**Note: For this assignment, your Handwritten, hard-copy solution is**

**due on or before November 10th, 2012.**

**Question No. 1**

Consider a digital sequence sampled at the rate of 20,000 Hz. If we use the 8,000-point DFT to compute the spectrum, determine:

1. the frequency resolution
2. the folding frequency in the spectrum.

**Question No. 2**

We use the DFT to compute the amplitude spectrum of a sampled data sequence with a sampling rate$ f\_{s}=2,000 Hz$. It requires the frequency resolution to be less than$ 0.5 Hz$. Determine the number of data points used by the FFT algorithm and actual frequency resolution in$ Hz$, assuming that the data samples are available for selecting the number of data points.

**Question No. 3**

Given the sequence in Figure shown below

$$x\left(n\right)$$

**-1**

**4**

**2**

**1**

**4**

**-1**

**2**

**0**

**1**

**2**

**3**

**4**

**5**

**-1**

**-2**

**2**

**-1**

**5**

**1**

$$n$$

**6**

**4**

**3**

**2**

$$T\_{0}=NT$$

and assuming that the sampling rate is$ f\_{s}=100 Hz$, Compute the amplitude spectrum, phase spectrum, and power spectrum.

**Question No. 4**

Given the following data sequence with a length 6,

$$x\left(0\right)=0, x\left(1\right)=1, x\left(2\right)=0, x\left(3\right)=-1, x\left(4\right)=0, x\left(5\right)=1$$

compute the windowed sequence$ x\_{w}\left(n\right) $using the

1. triangular window function
2. Hamming window function
3. Hanning window function

**Question No. 5**

Given the sequence in Figure shown below

$$x\left(n\right)$$

**-1**

**4**

**2**

**1**

**4**

**-1**

**2**

**0**

**1**

**2**

**3**

**4**

**5**

**-1**

**-2**

**2**

**-1**

**5**

**1**

$$n$$

**6**

**4**

**3**

**2**

$$T\_{0}=NT$$

where the sampling rate is$ f\_{s}=100 Hz$ and$ T=0.01 sec$, compute the amplitude spectrum, phase spectrum, and power spectrum using

1. triangular window
2. Hamming window
3. Hanning window

**Question No. 6**

Given the sinusoid

$$x\left(n\right)=2 . \sin(\left(2000 . 2π . \frac{n}{8000}\right))$$

obtained by using the sampling rate$ f\_{s}=8,000 Hz$, we apply the DFT to compute the amplitude spectrum.

1. Determine the frequency resolution when the data length is 100 samples. Without using the window function, is there any spectral leakage in the computed spectrum? Explain.
2. Determine the frequency resolution when the data length is 73 samples. Without using the window function, is there any spectral leakage in the computed spectrum? Explain.

**Question No. 7**

Given eight samples values$ x\left(0\right), x\left(1\right), …, x(7)$, draw a diagram to compute the DFT of given sequence

1. using the decimation-in-frequency FFT method and
2. using the decimation-in-time FFT method.

**Question No. 8**

Given eight DFT coefficient values$ X\left(0\right), X\left(1\right), …, X(7)$, draw a diagram to compute the inverse DFT of given sequence

1. using the decimation-in-frequency FFT method and
2. using the decimation-in-time FFT method.

**Question No. 9**

Given a sequence$ x\left(n\right)$ for$ 0\leq n\leq 3$, where $x\left(0\right)=4, x\left(1\right)=3, x\left(2\right)=2, and x\left(3\right)=1$. Evaluate its DFT $X\left(k\right), $

1. using the decimation-in-frequency FFT method,
2. using the decimation-in-time FFT method,
3. also determine the number of complex multiplications in part (a) and (b) above.

**Question No. 10**

Given three sinusoids with the following amplitudes and phases

$$x\_{1}\left(n\right)=5\cos(\left(2π .500t\right))$$

$$x\_{2}\left(n\right)=5\cos(\left(2π .1200t+0.25π\right))$$

$$x\_{3}\left(n\right)=5\cos(\left(2\left(500\right)t+0.5π\right))$$

1. Create a MATLAB program to sample each sinusoid and generate a sum of three sinusoids, that is, $x\left(n\right)=x\_{1}\left(n\right)+x\_{2}\left(n\right)+x\_{3}\left(n\right)$, using a sampling rate of 8000 Hz, and plot the sum$ x\left(n\right)$ over a range of time that will exhibit approximately 0.1 second.
2. Use the MATLAB function fft() to compute the DFT coefficients, and plot and examine the spectrum of the signal$ x\left(n\right)$.

**Question No. 11**

Given three sinusoids with the following amplitudes and phases

$$x\_{1}\left(n\right)=5\cos(\left(2π .500t\right))$$

$$x\_{2}\left(n\right)=5\cos(\left(2π .1200t+0.25π\right))$$

$$x\_{3}\left(n\right)=5\cos(\left(2\left(500\right)t+0.5π\right))$$

1. Create a MATLAB program to sample each sinusoid and generate a sum of three sinusoids, that is, $x\left(n\right)=x\_{1}\left(n\right)+x\_{2}\left(n\right)+x\_{3}\left(n\right)$. Generate 240 samples using a sampling rate of 8000 Hz.
2. Write a MATLAB program to compute and plot the amplitude spectrum of the signal$ x\left(n\right)$ with the FFT and using each of the following window functions
	1. Rectangular window (no window)
	2. Triangular window
	3. Hamming window
3. Examine the effect of spectral leakage for each window used in part (b) above.

**Question No. 12**

Compute the eight-point DFT of the sequence

$$x\left(n\right)=\left\{\begin{matrix}1&0\leq n\leq 7\\0&otherwise\end{matrix}\right.$$

1. using the decimation-in-frequency FFT method and
2. using the decimation-in-time FFT method.

**Question No. 13**

Compute the eight-point inverse DFT of the sequence made up of DFT coefficients$ X\left(k\right)$ as

$$X\left(0\right)=4, X\left(1\right)=1-j\left(1+\sqrt{2}\right), X\left(2\right)=0, X\left(3\right)=1-j\left(1-\sqrt{2}\right),$$

$$X\left(4\right)=0, X\left(5\right)=1+j\left(1-\sqrt{2}\right), X\left(6\right)=0, X\left(7\right)=1+j\left(1+\sqrt{2}\right),$$

1. using the decimation-in-frequency FFT method and
2. using the decimation-in-time FFT method.

**Question No. 14**

Compute the eight-point inverse DFT of the sequence made up of DFT coefficients$ X\left(k\right)$ as

$$X\left(0\right)=0.125, X\left(1\right)=0.125, X\left(2\right)=0.125, X\left(3\right)=0.125,$$

$$X\left(4\right)=0.125, X\left(5\right)=0.125, X\left(6\right)=0.125, X\left(7\right)=0.125$$

1. using the decimation-in-frequency FFT method and
2. using the decimation-in-time FFT method.

**Question No. 15**

Compute the eight-point DFT of the sequence

$$x\left(0\right)=1, x\left(1\right)=1, x\left(2\right)=1, x\left(3\right)=1,$$

$$x\left(4\right)=0, x\left(5\right)=0, x\left(6\right)=0, x\left(7\right)=0,$$

1. using the decimation-in-frequency FFT method and
2. using the decimation-in-time FFT method.