



TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY

MEDICAL ENGINEERING DEPARTMENT

UNIVERSITY EXAMINATION FOR:

EBL 4502 BTECH MEDICAL ENGINEERING

BIOMEDICAL SIGNAL PROCESSING

END OF SEMESTER EXAMINATION

SERIES: MARCH 2025

TIME: 2 HOURS

DATE:

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Question ONE is compulsory. In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory)

- (a) (i) Explain the applications of a digital signal processing system in digital sound audio effects.
- (ii) With appropriate equations describe how the following effects are obtained for an audio sequence $x(n)$.
 - (I) Echo
 - (II) Flanging and chorusing
 - (III) Reverberation

(7 marks)

- (b) (i) State the expression for DFT and write it in matrix form for a sequence of length $n = 4$.
(ii) State the **FOUR** properties of the twiddle factor.
(8 marks)
- (c) (i) State the expression for digital convolution.
(ii) Determine the convolution of two sequences:
 $x(n)=[1, 2, 1, 2, 1]$ and $h(n)=[2, 1, -1, 1]$
(4 marks)
- (d) (i) Determine the circular convolution of $h(n)=[1, 2, -1, 1]$ and $x(n)=[1.5, 2, 0, 1]$
(ii) Use overlap add method to determine the convolution of
 $x(n)=[1, 3, 2, -3, 0, 2, -1, 0, -2]$ and $h(n)=[1, 0, 1,]$
(iii) Realize the following IIR filter using:
(I) Direct form 1
(II) Canonical form
 $H(z)=2-3z^{-1}+4z^{-3}/1+0.2z^{-1}-0.3z^{-3}+0.5z^{-4}$
(11 marks)

Question TWO

- (a) Write C, Java or MATLAB code to implement IIR filtering in direct form **(9marks)**
(b) Write C, JAVA or MATLAB code to implement;
(i) Basic convolution
(ii) Block convolution by add overlap method **(11 marks)**

Question THREE

- (a) Show that the decimation in time and in place Radix two fast Fourier transform may be used to compute the DFT of a sequence. **(10 marks)**
- (b) Use Decimation in time and in place radix two fast fourier transform to compute the DFT of:
 $x(n)=[0, 2, 3, 4, 3, 4, 2, 0]$ **(10 marks)**

Question FOUR

(a) Derive the general form of Discrete Fourier transform pair. **(10 marks)**

(b) Determine and plot the magnitude and phase response a unit discrete sequence:

$$h(n)=1, \quad 0 \leq n-1 \quad \textbf{(10 marks)}$$

Question FIVE

(a) Describe using appropriate equations the application of digital signal processing in the following operations:

- (i) Noise reduction
- (ii) 1st order IIR smoothing
- (iii) Notch filter
- (iv) Comb filter

(12 marks)

(b) With the aid of a diagram and equations show the necessary conditions for an LTI system to be:

- (i) Stable
- (ii) Causal

(8 marks)