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Department of Information and Communication Technology

3rd year 2nd 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 & 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
 $x(n) = \{1, 0, -2, 3, 5, 4\}$
5. (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

$$X(z) = \frac{z^2 + 2z}{z^3 - 3z^2 + 4z + 1}$$
6. (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
7. (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.
8. (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