Ref No: **Ex/EE/5/T/414/2024(S)**

BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) 4TH YEAR 1ST SEMESTER SUPPLEMENTARY EXAMINATION, 2024

SUBJECT: - DIGITAL SIGNAL PROCESSING

Full Marks 100

Time: Three hours **Part-I** **(50 marks for each part)**✓

Use a separate Answer-Script for each part

Answer Any Three Questions

Two marks reserved for neat and well organized answers

Q.1a). Describe in detail how Radix-2 decimation-in-frequency in-place FFT algorithm can be employed to compute 4-point FFT of a discrete sequence. Draw the corresponding signal flow graph. 10

Q.1b). What is an N-point DFT pair? What is the role of twiddle factor in it? 06

Q.2a). The DFT coefficients for a sequence x_k are given as: $X_0 = 20$, $X_1 = -4 + j3$, $X_2 = 10$, and $X_3 = -4 - j3$. Evaluate its inverse DFT to recover the sequence x_k. 08

Q.2b). Describe in detail the bit reversal procedure employed in 8-point FFT. Derive the number of complex additions and multiplications required in computing an 8-point FFT. 08

Q.3a). What is Gibbs Phenomenon encountered in designing digital FIR filters? How can its effect be minimized? Describe the causal and non-causal forms of Hamming window and Hann window. 08

Q.3b). Prove that, an ideal digital filter, designed with a real and symmetric h_n, results in a distortion-less filter with zero phase shift. 08

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Ref No: **Ex/EE/5/T/511/2024(S)**

Q.4a). Show that the direct realization of a linear-phase digital FIR filter can be carried out using $\left(\frac{M+1}{2}\right)$number of multiplications, where M is the order of the filter and M is chosen odd. 08

Q.4b). Why in offline implementation of digital filters the length of output sequence is smaller than the length of input sequence? Establish with a suitable example. Why are non-causal filters preferred over causal filters for offline implementations? 08

Q.5.Write short notes on any **two**: 08+08

(a) Determination of Fourier series coefficients for a periodic discrete sequence.

(b) Circular symmetries of a discrete sequence.

(c) Properties of linear phase digital filters.

Ref. No.: Ex/EE/5/T/414/2024(S)

BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING)
FOURTH YEAR
FIRST SEMESTER SUPPLEMENTARY EXAM 2024

DIGITAL SIGNAL PROCESSING

Full Marks 100
(50 marks for each part)

Time: ~~Two hours~~/Three hours/ ~~Four hours/ Six hours~~

Use a separate Answer-Script for each part

Question No.	PART II	Marks
	Answer any *three* questions **Two marks reserved for neat and well-organized answers**	
1.	**Derive the relation between the Fourier transform of a continuous-time (analog) signal and that of its uniformly sampled version. Hence, with the help of relevant figures explain the phenomenon of aliasing.**	9+7
2. (a)	**Starting from the definition of Z-transform, determine the expressions for the Z-transforms of the following sequences.** $(i)\ x_n = e^{-an\tau} u_n \ ;\ a > 0.$ $(ii)\ g_n = \text{Cos}(\omega_o n\tau) u_n$ **Locate the poles and zeros of the Z-transforms on the z-plane.**	8
(b)	**Obtain the inverse Z-transform of $H(z)$ given below, by long division method, for n = 0,1,2 and 3.** $H(z) = \frac{z^2+2z+1}{z^3+2z^2+3z+1}$	8
3. (a)	**Derive the frequency warping expressions related to the designing of digital filters using bilinear transformation. Explain the significance of this warping phenomenon with the help of illustrations.**	6
(b)	**Using bilinear transformation, design a digital filter corresponding to the analog filter with transfer function** $G(s) = \frac{5}{(s+0.6)(s+0.1)}$ **Obtain the difference equation relating the output and the input of the digital filter.**	10

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Question No.	PART II	Marks
4.	The output $y[n]$ and the input $x[n]$ of a DTLTI system are related through the difference equation $0.5y_n + 0.05y_{n-1} - 0.36y_{n-2} = 0.35\, x_n + 0.126\, x_{n-2}$ Derive and draw the Direct form-I, the Direct form-II and the cascade realization (using 1st order subsystems).	16
5.	Write short notes on any *two* of the following.	8+8
(a)	Representing uniformly sampled signal by a train of scaled impulses.	
(b)	Designing digital filters by impulse-invariant transformation.	
(c)	Mapping of left-half of s-plane on to the z-plane .	
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