



Faculty of Engineering

End Semester Examination May 2025

EE3EL16 Digital Signal Processing

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|------------------|----------|----------------|------------------------------|----------|-----------|
| Programme | : | B.Tech. | Branch/Specialisation | : | EE |
| Duration | : | 3 hours | Maximum Marks | : | 60 |

Note: All questions are compulsory. Internal choices, if any, are indicated. Assume suitable data if necessary. Notations and symbols have their usual meaning.

| Section 1 (Answer all question(s)) | | | | | Marks | CO | BL |
|------------------------------------|---|--|--|--|-------|----|----|
| Q1. | Which of the following is a classification of discrete-time signals? | | | | 1 | 1 | 1 |
| | <input type="radio"/> Continuous-time signals | <input checked="" type="radio"/> Random signals | | | | | |
| | <input type="radio"/> Periodic signals | <input type="radio"/> All of the above | | | | | |
| Q2. | What condition must hold for a Linear Time-Invariant (LTI) system to be considered stable? | | | | 1 | 1 | 1 |
| | <input checked="" type="radio"/> Output remains bounded for bounded input | <input type="radio"/> Output is zero for all time | | | | | |
| | <input type="radio"/> System function has no poles | <input type="radio"/> System function is a polynomial | | | | | |
| Q3. | What is the main property of the Discrete Fourier Transform (DFT)? | | | | 1 | 1 | 1 |
| | <input type="radio"/> Time-shifting property | <input type="radio"/> Frequency-shifting property | | | | | |
| | <input type="radio"/> Linearity property | <input checked="" type="radio"/> All of the above | | | | | |
| Q4. | The Fast Fourier Transform (FFT) is primarily used to- | | | | 1 | 1 | 1 |
| | <input type="radio"/> Increase the sampling rate of signals | <input checked="" type="radio"/> Reduce computation time for DFT | | | | | |
| | <input type="radio"/> Increase the duration of signals | <input type="radio"/> None of the above | | | | | |
| Q5. | Which type of filter is characterized by a transfer function that can be expressed as a ratio of two polynomials? | | | | 1 | 1 | 1 |
| | <input type="radio"/> FIR filter | <input checked="" type="radio"/> IIR filter | | | | | |
| | <input type="radio"/> All-pass filter | <input type="radio"/> Band-pass filter | | | | | |
| Q6. | The Chebyshev filter is known for: | | | | 1 | 1 | 1 |
| | <input type="radio"/> Having a flat frequency response | <input checked="" type="radio"/> Ripple in the passband | | | | | |
| | <input type="radio"/> Steep roll-off | <input type="radio"/> Limited phase distortion | | | | | |
| Q7. | The main advantage of FIR filters over IIR filters is- | | | | 1 | 1 | 1 |
| | <input type="radio"/> Higher order requirements | <input checked="" type="radio"/> Linear phase response | | | | | |
| | <input type="radio"/> Computational complexity | <input type="radio"/> None of the above | | | | | |
| Q8. | Which technique is typically used for FIR filter design? | | | | 1 | 1 | 1 |
| | <input type="radio"/> Butterworth approximation | <input checked="" type="radio"/> Windowing techniques | | | | | |
| | <input type="radio"/> Chebyshev approximation | <input type="radio"/> Bilinear transformation | | | | | |
| Q9. | The process of removing redundant data points in a discrete signal is known as: | | | | 1 | 1 | 1 |
| | <input checked="" type="radio"/> Decimation | <input type="radio"/> Interpolation | | | | | |
| | <input type="radio"/> Sampling | <input type="radio"/> Quantization | | | | | |
| Q10. | What is the primary application of multirate signal processing? | | | | 1 | 1 | 1 |
| | <input type="radio"/> Speech recognition | <input type="radio"/> Data compression | | | | | |
| | <input checked="" type="radio"/> Sampling rate conversion | <input type="radio"/> Image processing | | | | | |

Section 2 (Answer all question(s))**Marks CO BL****Q11.** Explain the concept of stability in Linear Time-Invariant (LTI) systems.**2 2 2**

| Rubric | Marks |
|-----------------|-------|
| concept 2 marks | 2 |

Q12. Describe the concept of invertibility for LTI systems.**3 2 2**

| Rubric | Marks |
|----------------------|-------|
| Full concept 3 marks | 3 |

Q13. (a) Solve the difference equation $y[n] - 0.5y[n-1] = x[n]$ using Z-transforms.**5 3 3**

| Rubric | Marks |
|------------------|-------|
| Each step 1 mark | 5 |

(OR)**(b)** Explain the concept of the frequency domain representation of discrete-time signals.

| Rubric | Marks |
|------------------|-------|
| Each step 1 mark | 5 |

Section 3 (Answer all question(s))**Marks CO BL****Q14.** Derive the relationship between the Discrete Fourier Series (DFS) and the Discrete Fourier Transform (DFT).**3 3 3**

| Rubric | Marks |
|----------------------------------|-------|
| DFS and DFT equal marks 1.5 each | 3 |

Q15. (a) Describe the properties of the Discrete Fourier Transform (DFT) and provide examples.**7 2 2**

| Rubric | Marks |
|---|-------|
| Each property 4 marks and example 3 marks | 7 |

(OR)**(b)** Discuss linear filtering methods based on DFT and their applications.

| Rubric | Marks |
|--|-------|
| Method 4 marks and application 3 marks | 7 |

Section 4 (Answer all question(s))**Marks CO BL****Q16.** Explain the key differences between analog and digital filter designs.**3 2 2**

| Rubric | Marks |
|-------------------------|-------|
| Three differences (1x3) | 3 |

- Q17. (a)** Design of IIR digital filters from analog filters can be performed using which techniques? 7 3 3
Describe one with steps.

| Rubric | Marks |
|--------------------------------------|-------|
| Technique- 2 marks, Design Steps 1x5 | 7 |

(OR)

- (b)** Discuss linear filtering methods based on DFT and their applications.

| Rubric | Marks |
|--|-------|
| Methods—5 marks, Applications- 2 marks | 7 |

Section 5 (Answer all question(s))

Marks CO BL

- Q18.** Describe the characteristics of FIR filters with linear phase. How they affect frequency response? 3 2 2

| Rubric | Marks |
|--|-------|
| characteristics 1.5 marks and affect 1.5 marka | 3 |

- Q19. (a)** Compare and contrast IIR and FIR filters with respect to stability, phase response, and implementation complexity. 7 2 2

| Rubric | Marks |
|--------------------------|-------|
| Each compare equal marks | 7 |

(OR)

- (b)** Briefly describe the frequency sampling technique for FIR filter design.

| Rubric | Marks |
|--------------------------------|-------|
| Sampling Technique Steps...1x7 | 7 |

Section 6 (Answer any 2 question(s))

Marks CO BL

- Q20.** Explain the process of interpolation in multirate digital signal processing, including its applications. 5 2 2

| Rubric | Marks |
|---|-------|
| process 3.5 marks and application 1.5 marks | 5 |

- Q21.** Define decimation and explain its significance in digital signal processing. 5 1 1

| Rubric | Marks |
|---|-------|
| defination 3 marks and significance 2 marks | 5 |

- Q22.** Describe the implementation of sampling rate converters and their impact on signal quality. 5 2 2

| Rubric | Marks |
|---|-------|
| describe 3 marks and impact on signal quality 2 marks | 5 |
