T.E. Sem 6 (Rev.) I.T. Digital Signal Processing 16/6/08

P4/RT-Ex-08-634

Con. 2655–08. [REVISED COURSE] CO–2980

(3 Hours) [Total Marks : 100

N.B. : (1) Question No. **1** is **compulsory**.
(2) Attempt any **four** questions out of remaining **six** questions.
(3) Assume **suitable** data if **required**.

1. (a) Determine whether following is periodic – 4
   (i) cos (0·01 π n)
   (ii) Sin 3 n

   (b) Find x(n) if $x(z) = \frac{1+\frac{1}{2}z^{-1}}{1-\frac{1}{2}z^{-1}}$. 4

   (c) Compare IIR filter with FIR filter. 4

   (d) Find number of real additions and real multiplications required to find DFT for 32 point signal. Compare them with the number of computations required if FFT algorithm is used. 4

   (e) Let x(n) be a real sequence of 8 point having corresponding DFT x(k) as follows :– 4
   x(k) = {1, 2–j, 1 + 3j, 4–j, 2, — , —, — }. Complete the above sequence.

2. (a) (i) Find energy of the following signal :– 5

$$x(n) = \left(\frac{1}{2}\right)^n u(n) + 3^n u(-n-1)$$

   (ii) Show that if x(n) is odd signal then Σ x(n) = 0. 5

   (b) An analog signal – 10
   $x_a(t)$ = sin(480 π t) + 3 sin(720 π t) is sampled 600 times / second –
   (i) Determine Nyquist rate for $x_a(t)$.
   (ii) Determine the folding frequency.
   (iii) What are the frequencies, in radian, in the resulting discrete time signals?
   (iv) If x(n) is passed through ideal D/A converter, what is reconstructed signal $y_a(t)$?
   (v) What is the resolution Δ ?

3. (a) A causal DT system has transfer function H(z) such that $H(z) = H_1(z) \cdot H_2(z)$. $H_1(z)$ has one pole at z = 0·5 and one zero at $z = \frac{1}{3}$. $H_2(z)$ has one pole at z = 0 and one zero at $z = -\frac{1}{2}$.
   (i) Find transfer function of the system. 3
   (ii) Find difference equation of the system. 2
   (iii) Find response of the system to input 3

$$x(n) = \left(-\frac{1}{2}\right)^n u(n)$$

   (iv) Draw pole-zero plot of the overall system and hence comment on stability. 2

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(b) The difference equation of the system is given by – 10

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

to system input $x(n) = \left(\frac{1}{2}\right)^n u(n)$

$y(-1) = 1, (-2) = 0.$

Find – (i) zero input response
(ii) zero state response
(iii) total response.

4. (a) If x(n) = { 1, 2, 3, 4, 4, 3, 2, 1 }, find x(k) using DIT – FFT algorithm. 10

(b) If x(n) = { 1, 2, 3, 4 }, then

(i) Find x(k) using DFT equation

(ii) If $x_1(n)$ = { 1, 2, 3, 4, 1, 2, 3, 4 }, find $x_1(k)$ using above result.

5. (a) Obtain direct form I, direct form II, cascade and parallel realization for following function :– 10

$$H(z) = \frac{(z-1)\ (z-2)}{(z+1)\ (z+2)\ (z+3)}.$$

(b) Obtain linear convolution using circular convolution. 10

$x(n) = \delta(n) + 2\delta(n-1) - \delta(n-2)$

$h(n) = 2\delta(n) + 3\delta(n-2).$

6. (a) Design a Butterworth filter using BLT for following specifications :– 10

$A_P = 3dB$

$W_P = 0{\cdot}5\pi$

$A_S = 15dB$

$W_S = 0{\cdot}75\pi.$

(b) Design a low pass filter if desired frequency response is – 10

$$Hd(e^{jw}) = e^{-2jw} \qquad \frac{-\pi}{4} \le w \le \pi/4$$

$$= 0 \qquad \pi/4 \le w \le \pi$$

Use rectangular window.

7. Write short notes on :– 20

(a) Hilbert Transform
(b) Gortzel Algorithm
(c) Chirps Z Transform Algorithm
(d) Overlap Add and Overlap save method.