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ECE 5660

Heomwork 8

Problem 2

A

How does the feedback work?

The feedback for $1 + x + x^4$ works that the output is saved intput the left register and the previous value of the left register is XOR'ed with the output.

At count 4: the output is 1, the left register is 0. So the second-to-left register is given the value 1^0=1, and the left register is given the output, 1.

At count 13: the output is 1, the left register is 1, so the second-to-left register is 1^1=0, and the left register is given the output, 1.

At count 15: this is like 13 where the output is 1 and the left register is 1. So the second-to-left register is 0, and the left register is given the output, 1.

This takes 16 clocks cycles to return to it's original form.

Count	State	Output
0	1 0 0 0	0
1	0 1 0 0	0
2	0 0 1 0	0
3	0 0 0 1	1
4	1 1 0 0	0
5	0 1 1 0	0
6	0 0 1 1	1
7	1 1 0 1	1
8	1 0 1 0	0
9	0 1 0 1	1
10	1 1 1 0	0
11	0 1 1 1	1
12	1 1 1 1	1
13	1 0 1 1	1
14	1 0 0 1	1
15	1 0 0 0	0

B

The output for the starting register state [1,0,0,0] is

Count	State	Output
0	1 1 0 0	0
1	0 1 1 0	0
2	0 0 1 1	1
3	1 1 1 1	1
4	1 0 0 1	1
5	1 0 1 0	0
6	0 1 0 1	1
7	1 1 0 0	0
8	0 1 1 0	0
9	0 0 1 1	1
10	1 1 1 1	1
11	1 0 0 1	1
12	1 0 1 0	0
13	0 1 0 1	1
14	1 1 0 0	0
15	0 1 1 0	0

The state repeats after at count 7. Below are the 4 initial states that do traverse all states. Something interesting is most of the states are covered in two initial conditions, taking 7 cycles to repeat. Two of the states repeat every cycle, and don't go into any other states ([0,0,0,0], and [1,0,1,1])
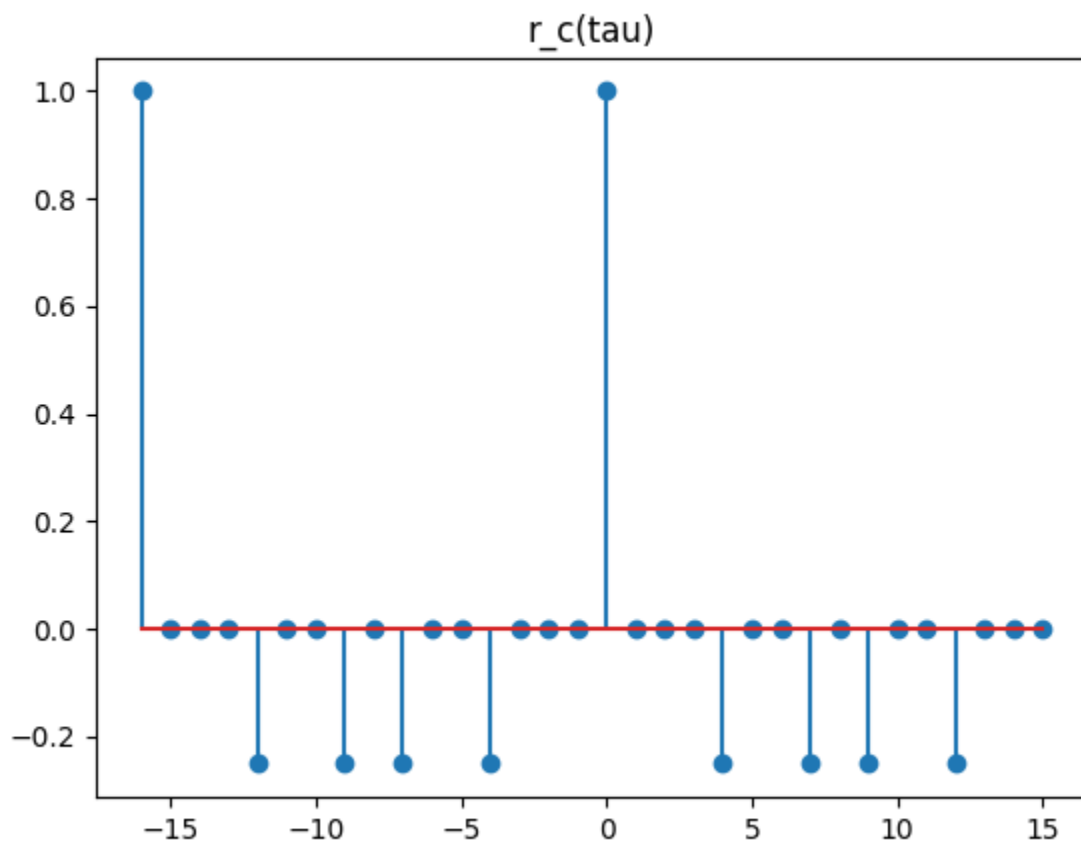
[1, 1, 0, 0] | Count | State | Output | |-------|---------|--------||0|1 1 0 0|0||1|0 1 1 0|0||2|0 0 1 1|1||3|1 1 1 1|1||4|1 0 0 1|1||5|1 0 1 0|0||6|0 1 0 1|1||7|1 1 0 0|0|

[0, 0, 0, 0] | Count | State | Output | |-------|---------|--------||0|0 0 0 0|0||1|0 0 0 0|0||2|0 0 0 0|0||3|0 0 0 0|0||4|0 0 0 0|0||5|0 0 0 0|0||6|0 0 0 0|0||7|0 0 0 0|0|

[0, 0, 0, 1] | Count | State | Output | |-------|---------|--------||0|0 0 0 1|1||1|1 1 1 0|0||2|0 1 1 1|1||3|1 1 0 1|1||4|1 0 0 0|0||5|0 1 0 0|0||6|0 0 1 0|0||7|0 0 0 1|1|

[1, 0, 1, 1] | Count | State | Output | |-------|---------|--------||0|1 0 1 1|1||1|1 0 1 1|1||2|1 0 1 1|1||3|1 0 1 1|1||4|1 0 1 1|1||5|1 0 1 1|1||6|1 0 1 1|1||7|1 0 1 1|1|

C

r_c(tau)

What do you observe about this autocorrelation function?

- I notice that there are only 4 values, [-1/4, 0, 1/4, 1], and they seem to be repeating every mod N

D

I saw the pattern pretty early, the outputs of the long division match the 1's of the output in Table 4.11. For example, the first coefficient is x^3 and the first 1 in the output of 4.11 is in cycle 3.

```
                      x^3 + x^6 + x^7
                   - - - - - - - - - - - - - - - -
    1 + x^3 + x^4 |  x^3
                     -x^3 + x^6 + x^7
                   - - - - - - - - - - - - - - - -
                       0 + x^6 + x^7
                       . . .
```

E