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. (Butterworth filter design)
Design a low pass digital Butterworth filter which has a maximum passband ripple of $-\alpha$ dB, and an edge frequency of 10 Hz. The filter also should have a minimum stopband attenuation of 40 dB from a stopband edge frequency of 20 Hz. Assume a sampling frequency of 720 samples/sec.

1. Find the transfer function of the filter.
2. Plot its pole zero plot. Comment on the system stability from the plot.
3. Plot also the bode plot (with respect to frequency in Hz).

Compare (plot on the same graph with legends) the impulse response and step response of the two filters for a duration of 1 sec. Write down your observations.

Problem 2. (Filtering)
Use the Butterworth filter to filter the ECG data ($F_S = 720$ Hz) stored in the text file. Plot the filtered output and compare it with the original signal in the same figure.

Problem 3. (Filtering — Time-Frequency Analysis)
Plot the spectrogram of the `instru`α`.wav` (Same as Exp-5). You may use any window of your choice and sample duration for the window. Design a digital Butterworth band pass filter to only extract the fundamental (The first major peak after DC) and remove the rest including the DC. Write it into a wav file and listen. Also plot the spectrogram to ensure that you only have the fundamental.

Problem 4. (Chebyshev filter design)
Try the lowpass filter specifications used in Problem 1 with Type I Chebyshev's filter. Compare the system order w.r.t Butterworth. Also, plot the Bode.

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