Basavarajeswari Group of Institutions **2022 SCHEME**

BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

USN | | | | | | | | | | |

Course Code | 2 | 2 | E | C | 6 | 1 |

Sixth Semester B.E. Degree Examinations, June/July 2025

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.**	With examples describe important elementary signals with suitable mathematical expressions and waveform.	**07**	**(2:1: 1.3.1)**
	b.	Determine whether or not each of the signals is periodic. If a signal is periodic, find its fundamental period (i) $x(t)=(\cos 2\pi t)^2$ (ii) $x(n)=\cos\left(\frac{2\pi}{5}n\right)+\sin\left(\frac{2\pi}{7}n\right)$.	**07**	**(3:1: 2.1.3)**
	c.	Find even and odd components of $x(t)$ for the Fig. Q1(c).	**06**	**(3:1: 2.1.3)**

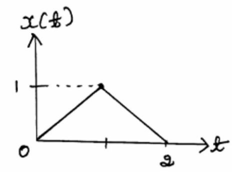

Fig. Q1 (c)

(OR)

Q. No		Question	Marks	(RBTL:CO: PI)
2.	**a.**	Find whether the following signals are energy or power signals and find its energy or power. (i) $x(n)=\left(\frac{1}{3}\right)^n u(n)$ (ii) $x(t)=A\cos(\omega_0 t+\theta)$	**07**	**(3:1: 2.1.3)**
	b.	Construct $x(t)$ in terms of $g(t)$ where $x(t)$ and $g(t)$ are shown in Fig. Q2(b).	**07**	**(3:1: 2.1.3)**

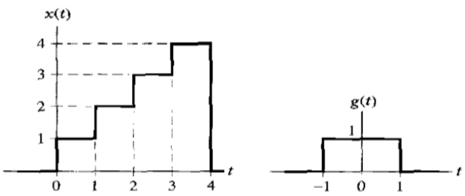

Fig. Q2(b)

Q. No		Question	Marks	(RBTL:CO: PI)
	c.	Verify whether the following systems are stable, causal and Time invariance (i) $y(n)=0.5^n x(n)$ (ii) $y(t)=\frac{dx(t)}{dt}$	**06**	**(3:1: 2.1.3)**
		Module-2		
3.	**a.**	Find N-point DFT of sequence $x(n)=e^{j\omega mn}$ Where $\omega=\frac{2\pi}{N}$	**06**	**(3:2: 2.1.3)**
	b.	Compute the 4-point IDFT of the sequence $X(k)=[2,1+j,0,1-j]$	**06**	**(3:2: 2.1.3)**

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

	c.	Evaluate 4-Point circular convolution of the sequences $x(n)=[1,2,3,-1]$ and $h(n)=[4,3,1,1]$ using time domain approach and verify the same using frequency domain approach.	**08**	**(3:2: 2.1.3)**
		(OR)		
4.	**a.**	State and prove the following properties (i) Circular frequency shift (ii)Linearity	**06**	**(2:2: 1.3.1)**
	b.	Find the 4-point DFT of the sequence $x(n)=[1,-1,1,-1]$. Also find DFT of sequence $y(n)=x(n-2)_4$.	**06**	**(3:2: 2.1.3)**
	c.	Consider a FIR filter with impulse response $h(n)=[1,2,1,3]$ if the input is $x(n)=[1,0,-1,3,2,1,-1,-2,3,5,6,-1,2,0,1,2]$. Find the output using overlap save method assuming length of block is 9.	**08**	**(3:2: 2.1.3)**
		Module-3		
5.	**a.**	Find 8-point DFT of the sequence $x(n)=[1,2,3,4,4,3,2,1]$ using DIT-FFT radix-2 algorithm.	**10**	**(3:3: 2.1.3)**
	b.	Determine IDFT using radix-2 DIT FFTA when $X(k)=[4,1-j2.414,0,1-j0.414,0,1+j0.414,0,1-j2.414]$.	**10**	**(3:3: 2.1.3)**
		(OR)		
6.	**a.**	Find the circular convolution of $x(n)$ and $h(n)$ when $x(n)=[2,1,1,2]$ and $h(n)=[1,-1,-1,1]$ using the radix-2 DIT-FFTA.	**10**	**(3:3: 2.1.3)**
	b.	Find 8-point DFT of the sequence $x(n)=[1,2,2,2,1,0,0,0]$ using DIF-FFT radix-2 algorithm.	**10**	**(3:3: 2.1.3)**
		Module-4		
7.	**a.**	Define the normalized low pass prototype function of Butterworth filter. Derive the expression for the filter order N=2.	**10**	**(2:4: 1.3.1)**
	b.	Given $H(s)=\frac{1}{s^2+s+1}$ represent the transfer function of low pass filter with a passband of 1 rad/sec. Use frequency transformation to find the transfer functions of the following analog filters. (i) A LPF filter with a passband of 10 rad/sec. (ii) A HPF with a cutoff frequency of 1 rad/sec. (iii) A BPF filter with a passband of 10 rad/sec and a center frequency of 100 rad/sec	**10**	**(3:4: 2.1.3)**
		(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: 1.3.1)**
	b.	A Butterworth low pass filter has to meet the following specifications: (i) Passband gain -1 dB at pass band frequency of 4 rad/sec. (ii) Stop band attenuation greater than or equal to 20 dB at stop band frequency of 8 rad/sec. Determine the transfer function $H_a(s)$ of the lowest-order Butterworth filter to meet the above specifications.	**10**	**(3:4: 2.1.3)**

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

Module-5

9. **a.** Write the time domain equations, width of main lobe and maximum stop band attenuation of the following windows
(i) Rectangular (ii) Bartlett (iii) Hamming and (iv) Hanning **10** **(2:5: 1.3.1)**

b. A low pass filter is to be designed with the following desired frequency response $H_d(\omega)=\begin{cases} e^{-j2\omega}, & |\omega|<\dfrac{\pi}{4} \\ 0 & ,\dfrac{\pi}{4}<|\omega|<\pi \end{cases}$. Determine the filter coefficients $h_d(n)$ and $h(n)$, if $W(n)$ is a rectangular window. Also find the frequency response $H(\omega)$ of the resulting FIR filter. **10** **(3:5: 2.1.3)**

(OR)

10. **a.** Realize the direct form structure of FIR filter given by **10** **(3:5: 2.1.3)**

$$H(z)=1+\frac{1}{2}z^{-1}+\frac{1}{3}z^{-2}+\frac{2}{5}z^{-3}+\frac{1}{3}z^{-4}+\frac{1}{2}z^{-5}+z^{-6}$$

b. A high pass FIR filter is to be designed with the following desired frequency response **10** **(3:5: 2.1.3)**

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

Find the frequency response of the FIR filter designed using a rectangular window $W_R(n)=\begin{pmatrix} 1, & 0\le n\le 4 \\ 0, & \text{otherwise} \end{pmatrix}$.

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