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| **Course Name:** | **Networks, Signals and Systems** | **Semester:** | **III** |
| **Date of Performance:** |  | **Batch No:** | **A - 3** |
| **Faculty Name:** |  | **Roll No:** | **16014022050** |
| **Faculty Sign & Date:** |  | **Grade/Marks:** | **\_\_\_ / 25** |

**Experiment No: 10**

**Title: Mini Project**

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| **Aim and Objective of the Experiment:** |
| Project based learning: Identify the applications of Signals and Systems and implement it using software. |

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| **COs to be achieved:** |
| **CO4:** Understand operations of continuous signals and systems.  **CO5:** Apply Fourier series and transform for spectral analysis. |

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| **Stepwise-Procedure:** |
| 1. **Identify any application (Not covered in Laboratory experiments) “Signals and Systems” course.** 2. **Implement the selected experiment using software.** 3. **Upload the plots/results in the experiment document.** |

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| **Observations:** |
| **Application - Adding and removing noise from a given signal (using Butterworth Filter)**  **Code –**  % experiment 10 mini project (NSS)  % ketaki mahajan / A-3 / 16014022050  t = 0:0.001:1;  % Sinosoidal signal, we can add any signal here  signal = sin(2 \* pi \* 10 \* t);  % To make noisy signal we make use of randn to add gausian white noise to the signal  noisy\_signal = sin(2 \* pi \* 10 \* t) + 0.5 \* randn(size(t));  % Design a Butterworth low-pass filter  order = 10; % Filter order  cutoff\_frequency = 20; % Cutoff frequency in Hz  sampling\_frequency = 1000; % Sampling frequency in Hz  [b, a] = butter(order, cutoff\_frequency / (sampling\_frequency / 2));  % Apply the filter to the noisy signal  filtered\_signal = filtfilt(b, a, noisy\_signal);  % Plot the original and filtered signals  figure;  subplot(3,1,1);  plot(t, signal);  title(['Given Signal (exp 10 - ketaki)']);  subplot(3,1,2);  plot(t, noisy\_signal);  title('Noisy Signal (exp 10 - ketaki)');  subplot(3,1,3);  plot(t, filtered\_signal);  title('Filtered Signal (exp 10 - ketaki)');  **Outputs –** |

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| **Post Lab Subjective/Objective type Questions:** |
| **Submit a detail project report of the mini project.**  This project is made in following steps and operations:   1. **Signal Generation:** A time vector t is created with a range from 0 to 1, sampled at 0.001-second intervals, defining the time domain for the signals. A clean sinusoidal signal, signal, with a frequency of 10 Hz is generated as the starting point for this project. This serves as the original signal for the experiment. 2. **Adding Noise:** To create a noisy signal, Gaussian white noise is introduced to the original signal by adding 0.5 \* randn(size(t)). The resulting noisy\_signal represents a real-world scenario where noise interferes with a desired signal. 3. **Butterworth Low-Pass Filter Design:** A Butterworth low-pass filter is designed with specific parameters. A filter order of 10 is chosen, which controls the roll-off rate of the filter. The cutoff frequency is set at 20 Hz, and the sampling frequency is specified as 1000 Hz, ensuring the filter is appropriate for the signal. 4. **Filter Application:** The designed Butterworth filter is applied to the noisy signal using the filtfilt function. This application aims to attenuate high-frequency noise, resulting in a filtered signal that is cleaner and closer to the original signal. 5. **Visualization:** To evaluate the effectiveness of noise reduction, the script generates a figure with three subplots:    1. Subplot 1: Displays the clean, given signal.    2. Subplot 2: Shows the noisy signal, where noise has been added.    3. Subplot 3: Presents the filtered signal, demonstrating the impact of the Butterworth filter on noise reduction.   This project emphasizes the importance of noise reduction in signal processing and data analysis. The Butterworth filter, with its adjustable parameters, proves to be a valuable tool for enhancing data quality by removing high-frequency noise.  It is vital to tailor the filter and its parameters to match the specific characteristics of the signal and noise in real-world applications. Ultimately, noise reduction plays a critical role in improving data reliability and is essential in various scientific and engineering processes, aiding informed decision-making and accurate problem-solving.  This project offers a practical demonstration of these principles, furthering our understanding of noise reduction techniques. |

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| **Conclusion:** |
| In this MATLAB project, we removed noise from a noisy signal using a Butterworth low-pass filter. We generated a noisy signal, designed the filter, applied it, and visualized the denoised signal, illustrating an effective technique for improving data quality in signal processing applications. This helped us understand and identify the applications of Signals and Systems. |

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