Q.1: Realize the following IIR filter: $H(z) = \frac{8z^3 - 4z^2 + 4z - 2}{\left(3z+\frac{1}{4}\right)\left(8z^2 - z + \frac{1}{2}\right)}$ **Using:** **[15]**

a. Direct form (I) method. b. Direct form (II) method. c. Cascaded method.

Q.2: Find the FFT and suitable DWT of the Following sequences: **[15]**

a. x=[1 0 0 1 1 0 0 1];
b. x=[1 -1 1 -1 1 -1 1 -1]
c. x=[1 1 1 1 0 0 0 0];
d. x=[1 1 0 0 0 0 1 1];

Q.3: Consider the following two LTI systems: **[15]**

$$\textbf{System 1:} \quad y_1[n] = \frac{x[n] + x[n-1]}{2}$$

$$\textbf{System 2:} \quad y_2[n] = \frac{x[n] - x[n-1]}{2}$$

a. Without calculating the respective system functions determine the following: (i) Is system 1 a lowpass filter, highpass filter, or bandpass filter? and (ii) Is system 2 a lowpass filter, highpass filter, or bandpass filter? Clearly give your reasoning.

b. Calculate the frequency responses $H_1(\Omega)$ and $H_2(\Omega)$ for systems 1 and 2 and plottheir magnitudes for the range of Ω between -2Ω and 2Ω.

Q.4: Discuss with the aid of neat sketches: **[15]**

a. Entire properties of systems.

b. How to decompose any signal into even and odd parts.

c. How to design an analog high pass filter using Butterworth method.

d. Convolution of the signal $x_1(n) = 2\delta(n+3)+\delta(n+1)+\delta(n)-2\delta(n-1)+\delta(n-5)$ and the signal $x_2(n)=\delta(n+1)-\delta(n+2)+\delta(n-1)+\delta(n-2)$ using three different methods.

Q.5: Given two signals $x_1(n) = \{2, 0, -1, 0\}$ and $x_2(n) = \{-1, 2, 0, 1\}$. **[15]**

a. Use z-Transform convolution to find the linear convolution of the two signals.

b. Use the FFT to find the 4-point circular convolution by finding the DFT of each of the signals, multiplying the result, and taking the inverse.

Q.6 Design a Butterworth approximation for a digital high pass filter whose requirements are characterized by: A_{max}=0.5 dB, A_{min}=12dB, ω_s=100, and ω_p=400. **[15]**

Q.7 a. Use the table to find the z transform of: **[15]**

i. $x(k) = 3(4)^k + 7k^2, k \geq 0$ ii. $x(k) = 3e^{-k}\sin 4k - k, k \geq 0$

b. Solve the following difference equations

i. $y[k+2] + 3y[k+1] + 2y[k] = 0;$ $y[0] = 0$, and $y[1] = 1$

ii. $x[k+2] - 7x[k+1] + 12x[k] = k;$ $x[0] = 1$, and $x[1] = 1$