KATHMANDU UNIVERSITY
End Semester Examination [C]
April 2023

07 APR 2023

Level : B.E.
Year : IV
Time : 2 hrs. 30 mins.

Course : COMP 407
Semester : I
F. M. : 40

SECTION "B"
[5Q × 8 = 40 marks]

Attempt *ANY FIVE* questions. Candidates are instructed to be specific while writing answers. Assume suitable values for any missing parameters.

1. a. For the signal $x[n]$ shown in Figure 1, find and sketch the following: [3]
   i) $x_1[n] = x[3n-1]$
   ii) $x_2[n] = x[2-n]\,u[n+1]$
   iii) $x_e[n] =$ even component of $x[n]$

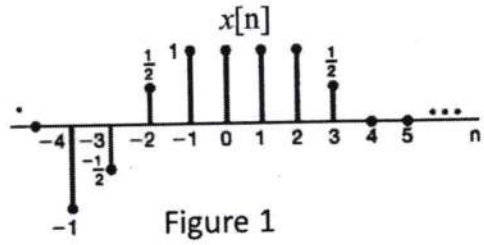

Figure 1

   b. Explain with examples: [3]
      i) Causal and non-causal systems
      ii) Linear and non-linear systems

   c. Check if the following system is a LTI system or not:
      $$y[n] = nx[n-1]$$
      where, x[n] and y[n] represent the input and output of the system respectively. [2]

2. a. Output of an LTI system is given by convolution between its input and impulse response. If for a DT LTI system, the input x[n] is a decaying exponential signal and impulse response h[n] is a rectangular pulse as defined below, compute the output of the system. [3]
   $x[n] = 0.5^n\,u[n]$ and $h[n] = u[n] - u[n-5]$

   b. Explain impulse train sampling with suitable figures and hence verify Nyquist sampling theorem. [3]

   c. Prove that Discrete Time Fourier Transform (DTFT) of any DT signal is periodic with period 2π. [2]

3. a. Find and sketch the five point circular convolution of two sequences given in figure below using circular graphs: [4]

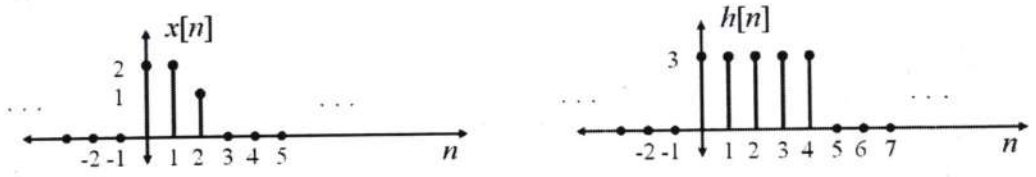

Figure 2

   b. What do you understand by FFT and why is it needed? [2]
   c. What is the role of ROC in z-transform? Explain. [2]

4. a. Use the butterfly diagram to compute 8 point FFT of the following sequence using radix 2 decimation in time algorithm: $x[n] = \{2, 2, 2, 2, 1, 1, 1, 1\}$. [4]

b. Explain how '*divide and conquer*' principle is implemented in radix-2 algorithms. [2]

c. A causal DT sequence is defined as below. Using the definition of z-transform, find the z-transform and its ROC of the sequence. [2]

$$x[n] = 0.5^n u[n-1]$$

5. a. Find the inverse z-transform of the following: [3]

$$X(z) = \frac{1-\frac{1}{3}z^{-1}}{(1-z^{-1})(1+2z^{-1})} \quad \text{ROC: } |z| > 2$$

b. How is direct form II structure different than direct form I structure? Explain. [2]

c. The transfer function of analog filter is $H_a(s) = \frac{3}{(s+2)(s+3)}$ with T=0.1 sec. Design the IIR filter by using Bilinear Transformation. [3]

6. a. Find the Lattice coefficients for the following DT IIR system and sketch the structure. [3]

$$H(z) = \frac{1}{1 + 0.928\,z^{-1} + 0.625\,z^{-1} - 0.33\,z^{-3}}$$

b. A filter is required to be designed with the desired frequency response $H_d(\omega)$ given below. Obtain filter coefficients if the window function to be used is the Hanning window and the length of the filter is 5. [4]

$$H_d(\omega) = \begin{cases} e^{-j\frac{N-1}{2}\omega} \; for, & |\omega| \le \frac{\pi}{4} \\ 0 \quad for, & \frac{\pi}{4} \le |\omega| \le \pi \end{cases}$$

Hanning window function is defined as:

$$W[n] = \begin{cases} 0.5 - 0.5\cos\frac{2\pi n}{N-1}, & 0 \le n \le N-1 \\ 0, & otherwise \end{cases}$$

c. State the principle behind the impulse invariance method of IIR filter design. [1]

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Time: 30 mins.
F.M. : 10

07 APR 2023
Date :

Registration No.:

SECTION "A"
[20Q. × 0.5 = 10 marks]

Encircle the most appropriate alternative from each set of choices.

1. Which of the following signal transformation changes the frequency content in the signal?
   a. Time shifting b. Time inversion c. Time scaling d. Addition

2. The highest DT frequency possible in any DT signal is _____.
   a. 2π b. π c. -2π d. 0

3. If a CT signal with frequency 'F' is sampled with one sample every T seconds, the resulting DT signal will have frequency 'f' given as _____.
   a. $f = F \times T$ b. $f = F/T$ c. $f = F/2T$ d. $f = 2\pi F \times T$

4. The DT signal $x[n] = An^2 + Bn + C$ is an example of _____.
   a. even signal
   b. odd signal
   c. neither odd nor even
   d. odd or even depending on value of coefficients

5. What is the z-transform of the following finite duration signal $x(n)=\{2,4,5,7,0,1\}$?
   a. $2 + 4z + 5z^2 + 7z^3 + z^4$
   b. $2 + 4z + 5z^2 + 7z^3 + z^5$
   c. $2 + 4z^{-1} + 5z^{-2} + 7z^{-3} + z^{-5}$
   d. $2z^2 + 4z + 5 + 7z^{-1} + z^{-3}$

6. Which of the following is **CORRECT** about power signals?
   a. Power signal are time limited b. Power signals are of infinite duration
   c. Power signals are aperiodic in nature d. Power signals have zero total energy

7. Which condition determines the causality of the LTI system in terms of its impulse response?
   a. Only if the value of an impulse response is zero for all negative values of time
   b. Only if the value of an impulse response is negative for all negative values of time
   c. Only if the value of an impulse response is infinity for all negative values of time
   d. Only if the value of an impulse response is unity for all negative values of time.

8. The total number of complex multiplications required for 4 point DFT is _____.
   a. 128 b. 64 c. 16 d. 32

9. What is the value of twiddle factor W_4^2 ?
   a. j b. -1 c. 1 d. 0

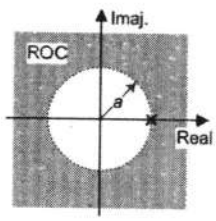
10. For an infinitely long causal signal, the ROC of its z-transform is _____.
    a. all z-plane except z=0
    b. outside a circle
    c. inside a circle
    d. between two circles

11. For an ideal low pass filter, the attenuation in its pass band is _____.
    a. infinity
    b. unity
    c. between 1 and -1
    d. zero

12. FIR filters are chosen over IIR filters when _____.
    a. low cost device is required
    b. smaller side lobes are desired
    c. linear phase is desired
    d. constant gain is desired

13. FIR filters are designed with _____.
    a. all zero structure
    b. all pole structure
    c. pole-zero structure
    d. Both b and c

14. Which of the following signal has Z-transform with ROC shown in the given figure?



    a. $a^n u[n]$
    b. $a^{-n} u[n]$
    c. $a^{-n} u[-n]$
    d. $a^n u[-n]$

15. Bilinear transformation is used to design a _____filter.
    a. FIR
    b. linear phase
    c. passive
    d. IIR

16. If $x[n]$ and $X[k]$ are N-point DFT pair, then $X[k+N]$ = _____.
    a. $X[-k]$
    b. $X[k]$
    c. $-X[k]$
    d. $X^*[k]$

17. Lattice structures are applied for _____.
    a. FIR
    b. IIR
    c. Both FIR and IIR
    d. None of above

18. Which of the following statement is **TRUE**?
    a. Direct Form I stricture is more efficient than direct Form II structure.
    b. For one system, only one structure is possible.
    c. Direct Form II structure uses larger number of components.
    d. Direct Form II structure uses less number of components.

19. Finite word length effects are limitations of _____.
    a. analog systems
    b. digital systems
    c. both analog and digital systems
    d. recursive systems

20. Rectangular windows have higher sidelobes than _____.
    a. Hanning window
    b. Hamming windows
    c. Blackman window
    d. All of these