



**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**FACULTY OF ENGINEERING**

**DEPARTMENT OF ELECTRONIC ENGINEERING**

**DIGITAL SIGNAL PROCESSING**

**EEE 3151**

**December 2024**

**This examination paper consists of 4 pages**

**Time Allowed: 3 Hours**

**Total Marks: 100**

**Examiner's Name: Eng. J Mwanza**

**INSTRUCTION AND INFORMATION TO THE CANDIDATE**

- 1. Answer ALL parts of Section A and any THREE questions from Section B.**
- 2. Section A carries 40 marks and Section B carries 60 marks.**
- 3. Start each question on a new page**
- 4. Use of calculators is permissible**

**MARK ALLOCATION**

<b><u>QUESTION</u></b>	<b><u>MARKS</u></b>
<b><u>1</u></b>	<b><u>40</u></b>
<b><u>2</u></b>	<b><u>20</u></b>
<b><u>3</u></b>	<b><u>20</u></b>
<b><u>4</u></b>	<b><u>20</u></b>
<b><u>5</u></b>	<b><u>20</u></b>
<b><u>Total marks attainable by candidate</u></b>	<b><u>100</u></b>

**SECTION B**

**Question 2**

a) Two digital signals are as follows

$$y_1[n] = \delta[n] - \delta[n - 2] + \delta[n - 3]$$

$$y_2[n] = 2\delta[n] + \delta[n - 2] - \delta[n - 3]$$

Determine the convolution of the two signals using the Z-transform method. [10 Marks]

b) Show the relation between the Z-transform and the Fourier Transform. [10 Marks]

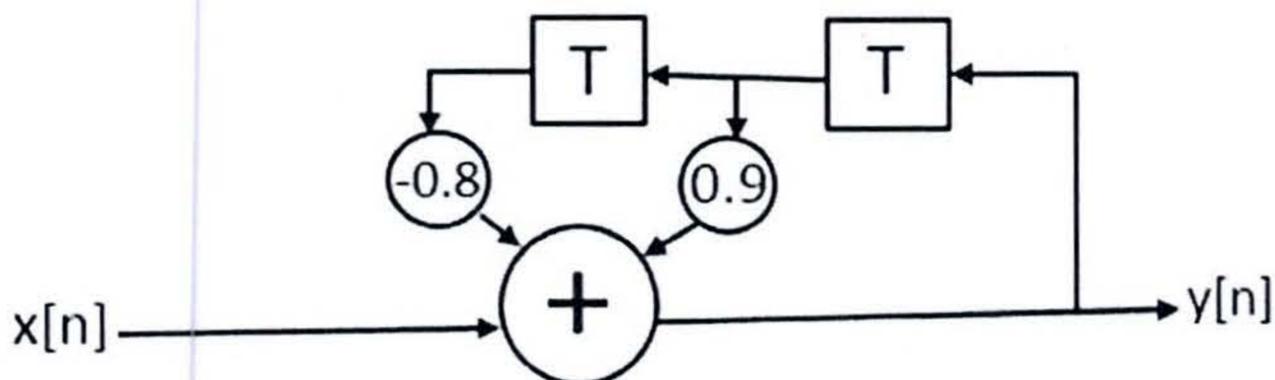
**Question 3**

a) The impulse response of an LTI system is  $h[n] = \left(\frac{1}{3}\right)^n u[n]$ . Determine the output  $y[n]$  of the system when the input is  $x[n] = \left(\frac{1}{2}\right)^n \cos\left(\frac{\pi n}{3}\right) u[n]$ . [10 Marks]

b) Using block diagrams, differentiate between the parallel and cascade interconnection of digital systems. [10 Marks]

**Question 4**

a) A digital bandpass filter is shown below



- Write down the difference equation of the filter. [10 Marks]
- Find an expression for its transfer function  $H(z)$ . [10 Marks]

**Question 5**

## SECTION A

### Question 1

a) Define the following terms

- a. Aliasing [3 Marks]
- b. Quantization [4 Marks]
- c. Linear time-invariant system [2 Marks]
- d. Digital filter [2 Marks]
- e. Sampling [3 Marks]

b) Describe any one technical application of digital signal processing in

- a. Radar [4 Marks]
- b. Sound production [4 Marks]
- c. Medical electronics [4 Marks]

c) Discuss the practicality of implementing the Discrete Fourier Transform (DFT) in comparison to the Continuous Fourier Transform (CFT) and Fourier Series. [14 Marks]

- a) Check the system  $y[n] = x[n] + x[n + 1] + 3x[n - 2]$  for causality, memory and stability.  
**[10 Marks]**
- b) Determine the signal  $x[n]$  corresponding to  $X[z] = \log(1 - 2z)$  where  $z = 0.3 + 0.3j$  is in the ROC.  
**[5 Marks]**
- c) Explain the following Z-transform of signal  $x[n]$  as a power series in  $z^{-1}$ , and write down its first 5 sample values (starting at  $n = 1$ ). Also, sketch the z-plane poles and zeros of the signal.

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

**[5 Marks]**