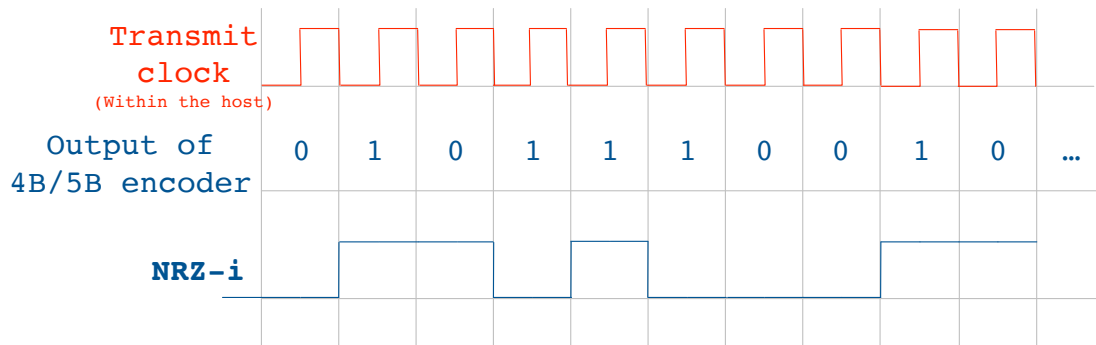
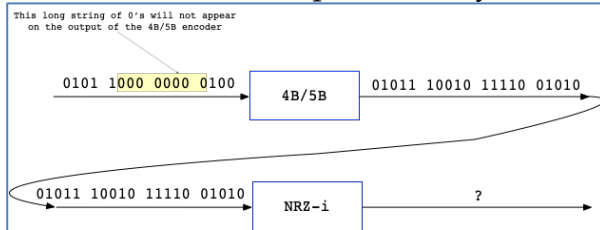
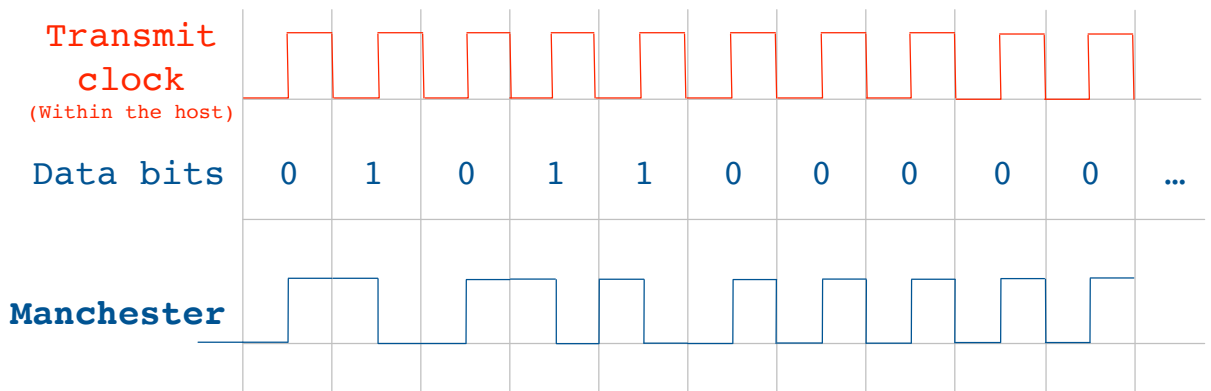


Reference Solution to WH₁

1. Draw the waveforms produced by the NRZ-I encoder in slide no. 19



2. Now, continuing with the preceding question, assume that we replace the tandem 4B/5B + NRZi with a Manchester encoder. Draw the waveforms resulting in this case (Follow the Manchester scheme explained in the relevant slides).



3. Observe slide no. 28 and check that the Channel Capacity calculated is correct.

- Where $B = 3300 - 300 = 3000\text{Hz}$, S is the signal power, N the average noise.

- The signal to noise ratio (S/N) is measured in decibels is related to $\text{dB} = 10 \times \log_{10}(\text{S/N})$. If there is 30dB of noise then $\text{S/N} = 1000$.
- Now $C = 3000 \times \log_2(1001) = 30\text{kbps}$.
- How can we get 56kbps?

The transmitter can increase its transmission speed if the medium transfer function's bandwidth allows it. Alternately, the transmission medium could be replaced by another one which B' is such that: $B' = B \cdot 1,867$

Since the improved C versus the old C is: $56/30 = 1,867$; we increase the used bandwidth by 1,867 ($B \cdot 1,867$) which results in $C_{\text{new}} = 56\text{kbps}$

4. What would you suggest to increase the Shannon's capacity of the considered channel: maybe, increasing the medium Bandwidth? Maybe improving the S/N ratio? Both? Make a brief composition explaining your answers.

We can improve s/n by increasing the signal's power s or by reducing the surrounding noise s maybe by suppressing electromagnetic interference. B can be increased by replacing the transmission medium for one that has an increased B .

5. Briefly explain the Nyquist's criterion, also known as the Sampling Theorem.

Nyquist's Sampling Theorem states that the reconstruction of a signal from its digital samples is possible if the digitization was achieved at least at a sampling frequency at least twice the maximum the signal's bandwidth. This is a necessary condition.

6. According to slide no. 27, if your voice has a bandwidth of 6KHz, what is the minimum sampling frequency which will allow us to reconstruct your voice from the samples taken?

$$F_{\text{sample-min}} = 2 \cdot 6 \text{ KHz} = 12 \text{ KHz}$$

Exercises about presentation for Chapter 1/Section 5:

· <http://paloalto.unileon.es/cn/lect/CN-Ch1-2018-Section5.pdf>

7. Check that the solution to the example on Bidimensional parity (Slide no. 10) is correct. You must assume the role of sender and proceed as is explained below:

1st: Compute the horizontal even parity of 1's of each 7-bit block. For example, the parity bit to the first row should be computed like this:

$$0 \text{ xor } 1 \text{ xor } 0 \text{ xor } 1 \text{ xor } 0 \text{ xor } 0 \text{ xor } 1 = 1$$

The calculation appearing on slide no. 10 is correct.

2nd: When all the six 8-bit¹ rows have been computed we can begin the calculation of the vertical parity of each column. For example, the calculation for the first column yields the following result:

$$0 \text{ xor } 1 \text{ xor } 1 \text{ xor } 0 \text{ xor } 0 \text{ xor } 1 = 1$$

The vertical parity calculation appearing on slide no. 10 is correct.

	Parity bits
↑ Data	0101001 1
	1101001 0
	1011110 1
	0001110 1
	0110100 1
	1011111 0
↓ Parity byte	1111011 0

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8. Continuing with the preceding exercise, assume that the sender sends the 7 8-bit blocks to the receiver and that the bit standing at the intersection of the second row and the third column gets an error. Simulate the behavior of the receiver and explain what it will do when it discovers the error.

	Parity bits
↑ Data	0101001 1
	1101001 0
	1011110 1
	0001110 1
	0110100 1
	1011111 0
↓ Parity byte	1111011 0

- The receiver will compute each of the horizontal parity bits and will flag an error on the second row. Then, it will proceed to compute the vertical parity bits, and will flag an error on the third column.
- The bit at the intersection of the flagged row and column will be corrected (The bit value will be complemented to correct the error).

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¹ The 8 bits from each row include the parity bit