PN Sequences and Scramblers

Exercise 1: How many bits are there in an m-sequence for $m = 6$? How many are 1's? How many are 0's?

$\text{period} = 2^6 - 1 = 63$ 32 1's 31 0's

Exercise 2: If the initial value of each flip-flop is 1, what are the values of the next 4 bits output by the right-most flip-flop?

1111	1
0111	1
0011	1
0001	1

1000

0100

Exercise 3: How many flip-flops would be required to generate a ML PRBS of period 8191? How many ones would the sequence have? What is the longest sequence of 0's?

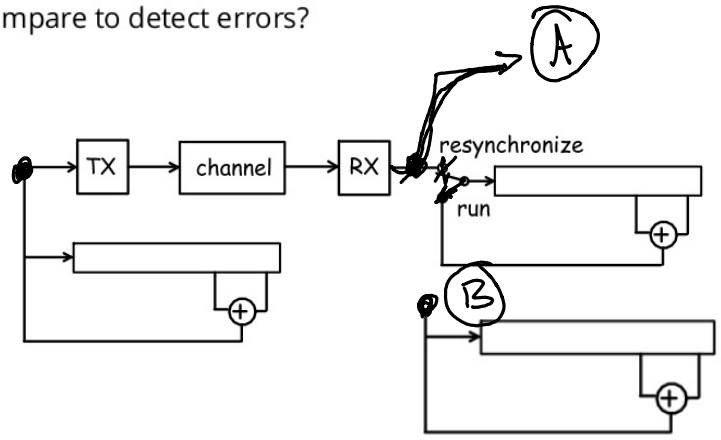
$2^k - 1 = 8191$ $2^k = 8192$ $k = 13$

4095 1's $m - 1 = 12$

Exercise 4: Why not?

descrambling procedure is public & implemented by all receivers

Exercise 5: In the diagram above, what two signals would the receiver compare to detect errors?



compare A & B

Exercise 6: Derive H_2 and H_4. Show that the first two rows and last two columns of each matrix are orthogonal.

$H_1 = [1]$

$$H_2 = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

cross-correlation:

$$R_{ij} = \sum_{k=0}^{N-1} H_{ik} H_{jk}$$

$$H_4 = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$$

rows 0 & 1: $1\cdot1 + 1\cdot-1 + 1\cdot1 + 1\cdot-1 = 1-1+1-1 = 0$

cols 2 & 3: $1\cdot1 + -1\cdot-1 + 1\cdot-1 = -1\cdot1 = 1-1+1-1 = 0$

$$H_8 = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 & 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 & 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 & 1 & -1 & -1 & 1 \\ 1 & 1 & 1 & 1 & -1 & -1 & -1 & -1 \\ 1 & -1 & 1 & -1 & -1 & +1 & -1 & +1 \\ 1 & 1 & -1 & -1 & -1 & -1 & +1 & +1 \\ 1 & -1 & -1 & 1 & -1 & +1 & +1 & -1 \end{bmatrix}$$

Exercise 7: Show this.

eg.

$1\ 1\ 1\ 1 \rightarrow$ low rate code

$1\ -1\ 1\ -1 \rightarrow$ higher rate code

$\sum 1\ -1\ 1\ -1 = 0$