

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

Fifth Semester

Electronics and Communication Engineering

(Common to Computer and Communication Engineering)

20ECPW501 - DISCRETE TIME SIGNAL PROCESSING WITH LABORATORY

Regulations - 2020

Duration: 3 Hours

Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

| | Marks | K- Level | CO |
|---|-------|-------------|-----|
| 1. The DFT of a length N sequence is a) Aperiodic b) Periodic with period N c) periodic with period 2π d) all the above | 1 | K1 | CO1 |
| 2. Radix-2 DIF FFT algorithm splits the input sequence into a) Input sample indices b) Output frequency bins c) Time domain shifting d) Windowing function | 1 | K1 | CO1 |
| 3. Practical frequency selective filters are characterized by: a) Infinite attenuation in stop band b) Zero phase distortion b) Perfectly flat pass band and stop band d) finite attenuation in stop band | 1 | K2 | CO2 |
| 4. The purpose of approximating derivatives in digital filter design is to _____. a) estimate frequency response b) perform spectrum folding b) compute impulse response directly d) avoid aliasing | 1 | K2 | CO3 |
| 5. If the impulse response is anti-symmetrical with N odd, then it can be used to design a) High Pass Filter b) Differentiator c) Band Pass Filter d) Low Pass Filter | 1 | K2 | CO4 |
| 6. _____ window gives a low pass filter with high transition band a) Blackmann b) Hanning c) Rectangular d) Hamming | 1 | K1 | CO4 |
| 7. Representation of 2.25 in floating point is a) $2^{001} \times 0.1100$ b) $2^{010} \times 0.1110$ c) $2^{010} \times 0.1010$ d) $2^{010} \times 0.1001$ | 1 | K2 | CO5 |
| 8. For the transfer function $H(z) = \frac{1}{1-0.9z^{-1}}$ when the coefficient is quantized to 3-bits by truncation the original and shifted poles are respectively a) 0.9, 1.0 b) 0.9, 0.875 c) -0.9, -0.875 d) -0.9, -1.0 | 1 | K2 | CO5 |
| 9. Which DSP architecture separates program memory and data memory for faster processing? a) Von Neumann architecture b) Harvard architecture c) Modified Harvard architecture d) Princeton architecture | 1 | K1 | CO6 |
| 10. _____ is the purpose of a Barrel Shifter in DSP architecture. a) Perform multiplication operations b) Store program instructions c) Perform fast bit-wise shifting in a single cycle d) Increase memory bandwidth | 1 | K1 | CO6 |

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

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| 11. State and prove the Linearity Property of Discrete Fourier Transform. | 2 | K1 | CO1 |
| 12. Calculate the number of multiplications needed in the calculation of DFT using FFT algorithm with 32 – point sequence. | 2 | K2 | CO1 |
| 13. Differentiate Analog Filter and Digital Filter. | 2 | K2 | CO2 |
| 14. Outline the steps to design an analog Butterworth low pass filter. | 2 | K1 | CO2 |
| 15. Construct a digital filter from the given analog transfer function $(s) = 1/(s+a)$ by impulse invariant method. | 2 | K2 | CO3 |
| 16. Derive the relationship between s-plane and z-plane in Bilinear transformation. | 2 | K2 | CO3 |

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| 17. Outline the condition for impulse response of FIR filter to satisfy Constant group and Phase Delay. | 2 | K2 | CO4 |
| 18. State the desirable characteristics of the window function. | 2 | K1 | CO4 |
| 19. Express the fraction $\frac{7}{8}$ and $\frac{-7}{8}$ in sign magnitude, 2's complement and 1's complement. | 2 | K2 | CO5 |
| 20. Give an expression for Quantization Step Size. Calculate the Quantization Step Size when the value of b=3 bits. | 2 | K2 | CO5 |
| 21. List the factors that influence the selection of DSPs. | 2 | K1 | CO6 |
| 22. Summarize the four phases in the pipelining operation of digital signal processors. | 2 | K2 | CO6 |

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

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| 23. a) i) Find the Inverse DFT (IDFT) of the sequence $X(k) = \{5, 0, 1-j, 0, 1, 0, 1+j, 0\}$ | 7 | K3 | CO1 |
| ii) Determine the Circular Convolution of the two sequences $x(n) = \{1, 2, 2, 1\}$ and $h(n) = \{4, 3, 2, 1\}$ using Concentric Circle Method. | 4 | K3 | CO1 |

OR

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| b) i) Compute the eight point DFT of the sequence $x_1(n) = \{0.5, 0.5, 0.5, 0.5, 0, 0, 0, 0\}$ using the radix-2 DIF – FFT algorithm. | 11 | K3 | CO1 |
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| 24. a) Obtain an analog Chebyshev filter transfer function that satisfies the constraints | 11 | K3 | CO2 |
| $\frac{1}{\sqrt{2}} \leq H(j\Omega) \leq 1; 0 \leq \Omega \leq 2$ | | | |

OR

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| b) Design an analog Low pass Butterworth filter that has a 3 dB attenuation at 500 Hz and an attenuation of 40 dB at 1000 Hz. | 11 | K3 | CO2 |
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OR

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| 25. a) Using Bilinear Transformation technique, design a high pass filter, monotonic in pass band with cut-off frequency of 1000 Hz and down 10 dB at 350 Hz. The Sampling frequency is 5000 Hz. | 11 | K3 | CO3 |
| b) Obtain the Direct Form – I, Direct Form – II, Cascade and Parallel form realization for the system | 11 | K3 | CO3 |
| $y(n) = -0.1y(n-1) + 0.2y(n-2) + 3x(n) + 3.6x(n-1) + 0.6x(n-2)$ | | | |

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| 26. a) Design an ideal Band Pass Filter using Hamming Window with a desired frequency response | 11 | K3 | CO4 |
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$$H_d(e^{j\omega}) = 1 \quad \text{for } \frac{\pi}{4}|\omega| \leq \frac{3\pi}{4}$$

$$= 0 \quad \text{otherwise}$$

Find the value of h(n) for N = 11. Plot the Magnitude Response

OR

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| b) i) Realize the system function with minimum number of Multipliers. | 5 | K3 | CO4 |
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$$H(z) = \left(1 + \frac{1}{2}z^{-1} + z^{-2}\right) \left(2 + \frac{1}{4}z^{-1} + 2z^{-2}\right)$$

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|---|---|----|-----|
| ii) Using frequency sampling method, design a FIR low pass filter with $\omega_c = \frac{\pi}{4}$, for N = 15. Also plot its magnitude response. | 6 | K3 | CO4 |
|---|---|----|-----|

27. a) i) Draw the Quantization Noise model for a second order system 8 K3 CO5
- $$H(z) = \frac{1}{1 - 2r \cos\theta z^{-1} + r^2 z^{-2}}$$
- Find the steady state output noise variance.
- ii) The filter coefficient $H = -0.673$ is represented by sign-magnitude fixed point arithmetic. If the word length is 6 bits, compute the quantization error due to truncation. 3 K3 CO5
- OR**
- b) i) Explain the characteristics of a limit cycle oscillation with respect to the system described by the difference equation $y(n) = 0.95 y(n-1) + x(n)$. The system is excited by input $x(n) = 0.75$ for $n = 0$ and $x(n) = 0$, for $n \neq 0$ and the product is quantized by 5 bits by rounding. 8 K3 CO5
- ii) Evaluate the Saturation Arithmetic method to prevent overflow. 3 K3 CO5
28. a) With neat block diagram, briefly explain the VLIW architecture and Harvard Architecture. Also the mechanism of pipelining to speed up the execution of an instruction. 11 K2 CO6
- OR**
- b) Write an assembly language program for the generation of Square Waveform and Saw tooth Waveform. 11 K2 CO6