Ref No: Ex/EE/PC/B/T/315(O)/2024

B.E. ELECTRICAL ENGINEERING THIRD YEAR FIRST SEMESTER EXAMINATION 2024

DIGITAL SIGNAL PROCESSING

Full Marks 100

Time: Three hours **(50 marks for each part)**

Use a separate Answer-Script for each part

Question No.	PART- I	Marks
	Answer any ***THREE*** questions Two marks reserved for neatness	
1. (a)	**Consider the bandlimited analog signal** $x(t) = 2\text{Sin}(300\pi t) + 3\text{Sin}(400\pi t) - \text{Sin}(1200\pi t)$, **where t is in seconds.** **Find the Nyquist sampling rate for the above signal.** **The above signal is sampled at rate of 350 samples per second, and the resulting sampled signal x_n is converted back to an analog signal by ideal low-pass filtering with a cut-off frequency of 175 Hz. Determine the values of the frequencies in the reconstructed analog signal. Derive any expression used**	8
(b)	If $x[n]=\delta[n]$, $y_1[n]=y_2[n-1]+x[n-1]$, $y_2[n]=y_1[n-2]+0.5x[n-1]$ and $y[n]=y_2[n-1]-y_2[n-2]$, **check whether or not the Z-transform of the sequence y[n] is** $Y(z)=\dfrac{0.5z^2+1}{z^2\left(z^2+z+1\right)}$.	8
2. (a)	**Starting from the definition of z-transform, obtain the expression for the z-transform of the sequence** $x[n]=e^{-3n}Cos(200n)u[n]$, **and its region of convergence (ROC).**	6
(b)	**The transfer function of a DTLTI system is** $$H(z)=\frac{z^2+2z-3}{(z-1)(z-1/2)(z-4)}$$ **Derive all possible expressions for the impulse response sequence of the system. Comment on the causality and the stability of the system in each case.**	10

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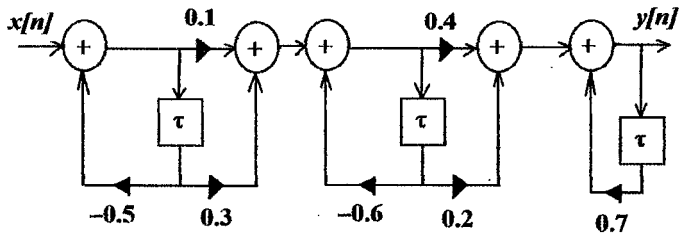
No. of Questions	PART I	Marks
3. (a)	A particular structure for realizing an IIR filter is shown in Fig. [A]. Name the structure. Obtain the set of difference equations describing the filter algorithm. Derive the Z-transfer function of the filter. Also determine and draw the Direct form-II and the parallel realizations (using 1st order subsystems) of the filter. *Give all the relevant sets of difference equations.*	10
	 Fig. [B]	
(b)	A causal DTLTI system is represented by the following difference equation relating the output *y[n]* and the input *x[n]*. $y[n] = b_o x[n] + a_1 y[n-1]$ Show that the system is an IIR system. Determine the effect of the coefficient values on the stability of the system.	6
4(a)	Using impulse-invariant transformation, design a digital filter corresponding to the analog filter with transfer function $G(s) = 10 / (s^2 + 6s + 8)$ Consider a sampling frequency of 20 Hz. Write down the difference equation relating the output and the input sequences.	10
(b)	Derive the frequency warping relation for bilinear transform method of designing digital filters. Point out clearly the significance of this warping phenomenon.	6

Question No.	PART I	Marks
5.	**Write short notes on any two of the following.**	8+8
(a)	**Frequency spectra of uniformly sampled signals.**	
(b)	**Representing discrete-time signals by trains of impulses.**	
(c)	**Mapping of left half of s-plane on to z-plane.**	
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B. E. ELECTRICAL ENGINEERING 3RD YEAR 1ST SEMESTER EXAMINATION

SUBJECT: - DIGITAL SIGNAL PROCESSING

Time: Three hours

Full Marks 100
(50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART II	Marks
	Answer any FIVE.	
1.	Derive an expression of N-point DFT of a sequence of length L where $L < N$.	10
2.	Develop with proper derivation the signal flow graph of an 8-point Radix-2 decimation-in-frequency FFT. Draw the signal flow graph.	10
3.	Define group delay and phase delay. From the expression of group delay and phase delay, how do you know that the gain of a low pass filter allowing distortionless transmission of signal is real or complex. Justify your comment.	10
4.	Derive the frequency response of a causal *M*-tap FIR digital filter, employing a causal, real and symmetric impulse sequence.	10
5.	"Even when the impulse response of the desired frequency characteristic of the FIR digital filter is truncated, the frequency response of the filter does not change." – State whether the statement is true or false. Justify your comment.	10
6.	Find filter coefficients of a 9-tap causal linear-phase FIR brick-wall type low-pass filter having a pass band gain of unity and a cut off frequency of 200 Hz, with a sampling frequency of 2 kHz. Apply Hamming window for smoothing filter coefficients. Realize the filter.	10
7.	Write short note on any ONE: (a) Circular convolution (b) Contrast enhancement by histogram equalization	10