ECE 5530/6530 Digital Signal Processing
Matlab Exercise 2

Submission guidelines (READ CAREFULLY)

- All submissions must be done using Canvas.
- The submission should contain a single zip file which contains the report (html) and code (matlab files).
- Scanned hand written submissions will be accepted; however, it is the student's responsibility to ensure that the answers are easily legible. Otherwise, you may lose points.
- MATLAB code should be submitted as part of the code (zip) file. A brief description of the code and how to run it should be included in the html report.
- If a question asks for plots, these should be generated by MATLAB (not handdrawn) and included in the html report.
- For late policy refer to syllabus.
- Unless otherwise specified, all MATLAB exercise questions refer to the dataset described in the first MATLAB exercise. We will indicate questions which use other data explicitly with the text **Other dataset**.

Module 2 - Introduction to Discrete-Time Systems

1. Download the data from

   `https://archive.ics.uci.edu/ml/datasets/Dataset+for+ADL+Recognition+with+Wrist-worn+Accelerometer`

   Please use the file `Accelerometer-2011-03-24-10-24-39-climb_stairs-f1.txt` in the `Climb_Stairs` directory.

2. Let us combine the three channels into a single one, $S = \sqrt{x^2 + y^2 + z^2}$. Compute the energy of the signal S. *(5 points)*

3. Implement a moving-average filter `my_smoothing_filter`, with a sliding window size = 3 to smooth the data. For your implementation first define the impulse response of the system and then use convolution (use MATLAB's conv command). Apply this to the signals x, y, z. Plot the input signals and the resulting smoothed signals. *(10 points)*

4. A recursive system is defined by the following difference equation $y(n) = 0.8 * y(n-1) + x(n)$. Calculate and plot the value of $y(n)$, given $x(n) = x$, the data signal, and an initially relaxed system. *(15 points)*

5. A recursive system is defined by the following difference equation $y(n) = \frac{n}{n+1} y(n-1) + \frac{1}{n+1} x(n)$. Calculate and plot the value of $y(n)$, given $x(n) = x$, the data signal, and an initially relaxed system. What is this system computing? *(15 points)*

6. A recursive system is defined by the following difference equation $y(n) = y(n-1) - y(n-2) + x(n)$. Calculate and plot the value of $y(n)$, given $x(n) = x$, the data signal, and an initially relaxed system. Is this a linear and/or a time-invariant system? Test using input/output signals pairs *(20 points)*

7. Use folding in time and convolution to implement cross-correlation. Plot the cross-correlation between the different data signals, i.e., r_{xy}, r_{yz}, r_{xz}. *(15 points)*

8. **Other dataset:** From the textbook: Problem 2.65 parts (a) through (d). *(20 points)*