

# Mawlana Bhashani Science and Technology University

## Department of Information and Communication Technology

### 3<sup>rd</sup> year 2<sup>nd</sup> Semester B. Sc (Engg.) Final Examination 2025

Course Title: Digital Signal Processing

Course Code: ICT 3205

Full Marks: 70

Time: 3 hour

#### Answer any five from the following questions

1. (a) Shortly describe various elementary discrete-time signals and indicate them graphically. 5  
 (b) Determine which of the following signals are energy signals or power signals. 6
  - (i)  $\left(\frac{1}{2}\right)^n u(n)$
  - (ii)  $e^{j[(\frac{\pi}{3})n + (\pi/2)]}$
  - (iii)  $\sin \frac{\pi}{3} n$
2. (a) Write down the advantages and disadvantages of digital signals processing. 3  
 (a) Show that, the overall impulse response is equal to the sum of two impulse responses if two systems are connected in parallel. 5  
 (b) Find the linear and circular convolution of the following sequence 6  
 $x(n) = \{2, 1, 2, 1\}$  and  $h(n) = \{1, 2, 3, 4\}$   
 Using the graphical method.  
 (c) What is auto-correlation ~~or~~ cross-correlation? 3
3. (a) Make a comparison among IIR filter and FIR filter 3  
 (b) Check the causality and stability of the following system. 5  
 $y(n) = x(n) - x(-n - 1) + x(n - 1)$   
 (c) Find the z-transform of the following sequences: 6
  - (i)  $u(n) - u(n - 4)$
  - (ii)  $u(-n) - u(-n - 3)$
4. (a) Derive the relation between discrete-time Fourier transform and Z-transform 4  
 (b) Construct the block diagram for the discrete-time systems whose input-output relations are described by the following difference equations: 5  
 $y(n) = 0.5y(n - 1) + 0.8x(n) + 0.4x(n - 1)$   
 (c) Determine the ROC and Z-transform of the causal sequence: 5  
 $x(n) = \{1, 0, -2, 3, 5, 4\}$   
 (a) Explain the convolution property of z-transform. 4  
 (b) A causal LTI system is defined by the difference equation : 6  
 $2y(n) - y(n - 2) = x(n - 1) + 3x(n - 2) + 2x(n - 3)$   
 Find the transfer function and frequency response of the system.  
 (c) Using long division, determine the inverse Z-transform for the following function: 4  

$$X(z) = \frac{z^2 + 2Z}{z^3 - 3z^2 + 4z + 1}$$
5. (a) State and prove the time shifting and frequency shifting properties of DFT. 6  
 (b) Describe the divide and conquer method for the DIT FFT algorithm with necessary figures. 6  
 (c) Write down the applications of DFT. 2
6. (a) What is FFT? Why it is needed? 2  
 (b) What is sampling theorem? Briefly explain the aliasing and anti-aliasing effect of a sampled signal. 4  
 (c) Consider a signal,  $x(n) = nu(n)$ . 8
  - (i) Find the spectrum of the signal
  - (ii) Find a signal with a decimation factor 2.
  - (iii) Find a signal with an interpolation factor 2.
7. (a) Explain the advantages and disadvantages of FIR filter? 4  
 (b) For the analog transfer function: 6  

$$H(s) = \frac{1}{(s + 1)(s + 2)}$$
  
 Determine H(z) using impulse invariant technique. Assume T=1s.  
 (c) Make a comparison among Harvard architecture and modified Harvard architecture for the computer. 4