Reg. No															

B.Tech DEGREE EXAMINATION, NOVEMBER 2023

Fifth Semester

18ECC204J - DIGITAL SIGNAL PROCESSING

(For the candidates admitted during the academic year 2018-19 to 2021-22)

OPEN BOOK EXAMINATION

18ECC204JO

Note:

i. Specific approved THREE text books (Printed or photocopy) recommended for the course.
ii. Handwritten class notes (certified by the faculty handling the course / Head of the Department).

Time: 3 Hours **Max. Marks: 100**

Answer **FIVE** Questions
(Question No. 3 is compulsory)

			Marks	BL	CO
1	i. a.	A digital communication link carries binary-coded words representing samples of an input signal $x_a(t)=3\cos 600\pi t + 2\cos 1800\pi t$ The link is operated at 10,000 bits/s, and each input sample is quantized into 1024 different voltage levels. What are the sampling frequency and the folding frequency? What is the Nyquist rate for the signal $x_a(t)$? What are the frequencies in the resulting discrete-time signal x(n)? [12 Marks]	12	3	1
	ii. b.	An analog electrocardiogram (ECG) signal contains useful frequencies up to 100 Hz. What is the Nyquist rate for this signal? Suppose we sample this signal at a rate of 250 samples/s, what is the highest frequency that can be represented uniquely at this sampling rate? [6 Marks]	6	3	1
	ii.	Which of the following is the process of 'aliasing'? (A) Peaks overlapping (B) Phase overlapping (C) Amplitude overlapping (D) Spectral overlapping	1	1	1
	iii.	The signal-to-quantization noise ratio in dB is represented as _____ (A) 6.02+1.76b (B) 1.76+6.02b (C) 2.76+6.02b (D) 3.76+6.02b	1	1	1
2	i. a.	Obtain the direct form I and direct form II realization for the following system [12 Marks] $y(n)=\frac{5}{8}y(n-1)-\frac{1}{16}y(n-2)+x(n)+\frac{3}{4}x(n-1)+\frac{1}{8}x(n-2)$	12	3	2
	ii. b.	The DFT of a sequence x(n) that has $N=2^m$ can be calculated using two algorithms. Algorithm A computes the DFT by direct evaluation and takes N^2 seconds to run. Algorithm B implements DIT-FFT and takes $5N \log_2 N$ seconds to run. What is the shortest sequence N such that Algorithm B runs faster than Algorithm A. [6 Marks]	6	3	2
	ii.	If X(k) is the DFT of a sequence x(n) then DFT of real part of x(n) is _____ (A) (1/2)[X(k)+X*(N-k)] (B) (1/2)[X(k)-X*(N-k)] (C) X(k)+X*(N-k) (D) X(k)-X*(N-k)	1	2	2
	iii.	The bit reversed order of the given sequence {1,2,3,4,4,3,2,1} is _____ (A) {1,3,2,4,4,2,3,1} (B) {1,4,3,2,2,3,4,1} (C) {4,3,2,1,4,3,2,1} (D) {4,1,2,3,3,2,1,4}	1	2	2
3	i. a.	Compute the 8-point DFT of the sequence x(n)=n+1 for $0 \le n \le 7$ by using the DIT-FFT algorithm. Defend that X(k) and X(N-k) are complex conjugates from the obtained DFT coefficients. [12 Marks]	12	4	2
	ii. b.	Perform the circular convolution of the two sequences $x_1(n)=\{2,1,2,1\}$ and $x_2(n)=\{1,2,3,4\}$ using the concentric circle method. [6 Marks]	6	4	2
	ii.	Select the value of twiddle factor W_8^3 (A) 1 (B) 0.707+j0.707 (C) -0.707-j0.707 (D) -j	1	1	2

iii.	If X(k)=[0,3+j3,-j4,3-j3,0] is the DFT of a 8-point sequence, then X(5)= (A) 0 (B) 3+3j (C) 3-3j (D) 4j		1	2	2
4	i. a. Design FIR filter by truncating the given desired frequency response to 9 samples $H_d(e^{j\omega}) = \begin{cases} 1 \text{ for } \lvert\omega\rvert \le \frac{\pi}{3} \text{ and } \lvert\omega\rvert \ge \frac{2\pi}{3} \\ 0 \text{ otherwise} \end{cases}$		18	3	3
	ii) Find the realizable transfer function. [12 Marks]				
	b. What are the desirable characteristics of a window? [6 Marks]				
	ii. The necessary and sufficient condition for linear phase characteristic in FIR filter is that the impulse response h(n) of the system should have the ___ property. (A) symmetric (B) anti-symmetric (C) linear (D) non-linear		1	1	3
	iii. Which window function is also regarded as 'Raised-cosine window'? (A) Hamming window (B) Hanning window (C) Barlett window (D) Blackman window		1	1	3
5	i. Design a digital Butterworth filter satisfying the following constraints using bilinear transformation: • 3 dB ripple in pass band $0 \le \omega \le 0.2\pi$ • 25 dB attenuation in stop band $0.45\pi \le \omega \le \pi$		18	4	4
	ii. In bilinear transformation, the left-half of S-plane is mapped ____in the z-domain (A) Entirely outside the unit circle (B) Partially outside the unit circle (C) Partially inside the unit circle (D) Entirely inside the unit circle		1	1	4
	iii. Which of the following filters cannot be designed using the impulse invariance method? (A) Low pass (B) Band pass (C) Low and band pass (D) High pass		1	1	4
6	i. a. For the given analog transfer function, determine H(Z) of the digital filter using the impulse invariance method. Assume T=1 sec. [12 Marks] $H(s) = \frac{4}{s^2 + 6s + 8}$		18	3	4
	ii) b. Compare digital and analog filters. [6 Marks]				
	ii. The poles of Chebyshev filter lie on (A) Unit circle (B) Ellipse (C) Parabola (D) Hyperbola		1	1	4
	iii. What is the transfer function of Butterworth low pass filter of order 2? (A) $1/(s^2+\sqrt{2}s+1)$ (B) $1/(s^2-\sqrt{2}s+1)$ (C) $s^2-\sqrt{2}s+1$ (D) $s^2+\sqrt{2}s+1$		1	1	4
7	i. a. Explain sampling rate conversion by a factor I/D. [12 Marks]		18	3	5
	ii) b. Develop an expression for y(n) as a function of x(n) for the given multirate system. [6 Marks]				
					
	ii. A two-channel subband coding filter bank is also called as _____ (A) Quadrature-mirror filter bank (B) Analysis filter bank (C) Synthesis filter bank (D) Alias free filter bank		1	1	5
	iii. If x[n] = [1, 5, 3, 2] then y[n]=x[n/2] will be (A) [1, 3] (B) [1, 0, 5, 0, 3, 0, 2, 0] (C) [1, 5, 0, 0] (D) [1, 5, 3, 2, 0, 0, 0, 0]		1	2	5

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