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B.Tech. DEGREE EXAMINATION, DECEMBER 2022

OPEN BOOK EXAMINATION

Fifth Semester

18ECC204J – DIGITAL SIGNAL PROCESSING

(For the candidates admitted from the academic year 2020-2021 to 2021-2022)

- Specific approved THREE text books (Printed or photocopy) recommended for the course
- 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	PO
1.a.i.	A digital communication link carries binary coded words representing samples of an input signal $x(t) = 3\cos 600\pi t + 200\cos 1800\pi t$. The link is operated at 10,000 bits/sec and each input sampled is quantized in to 1024 different voltage levels. (i) What are the sampling frequency and folding frequency? (ii) What is the Nyquist rate for the given signal? (iii) What are the frequencies in the resulting discrete time signal?	12	3	1	2
ii.	Validate that the quality of the quantized signal increases for each bit added to the word length for each doubling of the quantization level.	6	4	1	1
b.	The phase function of a discrete time signal $x(n) = a^n$, where $a = r.e^{j\theta}$ is (A) $\tan(n\theta)$ (B) $n\theta$ (C) $\tan^{-1}(n\theta)$ (D) $cot^{-1}(n\theta)$	1	1	1	1
c.	The quantization step size with b = 3 bits is (A) 0.175 (B) 9.125 (C) 0.125 (D) 0.875	1	2	1	1
2.a.i.	Using DIF FFT algorithm find the input sequences for the given DFT sequences $\{36, -1 + j2.414, -8 + j8, -1 + j0.414, -8, -1 - j0.414, -8, -j8, -1 - j2.414\}$.	12	3	2	2
ii.	Perform the circular convolution of $x(n) = \{0.2, 0.4, 0.6, 0.8, 1, 1.2, 1.4, 1.6\}$ and $h(n) = \{0.1, 0.3, 0.5, 0.7, 0.9, 1.1, 1.3, 1.5\}$.	6	3	2	2
b.	The structure that uses separate delays for input and output samples is (A) Cascade form (B) Parallel form (C) Direct form-II (D) Direct form –I	1	1	2	1

c. How many complex multiplications are need to be performed for each FFT algorithm? 1 2 2 1

(A) $2N\log_2 N$ (B) $N\log_2 N$

(C) $\frac{N}{2}\log N$ (D) $\left(\frac{N}{2}\right)\log_2 N$

3.a.i. For the given $x(n)=2^{n+1}$, determine 8-point DFT using DIT-FFT algorithm. 12 3 2 2

ii. Defend the $X(k)$ and $X(N-k)$ are complex conjugate and also discover the remaining DFT sequences of $\{10,6+j3,0,0.4+j0.6,0\}$ for N = 8. 6 4 2 1

b. The number of complex additions required using FFT algorithm for 128 point sequence is 1 2 2 2

(A) 689 (B) 869

(C) 986 (D) 896

c. The value of W_8^{-2} is 1 2 2 2

(A) –j (B) j

(C) 0.707–j0.707 (D) –0.707–j0.707

4.a.i. Realize a band stop filter to stop the frequencies, from 1 to 2 rad/sec for 7 samples using rectangular window function. 12 3 3 2

ii. Illustrate the need for employing window technique for FIR filter design. 6 4 3 1

b. The width of the main lobe in hanning window spectrum is 1 1 3 1

(A) $\frac{4\pi}{N}$ (B) $\frac{16\pi}{N}$

(C) $\frac{2\pi}{N}$ (D) $\frac{8\pi}{N}$

c. What is the condition on the system function of a linear phase filter? 1 2 3 1

(A) $H(z)=\pm z^{N}H\left(z^{-1}\right)$ (B) $H(z)=\pm z^{-N}H\left(z^{-1}\right)$

(C) $H(z)=z^{-N}H\left(z^{-1}\right)$ (D) $H(z)=z^{N}H\left(z^{-1}\right)$

5.a.i. Realize a Butterworth digital filter for the given specifications 12 2 4 2

$0.707\le|H(\omega)|\le 1;\quad 0\le\omega\le 0.2\pi$

$|H(\omega)|\le 0.08;\ 0.4\pi\le\omega\le\pi$

Using Bilinear transformation technique

ii. Illustrate the mapping procedure between S-plane and Z-plane in the method of mapping of differentials. 6 1 4 1

b. The zeros of Butterworth filter exist at 1 1 4 1

(A) Left half of S-plane (B) Infinity

(C) Origin (D) Right half of S-plane

c. Which of the following transformations is high pass to low pass in analog domain? 1 2 4 2

(A) $S \rightarrow \frac{\Omega_e}{S}$ (B) $S \rightarrow \Omega_e S^2$

(C) $S \rightarrow \frac{S}{\Omega_e}$ (D) $S \rightarrow \Omega_e S$

6.a.i. Design a LPF using Chebyshev approximations for the specifications $\alpha_p = 1dB$ ripple in passband $0 \le \omega \le 0.2\pi$, $\alpha_s = 15dB$ ripple in the stop band $0.3\pi \le \omega \le \pi$ using impulse invariant transformation technique. 12 3 4 2

ii. Why impulse invariant method is not preferred in the design of HP IIR filter? 6 4 4 1

b. Poles of Chebyshev filter lies on 1 1 4 1

(A) Circle (B) Origin

(C) Ellipse (D) Parabola

c. The non linear relation between analog and digital frequencies is called 1 2 4 1

(A) Antialiasing (B) Prewarping

(C) Aliasing (D) Warping

7.a.i. Considering a discrete time signal $x(n) = \{1,3,2,5,4,-1,-2,6,-3,7,8,9,....\}$, show that a cascade of D down sampler and I upsampler is interchangeable only when D and I are co-prime. Assume D=2 and I=3. 12 3 5 2

ii. Show that the upsampler and down sampler are time varying systems. 6 4 5 1

b. To eliminate multiple images at the output, during interpolation the output is filtered to have a bandwidth of 1 2 5 2

(A) $\frac{\pi}{I^2}$ (B) $\frac{I}{\pi}$

(C) $\frac{\pi}{I}$ (D) πI

c. Time scaling operation is also known as 1 1 5 1

(A) Upsamping (B) Sampling

(C) Aliasing (D) Down sampling

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