Ref No: **Ex/EE/5/T/414/2019 (Old)**

BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) FOURTH YEAR FIRST SEMESTER (OLD) EXAM 2019

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 I	Marks
	*Answer **any two** questions.*	
1. (a)	How can an (N/2)-point DFT be divided into two even and odd harmonic (N/4)-point DFTs? Describe the procedure in detail.	10
(b)	Why is radix-2 decimation-in-frequency in-place FFT algorithm so named? Give a detail description of how bit reversal procedure can be carried out in 8-point FFT.	08
(c)	Give a detail comparison of number of complex additions and complex multiplications required for computing DFTs and FFTs for $N = 4, 8, 16,$ and 32.	07
2. (a)	A 7-tap causal linear-phase FIR brick-wall type high-pass filter has been designed with pass band gain of 1.1 and a cut off frequency of 400 Hz. The sampling frequency has been chosen as 1200 Hz. The design employed Raised Cosine window for smoothing filter coefficients. Determine the filter coefficients. Also draw the schematic realization of the filter.	08
(b)	Derive the condition(s) for distortion-less transmission of signal through a filter.	08
(c)	What are the causal and non-causal forms of Hann window and Blackman window, employed for FIR filter design?	06
(d)	What is circular complex convolution integral?	03

No. of Questions	PART I	Marks
3. (a)	"A two-dimensional filtering operation can be achieved by performing a series of one-dimensional filtering operations." - Justify or correct this statement, citing suitable reasons.	05
(b)	In image processing, what is the importance of a two-dimensional sampling function and a two-dimensional sampled sequence? How are convolutional masks designed for FIR low-pass and high-pass image filters?	12
(c)	Derive the frequency response of a causal M-tap FIR digital filter, employing a causal, real and symmetric impulse sequence.	08
5.	Write short notes on ***any two*** of the following:	$12\frac{1}{2}\times 2 = 25$
(i)	Fourier series for a periodic signal.	
(ii)	Image contrast enhancement by histogram equalization.	
(iii)	FIR digital filters for off-line analysis.	

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No. of Questions		PART- II Answer any *THREE* questions Two marks reserved for neatness	Marks
1.	(a)	Write a short note on frequency spectra of uniformly sampled signals.	(10)
	(b)	Consider the analog signal $x(t) = 3\cos 100\pi t$ (a) Determine the minimum sampling rate required to avoid aliasing. (b) Suppose that the signal is sampled at the rate Fs = 200 Hz. What is the discrete-time signal obtained after sampling? (c) Suppose that the signal is sampled at the rate Fs =75 Hz. What is the discrete time signal obtained after sampling?	(6)
2.	(a)	Starting from the definition of Z-transform, determine the expressions for the Z-transforms and the corresponding ROCs of the following sequences. (i) Unit step sequence. (ii) Causal sinusoidal sequence.	(8)
	(b)	Find the final value of the following theorem using Final Value Theorem of Z-transform: $F(z) = \dfrac{0.79z^2}{(z-1)(z^2-0.416z+0.208)}$	(2)
	(c)	Find the inverse Z-transform of the following signal: $X(z) = \dfrac{z^2}{(z-1)(z-0.2)}$; ROC: $\lvert z\rvert > 1$	(6)
3.		If $X(z) = \dfrac{-1-z^{-1}}{1-5z^{-1}+6z^{-2}}$, find $Z^{-1}[X(z)]$ when (i) ROC of X(z) is $\lvert z\rvert > 3$ (ii) ROC of X(z) is $2 < \lvert z\rvert < 3$ (iii) ROC of X(z) is $\lvert z\rvert < 2$	(16)
4.	(a)	Derive the transfer function of discrete time differentiator and discrete time integrator.	(6)
	(b)	Using impulse invariant transformation, design a digital filter corresponding to the analog filter with transfer function $G(s) = 10 / (s^2 + 6s + 5)$ Write down the difference equation relating the output and the input	(10)

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	sequences of the filter. Consider a sampling frequency of 20 Hz.	
5.	Write short notes on the following: **(any two)** (i) Region of Convergence of Z transform. (ii) Uniform Sampling of a continuous time signal can be represented as Impulse Modulation. (iii) Designing digital filters by bilinear transformation. (iv) Mapping of entire left half of s-plane on to z-plane.	(8×2= 16)