

Total number of printed pages – 6

B. Tech  
CPEC 5302

FIFTH SEMESTER EXAMINATION – 2005

DIGITAL SIGNAL PROCESSING

Full Marks – 70

Time : 3 Hours

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

Answer any six questions including Q.1 which is compulsory. Answer all the questions from Group-A and any five from Group-B. Unless otherwise stated, consider  $x(n)$  as input and  $y(n)$  as the output of the system. Sketch of neat figures with proper labeling is mandatory in appropriate places.

**Group – A**

Each question in Group-A carries 2 marks.

1. (a) What is the minimum required sampling rate

P.T.O.

for an analog signal of the form  $5\cos 200\pi t$  to avoid aliasing ?

- (b) Give the step size of a 3-bit quantizer if it handles a signal swinging from  $-4v$  to  $+4v$  ?
- (c) Find out if a system described by  $y(n)=Ax(n)+B$  is linear ?
- (d) What is a discrete Hilbert transform ?
- (e) Prove that DFT is a linear operation.
- (f) Find out the frequency response of a system described by the difference equation  $y(n) = ay(n-1)+bx(n)$ . It is given that  $0 < |a| < 1$ .
- (g) Determine the Fourier transform of a unit rectangular pulse of width  $T$ . Sketch the spectrum.
- (h) How many multiplications and additions are needed for the direct computation of an  $N$ -point DFT ?

- (i) Give the mapping of the  $s$ -plane to the  $z$ -plane.
- (j) How DFT is used in the power spectrum estimation ?

### Group - B

Answer any five questions.

2. (a) Determine the range of values  $a$  and  $b$  for which the linear time-invariant system with the impulse response  $h(n) = \{a^n \text{ for } n \geq 0 \text{ and } b^n \text{ for } n < 0\}$  is stable. 5
- (b) Determine the output  $y(n)$  of a relaxed LTI system with impulse response  $h(n) = a^n u(n)$  when the input is a unit step function  $x(n) = u(n)$ . It is given that  $|a| < 1$ . 5
3. (a) Give the realization of a recursive cumulative averaging system whose input is  $x(n)$  and

output is  $y(n)$ . Develop the appropriate equation. Why it is recursive? 7

(b) Give the nonrecursive realization of an FIR moving average system with proper labeling. Why it is called moving average? 3

4 (a) Determine the crosscorrelation of the sequences :

$$x(n) = \{\dots, 0, 0, 2, -1, 3, 7, 1, 2, -3, 0, 0, \dots\} \text{ and}$$

↑

$$y(n) = \{\dots, 0, 1, -1, 2, -2, 4, 1, -2, 5, 0, 0, \dots\} \quad 6$$

↑

(b) Determine the z-transform of the signal  $x(n) = \{1, 0 \leq n \leq N - 1 \text{ and } 0 \text{ elsewhere}\}$

4

5 (a) By means of DFT and IDFT, determine the sequence  $x_3(n)$  corresponding to the circular convolution of two sequences  $x_1(n) = \{2, 1, 2, 1\}$  and  $x_2(n) = \{1, 2, 3, 4\}$ . 8

(b) What is circular convolution of two finite-duration sequences? 2

6. Determine the coefficients of a linear phase FIR filter length  $M=15$  which has a symmetric unit sample response and a frequency response that satisfies the conditions 10

$$H_r\left(\frac{2\pi k}{15}\right) = \begin{cases} 1, & k=0, 1, 2, 3 \\ 0.4, & k=4 \\ 0, & k=5, 6, 7 \end{cases}$$

7. Give the two direct forms of realizations of IIR structures. Work out the appropriate equations and label the diagrams clearly. 10

8. (a) Which mathematical tool you use to transform a time-domain signal to a frequency-domain signal? Prove that  $R_{xx}(\tau)$

and  $S_{xx}(F)$  constitute a Fourier transform pair where  $R_{xx}(\tau)$  and  $S_{xx}(F)$  carry their usual meaning. 5

(b) What is an ergodic process ? Describe the periodogram and its application. Derive the appropriate equations. 5

