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| **Course Name:** | **Digital Signal & Image Processing Laboratory** | **Semester:** | **VI** |
| **Date of Performance:** | **15 / 01 / 2025** | **Batch No.:** | **B - 2** |
| **Faculty Name:** | **Prof. Om Goswami** | **Roll No.:** | **16014022050** |
| **Faculty Sign & Date:** |  | **Grade/Marks:** | **\_\_\_ / 20** |

**Experiment No.: 1**

**Title:** Representation of Discrete-Time Signals and Performing Operations on them.

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| **Objective:** |
| To understand the representation of discrete-time signals and to perform basic operations such as addition, scaling, shifting, and folding using MATLAB. |

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| **COs to be achieved:** |
| **CO1:** Identify various discrete time signals and systems and perform signal manipulation |

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| **Materials Required:** |
| MATLAB software |

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| **Books/ Journals/ Websites referred:** |
| 1. Nagoor Kani “Digital Signal Processing”, 2nd Edition, TMH Education. 2. Alan V. Oppenheim and Ronald W. Schafer, "Discrete-Time Signal Processing." 3. MATLAB Documentation: https://www.mathworks.com/help/matlab/ |

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| **Theory:** |
| Discrete-time signals are sequences of values, typically represented as x[n], where n is an integer.   1. **Discrete time signals types** *(write about the following signals)* 2. Delta (Impulse) signal   The delta function, denoted as δ[n], is a discrete-time signal that is zero for all values of *n* except at *n=0*, where it takes an infinite value, typically defined as δ[0]=1. It's commonly used in signal processing as a mathematical tool to represent sudden changes or impulses.   1. Unit Step signal   The unit step signal, denoted as *u[n]*, is defined as:  It represents a signal that switches from 0 to 1 at *n=0* and remains at 1 for all subsequent values of *n*.   1. Ramp Function   The ramp function, denoted as r[n], is a discrete-time signal that increases linearly with time for n≥0 and is zero for n<0:  It represents a gradually increasing signal, often used to model systems with a steady increase in value over time.   1. Exponential Signal   The exponential signal in discrete time, denoted as x[n]=A⋅ α*n*, where A is the amplitude and α is a constant, is a signal that grows or decays exponentially depending on the value of α. If ∣α∣<1, the signal decays, and if ∣α∣>1, the signal grows.   1. Sinusoidal Signal   A sinusoidal signal, denoted as x[n]=A⋅sin(ωn + ϕ), where A is the amplitude, ω is the frequency, and ϕ is the phase, is a periodic signal that oscillates between positive and negative values. It’s commonly used to represent alternating currents or waveforms in many physical systems.  Plot each signal in a separate subplot.  Code:  close all;  clc;  n = -20:0.5:5;  % sinusoidal  x = 5 \* sin(0.2 \* pi \* n);  subplot(3, 2, 1);  stem(n, x, 'r');  title("Sinusoidal Signal");  xlabel("n");  ylabel("amplitude");  grid on;  % exponential  x = exp(0.1 \* n);  subplot(3, 2, 2);  stem(n, x, 'b');  title("Exponential Signal");  xlabel("n");  ylabel("amplitude");  grid on;  % ramp  x = n .\* (n >= 0);  subplot(3, 2, 3);  stem(n, x, 'g');  title("Ramp Signal");  xlabel("n");  ylabel("amplitude");  grid on;  % delta  x = (n == -5);  subplot(3, 2, 4);  stem(n, x, 'm');  title("Delta Signal");  xlabel("n");  ylabel("amplitude");  grid on;  % unit step  x = (n >= 0);  subplot(3, 2, 5);  stem(n, x, 'c');  title("Unit Step Signal");  xlabel("n");  ylabel("amplitude");  grid on;  Output:     1. **Operations** **on discrete-time signals are fundamental in signal processing.**   **Common operations include:** *(Write briefly about following operations)*   1. Addition/subtraction: Adding/subtracting two discrete signals element-wise.   This operation involves adding or subtracting two discrete-time signals element-wise. For two signals x1[n] and x2[n], their sum or difference is computed as:  It combines the values of corresponding samples in both signals.   1. Scaling: Multiplying a signal by a scalar value.   Scaling involves multiplying each sample of a signal by a scalar value k. For a signal *x[n]* the scaled signal is:  Scaling amplifies (k > 1) or attenuates (0 < k < 1) the signal's amplitude.   1. Shifting: Shifting the signal in time, either to the left (advance) or right (delay).   Shifting changes the time index of a signal.   * Right Shift (Delay): *y[n]=x[n−k]*, where k>0. * Left Shift (Advance): *y[n]=x[n+k]*, where k>0.  1. Folding: Reversing the time axis of the signal.   Folding reverses the time axis of the signal, effectively flipping it about the vertical axis. For a signal x[n], the folded signal is:  Perform all the operations mentioned.  Code:  x = input('Enter the input signal as a vector [x1, x2, x3, ...]: ');  n = 0:length(x)-1;  % original signal  figure;  subplot(3,2,1);  stem(n, x, 'filled');  title('Original Signal');  xlabel('n');  ylabel('x[n]');  % addition  y\_add = x + 2;  subplot(3,2,2);  stem(n, y\_add, 'filled');  title('Signal After Addition');  xlabel('n');  ylabel('x[n] + 2');  % scaling  y\_scale = 2 \* x;  subplot(3,2,3);  stem(n, y\_scale, 'filled');  title('Signal After Scaling');  xlabel('n');  ylabel('2 \* x[n]');  % shifting to right  y\_shift\_right = [zeros(1,2), x];  n\_shift\_right = 0:length(y\_shift\_right)-1;  subplot(3,2,4);  stem(n\_shift\_right, y\_shift\_right, 'filled');  title('Signal After Shifting Right');  xlabel('n');  ylabel('x[n-2]');  % shifting to left  y\_shift\_left = x(3:end);  n\_shift\_left = 0:length(y\_shift\_left)-1;  subplot(3,2,5);  stem(n\_shift\_left, y\_shift\_left, 'filled');  title('Signal After Shifting Left');  xlabel('n');  ylabel('x[n+2]');  % folding  y\_fold = fliplr(x);  subplot(3,2,6);  stem(n, y\_fold, 'filled');  title('Folded Signal');  xlabel('n');  ylabel('x[-n]');  Output: |

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| **Stepwise-Procedure:** |
| 1. **Representation of Discrete-Time Signals:**    * Define signals using MATLAB vectors.    * Use the stem function for visualization. 2. **Performing Operations on Discrete-Time Signals:**    * **Addition:** Add two signals element-wise.    * **Scaling:** Multiply the signal by a scalar value.    * **Shifting:** Shift the signal left or right by modifying the index.    * **Folding:** Reverse the signal using the fliplr or equivalent function. |

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| **Conclusion:** |
| In this experiment we visualized basic discrete-time signals such as impulse, step, ramp, exponential, and sinusoidal signals in MATLAB and additionally implemented operations like addition, scaling, shifting, and folding. |

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| **Post Lab Questions:** |
| 1. **Let x(n) = 8(0.5)n (u[n+1] - u[n-3]). Sketch the following signals**    1. **Y(n) = [x-3]**    2. **F(n) = x[n+1]**    3. **G(n) = x[-n+4]**      1. **The process of conversion of continuous time signal into discrete time signal is known as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**   **Sampling**   1. **Which of the following is an example of a deterministic signal?**    1. **Step**    2. **Ramp**    3. **Exponential**    4. **All of the above** 2. **For energy signals the energy will be finite and the average power will be \_\_\_\_\_.**   **Zero**   1. **In a signal x(n), if ‘n’ is replaced by ‘n/3’ the it is called \_\_\_\_\_\_\_\_\_\_\_\_.**   **Interpolation**   1. **The system y(n)=sin[x(n)] is**    1. **Stable**    2. **BIBO stable**    3. **Unstable**    4. **None of the above** |

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| **Signature of faculty in-charge with Date:** |