ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination
Course No.: EEE 4701
Course Title: Digital Signal Processing

Winter Semester, A. Y. 2022-2023
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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1. a) Given the input sequence x(n) and the impulse response h(n), graphically determine the resulting output. Subsequently, analyze the output and mention the type of the filter. 13 (CO2, PO2)

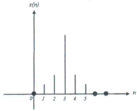

Figure: 1.1

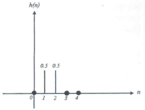

Figure: 1.2

b) Describe the concept of negative frequency, and illustrate it using appropriate graphical representations. 12 (CO1, PO1)

2. a) For a five-point moving average system deduce and approximately sketch the magnitude and phase response. 13 (CO2, PO1)

b) Show the approximate time domain response for the following four (04) figures: 12 (CO2, PO1)

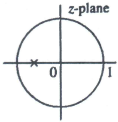

Figure: 2.1

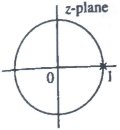

Figure: 2.2

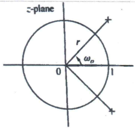

Figure: 2.3

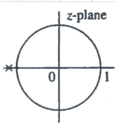

Figure: 2.4

3. a) For a Band Pass Filter, $H(z) = \frac{1-z^{-2}}{1-\beta(1+\alpha)z^{-1}+\alpha z^{-2}} * \frac{1-\alpha}{2}$, 13 (CO2, PO1)
Where, $\beta = cos\omega_0$, $\omega_2 - \omega_1 =$ Band Width $(BW) = cos^{-1}\frac{2\alpha}{1+\alpha^2}$.
$[\omega_0, \omega_1$ and ω_2 represents center, lower cut-off and higher cut-off frequency respectively]
Find and sketch the poles and zeros for the BPF having, $\omega_0 = \frac{\pi}{2}$, $BW = \frac{\pi}{4}$.

b) Illustrate the sequential steps and conduct the essential calculations for designing a Comb filter aimed at eliminating the DC component. Additionally, present the magnitude response and the pole-zero diagram in the Z-plane. 12 (CO3, PO2)

4. a) Given the input signal $x(n) = \cos(0.3n) + \cos(0.5n)$, formulate the design of a Finite Impulse Response (FIR) filter with the specific purpose of rejecting only the $\cos(0.5n)$ component. Additionally, provide a graphical representation of the designed filter's impulse response, $h(n)$. 13 (CO2, PO2)

b) Formulate a simple second-order band-stop FIR filter, and demonstrate the magnitude and phase response with a thorough derivation and diagram. 12 (CO2, PO1)

5. a) Given a voice signal [0 – 4 kHz] corrupted by 1 kHz and 2 kHz signals, and utilizing a sampling frequency of 12 kHz, approximately design a filter to eliminate those corrupted signals. Begin by strategically placing the required poles and zeros in the z-plane. Subsequently, illustrate the impulse response and magnitude response for the designed system. 13 (CO3, PO2)

b) Based on the provided z-plane representation (Figure: 5), evaluate and sketch the estimated magnitude response. 12 (CO2, PO1)

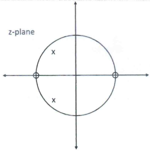

Figure: 5

6. a) Given the discrete signal $x(n) = \cos(\omega n)$ with ω and F as specified, where F = 2 Hz, Fs = 8 Hz, and N = 8, determine and graphically represent the magnitude spectrum $|X(k)|$. 13 (CO2, PO1)

b) Given that, 12 (CO2, PO1)

$$x(n) = \begin{cases} 1/3, & for\ n = 0,1,2 \\ 0, & otherwise \end{cases}$$

For N = 10, derive $X(k)$ and sketch the magnitude response of the system.