Wherever relevant, use $\alpha = 1 + \text{mod}(x, 4)$, 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. (Spectrogram of Chirp Signal)
Generate a chirp signal $x(t) = \sin(2\pi F(t)t)$ with $F(t)$ increasing linearly from $2 + 2\alpha$ Hz to $5 + 5\alpha$ Hz at a sampling rate of 100 samples per second for duration of 10 seconds.

1. Plot the signal as a function of time.
2. In a separate figure, plot the frequency spectrum of the signal using FFT. Can you identify the frequency components of the signal?
3. Now use the same signal and plot a spectrogram of the signal in a separate plot. Use a hamming window length of 100 samples and an overlap of 10 samples.

What do you observe? Compare the DFT and spectrogram representations. Which one do you prefer for such a signal? Try different window length (say 100, 150 and 200), different windowing techniques (say hanning, hamming, blackman) and compare them and comment on them.

Problem 2. (Pitch Extraction)

1. Plot the spectrogram of the `instru`α`.wav`. You may use any window of your choice and sample duration for the window. Can you now locate the fundamental pitch? Now plot the spectrum in the conventional way. Locate the fundamental pitch. Was our definition of the pitch correct in Experiment 3? Read upon the pitch of an instrument and discuss about it briefly in your report.
2. Plot the spectrogram of the `opera.wav`. Are you able to now track the variations in the fundamental pitch better compared to Experiment 3? Comment on it.

Problem 3. (Spectro-Temporal Analysis of Speech)
Record saying your name (preferably `.wav` file with a lower sampling rate, say 4000 Hz. Plot the spectrogram and analyse the plot. Try to map location of the *phoneme* to the spectrogram.