ECE 5530/6530 Digital Signal Processing
Matlab Exercise 5

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 5 - Discrete Fourier Transform (DFT) and the FFT

1. Given a 11-point sequence $x(n) = 10(0.6)^n,\ \text{for } n \in [0, 10]$, determine and plot $x((n-6))_{16}$.
2. Let $x_1 = [1, 4, 3],\ x_2 = [1, 3, 6, 9]$ be two sequences. Write a function `y = circconv(x1, x2, N)` to implement circular convolution (in the discrete-time domain), where, x_1 and x_2 are the input sequences of lengths L_1, L_2; such that $L_1, L_2 \leq N$. The output of circular convolution between the 2 sequences is given by y.
   (a) Choose $N = 4$ and compute the output of circular convolution.
   (b) Compute the linear convolution between x_1 and x_2.
   (c) Determine the minimum value of N necessary such that the linear and circular convolutions be the same on the N-point interval.
3. Develop a MATLAB function to implement the overlap-save method using the circular convolution operation developed in (2). Define this implementation as `overlap_save(x, h, N)`. Verify using the sequence $x = n^2 + 1,\ \text{for } n \in [0, 10]$. Assume h to be the impulse response function defined as $h = [1, 0, -1]$ and the block length N to be $N = 6$.
4. A 12-point sequence is $x(n)$ defined as $x(n) = \{1, 2, 4, 8, 16, 32, 32, 16, 8, 4, 2, 1\}$
   (a) Determine the DFT X(k) of $x(n)$. Plot its magnitude and phase.
   (b) Plot the magnitude and phase of the DTFT X($e^{j\omega}$) of $x(n)$ using MATLAB.
   (c) Verify that the above DFT is the sampled version of X($e^{j\omega}$).
5. Reimplement the `overlap_save` function developed in (3) using the FFT algorithm to obtain a new function `overlap_save_fft(x, h, N)`. MATLAB provides a function called `fft` to compute the DFT of a vector x. It is invoked as `X = fft (x,N)`, which computes the N-point DFT. Compute its output for the same input sequence as in (3).