Introduction to Computer Engineering
Fall 2021, Assignment 2

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Due on Monday November 14^{th}, 2021 by 11:59 PM

Parameters Specific To Your Submission

In this assignment we will use the digits from your IDs. We define the following numbers which are the **same** as the **numbers** you used in your assignment :

c_1: The average of of digits from your student ID, **rounded** + 1. Use Excel file provided to determine c_1.

My student ID is: 64160010

$$\begin{aligned} Average : \frac{6+4+1+6+0+0+1+0}{8} = \frac{18}{8} = 2.25 \approx 2 \\ c_1 = 2 \end{aligned}$$

c_2 : The average of digits from your Turkish ID, **rounded** + 1. Use the Excel file to determine c_2.

My Turkish ID is: 33098186424

$$\begin{aligned} Average : \frac{3+3+0+9+8+1+8+6+4+2+4}{11} = \frac{48}{11} = 4.36363636 \approx 4 \\ c_2 = 4 \end{aligned}$$

c_3: If $(c_1 \geq c_2)$ then $c_3 = 1$ otherwise $c_3 = -1$.

$c_1 < c_2$ so that by $c_3 = -1$.

c_4 = c_1 + c_2.

Then,

$$\begin{aligned} c_4 = 2+4 = 6 \\ c_4 = 6 \end{aligned}$$

c_5 : The first digit for your student ID.

My Student ID is: 64160010
So that by c_5 = 6

Question 1 (40 points): The following block diagram shows a cascaded DSP filter block.

(a) (7 Pts.) Determine the system by the operator equations.

$$\begin{aligned} V(n) &= -2x(n) + Rx(n)(4) + R^2x(n)(-6) \\ &= -2x(n) + 4Rx(n) - 6R^2x(n) \\ V(n) &= (-2 + 4R - 6R^2)x(n) \end{aligned}$$

y(n) given by

$$\begin{aligned} y(n) &= V(n) + Ry(n) - R^2y(n) \\ y(n) &= (-2 + 4R - 6R^2)x(n) + Ry(n) - R^2y(n) \\ y(n)[1 - R + R^2] &= [-2 + 4R - 6R^2]x(n) \end{aligned}$$

(b) (8 Pts.) Determine the difference equation, which should read y[n] = ...

from part a

$$\begin{aligned} y(n) = y(n-1) + y(n-2) &= -2x(n) + 4x(n-1) - 6(n-2) \\ y(n) &= -2x(n) + 4x(n-1) - 6(n-2) + y(n-1) - y(n-2) \end{aligned}$$

Question 2 (30 points): A system is given by the difference equation below.

(a) (15 Pts.) Describe the system by the operator equations.

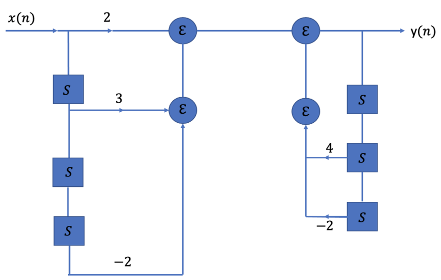
$$x(n+1) \to Ex(n) \quad x(n+2) \to E^2x(n) \quad \cdots$$

given y[n] = 2x[n] + 3x[n-1] - 2x[n-3] + 4y[n-2] - 2y[n-3]

y(n) = 4y(n-2) + 2y(n-3) = 2x(n) + 3x(n-1)
replace in = n+3

$$\begin{aligned} y(n+3) - 4y(n+1) + 2y(n) &= 2x(n+3) + 3x(n+2) \\ E^3y(n) - 4Ey(n) + 2y(n) &= 2E^3x(n) + 3E^2x(n) \\ [E^3 - 4E + 2]y(n) &= [2E^3 + 3E^2]x(n) \end{aligned}$$

(b) (15 Pts.) Draw the block diagram for the system as cascaded feedforward and feedback networks.



Question 3 (30 points): The systems given in Fig. 2 are equivalent systems.

(a) (15 Pts.) Find p_0, p_1 for the system on the right side. ($p_0 > p_1$)

(b) (b) (15 Pts.) If the system was at rest, find y[5] for x[n] = δ[n].

Left side system 1 and right side system 2.

System 1:

$$
\begin{aligned}
Part1 :& \\
w(n) &= x(n) + p_0 \cdot w(n-1) \\
w(n) &= p_0 \cdot w(n-1) = x(n) \\
w(z) &= \frac{x(z)}{1 - p_0 z^{-1}}
\end{aligned}
$$

$$
\begin{aligned}
Part2 :& \\
y(z) &= \frac{w(z)}{1 - p_1 z^{-1}} \\
y(z) &= \frac{x(t)}{(1 - p_0 z^{-1})(1 - p_1 z^{-1}} \\
y(z) &= \frac{x(z)}{1 - (p_0 + p_1) z^{-1} + p_0 p_1 z^{-2}}
\end{aligned}
$$

System 2:

$$
\begin{aligned}
y(n) &= x(n) + 0.6y(n-1) + 0.25y(n-2) \\
\Rightarrow y(n) &= 0.6y(n-1) - 0.25y(n-2) = x(n)
\end{aligned}
$$

z transform,

$$
\begin{aligned}
y(z) - 0.6z^{-1}y(z) - 0.25z^{-2}y(z) &= x(z) \\
y(z)(1 - 0.6z^{-1} - 0.25z^{-2}) &= x(z) \\
y(z) &= \frac{x(z)}{1 - 0.6z^{-1} - 0.25z^{-2}}
\end{aligned}
$$

$$
\begin{aligned}
p_0 + p_1 &= 0.6 \\
p_0 \cdot p_1 &= -0.25 \\
p_0 &= \frac{-0.25}{p_1} \\
p_1 &= \frac{-0.25}{p_0}
\end{aligned}
$$