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17EC52

Fifth Semester B.E. Degree Examination, July/August 2021
Digital Signal Processing

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions.

1 a. Explain the frequency domain sampling and reconstruction of discrete time signals. **(09 Marks)**

b. Determine the circular convolution of the sequences $x_1(n) = \{1, 2, 3, 1\}$ and $x_2(n) = \{4, 3, 2, 2\}$ using the time domain formula. **(05 Marks)**

c. Compute the N-point DFT of the signal $x(n) = \cos\frac{2\pi}{N}k_0 n$, $0 \le n \le N-1$ **(06 Marks)**

2 a. Establish the relationship between:
i) DFT and Fourier Transform
ii) DFT and Fourier series coefficients. **(08 Marks)**

b. Show that the multiplication of two DFT's leads to circular convolution of respective time sequences. **(07 Marks)**

c. The first three samples of 4-point DFT of a real sequence x(n) is $X(k) = \{2, 1+j, 0\}$. Find the remaining sample and also determine the sequence x(n). **(05 Marks)**

3 a. State and prove Parseval's theorem. Express the energy of the sequence interms of DFT. **(06 Marks)**

b. x(k) denote the 6-point DFT of the sequence $x(n) = \{1, 2, -1, 3, 0, 0\}$ without computing the IDFT, determine the sequence y(n)if
i) $y(k) = W_3^{2k} x(k)$
ii) $y(k) = X((k-2))_6$ **(06 Marks)**

c. Using overlap save method, compute the output y(n) of an FIR filter with impulse response $h(n) = \{1, 2, 3\}$ and input $x(n) = \{2, -3, 1, 0, -2, -1, 3, 5\}$. Use 6-point circular convolution. **(08 Marks)**

4 a. State and prove the property of circular time shift of a sequence. **(06 Marks)**

b. The 5-point DFT of a complex valued sequence x(n) is given by $X(k) = \{1 + j, 2 + j2, j, 2-j2, 1-j\}$. Compute y(k) if i) $y(n) = x^+(n)$ ii) $y(n) = x((-n))_N$ **(06 Marks)**

c. Find the response of an LTI system with an impulse response $h(n) = \{1, -1, 2\}$ for the input $x(n) = \{3, 2, -1, 1, 4, 5, -2, -3\}$, using overlap add method. Use n-point circular convolution with the input data block segment length L = 4. **(08 Marks)**

5 a. Compute the 8-point DFT of the sequence $x(n) = \{2, 2, 2, -1, -1, -1, -2, 1\}$ using decimation in time-FFT algorithm. **(08 Marks)**

b. Find the number of complex additions and multiplications required for 256-point DFT computation using i) Direct method ii) FFT method. What is the speed improvement factor? **(05 Marks)**

c. Explain the Goertzel algorithm and obtain the direct form-II realization. **(07 Marks)**

6 a. Given x(n) = n + 1, $0 \le n \le 7$, find the 8-point DFT of x(n) using radix-2 decimation in frequency FFT algorithm **(08 Marks)**

b. Perform the 4-point circular convolution of the sequences $x_1(n) = (2\ \ 1\ \ -1\ \ 2\}$ and $x_2(n) = \{1, 2, 3, -1\}$ using decimation in time FFT algorithm. **(07 Marks)**

c. What is chirp-z transform? Draw the contours on which Z-transform is evaluated. **(05 Marks)**

7 a. Obtain the direct form-II and cascade realization of the system function

$$H(z) = \frac{2(1 - z^{-1})(1 + \sqrt{2}z^{-1} + z^{-2})}{(1 + 0.5z^{-1})(1 - 0.9z^{-1} + 0.81z^{-2})}$$ **(07 Marks)**

b. Determine the order for a digital Butterworth filter design using bilinear transformation to meet the following specifications.

i) Passband ripple of 3dB at 1000Hz
ii) Stopband ripple of 20dB at 2000Hz
iii) Sampling frequency of 10kHz
iv) Indicate the steps to obtain the digital system function H(z). **(09 Marks)**

c. Describe the frequency transformations from low pass filter to any other types in the analog domain. **(04 Marks)**

8 a. Obtain the parallel realization for the system function

$$H(z) = \frac{\left(1 + \frac{1}{4}z^{-1}\right)}{\left(1 + \frac{1}{2}z^{-1}\right)\left(1 + \frac{1}{2}z^{-1} + \frac{1}{4}z^{-2}\right)}$$ **(06 Marks)**

b. An IIR digital lowpass filter is required to meet the following specifications:
Passband ripple ≤ 0.5dB
Passband edge = 1.2kHz
Stopband attenuation ≥ 40dB
Stopband edge = 2kHz
Sampling rate = 8kHz
Determine the filter order for

i) A digital Butterworth filter
ii) A digital Chebyshev filter, which uses bilinear transformation. **(09 Marks)**

c. An ideal analog integrator system function $H_a(s) = 1/s$. Obtain the digital integrator system function H(z) using bilinear transformation. Write the difference equation for the digital integrator. Assume T = 2. **(05 Marks)**

9 a. Consider an FIR filter with system function $H(z) = 1 + 2.88z^{-1} + 3.4z^{-2} + 1.74z^{-3} + 0.4z^{-4}$. Obtain the lattice filter coefficients. Sketch the direct form and lattice realization. **(10 Marks)**

b. An FIR filter is to be designed with the following desired frequency response:

$$H_d(w) = \begin{cases} e^{-j4w}, & |w| < \frac{\pi}{4} \\ 0, & \frac{\pi}{4} \le |w| < \pi \end{cases}$$

Find the frequency response H(w) of the filter using Hamming window function. **(10 Marks)**

10 a. Determine a direct form realization for the linear phase FIR filter impulse response $h(n) = \{1, 2, 3, 4, 3, 2, 1\}$. **(04 Marks)**

b. Consider an FIR lattice filter with coefficients $K_1 = 0.65$, $K_2 = -0.34$ and $K_3 = 0.8$.

i) Find its impulse response by tracing a unit impulse input through the lattice structure.

ii) Draw the equivalent direct-form structure. **(08 Marks)**

c. Determine the impulse response of the low pass FIR filter to meet the following specifications using a suitable window function:
Passband edge frequency = 1.5kHz
Stopband edge frequency = 2kHz
Minimum stopband attenuation = 50dB
Sampling frequency = 8kHz. **(08 Marks)**

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17EC54

Fifth Semester B.E. Degree Examination, July/August 2021
Information Theory and Coding

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions.

1 a. A code is composed of dots and dashes. Assuming that 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 10 m-sec and this time is allowed between symbols. **(08 Marks)**

b. A zero-memory source has a source alphabet. S = {s_1, s_2, s_3} with P = {½, ¼, ¼}. Find the entropy of this source and its 2nd extension. Also verify that $H(s^2) = 2H(s)$. **(06 Marks)**

c. Derive the expression to show that n^{th} extension entropy of the basic binary source $H(s^n) = n\,H(s)$. **(06 Marks)**

2 a. The state diagram of a Markoff source is shown in Fig.Q2(a):
(i) Find the entropy H of the source
(ii) Find G_1, G_2 and G_3 and verify that $G_1 > G_2 > G_3 > H$

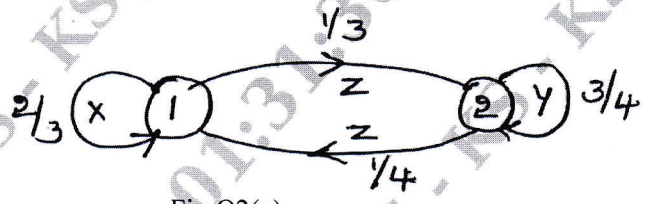

Fig.Q2(a) **(12 Marks)**

b. Suppose that s_1 and s_2 are two zero memory sources with probabilities p_1, p_2....p_n for source s_1 and q_1, q_2....q_n for source s_2. Show that the entropy of source s_1.

$$H(s_1) \le \sum_{k=1}^{n} p_k \log \frac{1}{q_k}$$ **(08 Marks)**

3 a. Explain properties of codes. **(08 Marks)**

b. Apply Shanon's encoding algorithm to the following message

S =	S_1	S_2	S_3
P =	0.5	0.3	0.2

Find code efficiency and redundancy for the basic source and its 2nd order extension source. **(12 Marks)**

4 a. Construct a binary and ternary Huffman code for the source with 8 alphabets A to H with respective probabilities 0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05, 0.02. Determine efficiency for both the codes. **(12 Marks)**

b. Explain:
(i) Arithmetic coding
(ii) Lempel-Ziv algorithm **(08 Marks)**

5 a. Show that the mutual information of a channel is symmetric. **(08 Marks)**

b. For the JPM given below, compute individually H(X), H(Y), H(X, Y), H(X/Y), H(Y/X) and I(X, Y)

$$P(X,Y)=\begin{bmatrix}0.05 & 0 & 0.20 & 0.05\\ 0 & 0.10 & 0.10 & 0\\ 0 & 0 & 0.20 & 0.10\\ 0.05 & 0.05 & 0 & 0.10\end{bmatrix}$$ **(12 Marks)**

6 a. Derive the expression of channel capacity for binary symmetric channel. **(08 Marks)**

b. Find the channel capacity of the channel matrix shown using Murgoa's method. The data transmission rate is 10,000 symbols/sec.

$$P(Y/X)=\begin{bmatrix}0.8 & 0.2 & 0\\ 0.1 & 0.8 & 0.1\\ 0 & 0.2 & 0.8\end{bmatrix}$$ **(08 Marks)**

c. Define the terms:

(i) PRIORI Entropy (ii) Posteriori (conditional) entropy

(iii) Equivocation (iv) Mutual information **(04 Marks)**

7 a. For a systematic (7, 4) linear block code, the parity check matrix P is given by

$$[P]=\begin{bmatrix}1 & 1 & 1\\ 1 & 1 & 0\\ 1 & 0 & 1\\ 0 & 1 & 1\end{bmatrix}$$

(i) Find all possible code vectors.

(ii) Draw the encoder and syndrome calculation circuit.

(iii) Direct and correct the single errors in the received vector R_A = [0111110] and R_B = [1010000]. **(12 Marks)**

b. Design a single error correcting code with a message block size of 11 and show that by an example that it can correct single error. **(08 Marks)**

8 a. For the (7, 4) single error correcting code g(x) = 1 + x + x3. Find the code vector for the message vectors D = [1001] and D = [1101]. Using systematic method. Also draw the encoder for (7, 4) cyclic code. **(10 Marks)**

b. A (15, 5) linear cyclic code has a generator polynomial $g(x)=1+x+x^2+x^4+x^5+x^8+x^{10}$

(i) Draw the encoder and syndrome calculation circuit.

(ii) Find the code polynomial for $D(x) = 1 + x^2 + x^4$ using shift registers.

(iii) Is $V(x)=1+x^4+x^6+x^8+x^{14}$ a code polynomial? **(10 Marks)**

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

(i) Draw the encoder block diagram.

(ii) Find the code word to the information sequence (11101) using time-domain and transform domain approach. **(10 Marks)**

b. Write short notes on:

(i) Golay codes

(ii) BCH codes **(10 Marks)**

10 a. For the (2, 1, 2) convolutional encoder $g^{(1)} = 111$, $g^{(2)} = (101)$. Draw the encoder diagram. Also write the state table, state transition table, state diagram and the corresponding code tree. Using the code tree, find the encoded sequence for the message (10111). Verify the output sequence so obtained using transform domain approach. **(14 Marks)**

b. For the convolutional encoder shown in Fig.Q10(b), find the encoded sequence for the information sequence 10111 using both time domain and transform domain approach.

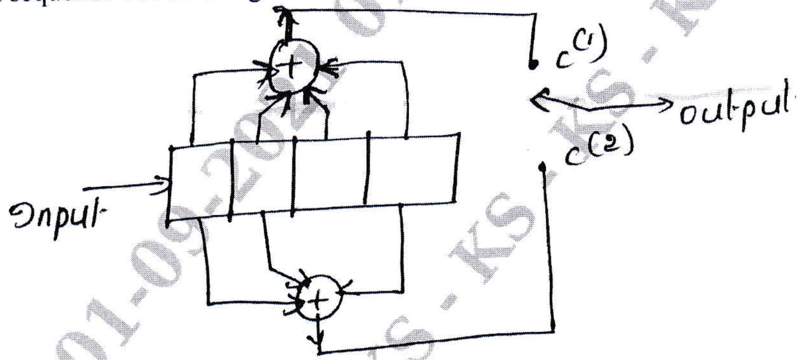

Fig.Q10(b) **(06 Marks)**

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17EC563

Fifth Semester B.E. Degree Examination, July/August 2021
8051 Microcontroller

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions.*

1 a. Explain the architecture of 8051 microcontroller with a neat diagram. **(10 Marks)**
b. Compare microprocessor and microcontroller. **(04 Marks)**
c. Explain the working of port 0 and port 1 with the help of necessary diagram. **(06 Marks)**

2 a. Show the internal memory organization of 8051. **(06 Marks)**
b. Explain the interfacing of external ROM and RAM to 8031 microcontroller with the help of a neat diagram. **(10 Marks)**
c. Explain the addressability and byte addressability with examples. **(04 Marks)**

3 a. Explain the different addressing modes with examples. **(08 Marks)**
b. Explain the following instructions with examples.
i) DJNZ R2, again ii) MOV A, 50h iii) INC R1 iv) DA A **(08 Marks)**
c. Write an ALP to add two 16-bit numbers. **(04 Marks)**

4 a. Write an ALP to transfer the data bytes 10h, 20h, 30h, 40h, 50h to memory locations 60h, 61h, 62h, 63h, 64h without using loops. **(08 Marks)**
b. Explain different rotate instructions with examples. **(08 Marks)**
c. Mention the flags of PSW and its applications in instructions. **(04 Marks)**

5 a. Explain the sequence of events when a call opcode occurs in the program and use of stack with necessary diagram. **(08 Marks)**
b. Write an ALP to find factional of an 8-bit number. The result should be maximum of 8-bit. **(06 Marks)**
c. Write an ALP to add first 10 natural numbers. **(06 Marks)**

6 a. Write an ALP to find smallest number in an array of 10 bytes from location 60h. **(10 Marks)**
b. Show different jump instructions in 8051 with diagram based on range. **(06 Marks)**
c. In the Fig Q6(c), write an ALP to turn on LED when switch is pressed and turn off, LED when switch is not pressed.

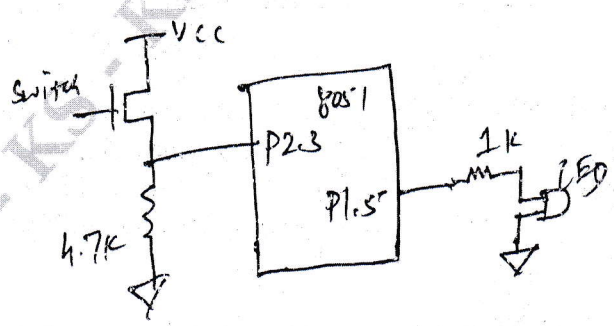

Fig Q6(c) **(04 Marks)**

7 a. Explain the brief the operation of timer in mode 1 and mode 2. Also calculate the maximum delay for both modes if XTAL is 11.0592MHz. **(10 Marks)**

b. Generate a waveform given in Fig Q7(b), if XTAL = 11.0592MHz P1.3 use timer 0 in mode 1.

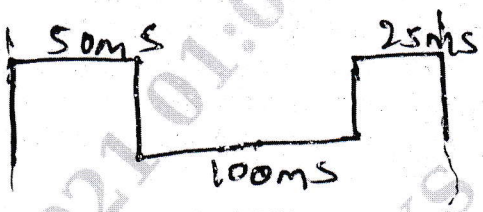

Fig Q7(b) **(10 Marks)**

8 a. Generate a square wave of frequency of 1KHz and 2KHz using timer 1 in mode 2 Assume XTAL = 22MHz. **(10 Marks)**

b. Write an 8051 C program to send two different strings to the serial port. Assuming that SW is connected to pin P2.0, monitor its status and make a decision follows :
SW = 0 : Send your data as BE
SW = 1 : Send your data as VTU
Assume XTAL = 11.0592MHz, baud rate of 9600, 8-bit data, 1 stop bit. **(10 Marks)**

9 a. Two switches are connected to pins P3.2 and P3.3. When a switch is pressed, the correspond lines goes low. Write an assemble language program to
i) Light an LED's connected to port 0 , if first switch is pressed
ii) Light all LED's connected to port 2 ; if the second switch is pressed **(10 Marks)**

b. Write a C program to create a square wave of 200ms period on pin 2.5. Use timer 0 in mode 2. Assume XTAL = 11.0592MHz. Simultaneously get data from P1.7 and send it to P1.0. **(10 Marks)**

10 a. With a neat diagram, explain interfacing of LCD to 8051. **(06 Marks)**

b. A switch is connected to pin P2.7. Write a assembly language program to monitor the status of SW and perform the following :
i) If SW = 0, the stepper motor moves clockwise
ii) If SW = 1, the stepper motor moves counter clockwise. **(08 Marks)**

c. With the neat diagram, explain the interfacing of ADC 0804 to 8051 Microcontroller **(06 Marks)**

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