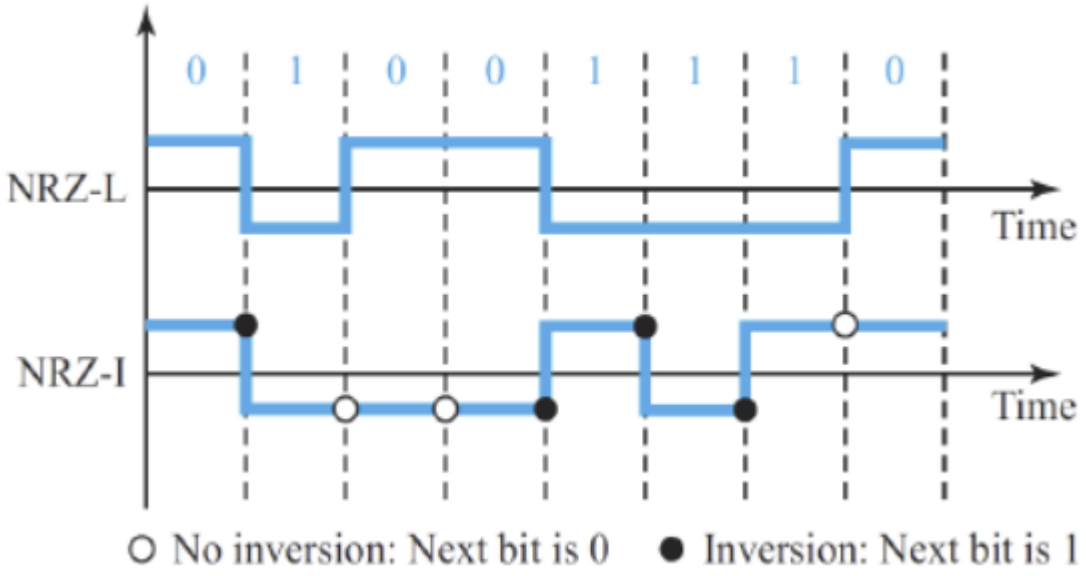
# Q1

## a.

**Polar NRZ-L scheme**, because it matches the definition of NRZ-L: two voltage levels represent bit values — a positive voltage for 0 and a negative voltage for 1.




## b.

It is a problem because it uses a single amplitude to represent a particular symbol. This means that if a long sequence of identical symbols appears, the average value of the signal becomes inaccurate. Since the baseline is determined using this average, it will shift toward the side where the repeated symbols occur more frequently.

## c.

Decrease. Because the bandwidth B required by a digital signal is proportional to the signal rate S.

## d.

The relationship between data rate N and signal rate S is

$$S = \frac{N}{r}$$

Therefore

$$2S = \frac{2N}{r}$$

e.

$$\begin{aligned} S_{avg} &= \frac{cN}{r} \\ 300,000,000 &= \frac{\frac{1}{2}N}{3} \\ N &= 1,800,000,000bps \\ &= 1.8Gbps \end{aligned}$$

Q2

## Q 2

**a.**

$$\begin{aligned} n_b &= \log_2 L = \log_2 128 = 7 \\ for\ Low-pass: B &= f_{\max} \\ 2f_{\max} &= f_s \end{aligned}$$

$$\begin{aligned} N &= f_s \times n_b \\ &= 2B \times \log_2 L \\ &= 600kHz \times \log_2 128 \\ &= 600kHz \times 7 \\ &= 4.2Mbps \end{aligned}$$

**b.**

$$When\ c = \frac{1}{2}, r = 1:$$

$$\begin{aligned} B_{\min} &= n_b \times B \\ &= 7 \times 300kHz \\ &= 2.1MHz \end{aligned}$$

Q3

# Q 3

## a.

$$\begin{aligned}\Delta &= \frac{V_{\max} - V_{\min}}{L} \\ &= \frac{2-(-2)}{4} \\ &= 1\end{aligned}$$

## b.

$$\begin{aligned}0 &: [-2, -1) \\ 1 &: [-1, 0) \\ 2 &: [0, 1) \\ 3 &: [1, 2]\end{aligned}$$

## c.

$$-1.5, -0.5, 0.5, 0.5$$

## d.

$$0, 1, 2, 2$$

## e.

$$\begin{aligned}n_b &= \log_2 L \\ &= \log_2 4 \\ &= 2\end{aligned}$$

$$\begin{aligned}&0, 1, 2, 2 \\ \Rightarrow &00, 01, 10, 11\end{aligned}$$

Q4

## Q 4

**a.**

$$\log_2 16 = 4bits$$

**b.**

$$log_2 128 = 7bits$$

**c.**

$$2^8 = 256$$