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Question Paper Code : 40580

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2025.

Fifth/Eighth Semester

Electrical and Electronics Engineering

EE 8591 – DIGITAL SIGNAL PROCESSING

(Common to : Electronics and Instrumentation Engineering/Instrumentation and control Engineering)

((Regulations 2017)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define quantization and quantization error.
2. What is the Nyquist sampling rate?
3. State any two properties of the Z-transform.
4. What is convolution in discrete-time systems?
5. Define the Discrete Fourier Transform (DFT).
6. What is the purpose of a butterfly structure in FFT?
7. List any two windowing techniques used in FIR filter design.
8. What is warping in filter design?
9. What are functional modes in digital signal processors?
10. Mention any two addressing formats supported by DSPs.

PART B — (5 × 13 = 65 marks)

11. (a) Classify continuous and discrete systems. Discuss sampling and aliasing effect with necessary mathematical illustrations.

Or

- (b) A continuous-time signal is given as $x(t) = \sin(100\pi t)$. Determine the sampling frequency required to avoid aliasing. Also compute the quantization error if this signal is quantized using 3 bits.
12. (a) Given the difference equation : $y[n] - 0.5y[n-1] = x[n]$. Find the system function and determine whether the system is stable or not.

Or

- (b) Compute the convolution of the signals : $x[n] = \{1, 2, 3\}$, $h[n] = \{1, 0, -1\}$. Also, determine the frequency response using DTFT.
13. (a) Compute the 4-point DFT of the sequence $x[n] = \{1, 2, 3, 4\}$ using radix-2 DIT FFT algorithm. Show all steps.

Or

- (b) For the sequence, $x[n] = \{2, 1, 0, 1\}$ compute DFT using DIF FFT algorithm. Use butterfly diagram and show intermediate results.
14. (a) Design a low-pass FIR filter using the Hamming window method with cut off frequency $\omega_c = 0.5\pi$, filter length $N = 5$. Show the full design process and derive the coefficients.

Or

- (b) Design an analog Butterworth low-pass filter with cutoff frequency of 1 kHz and transform it into a digital filter using bilinear transformation. Use $T = 0.001$ sec for discretization. Include warping and pre-warping steps.
15. (a) Explain the architecture of a typical commercial DSP processor with a block diagram. Write a simple assembly code segment to perform circular buffering.

Or

- (b) Analyze the performance of different addressing modes with an example of MAC (Multiply-Accumulate) operation implemented on a DSP processor.

PART C — (1 × 15 = 15 marks)

16. (a) Design and implement a band-stop FIR filter using the rectangular window method for the following specifications:

Stopband: 0.3π to 0.5π

Passband: 0 to 0.25π and 0.55π to π

Filter length: $N = 11$

Show all mathematical steps and final filter coefficients.

Or

- (b) Develop a case study to implement a speech enhancement system using a real-time DSP processor. Model the filtering stage using a suitable IIR filter and write the steps to optimize memory and speed using architecture-specific DSP features.
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