Total number of printed pages - 11

B. Tech
BPEC 5302

SIXTH SEMESTER EXAMINATION - 2007

DIGITAL SIGNAL PROCESSING

Full Marks - 70 **Time : 3 Hours**

Answer the questions either from Set - A or Set - B but not from both .

Set - 'A'

Answer Question No.1 which is compulsory and any five from the rest .

The figures in the right-hand margin indicate full marks for the questions .

1. Answer the following questions : 2×10

a) What is Nyquist rate ? Compute the Nyquist rate for the given analog signal .

$x_a(t) = 10 \cos 50\pi t + 20 \sin 200\pi t - 10 \cos 100\pi t$

b) Find the discrete-time-signal having the following Fourier transform :

$$X(\omega) = \begin{cases} 0, & 0 \le |\omega| \le 1.2 \\ 1, & 1.2 < |\omega| \le \pi \end{cases}$$

c) Determine the even and odd parts of the following real sequence :

$x(n) = \{-2\ 1\ 2\ 5\ \underset{\uparrow}{0}\ 0.1\ 6\ 3\}$

d) Show that a causal real sequence x (n) can be fully recovered from its even part x_{ev} (n) for all n, whereas it can be recovered from its odd part x_{odd} (n) for all n > 0 .

e) What is the unit of z^{-1} ?

f) What is time reversal property of Z-transform ? Discuss .

g) What is the link between autocorrelation and power spectral density ?

h) Draw the structure of the following difference equation :

$y(n) = 4x(n) + 6x(n-1) + 4x(n-2) - 2y(n-1)$

i) What is linear phase characteristic of FIR filter ? Where is it useful ?

j) Write two advantages of non parametric method of power spectrum estimation .

2. a) Test the following discrete systems as per the given direction : 2

i) $y(n) = \alpha x(-n)$, Linearity test ;

ii) $y(n) = \beta + \sum_{i=-5}^{i=5} x(n-1)$, Causality test .

b) Test whether the system y (n) = x (-n +2) is shift invariant and stable . 2

c) The impulse response of a LTI system is h (n) = {2, 1, 4, 2 } . Find the response of the system if the input is x (n) = { 1, 2, 3, 4 }. Use graphical method . 6

3. a) Obtain the circular convolved output from the following data : 5

N = 3, x (n) = -1, 2, 4 and h (n) = 2, 1, 2

b) Let y(n) be the sequence obtained by a linear convolution of two causal finite duration sequences h(n) and x (n) . For the given y(n) and h (n) , determine x (n) . 5

$y(n) = \{2, 8, 20, 40, 60, 68, 62, 40\}$;

$h(n) = \{2, 4, 6, 8\}$

4. a) Find the impulse response of the system described by $x(n) = y(n-1) + 2y(n-2)$. Assume zero initial conditions . 4

b) Define 'Z-transforms' . Find the inverse Z-trans-form for the following function : 4

$X(z) = \frac{1+4z^{-2}}{1+z^{-2}}$. Use long division method .

c) Write circular convolution property of DFT . 2

5. a) Distinguish between digital FIR and IIR filters . Discuss window based design method for design of FIR filters . 4

b) Find the system function H (z) of the digital Butterworth filter that meets the following specifications :

i) 2-dB ripple in the passband $0 \leq |\omega| \leq 0.3\pi$.

ii) At least 30 dB attenuation in the stop band $0.3\pi \leq |\omega| \leq \pi$.

Use bilinear transformation method . 6

6. a) Show how an inverse DFT can be obtained by using direct DFT method. Draw the flow graph for a 4-point FFT by DFT method. Explain how the same flow graph can be used to compute inverse DFT . 5

b) Compute the IDFT of the sequence $X(k) = \{4, 2 + j, 2, 2 - j\}$. 5

7. a) Using impulse invariance method obtain the digital transfer function and the corresponding filter structure .

$H_a(s) = \{1/(s+0.5)(s^2 + 0.5s + 2)\}$. Assume T = 1 sec . 6

b) Draw the corresponding IIR filter structure . 2

c) Define ' analog frequency' and 'digital frequency' . 2

8. a) Why power spectrum estimation is required in signal processing ? List two applications. 5

b) Explain Blackman and Tukey method of power spectrum estimation. What are its advantages over Bartlett method ? 5

Set - 'B'

Answer Question No.1 which is compulsory and any five the rest .

The figures in the right-hand margin indicate full marks for the questions .

1. Answer the following questions : 2×10

i) What are the discrete time and continuous time signals ?

ii) Differentiate between odd and even signals .

iii) What is an impulse function ?

iv) What is the Fourier Transform of sin (t) ?

v) What is a causal system ?

vi) What do you mean by periodic or circular convolution ?

vii) What are twiddle factors ?

viii) What are advantages and disadvantages of digital filters over analog filters ?

ix) What is quality of power spectrum estimation ?

x) What do you mean by parametric methods for power spectrum estimation ?

2. a) Find even and odd parts of the function $x(n) = A \sin\omega n$. 5

b) Plot the even and odd parts of the function .

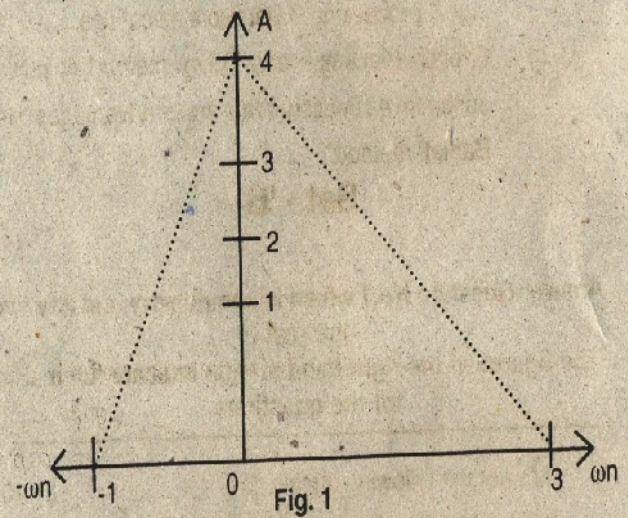

Fig. 1

3. Given $y(n) = \delta(n)$, sketch the following signals : 10

a) $a(n-6)$.

b) $y(n+4)$.

c) $y(n^2)$.

d) $y[(n-6)^2]$.

4. Convolve the followings : 5+5

a) $x(n) = u(n+1) - u(n-5) + u(n-6)$

$h(n) = u(n+2) - u(n-3)$

b) $x_1(n) = (\ldots, 1,1,1,1,\ldots)$ and $x_2(n) = (\ldots, 1,1,1,1\ldots)$, $N = 4$

5. Prove that convolution in time domain is equal to multiplication in frequency domain . Compute N-point DFT of the sequence : 10

a) $x(n) = \delta(n)$

b) $x(n) = \delta(n-n_0), 0 \le n \le N-1$

6. Explain is Decimation - in - time EFT algorithm, Decimation-in-frequency FET algorithm . 10

7. Design a Butterworth digital filter for : 10

Pass-band gain required : 0.95

Frequency up to which pass-band gain must remain steady, $f_1 = 500$ Hz

Amount of attenuation : 0.20

Frequency from which attenuation must start, $f_2 = 3000$ Hz .

8. Define and plot the followings : 10

a) Delta function .

b) Step function .

c) Ramp function .

d) Exponential function .

e) sinusoidal function .

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