# Speech Processing Lab Assignment-3

## Experiment-1: Fourier Transform and Short-Time Fourier Transform (STFT)

Objective: To understand and apply the Fourier Transform (FT) and Short-Time Fourier Transform (STFT) to analyze speech signals using Python. This experiment will help visualize frequency components of speech over time.

***Experiment 1(A): Fourier Transform for Speech Signal Analysis***

Objective: Compute and visualize the Fourier Transform of a speech signal.

Steps to be followed:

1. Load a speech waveform from the LJ Speech dataset.
2. Apply the Fast Fourier Transform (FFT) to obtain the frequency spectrum.
3. Plot the time-domain and frequency-domain representations.

***Experiment 1(B): Short-Time Fourier Transform (STFT) for Speech Analysis***

Objective: Compute and visualize the STFT of a speech signal to analyze its time-varying frequency content.

Steps to be folowed:

1. Compute the STFT using Librosa's STFT function.
2. Convert the amplitude spectrum to decibels (dB).
3. Plot the spectrogram to observe frequency changes over time.

*Analyze and interpret both and results of FT and STFT. Discuss about the results*

## Experiment-2: Energy Distribution in Vowels and Consonants

Objective: To analyze and compare the energy distribution of vowels and consonants in speech signals using Python. This experiment will help in understanding how different phonemes exhibit energy in low and high-frequency ranges.

Steps to be followed:

1. Load and Visualize Speech Signal- Load a speech signal, extract a phoneme segment, and visualize its waveform and spectrogram.
2. Compute Energy in Different Frequency Bands- Compute and compare the energy of vowels and consonants in different frequency bands. For this, perform the Short-Time Fourier Transform (STFT) of the speech signal. Integrate the energy in low-frequency (300–3000 Hz) for vowels and high-frequency (4000–8000 Hz) for fricatives. Compute the energy ratio between vowels and consonants.

Expected Outcomes:

1. Fourier Transform visualization: A frequency spectrum showing dominant components of the speech signal.
2. STFT Spectrogram: A visual representation of how frequency components evolve over time.
3. Spectrogram analysis should visually confirm the energy concentration differences between vowels and consonants. Energy values should be higher in low frequencies for vowels and higher in high frequencies for fricatives.