

IUG - Faculty of Engineering
Department of Computer Engineering
Data communications Lab
Summer 2022-2023



Data Communications

Lab 5

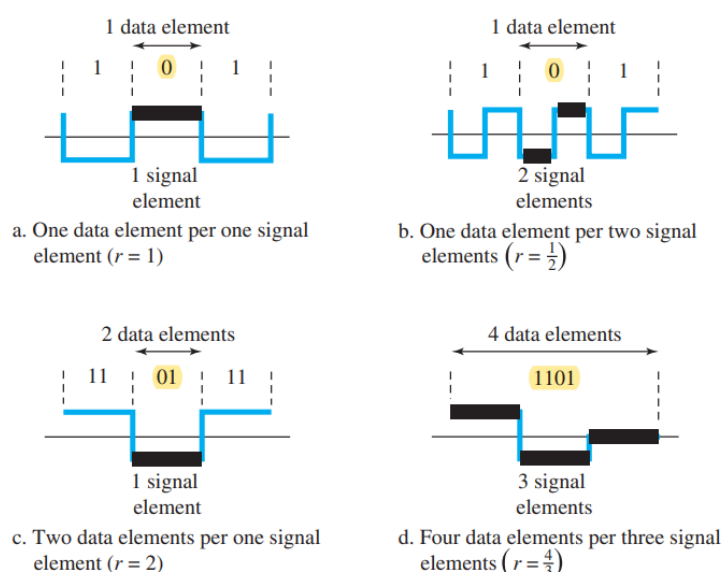
Chapter 4:

Digital Transmission

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P4-1. Calculate the value of the signal rate for each case in Figure 4.2 if the data rate is 1 Mbps and $c = 1/2$.

Figure 4.2 Signal element versus data element



Solution:

We use the formula $s = c \times N \times (1/r)$ for each case. We let $c = 1/2$.

- a. $r = 1 \rightarrow s = (1/2) \times (1 \text{ Mbps}) \times 1/1 = 500 \text{ kbaud}$
- b. $r = 1/2 \rightarrow s = (1/2) \times (1 \text{ Mbps}) \times 1/(1/2) = 1 \text{ Mbaud}$
- c. $r = 2 \rightarrow s = (1/2) \times (1 \text{ Mbps}) \times 1/2 = 250 \text{ Kbaud}$
- d. $r = 4/3 \rightarrow s = (1/2) \times (1 \text{ Mbps}) \times 1/(4/3) = 375 \text{ Kbaud}$

P4-2. In a digital transmission, the sender clock is 0.2 percent faster than the receiver clock. How many extra bits per second does the sender send if the data rate is 1 Mbps?

Solution:

The number of bits is calculated as $(0.2 / 100) \times (1 \text{ Mbps}) = 2000 \text{ bits}$

P4-3. Draw the graph of the NRZ-L scheme using each of the following data streams, assuming that the last signal level has been positive. From the graphs, guess the bandwidth for this scheme using the average number of changes in the signal level. Compare your guess with the corresponding entry in Table 4.1.

- a. 00000000 b. 11111111 c. 01010101 d. 00110011

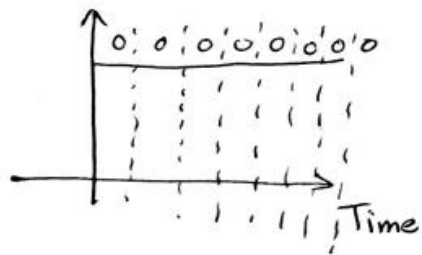
Solution:

NRZ-L (non return to zero level):

+ve: bit 0

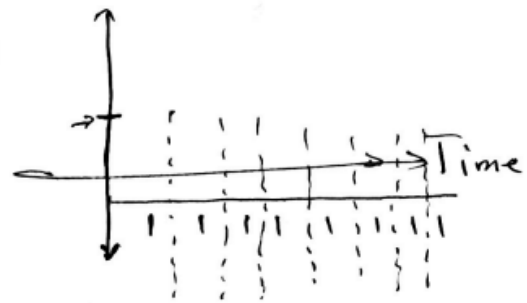
-ve: bit 1

(a) 0000 0000



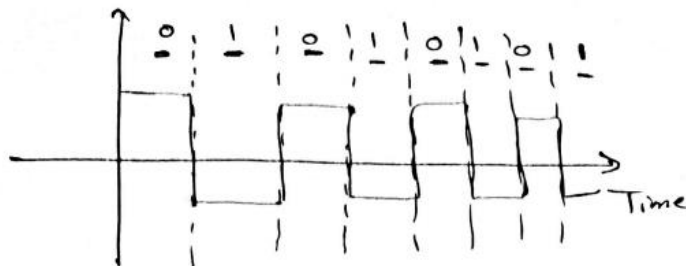
No. of changes = 0.

(b)



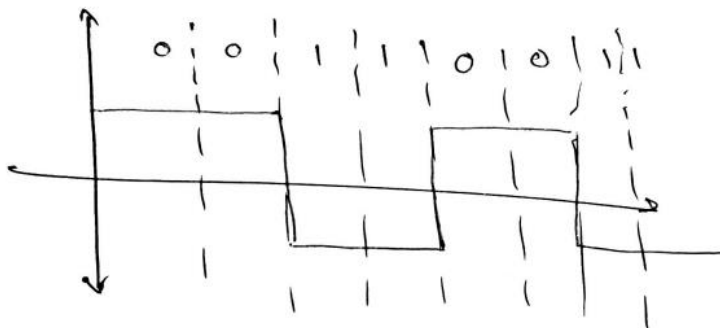
No. of changes = 0.

(c) 01010101



No. of changes : 7

(d) 00110011



No. of changes : 3

Average number of changes = $(0+0+7+3) / 4 = 11/4 = 2.75$

Data rate is the number of data element, so equals to 8

B = (2.75/8) N

P4-4. Repeat Problem P4-3 for the NRZ-I scheme.

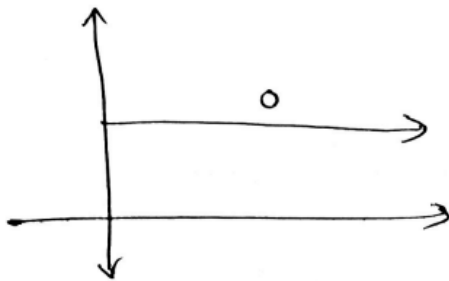
Solution:

NRZ-I:

If the next bit is 0, then No inversion

If the next bit is 1, then inversion

(a) 0000 0000



No. change.

NRZ-I :

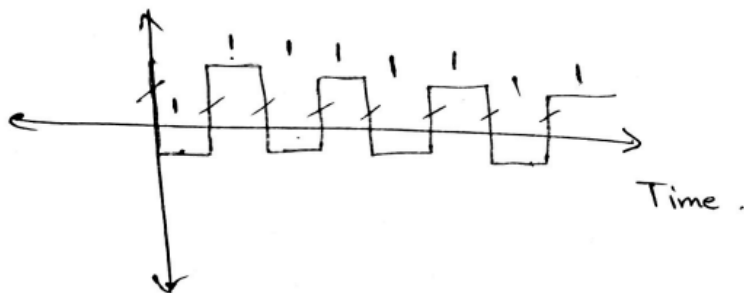
⇒ Next bit is 0

Then, No inversion

⇒ Next bit is 1

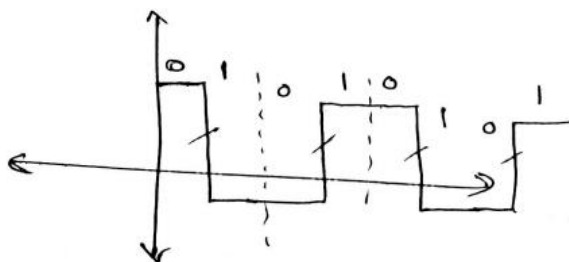
Inversion

(b) 11111111



No. of changes is 8

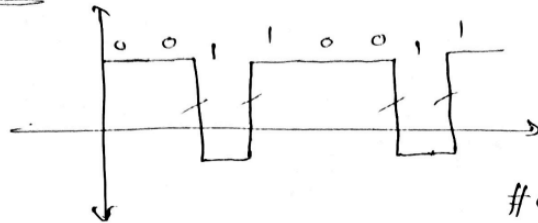
(c) 01010101



No. of changes is 4

d) 00110011

Sol:



changes = 4

$$\text{avg. of changes} = \frac{(0+8+4+4)}{4} = 4, N=8$$

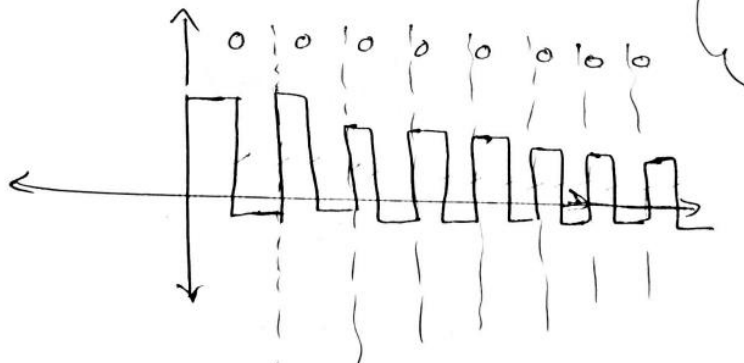
$$BW = \frac{4}{8} = \left\lceil \frac{1}{2} \right\rceil N = \left\lceil N/2 \right\rceil$$

P4-5. Repeat Problem P4-3 for the Manchester scheme.

Solution: Manchester:

0 is 1 is

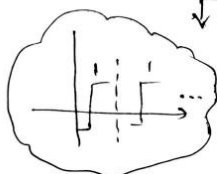
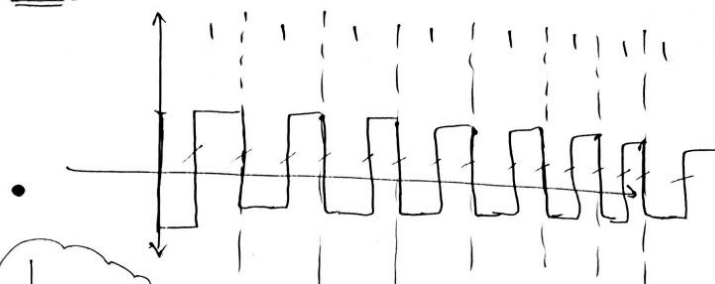
a) 00000000



No. changes = 15

b) 11111111

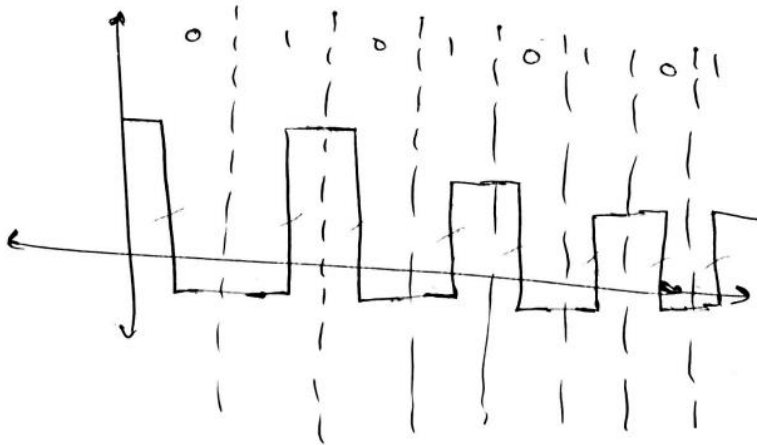
Sol:



No changes = 16

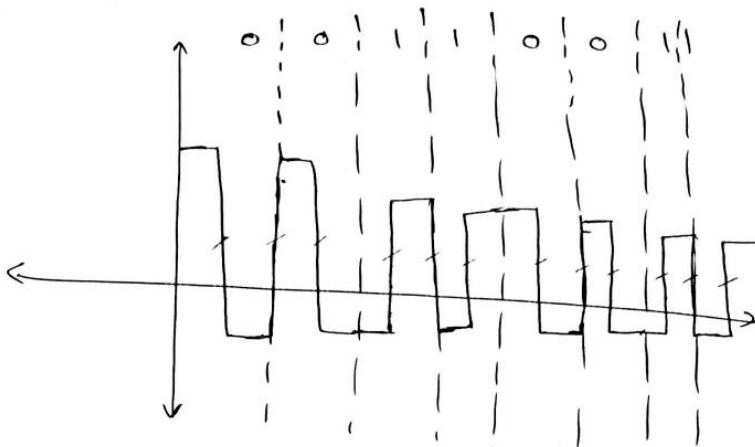
c) 0 1 0 1 0 1 0 1

SR:



changes = 8

d) 0 0 1 1 0 0 1 1



changes = 12

$$\text{avg.} = \frac{(15 + 16 + 8 + 12)}{4} = 12.75$$

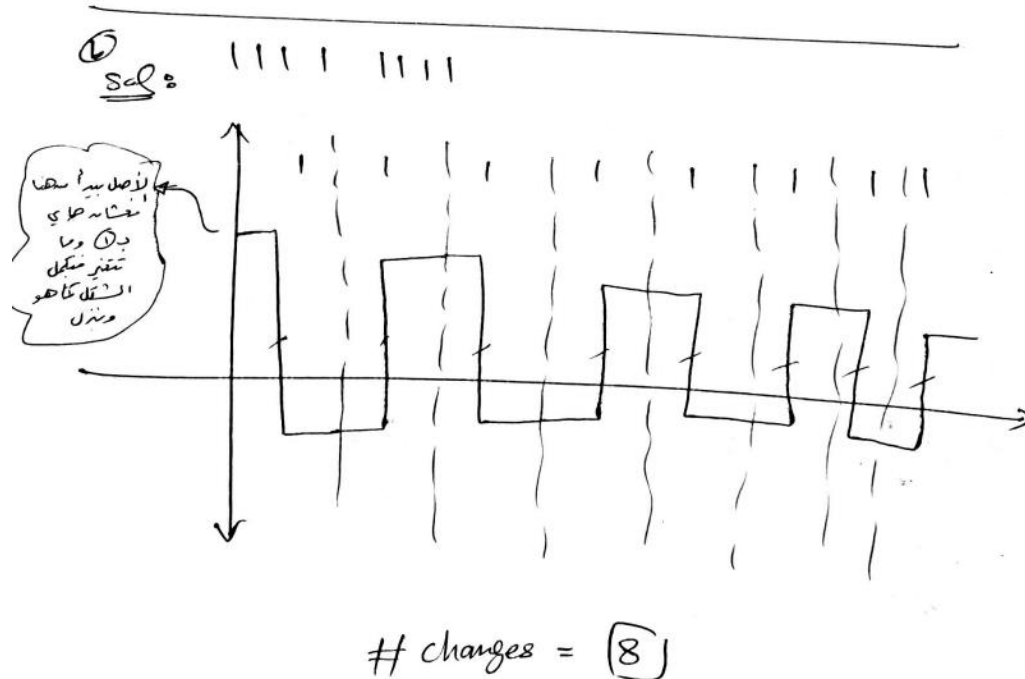
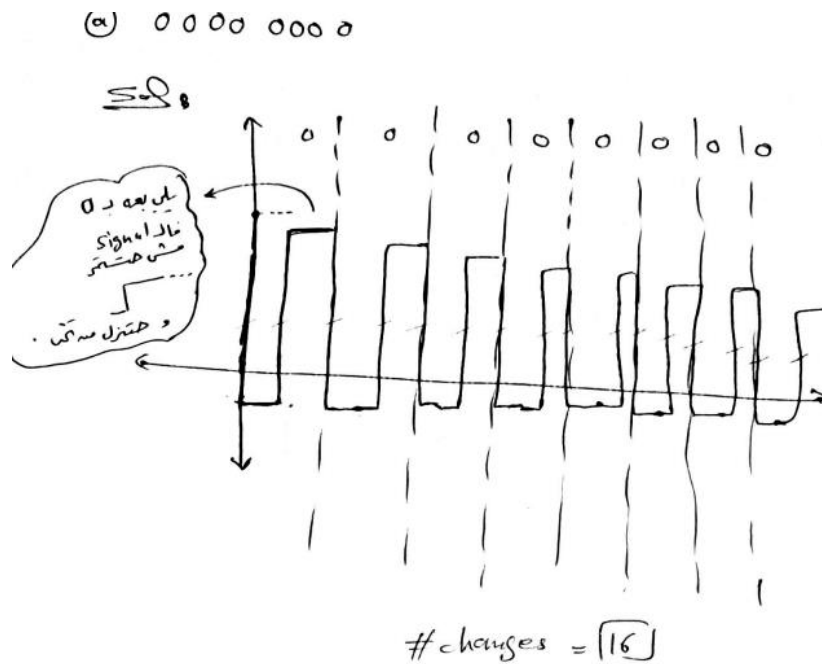
$$N = 8$$

$$BW = \left(\frac{12.75}{8} N \right) \#$$

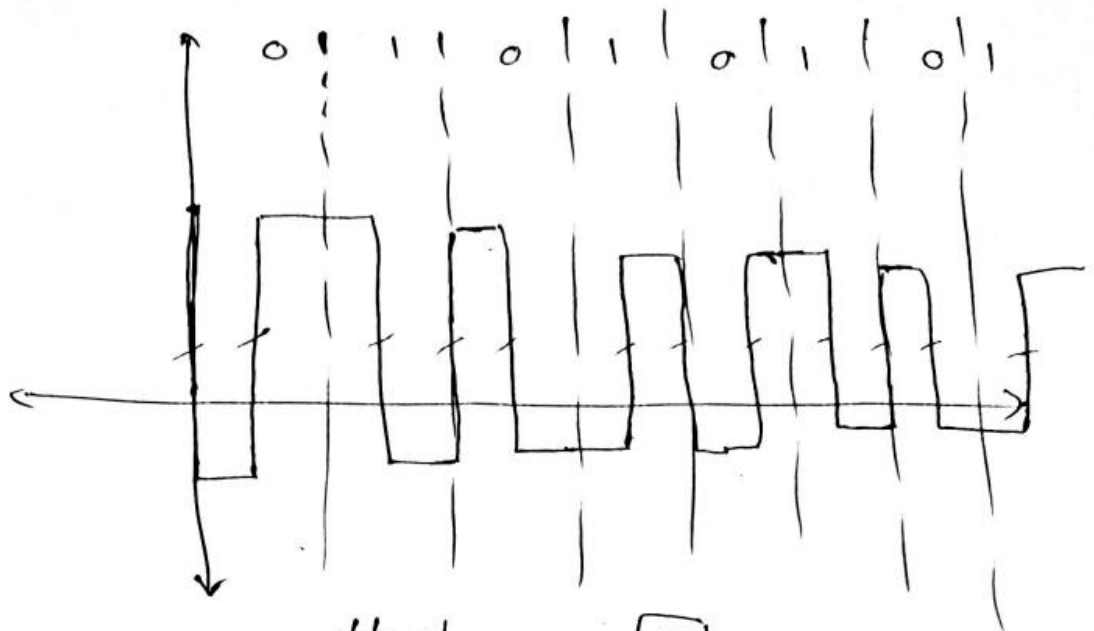
P4-6. Repeat Problem P4-3 for the differential Manchester scheme.

Solution:

○ No inversion: Next bit is 1 ● Inversion: Next bit is 0

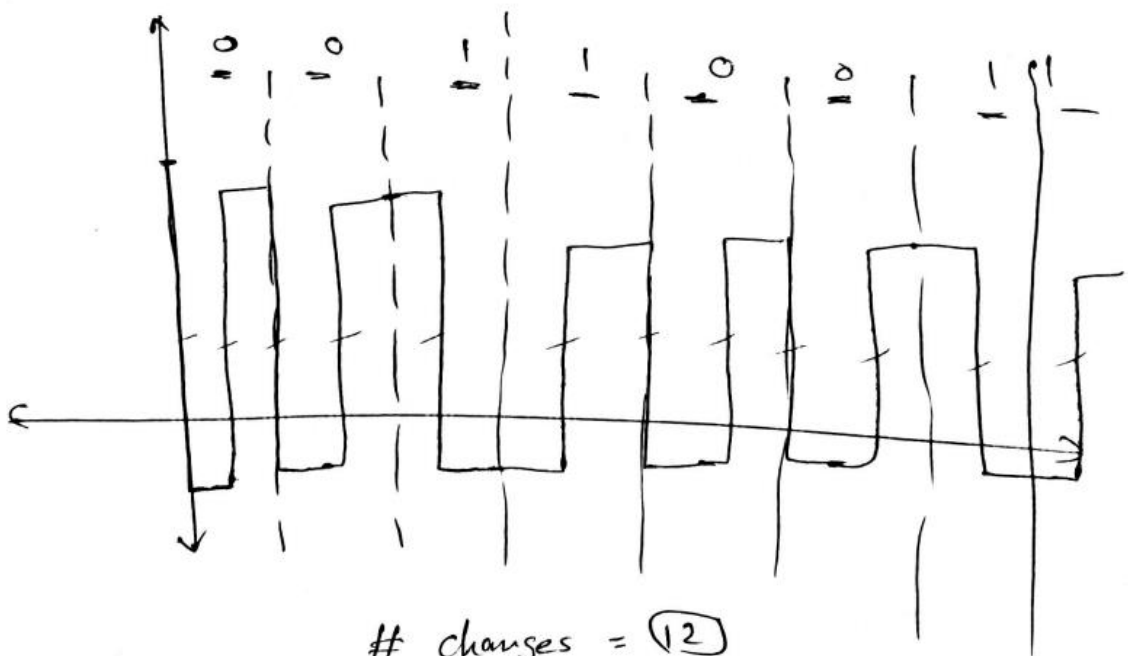


c) 0 1 0 1 0 1 0 1



changes = 12

d) 0 0 1 1 0 0 1 1



changes = 12

$$\text{avg. of changes} = \frac{16 + 8 + 12 + 12}{4} = 12, N = 8$$

$$BW = 12/8 = 1.5 N \#$$

P4-7. Repeat Problem P4-3 for the 2B1Q scheme, but use the following data streams.

- a. 0000000000000000
- b. 1111111111111111
- c. 0101010101010101
- d. 0011001100110011

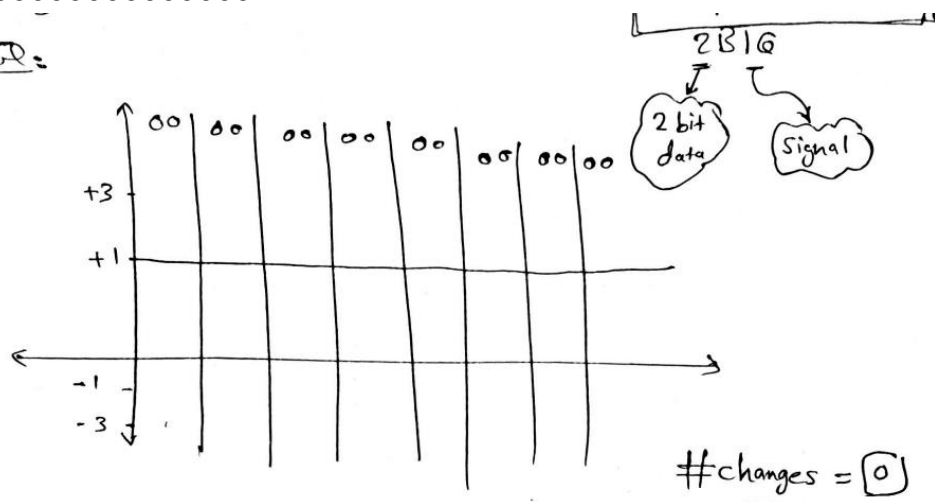
Solution:

	Previous level: positive	Previous level: negative
Next bits	Next level	Next level
00	+1	-1
01	+3	-3
10	-1	+1
11	-3	+3

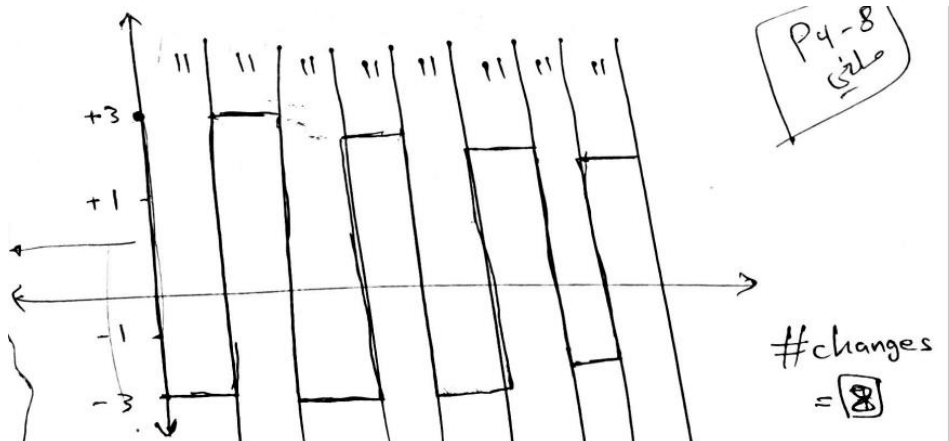
Transition table

a. 0000000000000000

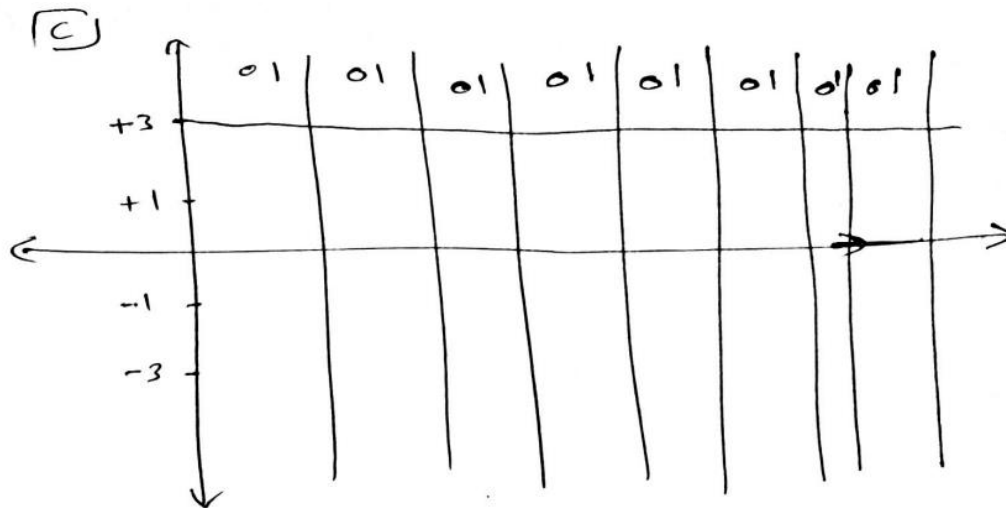
Sol:



b. 1111111111111111

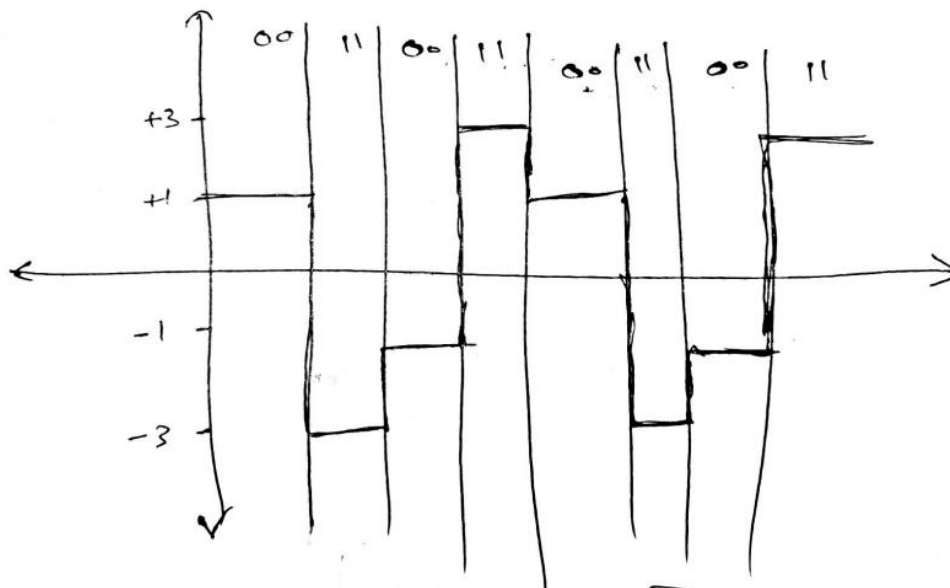


c. 01010101010101



changes = 6

d. 0011001100110011



changes = 7

$$\text{avg. of changes} = \frac{0+8+0+7}{4} = 3.75$$

)

$$B = \left(\frac{3.75}{16} \right) N \quad \#$$