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

III B.Tech I Semester Regular Examinations, November 2006
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. By explicitly evaluating the convolution sum, evaluate the convolution y(n)=(n)*h(n) of the sequences
$h(n) = \begin{cases} \alpha^n & 0 \le n < N \\ 0 & elsewhere \end{cases}$
$X(n) = \begin{cases} \beta^{n-n0}, & n_0 \le n \\ 0 \quad , & n \le n_0 \end{cases}$ [16]

2. (a) Let x(n) and $X(e^{jw})$ represent a sequence and its transform. Determine, in terms of $X(e^{jw})$, the transform of each of the following sequences :
   i. g(n) = x(2n)
   ii. $g(n) = \{x(n/2)$
   (b) State and prove convolution theorem. [10+6]

3. (a) Prove the following properties
   i. $arg[X(K)] = -arg[X((-K)_N)R_N(K)]$
   ii. $Im[X(K)] = -Im[X((-K))_N R_N(K)]$
   (b) If X(K) denotes the N-point DFT of N-Point sequence x(n), show that with N even and if x(n) = x(N-1-n) then X(N/2)=0. [8+8]

4. (a) Implement the Decimation in frequency FFT algorithm of N-point DFT where N-8. Also explain the steps involved in this algorithm.
   (b) Compute the FFT for the sequence x(n) = { 1, 1, 1, 1, 1, 1, 1, 1 } [8+8]

5. (a) How will you test the stability of a digital filter? Discuss the stability of the system described by $H(Z) = \frac{Z^{-1}}{1-Z^{-1}-Z^{-2}}$
   (b) Determine the frequency, magnitude and phase responses and time delay for the system
   $y(n) + \frac{1}{4}y(n-1) = x(n) - x(n-1)$ [8+8]

6. Given that $|Ha(j\Omega)|^2 = 1/1 + 64\Omega^6$, determine the analog filter system function Ha(S) and convert it to a digital proto type using Bilinear transformation technique. [16]

7. (a) Design a Finite Impulse Response low pass filter with a cut-off frequency of 1 kHz and sampling rate of 4 kHz with eleven samples using Fourier series method.

(b) Show that an FIR filter is linear phase if h(n) = h(N-1-n). [8+8]

8. (a) Describe how targets can be decided using RADAR
   (b) Give an expression for the following parameters relative to RADAR
      i. Beam width
      ii. Maximum unambiguous range
   (c) Discuss signal processing in a RADAR system. [4+6+4]

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

III B.Tech I Semester Regular Examinations, November 2006
DIGITAL SIGNAL PROCESSING
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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) Check the following systems for linearity, causality time invariance and stability
   i. $y(n) = \sum_{K=n-n_0}^{n+n_0} x(k)$
   ii. y(n) = a x(n-1) + b x(n)
   (b) A discrete system is described by the difference equation $y(n) - 1/2y(n-1) = x(n)$ with $y(-1) = a \ \ and \ \ x(n) = \alpha \ \ \delta(n)$. Find y(n) for all n. Verify whether the system is linear shift invariant causal system. [8+8]

2. (a) Let x(n) and $X(e^{jw})$ represent a sequence and its transform. Determine, in terms of $X(e^{jw})$, the transform of each of the following sequences :
   i. g(n) = x(2n)
   ii. $g(n) = \{x(n/2)$
   (b) State and prove convolution theorem. [10+6]

3. (a) Distinguish between DFT and DTFT .
   (b) Consider a sequence x(n) of length L. Consider its DTFT $X_d(w)$ is sampled and N is the number of frequency samples. Discuss the relation between L and N for inverse DTFT = inverse DFT comment on the aliasing problem.
   (c) Compute the DFT of $x(n) = \{1, 0, 0, 0\}$ and compare with $X_d(w)$. [4+6+6]

4. (a) Implement the Decimation in frequency FFT algorithm of N-point DFT where N-8. Also explain the steps involved in this algorithm.
   (b) Compute the FFT for the sequence x(n) = { 1, 1, 1, 1, 1, 1, 1, 1 } [8+8]

5. (a) How will you test the stability of a digital filter? Discuss the stability of the system described by $H(Z) = \frac{Z^{-1}}{1-Z^{-1}-Z^{-2}}$
   (b) Determine the frequency, magnitude and phase responses and time delay for the system
   $y(n) + \frac{1}{4}y(n-1) = x(n) - x(n-1)$ [8+8]

6. Determine the system function H(Z) of the lowest order Chebyshev and Butterworth digital filter with the following specification
   (a) 3 db ripple in pass band $0 \leq w \leq 0.2\pi$

(b) 25 db attenuation in stop band $0.45\pi \leq w \leq \pi$ [16]

7. (a) Define Infinite Impulse Response & Finite Impulse Response filters and compare.

   (b) Design a low pass Finite Impulse Response filter with a rectangular window for a five stage filter given:
   Sampling time 1 msec; $f_c = 200Hz$
   Draw the filter structure with minimum number of multipliers. [6+10]

8. (a) An LTI system is described by the equation , y(n) + y(n-1) - 1/4y(n-2) = x(n). Determine the cascade realisation structure of the system. Discuss the stability of the system.

   (b) Explain how speech is processed digitally. [10+6]

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

III B.Tech I Semester Regular Examinations, November 2006
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 discrete linear time invariant system described by the difference equation:
Y(n)-(3/4)y(n-1)+(1/8)y(n-2)=x(n))+(1/3)x(n-1)
Where y(n) is the output and x(n) is the input.
Assuming that the system is relaxed initially obtain the unit sample response of the system.

   (b) Find the:

      i. impulse response

      ii. output response for a step input applied at n=0 of a discrete time linear time invariant system whose difference equation is given by y(n) = y(n-1)+0.5 y(n-2)+x(n)+x(n-1). [8+8]

2. (a) State and prove time and frequency shifting properties of Fourier transform.

   (b) Find the Fourier transform of the following signals [8+8]

      i. $x(n) = (\alpha^n sinw_o n)u(n)\ |\alpha| < 1$

      ii. $x(n) = (1/4)^n u(n+4)$

3. (a) Compute the discrete Fourier transform of each of the following finite length sequences considered to be of length N.

      i. $x(n) = \delta(n)$

      ii. $x(n) = \delta(n - n_0) where 0 < n_0 < N$

      iii. $x(n) = a^n 0 \leq n \leq N-1$

   (b) Let $x_2(n)$ be a finite duration sequence of length N and $x_1(n) = \delta(n - n_0)$ where $n_0 < N$. Obtain the circular convolution of two sequences. [8+8]

4. (a) Implement the Decimation in frequency FFT algorithm of N-point DFT where N-8. Also explain the steps involved in this algorithm.

   (b) Compute the FFT for the sequence x(n) = { 1, 1, 1, 1, 1, 1, 1, 1 } [8+8]

5. (a) How will you test the stability of a digital filter? Discuss the stability of the system described by $H(Z) = \frac{Z^{-1}}{1-Z^{-1}-Z^{-2}}$

   (b) Determine the frequency, magnitude and phase responses and time delay for the system
$y(n) + \frac{1}{4}y(n-1) = x(n) - x(n-1)$ [8+8]

6. (a) Discuss impulse invariance method of deriving IIR digital filter from corresponding analog filter.

   (b) Convert the following analog filter with transfer function $H_A(S) = S + 0.2/(S + 0.2)^2 + 16$ using impulse invariance method. [8+8]

7. (a) Outline the steps involved in the design of FIR filter using windows.

   (b) Determine the frequency response of FIR filter defined by y(n) = 0.25x(n)+ x(n-1)+ 0.25x(n-2). Calculate the phase delay and group delay. [8+8]

8. (a) A causal system is represented by the following difference equation.
   $y(n) + \frac{1}{4}y(n-1) = x(n) + \frac{1}{2}x(n-1)$
   Find the system transfer function H(Z), unit sample response and frequency response of the system

   (b) Realize $H(Z) = 1 + \frac{1}{2}Z^{-1} + \frac{1}{8}Z^{-2} + \frac{3}{4}Z^{-3} + \frac{1}{8}Z^{-4} + \frac{1}{2}Z^{-5} + Z^{-6}$ with minimum number of multipliers. [8+8]

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

III B.Tech I Semester Regular Examinations, November 2006
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) 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. $F[x(n)] = a[x(n)]^2 + bx(n)$ [4+4+8]

2. (a) State and prove time and frequency shifting properties of Fourier transform.
   (b) Find the Fourier transform of the following signals [8+8]
      i. $x(n) = (\alpha^n sinw_o n)u(n)\ |\alpha| < 1$
      ii. $x(n) = (1/4)^n u(n+4)$

3. (a) Prove the following properties
      i. $arg[X(K)] = -arg[X((-K)_N)R_N(K)]$
      ii. $Im[X(K)] = -Im[X((-K))_N R_N(K)]$
   (b) If X(K) denotes the N-point DFT of N-Point sequence x(n), show that with N even and if x(n) = x(N-1-n) then X(N/2)=0. [8+8]

4. (a) Implement the Decimation in frequency FFT algorithm of N-point DFT where N-8. Also explain the steps involved in this algorithm.
   (b) Compute the FFT for the sequence x(n) = { 1, 1, 1, 1, 1, 1, 1, 1 } [8+8]

5. (a) How will you test the stability of a digital filter? Discuss the stability of the system described by $H(Z) = \frac{Z^{-1}}{1-Z^{-1}-Z^{-2}}$
   (b) Determine the frequency, magnitude and phase responses and time delay for the system
   $y(n) + \frac{1}{4}y(n-1) = x(n) - x(n-1)$ [8+8]

6. (a) What is an IIR digital filter?
   (b) How are IIR digital filter realized?
   (c) What are the various realizability constraints imposed on transfer function of an IIR digital filter. [4+4+6]

7. Design a low pass Finite Impulse Response filter that approximate the following frequency response:
$H(f) = \begin{cases} 1\,;\ 0 \le f \le 1000\,Hz \\ 0\,;\ elsewhere\,\text{in}\,the\,range\,0 \le f \le f_s/2 \end{cases}$
when the sampling frequency is 8000 sps. The impulse response duration is to be limited to 2.5 msec. Draw the filter structure. [16]

8. (a) What are the basic elements used to construct the block diagram of discrete time system?

   (b) Construct the block diagram and signal flow graph of the discrete time system whose input-output relations are described by following difference equation

   i. $y(n) = 0.5x(n) + 0.5x(n-1)$

   ii. $y(n) = 0.25y(n-1) + 0.5x(n) + 0.75x(n-1)$ [4+12]

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