



TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY ELECTRICAL AND ELECTRONICS ENGINEERING

TEE 4313 DIGITAL SIGNAL PROCESSING

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: JULY 2025

TIME: 2 HOURS

DATE: July 2025

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

- (a) (i) Illustrate **TWO** methods of generating discrete sequences.
- (ii) Derive the necessary conditions for LTI systems to be:
- (I) Causal
- (II) Stable

(11 marks)

- (b) (i) State the general expression for digital convolution.
- (ii) Using convolution table determine the output for an input sequence:
 $x(n) = 1, 2, 1, 2, 1$ into an LTI system $h(n) = 2, 1, -1, 1$
- (iii) Using matrix form compute the circular convolution of:
 $h(n) = [1, 2, -1, 1]$ with $x(n) = [1.5, 2, 0, 1]$

(11 marks)

(c) Derive the expression for Discrete Fourier Pair

(8 marks)

Question TWO

Design an FIR low pass filter with the following specifications. Cut off frequency 1.5Hz, transition width 0.5kHz stop band attenuation 50dB, sampling frequency $f_s = 8 \text{ kHz}$.

(20 marks)

Question THREE

(a) A first order system is described by a difference equation:

$$y(n) = x(n) + ky(n-1) \quad |k| < 1$$

With $y(-1) = 0$

- (i) Determine $h(n)$
- (ii) Plot the magnitude and phase responses

(14 marks)

(b) A second order system is described by the following difference equation:

$$y(n) = -0.2y(n-1) - 0.4y(n-2) + 3x(n) + 2x(n-1) + x(n-2)$$

Realize the filter using:

- (i) Direct form I
- (ii) Direct form II

(6 marks)

Question FOUR

(a) With the aid of diagram, equations as appropriate, describe how a digital filter is used to implement:

- (i) Noise reduction
- (ii) First order IIR smoother
- (iii) Notch filter
- (iv) Comb filter

(12 marks)

(b) (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

(7 marks)

Question FIVE

(a) (i) Show that Radix 2 decimation in time and in place EFT may be used to reduce the number of computations for DFT.

(ii) State the **FOUR** properties of twiddle factor.

(10 marks)

(b) Use FFT to compute DFT of:

$$x(n)=[0, 2, 3, 4, 3, 4, 2, 0]$$

(10 marks)