EECS 361
Homework #15

1. Section 6.19 Participation Activities
6.19.2: Computing a DFT.

2. Section 6.21 Participation Activities
6.21.1: Cyclic convolution, graphical and textual methods.
6.21.2: DFT and convolution.

3. (Concept: Calculating the DFT and picket fence effect.)
Compute (recommend you use a computer program, e.g., MatLab) the DFT of the following sequences and plot the |DFT|.

$x_1[n]$ ={-1, 3, 3, -1}
$x_2[n]$={-1, 3, 3, -1, 0, 0, 0, 0, 0, 0, 0, 0}

a. Plots of the |DFT| of $x_1[n]$ and $x_2[n]$.
These discrete time signals were obtained from an analog signal sampled at a sample rate of 4000 samples/sec.
b. What is the record length and frequency resolution of the DFT of $x_1[n]$.
c. What is the record length and frequency resolution of the DFT of $x_2[n]$.
d. From the plots the |DFT[$x_1[n]$]| and |DFT[$x_2[n]$]| discuss the cause of the difference.

4. (Concept: Calculating the IDFT)
Compute (recommend you use a computer program, e.g., MatLab) the IDFT of

a. {0, 0, 6, 0, 16, 0, 6, 0}
b. {0, 6+j6, 0, 0, 0, 0, 0, 6-j6}
c. {4., -4.-4. j , 0. ,-4.+2. j} (compare result to the solution to Problem 3a)

5. Section 6.23 Participation Activities
6.23.1: Padding data arrays for the FFT.
6.23.3: FFT and lowpass filtering.

6. (Concept: Spectral leakage)
Let x(t) = cos(2π1500t) be sampled at 25000 samples/sec.

a. For a record length of 16 ms find Δf. Calculate DFT of x[n] and plot |DFT[x[n]]|
b. For a record length of 16.3ms find Δf. Calculate the DFT of x[n] and plot |DFT[x[n]]|
c. Explain the difference between the results in parts a. and b. above.

(Do not report X[k] values and recommend you use a computer program, e.g., MatLab.)

7. (Concept: Calculating the DFT and predicting the first zero of the DFT[x[n]].)
Let x(t) = $\mathrm{rect}\left(\frac{t-\frac{\tau}{2}}{\tau}\right)$ with τ= 1ms

a. What is the first frequency in Hz where the Fourier transform of x(t) is zero.
b. The signal x(t) is sampled at 4000 samples/sec for 2 ms to create x[n]={1, 1, 1, 1, 0, 0, 0, 0}. What is the record length and the frequency resolution of the DFT of x[n].
c. Let X[k] = DFT[x[n]]. What is the first value of k such that X[k]=0, let this value be k_0, i.e., X[k_0]=0.
d. At what frequency in Hz corresponds to k_0? Compare this result to the answer in part a.

8. (Concept: Calculating the DFT, picket fence effect, and impact of zero padding.)
Let x(t) = $\mathrm{tri}\left(\frac{t-\tau}{\tau}\right)$ with τ= 1ms be sampled at 4000 samples/sec. (Recommend you use a computer program, e.g., MatLab.)
For the plots of |DFT[x[n]]| put the x-axis in Hz and plot only up to the maximum frequency present. You can modify **FFT Plot** to create the plots.

a. For a record length of 10 ms, calculate the DFT of x[n] and plot |DFT[x[n]]|.
Is the first zero of the DFT at the expected frequency?
b. For a record length of 30 ms calculate the DFT of x[n] and plot |DFT[x[n]].
Is the first zero of the DFT at the expected frequency?
c. Explain the difference between the results in parts a. and b. above.
(Do not report X[k] values)

9. (Concept: Using the FFT to perform linear convolution)
   Let h[n] = {1, 3, 3, 3, 1} and x[n] = {1, 2, 3, 4, 5 ,6 ,7}, use FFT algorithm to find the linear convolution of h[n] and x[n]. Check your result.

10. (Concept: Deconvolution)
    Exercise 6.23.3 (Use any software package to work this problem, you are not limited to MATLAB or MathScript)