Lab5 Report

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1 Problem1

1.1 Calculate code rate R.

k = 1, n = 2, so the code rate R = 1/2 = 0.5.

1.2 Draw the shift register structure.

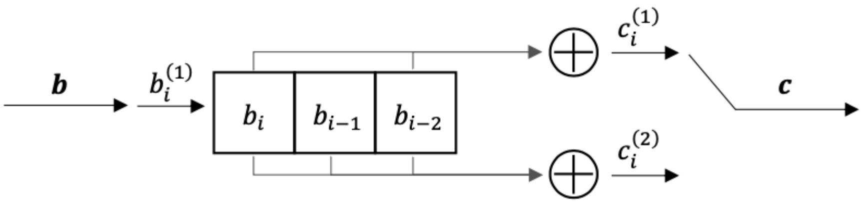

Figure 1: Shift register structure

1.3 Draw the state transition diagram.

We first construct the state transition table (as Table1) and turn it into state transition diagram (as Fig.2).

Input b_i	State (before)	Output $C_i^{(1)}$	Output $C_i^{(2)}$	State (after)
0	00(State A)	0	0	00(State A)
0	01(State B)	1	1	00(State A)
0	10(State C)	0	1	01(State B)
0	11(State D)	1	0	01(State B)
1	00(State A)	1	1	10(State C)
1	01(State B)	0	0	10(State C)
1	10(State C)	1	0	11(State D)
1	11(State D)	0	1	11(State D)

Table 1: State Transition Table

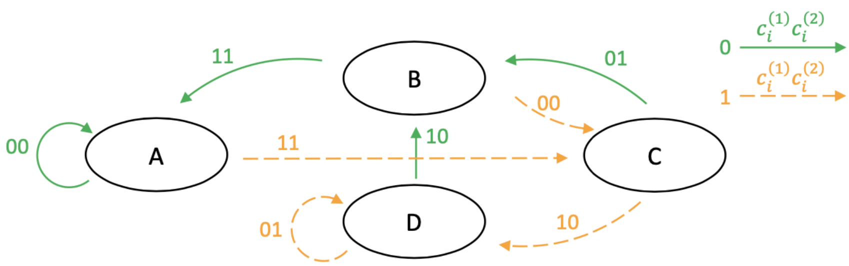

Figure 2: State transition diagram

1.4 Draw the trellis diagram.

Suppose the intial state is A, and the trellis diagram is shown in Fig.3, and here I only plot the 4 steps, for it is repeated after the 4-step.

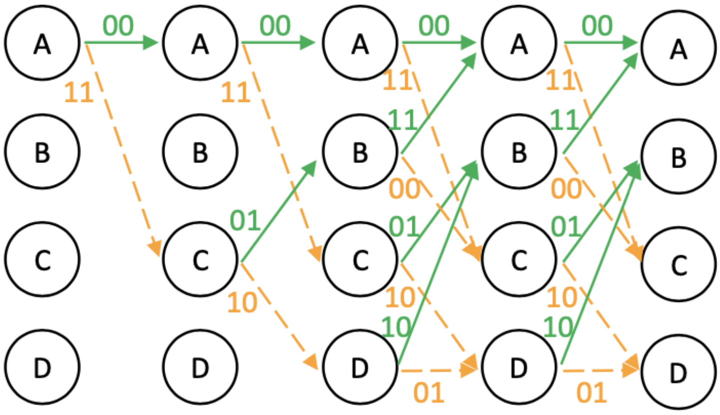

Figure 3: Trellis diagram

1.5 Illustrate the path on the trellis diagram for the received sequence, and list the decoded codewords and the decoded bits.

The path on the trellis diagram is shown in Fig.4, and the numbers in circles represent the Hamming distance at the time. And for $y = 00110100010100$, decoded codewords $\hat{c} = 00110100011100$, and decoded bits $\hat{b} = 0101000$

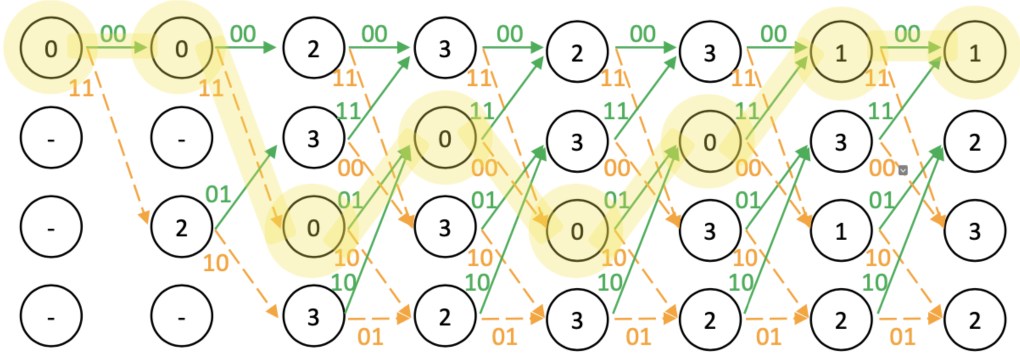

Figure 4: Path on trellis diagram

1.6 Calculate the Hamming distance between y and $\hat{c}$

From the result in problem 1e, we can know that one bit of $\hat{c}$ is different to y, so the hamming distance between y and $\hat{c}$ is 1.

2 Problem2

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Command Window
2a result: 1 1 1 0 0 1 1 0 0 1 1 0 0 1 0
2b result: 0 0 0 1 0 0 0
1e result: 0 1 0 1 0 0 0
2c result:
0.000010 0.016910 0.142020 0.319520 0.434990 0.503690 0.533940 0.556380 0.567270 0.566420 0.501900
Problem3 result:
0.000000 0.493550 0.494400 0.501580 0.500380 0.498700 0.503380 0.500310 0.499510 0.500090 0.500000
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Figure 5: Program output

2.1 Verify your results with the example to the associated output binary sequence $c = \{c_i\}_i$ is the same as what taught in class

From Fig.5, we can see the result is "1 1 1 0 0 1 1 0 0 1 1 0 0 1 0", which is the same with the example in class.

2.2 Verify your results with the example and the results in Problem 1e

From Fig.5, we can see the result is "0 0 0 1 0 0 0", which is the same with the example in class. And, the result of 1e is also the same with the answer to the problem 1e.

2.3 Plot the simulation results.

The result is shown in Fig.6, and we can see when p > 0.5, BER is also > 0.5.

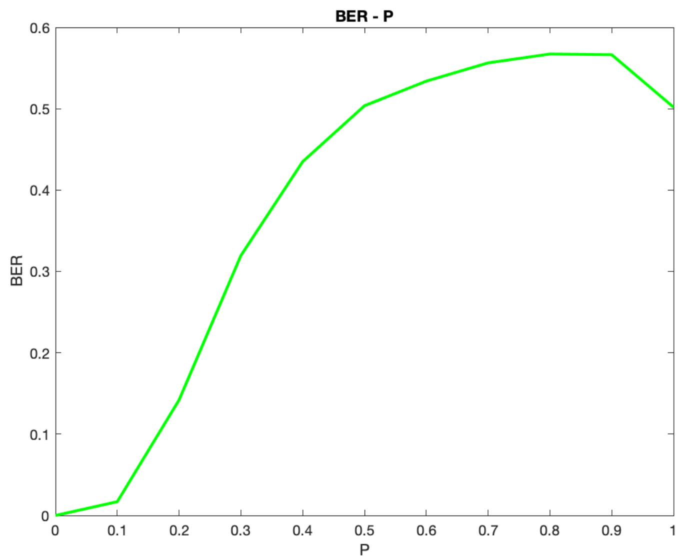

Figure 6: BER v.s p

3 Problem3

3.1 Please do the simulation described in Problem 2c but with the FIR given in (3). How is the simulation results compared with that in Problem 2c? Why?

The result is shown in Fig.7, the difference is: for all $p > 0$, the corresponding BERs are all around 0.5, that is, the decoded data is randomly determined. And this is the example of "catastrophic", that is, the state transition diagram is totally symmetric. Thus, when we change A and C, B and D, as well as 0 and 1, we can get the same state transition diagram, which cannot be distinguished from the other one. So, when any error occurs, the result will be randomly distributed, and that leads to the conclusion: **"When $p \neq 0$, the BER will be around 0.5".**

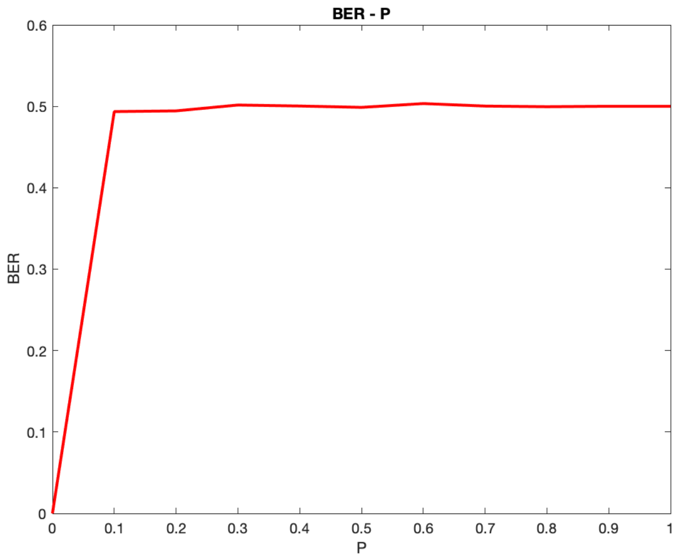

Figure 7: BER v.s P