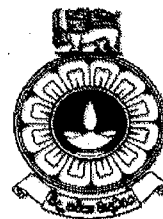


The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering



Study Programme : Bachelor of Science Honours in Engineering
Name of the Examination : Final Examination
Course Code and Title : EEX7434 Digital Signal Processing
Academic Year : 2024/25
Date : 08th March 2026
Time : 13:30 – 16:30 h
Duration : 3 hours

General instructions

1. Read all instructions carefully before answering the questions.
 2. This question paper consists of **Five (5)** questions in **Three (3)** pages.
 3. Answer **all** questions.
 4. All questions carry equal marks.
 5. Answers for each question should commence from a new page.
 6. This is a Closed Book Test (CBT).
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Question 1**[20 marks]**

Answer the following questions related to digital signal processor (DSP) architectures and functionalities.

1. Compare the three (03) common architecture types of DSPs based on access to data and instructions.
2. What is the role of the Multiply-Accumulate (MAC) unit in DSPs?
3. Why do DSPs use circular buffering?
4. What are the five (05) main stages of an execution cycle in DSP?
5. What is pipelining in DSP?

Question 2**[20 marks]**

A discrete-time system is described by the difference equation: $y(n) - 0.5y(n - 2) = x(n)$

where $x(n)$ is the input and $y(n)$ is the output.

1. Find the system's transfer function $H(z)$ using the Z-transform.
2. Determine the impulse response $h(n)$ of the system.
3. Analyze the stability of the system using the pole locations.

Question 3**[20 marks]**

1. Find the Fourier transform of $e^{-at}u(t)$. [04 marks]
2. Calculate the 4-point Discrete Fourier Transform (DFT) of the sequence:
 $x[n] = \{1, 2, 3, 4\}, n = 0, 1, 2, 3$ [08 marks]
3. Describe the computational steps of the Cooley-Tukey FFT algorithm. [08 marks]

Question 4**[20 marks]**

1. Design a low-pass FIR filter with cutoff frequency $f_c = 1$ kHz, sampling frequency $f_s = 8$ kHz, and filter length $N = 21$. Use the window method with a Hamming window. What are the filter coefficients? [10 marks]
2. Design a digital low-pass IIR filter with cutoff frequency $f_c = 1$ kHz, sampling frequency $f_s = 8$ kHz, and passband ripple of 1 dB. Use a Butterworth design with order $N = 4$. What are the filter coefficients? [10 marks]

Question 5**[20 marks]**

1. Prove that a time shift in the discrete-time domain corresponds to a phase shift in the frequency domain for the Discrete-Time Fourier Transform (DTFT). [04 marks]

2. Show that the DFT of a real-valued sequence $x[n]$ has conjugate symmetry, i.e.,

$$X[N - k] = X^*[k], \text{ for } k = 1, 2, \dots, N - 1$$

where $X[k]$ is the DFT of $x[n]$.

[08 marks]

3. Given the 4-point DFT sequence:

$$X[k] = \{10, -2 + 2j, -2, -2 - 2j\}, k = 0, 1, 2, 3$$

Compute the original time-domain sequence $x[n]$ using the IDFT.

[08 marks]

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