(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2021/2022 ACADEMIC YEAR

FIFTH YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND COMMUNICATIONS ENGINEERING

COURSE CODE: ECE 521

COURSE TITLE: DIGITAL SIGNAL PROCESSING

DATE: Thursday, 06th October, 2022 **TIME:** 09:00a.m-11:00a.m

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

MMUST observes ZERO tolerance to examination cheating

QUESTION ONE [30MARKS]

(a) Differentiate the following types of discrete time signals

i. Linear and nonlinear signals [2marks]

ii. Energy and power signals [2marks]

iii. Causal and No-causal signals [2marks]

(b) (i) Determine the response of the time invariant system with impulse response, h(n) = {1, 2, -1, -2} to an input signal, x(n) = {1, 2, 3, 4}. [3marks]

(ii) Explain any THREE properties of z-transforms [3marks]

(c) Determine the discrete time Fourier transform of the following sequences

(i) $x(n) = u(n+3) - u(n-3)$ [3marks]

(ii) $x(n) = \{1, -2, 2, 3)\}$ [3marks]

(d) Determine the transfer function and unit sample response of the second-order difference equation with zero initial condition,

[6marks]

$$y(n) = x(n) - 0.25y(n-2).$$

(e) Construct a block diagram for the discrete-time systems whose input-output relations are described by the following difference equations.

(i) $y(n) = 0.7\,x(n) + 0.3\,x(n-1)$ [3marks]

(ii) $y(n) = 0.5\,y(n-1) + 0.8\,x(n) + 0.4\,x(n-1)$ [3marks]

QUESTION TWO [20MARKS]

(a) (i) State any TWO advantages of z-transforms [2marks]

(ii) With suitable examples distinguish a deterministic signal from a random signal. [3marks]

(b) A system has an impulse response h(n)={1, 2, 3} and output response y(n)={1, 1, 2, 21, 3}. Determine the input sequence x(n) using long division method. [5marks]

(c) Determine the causal signal x(n) having the z-transform [4marks]

$$X(z) = \frac{1}{(1+z^{-1})(1-z^{-1})^2}$$

(d) Determine the difference equation of a causal system represented by; [3marks]

$$H(z) = \frac{z+1}{z^2 - 0.9z + 0.81}$$

(e) Compute the convolution *x(n)* of the signals [3marks]

$$x_1(n) = \{4, \ -2, 1\}$$

$$x_2(n) = \begin{cases} 1, & 0 \le n \le 5 \\ 0, & \text{otherwise} \end{cases}$$

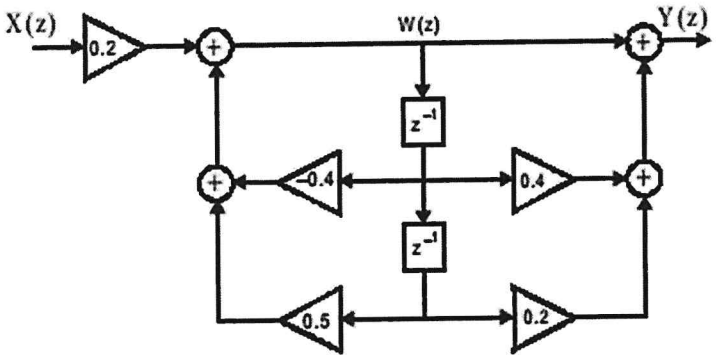
QUESTION THREE [20MARKS]

(a) The transfer function of an IIR system has 'Z' number of zeros and 'P' number of poles. Determine the number of additions, multiplications and memory locations are required to realize the system in direct form-I and direct form-II. [3marks]

(b) With illustrations, explain shifting and time scaling operations on discrete-time signals. [8marks]

(c) Determine the z-transform for the analog input signal $x(t) = e^{-at}$ applied to a digital filter [4marks]

(c) Obtain the transfer function for the following structure. [5marks]



QUESTION FOUR [20MARKS]

(a) Determine the convolution of the two sequences *x(n)= {2, 1, 0, 0.5}* and *h(n)= {2, 2, 1, 1}* using the following techniques.

(i) Graphical method [4marks]

(ii) Tabular method [4marks]

(iii) Matrices method [4marks]

(b) A discrete system is given by the following equation

$$y(n) - 5\,y(n-1) = x(n) + 4\,x(n-1)$$

Where $x(n)$ is the input and $x(n)$ is the output. Determine the magnitude and phase response using discrete time Fourier transform. [4marks]

(c) Determine the frequency response of an LTI system governed by the difference equation [4marks]

$$\mathbf{y(n) = x(n) + 0.81\,x(n-1) + 0.81\,x(n-2) - 0.45\,y(n-2)}$$

QUESTION FIVE [20MARKS]

(a) Define the following terms as applied in digital signal processing

(i) Signal [1mark]

(ii) System [1mark]

(b) Explain the concept of convolution in discrete time signals [2marks]

(b) An LTI system is described by the equation,

$y(n) = x(n) + 0.8\,x(n-1) + 0.8\,x(n-2) - 0.49\,y(n-2)$.

Determine the transfer function of the system. Sketch the poles and zeros on the z-plane. [6marks]

(c) Obtain the direct form-I and direct form-II form realizations of the LTI system governed by the equation [6marks]

$$y(n) = -\frac{3}{8}y(n-1) + \frac{3}{32}y(n-2) + \frac{1}{64}y(n-3) + x(n) + 3x(n-1) + 2x(n-2)$$

(d) Draw the direct form structure of the FIR system described by the transfer function. [4marks]

$$H(z) = 1 + \frac{1}{2}z^{-1} + \frac{3}{8}z^{-2} + \frac{5}{4}z^{-3} + \frac{1}{2}z^{-4} + \frac{7}{8}z^{-5}$$