T.E. (Extc) (Sem VI / Rev) 4/6/07.
(Library)
ws May 07-237
Discrete Time Signal Processing.

Con. 3176-07. **(REVISED COURSE)** **ND-1969**

(3 Hours) **[Total Marks : 100**

N.B. : (1) Question No. **1** is **compulsory**.
(2) Attempt any **four** out of remaining **six** questions.
(3) **Figures** to the **right** indicate **full** marks.
(4) Assume **suitable** data if **necessary**.

1. (a) State whether each of the following statement is **true** or **false**. Justify your answer (any **three**) : **12**
   (i) A stable filter is always causal.
   (ii) LTI system is stable if its response is absolutely summable.
   (iii) $H_1(z)$ and $H_2(z)$ both have zeros at (+0·5) and (–0·2). However $H_1(z)$ has both the poles at origin, whereas $H_2(z)$ has only one pole and it is situated at origin. Both systems are causal FIR systems.
   (iv) ROC of the transfer function of stable filter must include z = 0.

   (b) Test the following systems for Linearity, Stability, Time Invariance, Causality : **8**
   (i) $y(n) = x(n) \cos (w_0 n)$
   (ii) $y(n) = \text{Trunc}\{x(n)\}$ i.e. Truncation of x(n).

2. When the input to LTI system is —

$$x(n) = \left(\frac{1}{2}\right)^n u(n) + 2^n u(-n-1) \text{ the output is } y(n) = 6\left(\frac{1}{2}\right)^n u(n) - 6\left(\frac{3}{4}\right)^n u(n)$$

   (a) Find system function H(z) of the system **4**
   (b) Show DF – I, DF – II realization of the system **4**
   (c) Obtain impulse response of the system **4**
   (d) Obtain expression for Magnitude Response and Phase Response and Sketch it **6**
   (e) Identify the system type based on its passband and based on its phase response. **2**

3. (a) $x_1(n) = \{1, 1, 2, 2\}$; $x_2(n) = \{2, 3, 4, 2\}$. Find $X_1(k)$ and $X_2(k)$ of the above sequences by computing DFT only once. **8**

   (b) (i) Using DIT – FFT, find X(k) of the following sequence : **8**
$$x(n) = 1, \quad 0 \le n \le 3$$
$$= 0, \quad 4 \le n \le 7$$
   (ii) Using above DFT, compute DFT of following sequence : **4**
$$x(n) = 1, \quad n = 0$$
$$= 0, \quad 1 \le n \le 4$$
$$= 1, \quad 5 \le n \le 7$$

4. (a) Using overlap and save technique perform convolution of $x(n) = \{1, 2, 3, 4, 5, 6, 7, 8\}$ with $h(n) = \{1, {}^1/_2\}$. **10**

   (b) Using DFT / IDFT method, find response of the system with impulse response $h(n) = 2\,\delta(n) + 5\,\delta(n)$ if the input to the system is — **10**
$x(n) = 2\,\delta(n) + 3\,\delta(n-1) + 5\,\delta(n-2)$.

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5. (a) The difference equation of the system is given by –

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

to the system i/p $x(n) = \left(\frac{1}{2}\right)^n u(n)$ $y(-1) = 1,\ y(-2) = 0$

Find (i) Zero i/p response 4
(ii) Zero state response 4
(iii) Total response of the system. 2

(b) The system function of the LTI system is given as — 10

$$H(z) = \frac{3 - 4z^{-1}}{1 - 3\cdot 5\,z^{-1} + 1\cdot 5\,z^{-2}}$$

Specify ROC of H(z) and determine unit sample response h(n) for following conditions :
(i) Stable system
(ii) Causal system
(iii) Anticausal system.

6. (a) Consider a causal LTI system whose system function is : 12

$$H(z) = \frac{1 + \frac{1}{5}z^{-1}}{\left(1 - \frac{1}{2}z^{-1} + \frac{1}{3}z^{-2}\right)\left(1 + \frac{1}{2}z^{-1}\right)}$$

Implement the system in each of the following forms :
(i) Direct form I
(ii) Direct form II
(iii) Cascade form
(iv) Parallel form.

(b) Determine energy of the signal : 4

$$x(n) = \left(\frac{1}{2}\right)^n \quad \text{for } n \ge 0$$
$$= 3^n \quad \text{for } n < 0$$

(c) Obtain inverse z-transform of — 4
$X(z) = \ln(1 + az^{-1}), \quad |z| > |a|.$

7. (a) With the help of neat block diagram explain any one DSP processor in detail. 8
(b) Explain relationship between DFT, DTFT and z-transforms. 4
(c) Write short note on system classification. 4
(d) Compare IIR and FIR systems. 4