B.Sc. Engg. CSE 6th Semester

26 October 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION — **SUMMER SEMESTER, 2017-2018**

DURATION: 3 Hours — **FULL MARKS: 150**

CSE 4631: Digital Signal Processing

Programmable calculators are not allowed. Do not write anything on the question paper.

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

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1. a) Describe the two main uses of Digital Filters. Why do we usually look at step response of the filters instead of impulse response, even though they contain identical information? 4+4

   b) The impulse response a low-pass filter having cut-off frequency 0.3 is $h_1 = [1,2,3,2,1]$. Calculate the filter kernel of the following filters: 12
      i. A High-pass filter that allows only the frequencies above 0.2
      ii. A Band-pass filter that allows the frequencies in the range 0.2 to 0.3 and stops others.
      iii. A Band-reject filter that stops the frequencies in the range 0.2 to 0.3 and allows others.

   c) Why Hamming window is used in spectral analysis? 5

2. a) Calculate and draw the filter kernel of a 7-point moving average filter (MAF). Calculate the frequency response of the MAF for the following frequency values. What conclusion can you draw from the frequency response? 3+7
      F = [0, 0.1, 0.2, 0.3, 0.4, 0.5]

   b) A financial expert receives daily reports on the value of a particular stock. Each day he calculates the average value of the stock over the last 30 days. If this averaging were describe as a system: 10
      i. What are the input and output signals?
      ii. Is this system linear?
      iii. What is the impulse response of the system?
      iv. What would be the impulse response if the average was taken over *M* days?

   c) Why is it impossible to design an ideal low pass filter for computers? 5

3. a) Why FFT works faster than DFT? 7

   b) Suppose you are asked to design a Windowed-Sinc filter using the Blackman window. The transition bandwidth and cut-off frequency of the filter is set to 0.4 and 0.04, respectively. If the first five points of the Blackman window is (0, 0.05, 0.25, 0.63, 0.95), calculate the first four points ($i = 0,1,2,3$) of the filter kernel. 12

   c) What is the relationship between *computation time* and *sharpness* for Windowed-Sinc filter? 6

4. a) What are the Discrete Fourier Transform (DFT) basis functions? Calculate, sketch and label the basis functions for an 8 point DFT. 3+10

   b) You are told that the following signals are the frequency domain of a 32 point real DFT. Give two reasons why this is not possible. 6

      Real part: {1,2,3,4,5,6,7,8,7,6,5,4,3,2,1,0}
      Imaginary part: {8,7,6,5,4,3,2,1,0,1,2,3,4,5,6,7}

   c) Convert the following real and imaginary parts into polar form (Magnitude and Phase). 6
      i. Re = 1, Im = 1
      ii. Re = -1, Im = -1
      iii. Re = -1, Im = 1

5. a) Name the three common application domains of the DFT. 6

b) Figure 1 shows the corresponding phase change of a signal resulting from time domain shifting. Inspect this carefully and answer the following questions: 13

i. Why is there no change of phase in zero frequency?

ii. How much is the phase change at the highest frequency for one sample shift in time domain? Why is it so?

iii. Observe that for all the other frequencies between 0 and 0.5, the phase change is linear. Why is it so?

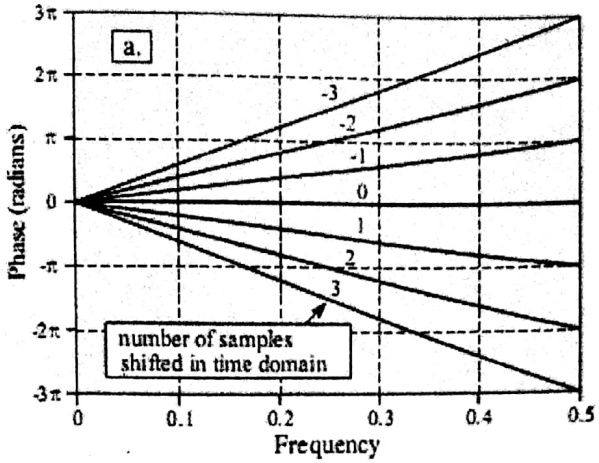

Figure 1: Phase change with respect to time domain shifting

c) If $x(n)$ has the frequency domain: Xreal(f) and Ximag(f), and $y(n)$ has the frequency domain: Yreal(f) and Yimag(f), calculate the frequency domain of the following signals: 6

i. $x(n) + y(n)$

ii. $3.14x(n) + \frac{y(n)}{3.14}$

6. a) Why complex conjugate is important? 6

b) What is circular convolution? How can you avoid it? Explain with appropriate figures. 4+5

c) How fast is the FFT compared to the DFT? The real and imaginary parts of a signal after performing real DFT is given below: 4+6

$$ReX = [1\ 2\ 3\ 4\ 5]; ImX = [0\ 4\ 3\ 2\ 0]$$

What would be the Real and Imaginary part if complex DFT was performed instead of real DFT?

7. a) Using interlaced decomposition determine the final 16 one-point signals that will be formed in the time domain from the following 16-point signal. Your answer should show each step of the decomposition process. 10

$$x(n) = \{5, 2, 8, 10, 3, 11, 18, 0, 6, 15, 19, 20, 17, 1, 13, 25\}$$

b) Define: Passband, Stopband, Transition band, Roll-off 8

c) What are the important time domain and frequency domain parameters to be considered while designing a filter? Briefly describe them. 7

8. a) Calculate the convolution of the following signals (your answer will be in the form of an equation): 15

i. $h(n) = \delta(n-2), x(n) = \delta(n-1) + \delta(n+4)$

ii. $h(n) = \delta(n-1) + \delta(n+1), x(n) = \delta(n-a) + \delta(n+b)$

iii. $h(n) = \delta(n), x(n) = \exp(-n)$

iv. $h(n) = \exp(-n), x(n) = \delta(n-2)$

v. $h(n) = \delta(n) - \delta(n-1), x(n) = \exp(-n)$

b) Explain with appropriate figures - "*How FFT synthesis works.*" 10