*Basavarajeswari Group of Institutions*

# BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

**USN** | | | | | | | | | | | **Course Code** **2 1 E C 4 3**

## Fourth Semester B.E. Degree Examinations, September/October 2024

## DIGITAL SIGNAL PROCESSING

**Duration: 3 hrs** **Max. Marks: 100**

***Note:*** ***1. Answer any* FIVE *full questions, choosing* ONE *full question from each module.***
***2. Missing data, if any, may be suitably assumed.***

| *Q. No* | | *Question* | *Marks* | *(RBTL:CO:PI)* |
|---|---|---|---|---|
| | | **MODULE – 1** | | |
| **1.** | **a.** | Define DFT? Explain the frequency domain sampling of discrete time signal? | **06** | (2 :1 : 1.6.1) |
| | **b.** | Find 4-Point IDFT of *X(K) = [4, -2j, 0, 2j]* | **07** | (2 :1 : 1.6.1) |
| | **c.** | Compute the N-point DFT of $x(n) = \sin(n\omega_0)$ where $\omega_0 = \frac{2\pi}{N} k_0$ . | **07** | (2 :1 : 1.6.1) |
| | | **OR** | | |
| **2.** | **a.** | State and prove the following DFT properties<br>(i) Circular Time Shift (ii) Multiplication in Time Domain | **06** | (2 :1 : 1.6.1) |
| | **b.** | Evaluate 4-Point circular convolution of the sequences x(n) = (1,2,3,1) and h(n) = (4,3,2,2) using time domain approach and verify the same using frequency domain approach. | **07** | (2 :1 : 1.6.1) |
| | **c.** | State and Prove Linearity property. | **07** | (2 :1 : 1.6.1) |
| | | **MODULE – 2** | | |
| **3.** | **a.** | Write the computational procedure to find the filtered output using overlap save method. | **06** | (2 :2 : 1.6.1) |
| | **b.** | Compute 8-Point DFT of x(n) = (1,1,1,1,0,0,0,0) using decimation in time –FFT algorithm. | **07** | (2 :2 : 1.6.1) |
| | **c.** | Explain the Goertzel algorithm and obtain the direct form II realization of Goertzel filter | **07** | (2 :2 : 1.6.1) |
| | | **OR** | | |
| **4.** | **a.** | Develop Radix-2 DIT-FFT algorithm and draw complete signal flow graph for N=8. | **06** | (2 :2 : 1.6.1) |
| | **b.** | Consider a FIR filter with impulse response $h(n) = [2,1,-3]$ if the input is $x(n) = [1,0,-1,3,2,1,-1,-2,3,5,6,1]$. Find the output $y(n)$ using overlap add method | **07** | (2 :2 : 1.6.1) |
| | **c.** | Explain chirp-Z-Transform algorithm with applications. | **07** | (2 :2 : 1.6.1) |
| | | **MODULE – 3** | | |
| **5.** | **a.** | Briefly explain the characteristics of FIR filter. | **06** | (2 :3 : 1.6.1) |
| | **b.** | A lowpass filter is to be designed with the following desired frequency response $H_d(\omega) = \begin{cases} e^{-j2\omega} & \lvert\omega\rvert < \frac{\pi}{4} \\ 0 & \frac{\pi}{4} < \lvert\omega\rvert < \pi \end{cases}$<br>Determine the filter coefficients $h_d(n)$ and w(n) is a rectangular window defined by $w_R(n) = 1, 0 \le n \le 4$. Also, find the frequency response $H(\omega)$ | **08** | (2 :3 : 1.6.1) |

Note: (**RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI - Performance Indicator)**

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|---|---|---|---|---|
| | c. | ------------------------------- | 06 | |
| | | **OR** | | |
| 6. | a. | List the different types of windowing techniques used in the design of FIR filter. Write analytical equations and draw the magnitude response | 06 | (2 :3 : 1.6.1) |
| | b. | A LPF FIR is to be designed with the following specification $H_d(\omega) = \begin{cases} e^{-j3\omega}, & \lvert\omega\rvert \le \frac{3\pi}{4} \\ 0, & \frac{3\pi}{4} \le \lvert\omega\rvert \le \pi \end{cases}$ Determine the frequency response H(ω) of the resulting FIR filter if hamming window N=7 is used | 08 | (2 :3 : 1.6.1) |
| | c. | Realize the linear phase structure of FIR filter when its $h(n) = \delta(n) + \frac{1}{4}\delta(n-1) - \frac{1}{8}\delta(n-2) + \frac{1}{4}\delta(n-3) + \delta(n-4)$ | 06 | |
| | | **MODULE – 4** | | |
| 7. | a. | Derive the expression for the filter order. Find the poles of N = 3 and plot the same in the S-Plane | 10 | (2 :4 : 1.6.1) |
| | b. | A Butterworth low pass filter has to meet the following specifications<br>(i) Passband gain $K_p$ = -1dB at $\Omega_p$ = 4 rad/sec.<br>(ii) Stopband attenuation greater than or equal to 20dB at $\Omega_s$ = 8 rad/sec<br>Determine the transfer function $H_a(s)$ of the lowest order butterworth filter to meet the above specifications. | 10 | (2 :4 : 1.6.1) |
| | | **OR** | | |
| 8. | a. | Derive and discuss the general mapping properties of bilinear transformation and show the mapping between the s-plane and the z-plane. | 10 | (2 :4 : 1.6.1) |
| | b. | A digital low pass filter is required to meet the following specifications<br>(i) Monotonic passband and stopband<br>(ii) -3.01 dB cut-off frequency of 0.5π rad/sec<br>(iii) Stopband attenuation of atleast 15 dB at 0.75π rad/sec.<br>Find the system function H(z). Verify the design by checking for passband and stopband specifications | 10 | (2 :4 : 1.6.1) |
| | | **MODULE – 5** | | |
| 9. | a. | Explain digital signal processor using Harvard architecture | 07 | (2 :5 : 1.6.1) |
| | b. | Explain the following DSP hardware units<br>(i) MAC ( ii) Shifters (iii) Address Generators | 07 | (2 :5 : 1.6.1) |
| | c. | Discuss Signed Q-15 fixed format. Find the signed Q-15 representation for decimal number -0.160123. | 06 | (2 :5 : 1.6.1) |
| | | **OR** | | |
| 10. | a. | Explain fixed point digital signal processer using basic architecture of TMS320C54X Family | 07 | (2 :5 : 1.6.1) |
| | b. | Discuss IEEE Single Precision floating format. Convert the following number in the IEEE Single Precision format to decimal format 1 10000011 11100000000000000000000 | 07 | (2 :5 : 1.6.1) |
| | c. | Convert the following Q-15 numbers to decimal number<br>(i) $(0.101011100001101)_2$ (ii) $(1.010100011110011)_2$ | 06 | (2 :5 : 1.6.1) |

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Note: (**RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI - Performance Indicator)**