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| **Course Name:** | **Networks, Signals and Systems** | **Semester:** | **III** |
| **Date of Performance:** | **18 / 10 / 2023** | **Batch No:** | **A - 3** |
| **Faculty Name:** |  | **Roll No:** | **1604022050** |
| **Faculty Sign & Date:** |  | **Grade/Marks:** | **\_\_\_ / 25** |

**Experiment No: 5**

**Title: Stability analysis of signals and systems using Laplace Transform**

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| **Aim and Objective of the Experiment:** |
| Stability analysis of signals and systems using Laplace Transform. |

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| **COs to be achieved:** |
| **CO2:** Analyze transient and steady-state response using Laplace Transform. |

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| **Theory:** |
| 1. **Laplace Transform**   Laplace transform is named in honour of the great French mathematician, Pierre Simon De Laplace (1749-1827). Given a continuous-time signal x(t), the Laplace transform of x(t) is defined as: |

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| **Stepwise-Procedure:** |
| 1. **Determine the stability of the system of the given impulse response.** 2. **Plot the Laplace transform.** 3. **Upload the results in the experiment document.** |

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| **Observations** |
| % impulse response of system  h = [1, -0.5, 0.25, -0.125, 0.0625];  % frequency response using frequency  [H, w] = freqz(h, 1);  % Plot magnitude and phase of frequency response ﬁgure  subplot(2, 1, 1);  plot(w, abs(H));  title('Magnitude of Frequency Response (ketaki)'); xlabel('Frequency (radians/sample)'); ylabel('Magnitude');  subplot(2, 1, 2);  plot(w, angle(H));  title('Phase of Frequency Response (ketaki)'); xlabel('Frequency (radians/sample)'); ylabel('Phase (radians)');      syms t s;  A = 1; % Amplitude  f = 1; % Frequency (in Hz)  n = 2; % Exponent for t^n  % Deﬁne the functions  constant = 1;  exponential = A \* exp(t);  power = t^n;  sine\_wave = A \* sin(2 \* pi \* f \* t);  cos\_wave = A \* cos(2 \* pi \* f \* t);  sinh\_wave = A \* sinh(t);  cosh\_wave = A \* cosh(t);  % Store the functions in a cell array  functions = {constant, exponential, power, sine\_wave, cos\_wave, sinh\_wave, cosh\_wave}; function\_names = {'Constant', 'Exponential', 't^n', 'Sine Wave', 'Cosine Wave', 'Hyperbolic Sine', 'Hyperbolic Cosine'};  for i = 1:length(functions)  F = laplace(functions{i}, t, s);  % Display the Laplace transform expression  disp(['Laplace Transform of ', function\_names{i}, ':']);  disp(F);  end |

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| **Post Lab Subjective/Objective type Questions:** |
| 1. **Write the properties of one-sided and two-sided Laplace Transform and Inverse Laplace Transform.**   **One-sided Laplace Transform:**   * One-sided Laplace transform is defined for functions that are defined only for *t ≥ 0*. * It is denoted by *L{f(t)} = F(s)* and is defined by the integral . * The one-sided Laplace transform exists only if the function f(t) satisfies certain conditions, such as exponential order or the Dirichlet conditions.   **Two-sided Laplace Transform:**   * Two-sided Laplace transform is defined for functions that are defined for both positive and negative time values. * It is denoted by *L{f(t)} = F(s)* and is defined by the integral . * The two-sided Laplace transform exists only if the function *f(t)* satisfies certain conditions, such as absolute integrability or exponential order.   **Inverse Laplace Transform:**   * Inverse Laplace transform is used to find the original function from its Laplace transform. * For a function F(s), the inverse Laplace transform is denoted as *L−1{F(s)} = f(t)* and is defined by the integral where c is a real number such that the integration path is to the right of all singularities of *F(s)*.  1. **Explain the relationship of Laplace Transform with Fourier Transform.**  * The Laplace transform is an extension of the Fourier transform for signals with exponential growth or decay. * The Laplace transform is defined for a broader class of signals than the Fourier transform, allowing for the analysis of systems with exponential components. * The Laplace transform can be used to find the frequency response of linear time-invariant systems, which helps in the analysis of stability and other system properties. * When the real part of the Laplace variable is set to zero, the Laplace transform reduces to the Fourier transform. Therefore, the Fourier transform can be obtained as a special case of the Laplace transform by setting *s = jw* where *j* is the imaginary unit and *ω* is the angular frequency.  1. **Explain BIBO stability.**   BIBO stability is a property of a system that states if an input signal is bounded, the output of the system remains bounded. A system is BIBO stable if the integral of the absolute value of its impulse response is ﬁnite, ensuring that the output does not grow without bound in response to bounded inputs. |

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| **Conclusion:** |
| To conclude, the experiment employing MATLAB showcased the effectiveness of utilizing Laplace Transform for stability analysis of signals and systems, highlighting its crucial role in assessing system behaviors and ensuring robust performance under various conditions. |

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