CBCS Scheme

USN | | | | | | | | | | | 15EC52

Fifth Semester B.E. Degree Examination, June/July 2018
Digital Signal Processing

Time: 3 hrs.   Max. Marks: 80

Note: 1. *Answer FIVE full questions, choosing one full question from each module.*
2. *Use of filter table is not permitted.*

Module-1

1 a. Compute N-point DFT of a sequence $x(n)=\frac{1}{2}+\frac{1}{2}\cos\left(\frac{2\pi}{N}\left(n-\frac{N}{2}\right)\right)$. **(08 Marks)**

b. Compute 4-point circular convolution of the sequences using time domain and frequency domain.
$x(n)=\{\underset{\uparrow}{2},1,2,1\}$ and $h(n)=\{\underset{\uparrow}{1},2,3,4\}$ **(08 Marks)**

OR

2 a. Obtain the relationship between DFT and z-transform. **(08 Marks)**

b. Let x(n) be a real sequence of length N and its N-point DFT is X(K), show that
(i) $X(N-K)=X^*(K)$
(ii) $X(0)$ is real.
(iii) If N is even, then $X\left(\frac{N}{2}\right)$ is real. **(08 Marks)**

Module-2

3 a. Let x(n) be a finite length sequence with $X(K)=\{\underset{\uparrow}{1}0,1-j,4,1+j\}$, using properties of DFT, find the DFT of the followings:
(i) $x_1(n)=e^{j\frac{\pi}{2}n}x(n)$
(ii) $x_2(n)=\left\{\cos\frac{\pi}{2}n\right\}x(n)$ **(08 Marks)**

b. Find the response of an LTI system with an impulse response $h(n)=\{3,2,1\}$ for the input $x(n)=\{2,-1,-1,-2,-3,5,6,-1,2,0,2,1\}$, using overlap add method. Use 8-point circular convolution. **(08 Marks)**

OR

4 a. State and prove the,
(i) Modulation property. (ii) Circular time shift property. **(08 Marks)**

b. Consider a finite duration sequence $x(n)=\{\underset{\uparrow}{0},1,2,3,4,5\}$
(i) Find the sequence, y(n) with 6 point DFT is $y(K)=W_2^K X(K)$.
(ii) Determine the sequence y(n) with 6-point DFT $y(K)=\text{Real}[X(K)]$. **(08 Marks)**

Module-3

5 a. Develop the radix – 2 Decimation in frequency FFT algorithm for N = 8 and draw the signal flow graph. **(10 Marks)**

b. What is Goertzel algorithm and obtain the direct form – II realization? **(06 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

6 a. Let x(n) be the 8-point sequence of $x(n) = \left\{\frac{1}{\sqrt{2}}, 1, \frac{1}{\sqrt{2}}, 0, \frac{-1}{\sqrt{2}}, -1, \frac{-1}{\sqrt{2}}, 0\right\}$. Compute the DFT of the sequence using DIT FFT algorithm. **(06 Marks)**

b. What is Chirp-Signals and mention the applications of Chirp-Z-transform? **(04 Marks)**

c. A designer is having a number of 8-point FFT chips. Show explicitly how he should interconnect three chips in order to compute a 24-point DFT. **(06 Marks)**

Module-4

7 a. Design a digital low pass Butterworth Filter using bilinear transformation to meet the following specifications:

$$-3\,\text{dB} \le |H(e^{j\omega})| \le -1\,\text{dB for } 0 \le \omega \le 0.5\pi$$

$$|H(e^{j\omega})| \le -10\,\text{dB for } 0.7\pi \le \omega \le \pi$$ **(10 Marks)**

b. Obtain the parallel form of realization of a system difference equation,

$$y(n) = 0.75y(n-1) - 0.125y(n-2) + 6x(n) + 7x(n-1) + x(n-2)$$ **(06 Marks)**

OR

8 a. Convert the analog filter with system function,

$H_a(s) = \frac{s+0.1}{(s+0.1)^2 + 9}$ into a digital IIR filter by means of the impulse invariance method. **(08 Marks)**

b. Obtain the DF-I and cascade form of realization of the system function,

$$H(z) = \frac{1+\frac{1}{3}z^{-1}}{\left(1-\frac{1}{5}z^{-1}\right)\left(1-\frac{3}{4}z^{-1}+\frac{1}{8}z^{-2}\right)}.$$ **(08 Marks)**

Module-5

9 a. Obtain the linear phase realization of FIR filter with impulse response,

$$h(n) = \delta(n) - \frac{1}{2}\delta(n-1) + \frac{1}{4}\delta(n-2) + \frac{1}{4}\delta(n-3) - \frac{1}{2}\delta(n-4) + \delta(n-5).$$ **(06 Marks)**

b. What are the advantages and disadvantages of the window technique for designing FIR filter? **(04 Marks)**

c. A low pass filter is to be designed with the following desired frequency response:

$$H_d(e^{j\omega}) = \begin{cases} e^{-j2\omega}, & |\omega| < \frac{\pi}{4} \\ 0, & \frac{\pi}{4} < |\omega| < \pi \end{cases}$$

Determine the filter coefficients $h_d(n)$ and h(n) if $\omega(n)$ is a rectangular window defined as,

$$\omega_R(n) = \begin{cases} 1, & 0 \le n \le 4 \\ 0, & \text{Otherwise} \end{cases}.$$ **(06 Marks)**

OR

10 a. The desired frequency response of a low pass filter is given by,

$H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega}, & |\omega| < \frac{3\pi}{4} \\ 0, & \frac{3\pi}{4} < |\omega| < \pi \end{cases}$. Determine the frequency response of the FIR filter if Hamming window is used with N = 7. **(10 Marks)**

b. Realize an FIR filter with impulse response h(n) given by,

$h(n) = \left(\frac{1}{2}\right)^n [u(n) - u(n-4)]$ using direct form. **(06 Marks)**

CBCS SCHEME

USN | | | | | | | | | | **15EC54**

Fifth Semester B.E. Degree Examination, June/July 2018
Information Theory and Coding

Time: 3 hrs.   Max. Marks: 80

Note: Answer any FIVE full questions, choosing one full question from each module.

Module-1

1 a. With neat sketch, explain the block diagram of an information system. **(04 Marks)**

b. Define entropy. State various properties of the entropy. **(04 Marks)**

c. A code is composed of dots and dashes. Assuming a dash is 3 times as long as a dot and has one-third the probability of occurrence. Calculate:

i) The information in a dot and a dash.

ii) The entropy of dot-dash code.

iii) The average rate of information if a dot lasts for 10mili seconds and the same time is allowed between symbols. **(08 Marks)**

OR

2 a. Derive an expression for the entropy of n^{th} extension of a zero memory source. **(06 Marks)**

b. The first order Markoff model shown in Fig.Q.2(b). Find the state probabilities, entropy of each state and entropy of the source. **(10 Marks)**

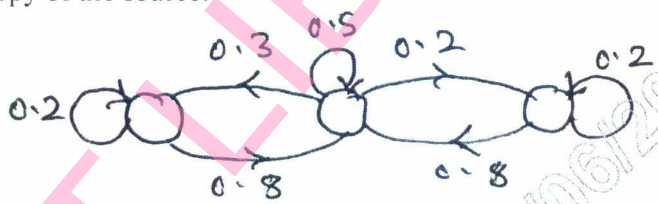

Fig.Q.2(b)

Module-2

3 a. Apply Shannon's binary encoding algorithm to the following set of symbols given in table below. Also obtain code efficiency. **(08 Marks)**

Symbols	A	B	C	D	E
P	1/8	1/16	3/16	1/4	3/8

b. Consider a source S = {s_1, s_2} with probabilities 3/4 and 1/4 respectively. Obtain Shannon-Fano code for source S and its 2^{nd} extension. Calculate efficiencies for each case. Comment on the result. **(08 Marks)**

OR

4 a. Consider a source with 8 alphabets A to H with respective probabilities of 0.22, 020, 018, 015, 0.10, 0.08, 0.05 and 0.02. Construct Huffman's code and determine its efficiency. **(10 Marks)**

b. With an illustrative example, explain arithmetic coding technique. **(06 Marks)**

Module-3

5 a. Define: i) Input entropy ii) Output entropy iii) Equivocation iv) Joint entropy and v) Mutual information with the aid of respective equations. **(04 Marks)**

b. In a communication system, a transmitter has 3 input symbols $A = \{a_1, a_2, a_3\}$ and receiver also has 3 output symbols $B = \{b_1, b_2, b_3\}$. The matrix given below shows JPM. **(08 Marks)**

$a_i \backslash b_j$	b_1	b_2	b_3
a_1	$\frac{1}{12}$	*	$\frac{5}{36}$
a_2	$\frac{5}{36}$	$\frac{1}{9}$	$\frac{5}{36}$
a_3	*	$\frac{1}{6}$	*
$P(b_j)$	$\frac{1}{3}$	$\frac{14}{36}$	*

i) Find missing probabilities (*) in the table.

ii) Find $P\left(\frac{b_3}{a_1}\right)$ and $P\left(\frac{a_1}{b_3}\right)$.

c. A transmitter has 5 symbols with probabilities 0.2, 0.3, 0.2, 0.1 and 0.2. Given the channel matrix P(B/A) as shown below, calculate H(B) and H(A, B). **(04 Marks)**

$$P(B/A) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1/4 & 3/4 & 0 & 0 \\ 0 & 1/3 & 2/3 & 0 \\ 0 & 0 & 1/3 & 2/3 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

Fig.Q.5(c)

OR

6 a. A Gaussian channel has a 10MHz bandwidth. If (S/N) ratio is 100, calculate the channel capacity and the maximum information rate. **(04 Marks)**

b. A binary symmetric channel has channel matrix $P(Y/X) = \begin{vmatrix} 3/4 & 1/4 \\ 1/4 & 3/4 \end{vmatrix}$ with source probabilities of $P(X_1) = \frac{2}{3}$ and $P(X_2) = \frac{1}{3}$.

i) Determine H(X), H(Y), H(Y/X) and H(X, Y).

ii) Find the channel capacity. **(06 Marks)**

c. Find the channel capacity of the channel shown in Fig.Q.6(c) using Muroga's method. **(06 Marks)**

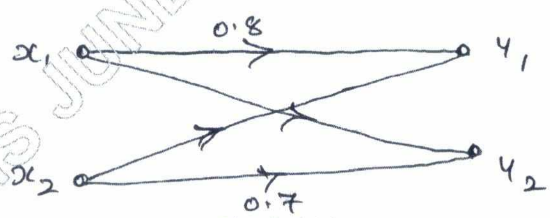

Fig.Q.6(c)

Module-4

7 a. Distinguish between "block codes" and "convolution codes". **(02 Marks)**

b. For a systematic (6, 3) linear block code, the parity matrix is $P = \begin{vmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{vmatrix}$. Find all possible code vectors. **(08 Marks)**

c. The parity check bits of a (8, 4) block code are generated by $c_5 = d_1 + d_2 + d_4$, $c_6 = d_1 + d_2 + d_3$, $c_7 = d_1 + d_3 + d_4$ and $c_8 = d_2 + d_3 + d_4$ where d_1, d_2, d_3 and d_4 are message bits. Find the generator matrix and parity check matrix for this code. **(06 Marks)**

OR

8 a. A (7, 4) cyclic code has the generator polynomial $g(x) = 1 + x + x^3$. Find the code vectors both in systematic and nonsystematic form for the message bits (1001) and (1101). **(12 Marks)**

b. Consider a (15, 11) cyclic code generated by $g(x) = 1 + x + x^4$. Device a feed back shift register encoder circuit. **(04 Marks)**

Module-5

9 a. Write a note on BCH codes. **(06 Marks)**

b. Consider the (3, 1, 2) convolutional encoder with $g^{(1)} = (110)$, $g^{(2)} = (101)$ and $g^{(3)} = (111)$.

i) Draw the encoder diagram.

ii) Find the generator matrix.

iii) Find the code word for the message sequence (11101). **(10 Marks)**

OR

10 a. For a (2, 1, 3) convolutional encoder with $g^{(1)} = (1101)$, $g^{(2)} = (1011)$, draw the encoder diagram and code tree. Find the encoded output for the message (11101) by traversing the code tree. **(10 Marks)**

b. Describe the Viterbi decoding algorithm. **(06 Marks)**

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