Homework - 2
CSE 431: Digital Signal Processing
Fall 2020

Al Mehdi Saadat Chowdhury

Assigned Date: 22nd January, 2020
Due Date for Written Task: 27th January, 2020; 11.58PM
Date for Viva: Will be announced later

Basic Instructions:

This homework, accompanied by a viva-voce will replace your semester final examination. In this section, you will find a general overview about the homework, along with its grading policy.

- **Exam Format** The homework has two components:
    1. A submitted solution PDF file outlining handwritten answers to all questions asked here
    2. A viva-voce based on everything taught in the class before the viva date

  Marks Distribution Total marks for this examination is 40. However, questions asked in this file is graded on points, instead of on marks. Total points that you obtain will later be converted to 20 marks based on your answers and a verification viva-voce. Rest of the 20 marks will come entirely from a comprehensive general viva-voce based on everything taught in the class, along with reading materials from the textbook.

  Format of your submitted PDF You will solve all questions by hand in a notebook. You will then capture images of your solutions, combine them in a single PDF and submit this PDF. Remember that, you are required to submit a SINGLE PDF, not multiple image files or multiple PDF files. Also remember that, you cannot type your solutions in any word processing application (eg: MS Word or Latex). The name of your PDF must be "YourRegistrationNumber-YourName.PDF" (for example, "170103020099-Abdullah.PDF").

  Submission Deadline Please look at the due date mentioned above.

- All submissions must follow the honor code mentioned in the class, which in summary is: **Do not copy anything from any sources including online resources, your classmates, friends, seniors and so on. You are NOT PERMITTED to do group study for this homework**. Of course, you can use the class lecture or the textbook or any other textbooks available to you **(except any solution manual)** for solving your homework problems. If you are using any book, mention the name of the book in the acknowledgement section of your PDF file. Violating the honor code will incur the following penalties:
    1. The homework will not be graded. You will also lose marks of the general viva-voce. This in summary means, you will receive 0 marks against this examination.
    2. You will also be reported for further disciplinary actions to the head of the department.

- Understand that, even 1% copy will be regarded as violation of the honor code. **All parties involved in the process will be penalized**. Also remember that, any suspected work will only be penalized after a thorough discussion with you. This discussion will start by giving you a chance to accept or reject my suspicion. If you actually were involved in this violation in any way and you accept it, then the viva marks reduction will not apply to your case. If you reject my suspicion, then further investigation will be conducted and you will also face a viva related to the **TOPICS** of the assignment, which will carry no marks for you. I kindly request you to obey the honor code so that we both can be saved from this unwanted hassle.

Homework Questions

Answer the following questions:

1. {15 points}
   Consider Professor Parvez - who is an expert in DSP - taught you that the Hanning window is defined as:
   $$w[n] = 0.5 - 0.5cos\Big(\frac{2\pi n}{N}\Big) \qquad for\ n = 0, 1, ..., N-1 \tag{1}$$
   Later in another class, Professor Saadat taught you that the Hanning window is defined as:
   $$w[n] = sin^2\Big(\frac{\pi n}{N}\Big) \qquad for\ n = 0, 1, ..., N-1 \tag{2}$$
   Consider we all know that, Professor Parvez's definition is absolutely perfect. Given this information, Professor Saadat's definition can either be right or wrong. If he is right, then prove that these two equations are equivalent. If he is wrong, then find where in the equation he made a mistake.

2. {15 points}
   Consider Mr. Thomas, a client of yours who lives in a remote area with very slow internet connection asked you to compute a 20-point Discrete Fourier Transform (hereafter, DFT) of a real-valued time domain signal. Consider you will compute this DFT in your own computer and send the result to him via an email. Since Mr. Thomas has a very slow internet connection, this email cannot be large, otherwise the email will not reach him. In this scenario, What is the absolute minimum number of (complex) frequency-domain sample values you will need to type in your e-mail so that Mr. Thomas has complete information regarding your DFT results? Please give proper explanation to your answer. Entire points on this question will depend on the explanation.

3. {30 + 40 = 70 points}
   Consider you are given the following time-domain input samples:
   $$x[n] = \{9, 9, 9, 9, 9, 9, 9, 9\} \tag{3}$$
   Now compute an 8-point DFT of these sample values in:
   (a) $\Theta(n \log n)$ time
   (b) $\Theta(n)$ time

   For both algorithms, show each step of computing the DFT. Also draw the magnitude graph and the phase graph for both algorithms.