Code No: RR320402

Set No. 1

III B.Tech II Semester Supplementary Examinations, November/December 2005
DIGITAL SIGNAL PROCESSING
(Common to Electronics & Communication Engineering, Electronics & Instrumentation Engineering, Electronics & Control Engineering, Electronics & Telematics and Instrumentation & Control Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) A second order discrete time system is characterized by the difference equation. y(n)-0.1y(n-1)-0.02y(n-2)=2x(n)-x(n-1). Determine y(n) for $n \geq 0$ when $x(n) = u(n)$ and the initial conditions are y(-1) = -10 and y(-2) = 5.
   (b) State the conditions for a digital filter to be causal and stable.
   [12+4]

2. Prove the following properties of the discrete Fourier series for periodic sequences.

Sequences	Discrete Fourier Series
(a) x(n+m)	$W_N^{-Km}X(K)$
(b) x*(n)	X*(-K)
(c) x*(-n)	X*(K)
(d) Re[x(n)]	$X_e(K)$
(e) jIm[x(n)]	$X_o(K)$

[16]

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. $W_N^n x(n) \rightarrow X\left((K+1)\right)_N R_N(K)$
      ii. $\mathrm{x} * (\mathrm{n}) \rightarrow \mathrm{X} * \left((-\mathrm{K})\right)_{\mathrm{N}} \mathrm{R_N(K)}$ [8+8]

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. [16]

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+10]

6. (a) Find the order and poles of a low pass Butterworth filter that has a -3db bandwidth of 500 Hz and an attenuation of 40db at 1KHz.

(b) Convert the following analog filter with transfer function $H(S) = S + 0.1/(S + 0.2)^2 + 9$ into a digital IIR filter by using bilinear transformation method. The digital IIR filter is having a resonant frequency of $Wr = \pi/2$. [8+8]

7. (a) Compare the performances of rectangular window, hamming window and Keiser window

(b) The desired response of a low pass filter is

$$H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega}, & -3\pi \leq \omega \leq 3\pi/4 \\ 0 \quad , & 3\pi/4 \leq |\omega| \leq \pi \end{cases}$$

Determine $H(e^{j\omega})$ for M=7 using a Hamming window. [6+10]

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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1. (a) Let e(n) be an exponential sequence $e(n) = \alpha^n$ for all 'n' and let x(n) and y(n) be two arbitrary sequences. Show that [e(n)y(n)]* [e(n)x(n)]=e(n)[y(n)*x(n)]where '*' denotes convolution operation.
   (b) A system is described by the difference equation y(n)-y(n-1)-y(n-2) = x(n-1). Assuming that the system is initially relaxed, determine it s unit sample response h(n). [8+8]

2. Explain the geometrical construction method to determine magnitude and phase response of second order digital systems. [16]

3. (a) Define DFT. Guide tow properties of DFT.
   (b) Discuss the effects of truncating a sequence x(n) of infinite duration.
   (c) Compute the DFT of $X(n) = \{-1, 0, -1\}$ with T = 0.5. Plot the DFT sequence suggest a method for improving frequency resolution. [4+6+6]

4. (a) Implement the decimation in time FFT algorithm for N=16.
   (b) In the above Question how many non - trivial multiplications are required. [10+6]

5. (a) An LTI system is described by the equation y(n)=x(n)+0.81x(n-1)-0.81x(n-2)-0.45y(n-2). Determine the transfer function of the system. Sketch the poles and zeroes on the Z-plane.
   (b) Define stable and unstable system test the condition for stability of the first-order IIR filter governed by the equation y(n)=x(n)+bx(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. (a) Design a low pass digital FIR filter using Kaiser window satisfying the specifications given below.
   Pass band cut-off frequency = 150 Hz.

Stop band cut-off frequency = 250 Hz.
Pass band ripple = 0.1dB
Stop band attenuation = 40 dB
Sampling frequency = 1000 Hz.

(b) Draw the butterfly line diagram for 8 - point FFT calculation and briefly explain. Use decimation -in-time algorithm. [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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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) Prove the modulation and time shifting properties of distribute time Fourier transform.
   (b) A discrete system is given by following difference equation
   y(n)-5y(n-1) = x(n) + 4x(n-1)
   where x(n) is the input and y(n) is the out put. Determine its magnitude and phase response as a function of frequency.
   [8+8]

3. (a) Define DFT. Guide tow properties of DFT.
   (b) Discuss the effects of truncating a sequence x(n) of infinite duration.
   (c) Compute the DFT of $X(n) = \{-1, 0, -1\}$ with T = 0.5. Plot the DFT sequence suggest a method for improving frequency resolution. [4+6+6]

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. [8+8]

5. (a) With reference to Z-transform, state the initial and final value theorem.
   (b) Determine the causal signal x(n) having the Z-transform $X(Z) = \frac{Z^2+Z}{\left(Z-\frac{1}{2}\right)^2\left(Z-\frac{1}{4}\right)}$.
   [6+10]

6. (a) Using Bilinear transformation on an analog filter transfer function Ha(S), given the following 'S' plane points.
   S = 0.2++j0, -0.1+j0.3, -0.1+j0.6
   Find the corresponding 'Z' plane points. Also plot the resulting 'Z' plane points.

(b) A signal $x(t) = 5Sin5\pi t$ is passed through a filter. If the signal is samples at T=1/50 seconds and number of sampling intervals equals 150 then sketch the input signal x(nT) and the output of the filter. [8+8]

7. (a) Design a low pass filter using Fourier series method using rectangular windows for 5 taps only, if the folding frequency is 5 kHz and the corner frequencies are 1 and 3 kHz.

   (b) List the merits and demerits of Finite Impulse Response filters. [10+6]

8. (a) What are the advantages in cascade and parallel realisation of IIR systems

   (b) The transfer function of a system is given by

$$H(Z) = \frac{\left(1 + Z^{-1}\right)^3}{\left(1 - \frac{1}{4}Z^{-1}\right)\left(1 - Z^{-1} + \frac{1}{2}Z^{-2}\right)}$$

[6+10]

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1. (a) A second order discrete time system is characterized by the difference equation. y(n)-0.1y(n-1)-0.02y(n-2)=2x(n)-x(n-1). Determine y(n) for $n \geq 0$ when $x(n) = u(n)$ and the initial conditions are y(-1) = -10 and y(-2) = 5.
   (b) State the conditions for a digital filter to be causal and stable. [12+4]

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. [16]

3. (a) Prove the following properties.
      i. $x^*(n) \rightarrow X^*((-K))_N R_N(K)$
      ii. $x^*((-n))_N R_N(n) \rightarrow X_{ep}(k) = 1/2[X((K))_N + X^*((-K))_N]R_N(K)$
   (b) Let X(K) denotes the N-point DFT of the N-point sequence x(n) show that if x(n) satisfies the relation $x(n) = -x(N-1-n) then X(0) = 0$. [8+8]

4. (a) Let x(n) be a real valued sequence with N-points and Let X(K) represent its DFT , with real and imaginary parts denoted by $X_R(K)$ and $X_1(K)$ respectively. So that X(K) = $X_R(K) + JX_1(K)$. Now show that if x(n) is real, $X_R(K)$ is even and $X_1(K)$ is odd.
   (b) Compute the FFT of the sequence x(n) = { 1, 0, 0, 0, 0, 0, 0, 0 } [8+8]

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. [8+8]

6. Design a Digital IIR low pass filter with pass band edge at 1000 Hz and stop band edge at 1500 Hz for a sampling frequency of 5000 Hz. The filter is to have a pass band ripple of 0.5 db and stop band ripple below 30 db. Design Butter worth filler using both impulse invariant and Bilinear transformations. [16]

7. (a) Design a low pass filter using rectangular window by taking samples of $\omega(n)$ and with a cut-off frequency of 1.2 radians/sec.

(b) Compare the various window functions. [8+8]

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. [12+4]

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