ISTANBUL TECHNICAL UNIVERSITY

COMPUTER ENGINEERING DEPARTMENT

BLG 354E

SIGNALS AND SYSTEMS

FOR COMPUTER ENGINEERING
ASSIGNMENT 2

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Question 1

Part a)

$$x[n] = \{0, e^{-1}, 2e^{-2}, 0\}$$

$$y[n] = x[n] * h[n] = \sum_{-\infty}^{\infty} x[k]h[n-k]$$

$$y[0] = 1 \cdot 0 = 0$$

$$y[1] = 0.5 \cdot 0 + 1 \cdot e^{-1} = e^{-1}$$

$$y[2] = 0.25 \cdot 0 + 0.5 \cdot e^{-1} + 1 \cdot 2e^{-2} = 0.5e^{-1} + 2e^{-2}$$

$$y[3] = 0.125 \cdot 0 + 0.25 \cdot e^{-1} + 0.5 \cdot 2e^{-2} + 1 \cdot 0 = 0.25e^{-1} + e^{-2}$$

$$y[4] = 0.0625 \cdot 0 + 0.125 \cdot e^{-1} + 0.25 \cdot 2e^{-2} + 0.5 \cdot 0 = 0.125e^{-1} + 0.5e^{-2}$$

$$y[5] = 0.0625 \cdot e^{-1} + 0.125 \cdot 2e^{-2} + 0.25 \cdot 0 = 0.0625e^{-1} + 0.25e^{-2}$$

$$y[6] = 0.0625 \cdot 2e^{-2} + 0.125 \cdot 0 = 0.125e^{-2}$$

$$y[7] = 0.0625 \cdot 0 = 0$$

$$y[n] = \{0, e^{-1}, 0.5e^{-1}+2e^{-2}, 0.25e^{-1}+e^{-2}, 0.125e^{-1}+0.5e^{-2}, 0.0625e^{-1}+0.25e^{-2}, 0.125e^{-2}, 0\}$$

Part b)

Z-transform of impulse response of DT signal is equal to transfer function of the discrete system.

$$h[n] = \delta[n] + 0.5\delta[n-1] + 0.25\delta[n-2] + 0.125\delta[n-3] + 0.0625\delta[n-4]$$

$$H(z) = 1 + 0.5z^{-1} + 0.25z^{-2} + 0.125z^{-3} + 0.0625z^{-4}$$

Part c)

$$H(z) = \frac{Y(z)}{X(z)} = \frac{b_0 + b_1z^{-1} + b_2z^{-2} + \cdots + b_mz^{-m}}{a_0 + a_1z^{-1} + a_2z^{-2} + \cdots + a_nz^{-n}}$$

$$Y(z) = \frac{1}{a_0}(b_0 + b_1z^{-1} + b_2z^{-2} + \cdots + b_mz^{-m})A(z)$$

$$A(z) = \frac{1}{a_0}X(z) - \frac{1}{a_0}(a_1z^{-1} + a_2z^{-2} + \cdots + a_nz^{-n})A(z)$$

$$T(z) = H(z) = \frac{Y(z)}{X(z)} = \frac{1 + 0.5z^{-1} + 0.25z^{-2} + 0.125z^{-3} + 0.0625z^{-4}}{1}$$

$$b_0 = 1, b_1 = 0.5, b_2 = 0.25, b_3 = 0.125, b_4 = 0.0625, a_0 = 1, A(z) = X(z)$$

Canonical form is drawn below:

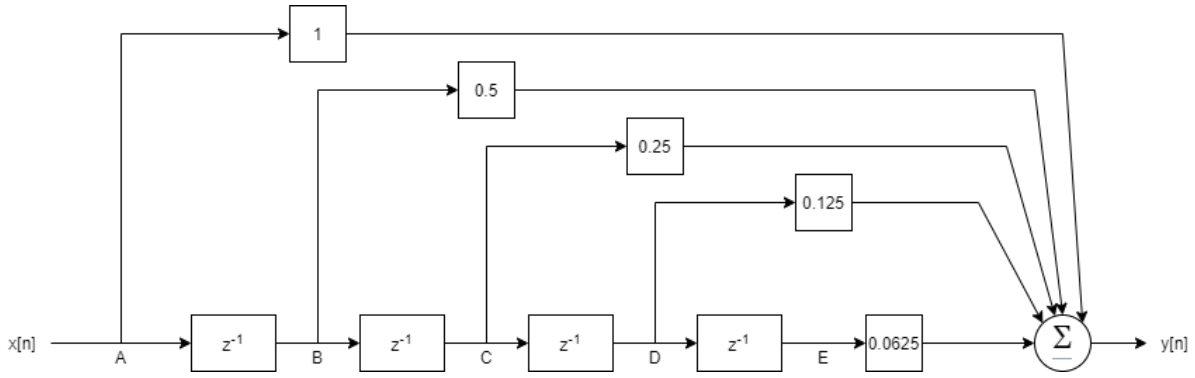

Figure 1: Canonical Form

Part d)

Pseudo code is written below:

```
Timer interrupt Ts=1/fs
A = X
Y = A + 0.5B + 0.25C + 0.125D + 0.0625E
Output(Y)
E = D
D = C
C = B
B = A
Return
```

Question 2

Plot of a)

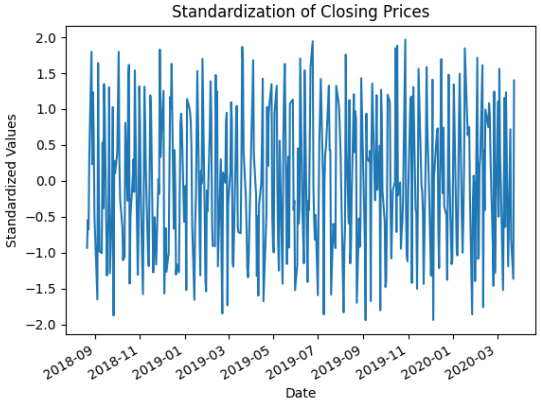

Figure 2: Standardization Plot

Plot of b)

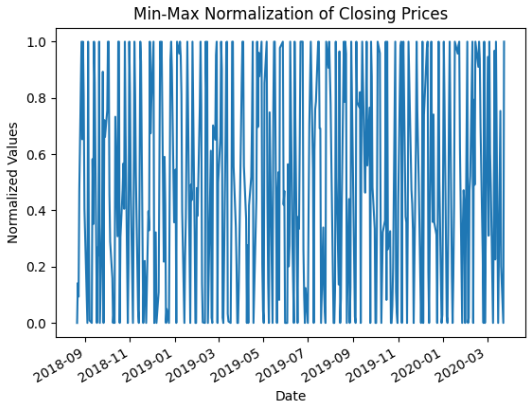

Figure 3: Min-Max Normalization Plot

Plot of c) (h = [0.2, 0.4, 0.6, 0.8, 1])

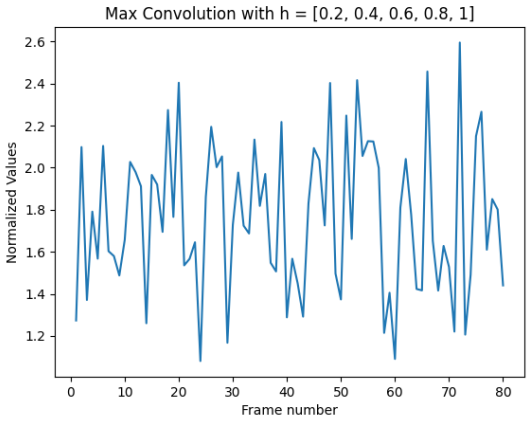

Figure 4: Max convolution v1

Plot of c) (h = [0.8, 0.6, 0.4, 0.2, 0])

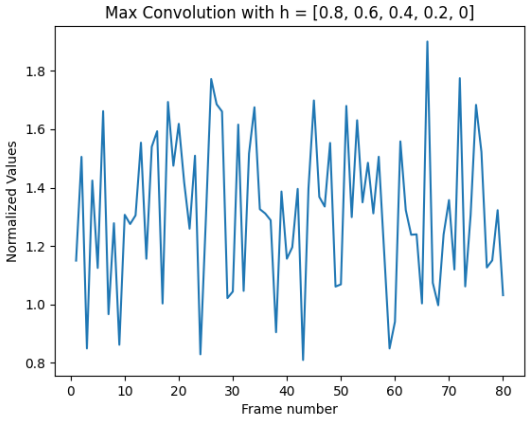

Figure 5: Max convolution v2