Code No: RR311102 **Set No.1**

III B.Tech. I Semester Supplementary Examinations, April/May -2005
DIGITAL SIGNAL PROCESSING
(Common to Bio-Medical Engineering and Electronics & Computer Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Find the impulse and step responses for the given system:
y(n)+y(n-1) = x(n)-2x(n-1)
   (b) Test the following systems for linearity, time invariance, causality and stability.
      i. $y(n) = a^{|x(n)|}$
      ii. y(n) = $sin(2nf\pi/F)x(n)$

2. Consider two periodic sequences x(n) and y(n), x(n) has period N and y(n) has period M. The sequence w(n) is defined as w(n) = x(n) + y(n).
   (a) Show that w(n) is periodic with period MN.
   (b) Determine W(K) in terms X(K) and Y(K) where X(K), Y(K) and W(K) are the Discrete Fourier series coefficients with a period of N, M and MN respectively.

3. (a) Define DFT of a sequence. Compute the N - point DFT of the sequence. $X(n) = Cos(2\pi rn/N), 0 \leq n \leq N-1$ and $0 \leq r \leq N-1$
   (b) Explain how DFT can be obtained by sampling DFS for a given sequence.

4. (a) Draw the butterfly line diagram for 8 - point FFT calculation and briefly explain. Use decimation in-time algorithm.
   (b) What is FFT? Calculate the number of multiplications needed in the calculation of DFT using FFT algorithm with 32 point sequence.

5. (a) Determine the frequency response , magnitude response and phase response for the system given by $y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) - x(n-1)$
   (b) A causal LTI system is described by the difference equation y(n)=y(n-1)+y(n-2)+x(n-1), where x(n) is the input and y(n) is the output. Find
      i. The system function H(Z)=Y(Z)/X(Z) for the system, plot the poles and zeroes of H(Z) and indicate the region of convergence.
      ii. The unit sample response of the system.
      iii. Is this system stable or not?

6. (a) What is warping effect? Discuss influence of warping effect on amplitude response and phase response of a derived digital filter from a corresponding analog filter.
   (b) Discuss impulse invariance method.

7. (a) Design a linear phase low pass filter with a cut-off frequency of $\pi/2$ radians/seconds. Take N=7

   (b) Write the magnitude and phase functions of Finite Impulse Response filter when

      i. impulse response is symmetric & N is odd

      ii. impulse response is symmetric & N is even

8. (a) Explain the structures for realisation of FIR system and draw the direct form structure of the FIR system described by the transfer function
   $H(Z) = 1 + \frac{1}{2}Z^{-1} + \frac{3}{4}Z^{-2} + \frac{1}{4}Z^{-3} + \frac{1}{2}Z^{-4} + \frac{1}{8}Z^{-5}$

   (b) Realize the following IIR system by cascade and parallel forms.
   $y(n) + \frac{1}{4}y(n-1) - \frac{1}{8}y(n-2) = x(n) - 2x(n-1) + x(n-2)$

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Code No: RR311102 **Set No.2**

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DIGITAL SIGNAL PROCESSING
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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Consider a LSI system with unit sample response $h(n)n = \alpha^n u(n)$ where α is real and $0 < \alpha < 1$. If the input is $x(n) = \beta^n\, u(n), 0 < |\beta| < 1$,determine the the output f(n) in the form $y(n) = (k_1\alpha^n + k_2\beta^n u(n)$ by explicitly evaluating the convolution sum.
   (b) Define causality and stability of LSI system and state the conditions for stability.

2. (a) State and prove time and frequency shifting properties of Fourier transform.
   (b) Find the Fourier transform of the following signals
      i. $x(n) = (\alpha^n sinw_o n)u(n)\ |\alpha| < 1$
      ii. $x(n) = (1/4)^n u(n+4)$

3. (a) If x(n) is a periodic sequence with a period N, also periodic with period $2N.X_1(K)$ denotes the discrete Fourier series coefficient of x(n) with period N and $X_2(k)$ denote the discrete Fourier series coefficient of x(n) with period 2N. Determine $X_2(K)$ in terms of $X_1(K)$.
   (b) Prove the following properties.
      i. $W_N INx(n) \rightarrow X((K+1))_N R_N(K)$
      ii. $X^*(n) \rightarrow X^*((-K))_N R_N(K)$

4. (a) Draw the butterfly line diagram for 8 - point FFT calculation and briefly explain. Use decimation in-time algorithm.
   (b) What is FFT? Calculate the number of multiplications needed in the calculation of DFT using FFT algorithm with 32 point sequence.

5. (a) Explain how the analysis of discrete time invariant system can be obtained using convolution properties of Z transform.
   (b) Determine the impulse response of the system described by the difference equation y(n)-3y(n-1)-4y(n-2)=x(n)+2x(n-1) using Z transform.

6. (a) Compare Butter worth and Chebydhev approximations.
   (b) Determine the order and transfer function of the Chebyshev filter for following specifications:
      i. Maximum pass band ripple is 1 db for $\Omega \leq 4$ radius/sec.

ii. Stop band attenuation is 40 db for $\Omega \geq 4$ radius/sec.

7. (a) What is the principle of designing FIR filters using windows.

   (b) Using a rectangular window technique design a low pass filter with pass band gain of unity, cut-off frequency of 1kHz and working at a sampling frequency of 5 kHz. The length of the impulse response should be 7.

8. (a) List the different types of structures for realizing FIR system and determine the direct form-I, direct form II of the following LTI system
   y(n)=-0.5y(n-1)+0.25y(n-2)+0.125y(n-3)+x(n)+0.5x(n-1)+0.75x(n-2)

   (b) Write briefly about digital processing of speech.

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Code No: RR311102 **Set No.3**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) Explain the terms "single-sided spectrum" and "double-sided spectrum" with respect to a signal.
   (b) What are exponential and sinusoidal sequences and how they are represented graphically?
   (c) Check whether the following systems are linear and time invariant.
      i. F[x(n)] = n[x(n)]
      ii. $F[x(n)] = a[x(n)]^2 + bx(n)$

2. A LTI system is described by the difference equation y(n)=ay(n-1)+bx(n). Find the impulse response, magnitude function and phase function. Find the value of b if $|H(jw)| = 1$. Sketch the magnitude and phase response for a=0.9.

3. (a) If x(n) is a periodic sequence with a period N, also periodic with period $2N.X_1(K)$ denotes the discrete Fourier series coefficient of x(n) with period N and $X_2(k)$ denote the discrete Fourier series coefficient of x(n) with period 2N. Determine $X_2(K)$ in terms of $X_1(K)$.
   (b) Prove the following properties.
      i. $W_N INx(n) \rightarrow X((K+1))_N R_N(K)$
      ii. $X^*(n) \rightarrow X^*((-K))_N R_N(K)$

4. An 8 point sequence is given by x(n) = {2,2,2,2,1,1,1,1}. Compute 8 point DFT of x(n) by
   (a) radix 2 D I T F F T
   (b) radix 2 D I F FF T
   Also sketch magnitude and phase spectrum

5. (a) Explain how the analysis of discrete time invariant system can be obtained using convolution properties of Z transform.
   (b) Determine the impulse response of the system described by the difference equation y(n)-3y(n-1)-4y(n-2)=x(n)+2x(n-1) using Z transform.

6. (a) Compare the Digital Butterworth and Chebyshev filters.
   (b) Explain method of constructing Butterworth circle in the Z-plane using Bilinear transformation method.

7. Design a band pass Finite Impulse Response filter that approximate the following frequency response:
$H(f) = \begin{cases} 1\,;\ 160 \leq f \leq 200 \\ 0\,;\ elsewhere\, in\, the\, range\, 0 \leq f \leq f_s/2 \end{cases}$
when the sampling frequency is 8000 sps. Limit the duration of impulse response to 2 msec. Draw the filter structure.

8. (a) Obtain the cascade and parallel form realisation of the LTI system governed by the equation.
   (b) Compare cascade and performance of direct and canonic forms.

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Code No: RR311102 **Set No.4**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Write four advantages of Digital Signal Processing over Analog Signal Processing.
   (b) A signal y(n) is governed by the recursive equation $y(n) = 2y(n-1) + \delta(n) with y(0) = 4$. Find y(-2),y(3). Is the signal bounded or not?
   (c) Convolve the two signals $x(n) = (1/2)^n x(n) and\ \ h(n) = u(n) - u(n-10)$ where u(n) is unit step function.

2. Consider two periodic sequences x(n) and y(n), x(n) has period N and y(n) has period M. The sequence w(n) is defined as w(n) = x(n) + y(n).
   (a) Show that w(n) is periodic with period MN.
   (b) Determine W(K) in terms X(K) and Y(K) where X(K), Y(K) and W(K) are the Discrete Fourier series coefficients with a period of N, M and MN respectively.

3. (a) If x(n) is a periodic sequence with a period N, also periodic with period $2N.X_1(K)$ denotes the discrete Fourier series coefficient of x(n) with period N and $X_2(k)$ denote the discrete Fourier series coefficient of x(n) with period 2N. Determine $X_2(K)$ in terms of $X_1(K)$.
   (b) Prove the following properties.
      i. $W_N INx(n) \rightarrow X((K+1))_N R_N(K)$
      ii. $X^*(n) \rightarrow X^*((-K))_N R_N(K)$

4. An 8 point sequence is given by x(n) = {2,2,2,2,1,1,1,1}. Compute 8 point DFT of x(n) by
   (a) radix 2 D I T F F T
   (b) radix 2 D I F FF T
   Also sketch magnitude and phase spectrum

5. (a) Explain how the analysis of discrete time invariant system can be obtained using convolution properties of Z transform.
   (b) Determine the impulse response of the system described by the difference equation y(n)-3y(n-1)-4y(n-2)=x(n)+2x(n-1) using Z transform.

6. Use the Bilinear transformation to convert the analog filter with system function $H(S) = S + 0.1/(S + 0.1)^2 + 9$ into a digital IIR filters. Select T = 0.1 and compare the location of the zeros in H(Z) with the locations of the zeros obtained by applying the impulse invariance method in the conversion of H(S).

7. (a) Design a high pass filter using hamming window with a cut-off frequency of 1.2 radians/second and N=9

   (b) Compare FIR and IIR filters.

8. (a) Explain the parallel form realisation for IIR system and obtain the direct form I, direct form II realisation of the LTI systems governed by the equation.
   $y(n) = -\frac{3}{8}y(n-1) + \frac{3}{32}y(n-2) + \frac{1}{64}y(n-3) + x(n) + 3x(n-1) + 2x(n-2)$

   (b) Compare cascade and parallel form relations.

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