Wherever relevant, use $\alpha = 1 + \text{mod}(x, 3)$, where x is the last three digits of your registration number. Wherever relevant, plot signals with normalised axes, with an appropriate resolution for time and with appropriate labels and legends.

Problem 1. (Window Functions)

1. Explore the following windows: (a) Rectangular (b) Hamming (c) Hanning
2. Plot the spectrum of the window (if $\alpha = 1$ use Hanning window, if $\alpha = 2$ use Blackman window, if $\alpha = 3$ use Hanning window) signal for different lengths. Use a 1024 point DFT and normalise the magnitude by the actual lengths (Say $N = 100, 200, 300$).

Problem 2. (FIR Filter Design)
Design digital low pass FIR filter using rectangular and (if $\alpha = 1$ use Hanning window, if $\alpha = 2$ use Blackman window, if $\alpha = 3$ use Hanning window) functions for a cut-off frequency of $\omega_c = \frac{\pi}{\alpha+1}$ rad/sample. Select the window length for all the window functions to be 21.

1. Plot the impulse response of the two filters.
2. Perform a bode analysis on the two filters and comment on them.

Problem 3. (Filtering using FIR Filters)
Plot the spectrogram of the `instru`α`.wav` (same as Exp. 5 & 6). Use any window of your choice and sample duration for the window. Design a digital FIR filter (using windowing) to only extract the fundamental (the first major peak excluding $\omega = 0$) and remove the rest including $\omega = 0$. Write it into a `.wav` file and listen. Also plot the spectrogram to ensure that you only have the fundamental. You may use the same specs that you have used in Exp. 6.

Problem 4. Differentiate between the time-domain windowing and the window-based FIR filter design. Can you give a descriptive comparison of the same?

Hints: Refer to `SciPy`'s signal module for some helpful inbuilt functions.