2014

Digital Signal Processing

Time Alloted : 3 Hours *Full Marks : 70*

The figure in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable

GROUP - A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any ten of the following: 10x1=10

i) The energy of the signal x(n)= nu(n) is

a) n(n+1)/2
b) n(n+l)(2n+l)/6
c) $\{n(n+1)/2\}^2$
d) ∞

ii) The convolution of u(n) with u(n-3) at n=4 is

a) 4
b) 2
c) 1
d) 0

iii) If y(n)={l, 2, 3,4, 5, 6} then y(n-3) is

a) {1, 2, 3, 4, 5, 6}
b) {1, 2, 3, 4, 5, 6, 0}
c) {1, 2, 3, 4, 5, 6}
d) {1, 2, 3, 4, 5, 6}

iv) Zero padding a signal

a) reduces aliasing
b) increases time resolution
c) increases frequency resolution
d) has no effect

v) Choose the correct from the following for twiddle factor:

a) $W^r = W^{r\pm\frac{N}{2}}$
b) $W^r = -W^{r\pm\frac{N}{2}}$
c) $W^{r/2} = W^{r\pm\frac{N}{2}}$
d) $W^r = W^{\left(\frac{r\pm n}{2}\right)}$

vi) z-transform of u(- n) is:

a) 1
b) 0
c) $\frac{1}{1-z}$
d) $\frac{z}{z-1}$

vii) If x(n)={j,-j} then

a) X(k)={2j,0}

b) X(k)={0,0}

c) X(k)={ 0,2j}

d) X(k)={-j,j}

viii) The mapping from analog to digital domain in impulse invariant technique is

a) one-to-one

b) many-to-one

c) one-to-many

d) none of these.

ix) The transfer function of a system with impulse response h(n)= u(n)- u(n-l) is.

a) 2

b) $\frac{z}{(z-1)(z+1)}$

c) 1

d) $\frac{z}{z-1}$

x) For a rectangular window of N samples, width of the main lobe is

a) $\frac{2\pi}{N}$

b) $\frac{4\pi}{N}$

c) $\frac{12\pi}{N}$

d) $\frac{\pi}{N}$

xi) Pole of a Butterworth filter lie

a) on an ellipse

b) on a circle

c) on a parabola

d) on a rectangle.

xii) The direct evaluation of N-point DFT requires

a) N^2 complex multiplications and N^2 complex additions.

b) N^2 complex multiplications and N(N-l) complex additions.

c) N(N-1) complex multiplications and N^2 complex additions

d) N(N-1) complex multiplications and N(N-1) complex additions

xiii) For an analog signal x(t)= 3 cos(50πt)+10 sin(300πt). The Nyquist sampling rate is

a) 150Hz

b) 25Hz

c) 600 Hz

d) 300 Hz

GROUP - B
(Short Answer Type Questions)

Answer any ***three*** of the following. **3x5=15**

2. Consider an input x(n) & impulse response h(n) given by:

$x(n) = (\frac{1}{2})^{n-2} u(n-2), h(n) = u(n+2)$ Determine output y(n).

5

3. Determine the response of LT1 system described the equation, y(n)=0.5y(n-l)+x(n),

for input $x(n)=5^n u(n)$ and initial condition y(-1)=2.

5

4. Find out the IDFT of Y(k)={10, 2+j, -2,2-j}.

5

5. If x(n)=r(n)-r(n-2), determine whether the signal is power signal or energy signal.

5

6. Find out the circular convolution of the following sequences where,

$x_1(n)$={1,3,-3,2} & $x_2(n)$={2,3,1}.

5

GROUP - C
(Long Answer Type Questions)

Answer any ***three*** of the following. **3x15=45**

7. a) How will you obtain linear convolution from circular convolution? Explain with an example.

b) Find inverse z-transform of $X(z) = \frac{z^2}{\left(z-\frac{1}{4}\right)^2}$ $ROC: |z| > \frac{1}{4}$ using convolution method.

c) Find the inverse Z-transform of $X(z) = \frac{z\left(z^2-4z+5\right)}{(z-1)(z-2)(z-3)}$ for ROC: i) 2<|z|<3 ii) |z|<1

5+5+5

8. a) Consider the difference equation:

$$y(n) - \frac{5}{6}y(n-1) + \frac{1}{6}y(n-2) = \frac{1}{3}x(n-1)$$

i) Find the system function and ii) Find impulse response of the above system.

b) Find the output of an LTI system with input x(n) = u(n) and impulse response of the system $h(n) = 5\left(-\frac{1}{2}\right)^n u(n)$

c) Find the circular convolution of two sequence using concentric circle method:

x(n)={1, 2, 2, 1} and h(n)={1, 2, 1, 3}

5+5+5

9. a) Let x(n), 0≤n≤N-1 be a sequence with an N-point DFT X(k),

0≤k≤N-1:If N even and $x(n) = -x\left(n+\frac{N}{2}\right)$, then show that X(k)=0

for k even.

b) Compute the 8-point DFT of the sequence x(n)={1, 1, 1, 1, 0, 0, 0, 0} using DIF-FFT algorithm.

c) Draw the basic butterfly diagram for DIT-FFT algorithm.

5+8+2

10. An analog filter has transfer function $G(s) = \frac{2}{(s+1)(s+2)}$,

Discretize the filter to obtain the transfer function of an equivalent discrete time filter by impulse-invariant technique. Consider a sampling time, T=1sec

b) Design a digital Butterworth filter satisfying the constraints

$$0.707 \le |H(e^{jw})| \le 1; \text{ for } 0 \le w \le \frac{\pi}{2}$$

$$|H(e^{jw})| \le 0.2; \text{ for } \frac{3\pi}{4} \le w \le \pi$$

With T=1sec using the Bilinear transformation.

5+10

11. a) What is the difference between recursive and non-recursive system?

b) Design an FIR filter approximate the ideal frequency response

$$H_d(e^{jw}) = e^{-j\omega} \text{ for } |\omega| \le \frac{\pi}{6}$$

=0 $\text{for } \frac{\pi}{6} \le |\omega| \le \pi$ Determine the filter coefficients for N=13

c) What is the difference between FIR and IIR filer?

d) What is Gibbs phenomenon?

3+5+4+3