(n) = (n+1)u(n)$ and $h_4(n) = \delta(n-2)$. Also determine expression for frequency response of the system. 12 + 3
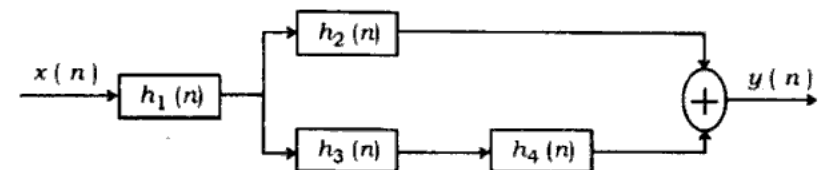
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10. a) Find out the DFT of a sequence $x[n] = \{1,2,3,4,3,2,1\}$ using DIT-FFT algorithm. 12

   b) What is bit reversal ? 3

11. a) What is meant by order of a filter ? 2

   b) Design a digital Butterworth IIR filter for the given frequency response :

   $0 \cdot 85 \leq |H(e^{j\omega})| \leq 1$ for $0 \leq \omega \leq 0 \cdot 2\pi$

   $|H(e^{j\omega})| \leq 0 \cdot 02$ for $0 \cdot 45\pi \leq \omega \leq \pi$

   Use impulse invariant method. 10

   c) What are the major factors to be taken into consideration in determining the choice of a specific system realisation from amongst many possible representations ? 3

12. a) What is the difference between FIR and IIR filter ? 4

   b) What is the utility of Windowing technique ? 3

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   c) A filter is to be designed with the following desired frequency response :

   $H_d(e^{j\omega}) = 0, \qquad -\frac{\pi}{4} \leq \omega \leq \frac{\pi}{4}$

   $= e^{-j2\omega}, \frac{\pi}{4} \leq \omega \leq \pi$

   Determine the filter coefficients $h_d(n)$ if the window function is defined as

   $\omega(n) = 1, 0 \leq n \leq 4$

   $= 0, \text{ elsewhere.}$ 8

13. Write short notes on any *three* of the following : 3 × 5

   a) Decimation in frequency algorithm (DIF-FFT)

   b) Bilinear transformation

   c) Parseval's relation for energy signal

   d) Design of FIR filter using Fourier series

   e) Architecture of TMS320C5416 processor.