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

SEMESTER FINAL EXAMINATION **SUMMER SEMESTER, 2019-2020**

DURATION: 1 Hour 30 Minutes **FULL MARKS: 75**

CSE 4631: Digital Signal Processing

Submit the answers of all the questions together upon completion of the exam. The images of the answer script must be clearly readable and in correct sequence.

There are 3 **(three)** questions. Answer all of them.

Figures in the right margin indicate marks.

---

1. a) Suppose you have an 8-point time domain signal x = [**2**, 3, P, -5, Q, -8, 9, -4]. Here, P and Q are respectively the first and second of the last two digits of your ID. Find ReX and ImX using forward DFT. 10

   b) Why do we try to avoid convolution in time domain and instead try to perform it through multiplication in frequency domain? 7

   c) i) Describe two main uses of digital filter. 4+4

   ii) When trying to design a time-domain filter, why do we usually look at the step response of a filter instead of the impulse response?

2. a) The impulse response of a Low-pass filter having cut-off frequency, $f_c = 0.3$ is 3+5+4

$$h_1 = [1, 2, \mathbf{3}, 2, 1]$$

   Here the middle element (3) in h_1 is in bold and represents the origin. Now, calculate the filter kernels of the following filters:

   i) A High-pass filter that allows only frequencies above 0.2.

   ii) A Band-pass filter that allows only 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.

   b) Suppose the frequency spectrum (magnitude only) in Figure 1 is obtained after taking an average over 100 of such spectra to reduce the random noise. 5

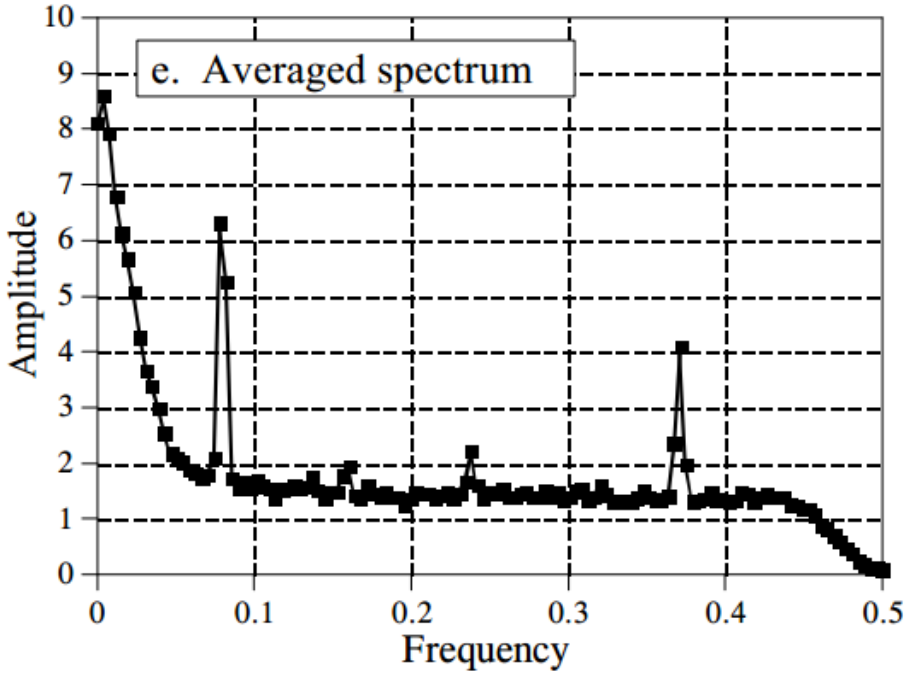

Figure 1: Averaged frequency spectrum (magnitude only)

Here the spectrum is shown only for frequencies from 0 to 0.5. Sketch the frequency spectrum for frequencies between -2 to 2.

c) Using an example, show how the general equation for the recursive implementation of the Moving Average Filter (MAF) is derived. Justify how the MAF is faster than other filters like Gaussian or Blackman. 6+2

3. a) Explain the different nuisances associated with polar notation. 10

b) i) Suppose you designed a 5-point Moving Average Filter using the symmetrical averaging approach. Determine the output of this 5-point Moving Average Filter for the following input signal. Here P and Q are respectively the first and second of the last two digits of your ID: 7+3

$$x(n) = [-3, -2, -4, P, -3, Q, 5, 2, 7, -1, 8]$$

ii) If a Windowed Sinc filter has a filter kernel of length 40, then what would be the width of its transition band?

c) The final design of a Windowed Sinc filter is given as: 5

$$h[i] = K\frac{\sin(2\pi f_c\left(i - \frac{M}{2}\right))}{\pi(i - \frac{M}{2})}[0.42 - 0.5\cos\frac{2\pi i}{M} + 0.08\cos\frac{4\pi i}{M}]$$

Explain the different parts of this equation.