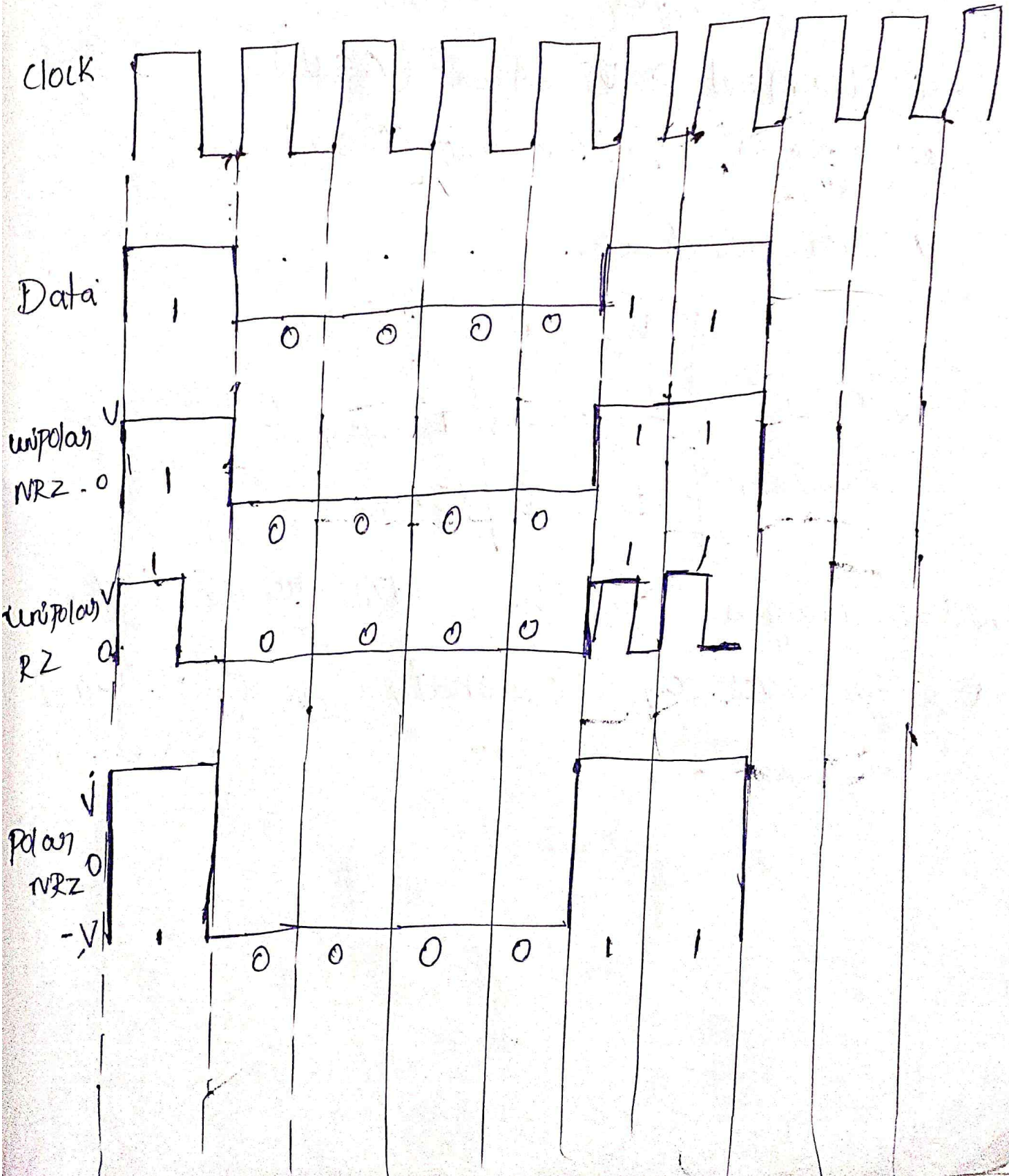
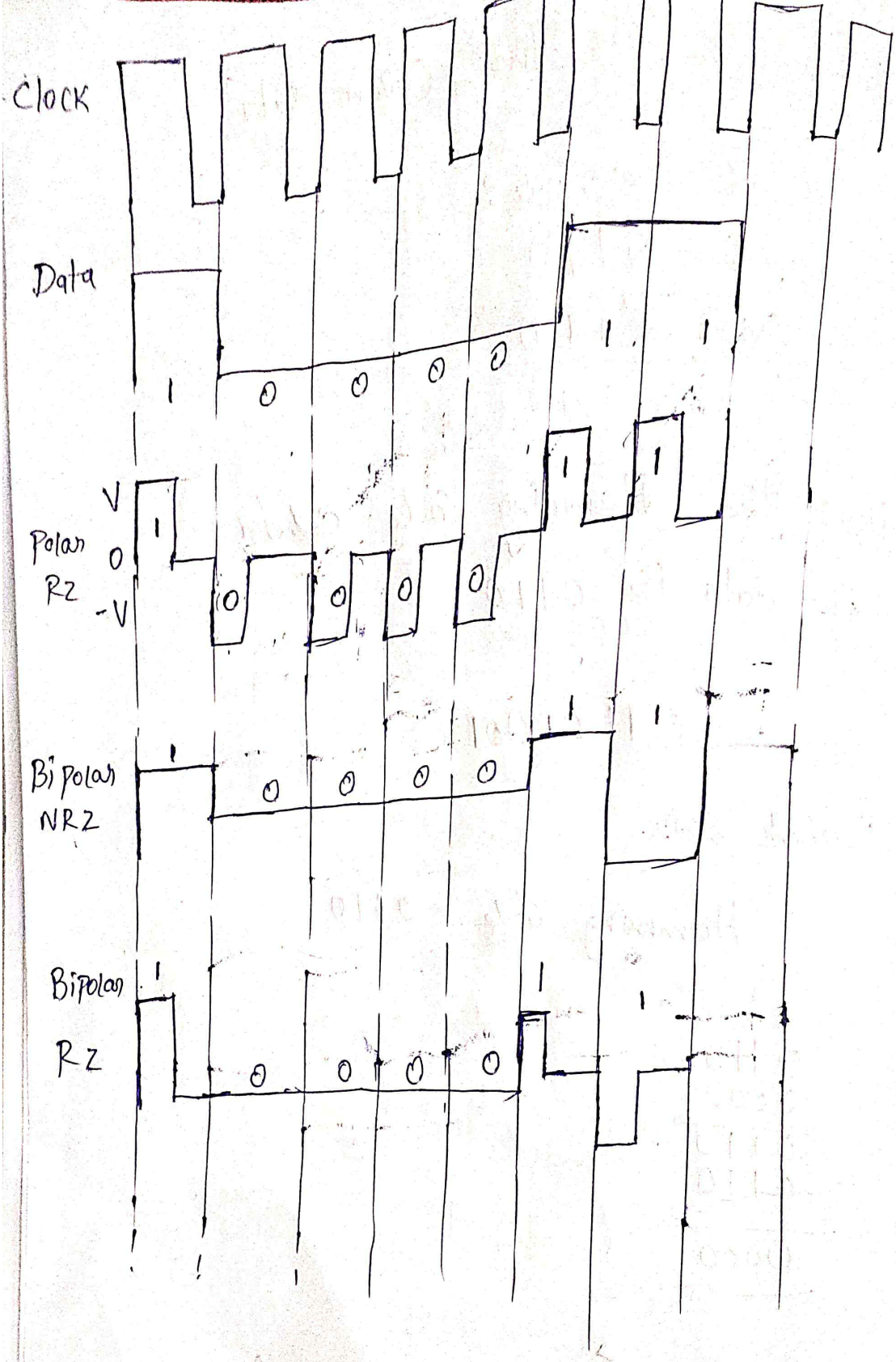
Tutorial - 6

1) C - 67

(A) B - 1000011

unipolar NRZ





3) Hamming Bits ASCII character "C"

C-67 → 6 5 4 3 2 1 0

Binary => 1 0 0 0 1 1

H 1 H 0 H 0 H 1

7 6 5 4 3 2 1 0

0 1 1 0 1 0 0 1

Binary 1's in the Given data

0 - 0000
6 - 0110
(XOR) 0110

Hence the Hamming code for the data is 0110

0110101

Received side.

Hamming code = 0110

0110
0000
0110
0110
0000

2) For a QPSK system and the given parameters, determine the following.

$C = 10^{-13}$ W $f_b = 30$ kbps

$N = 0.06 \times 10^{-15}$ W $B = 60$ KHz

a) Carrier power in dBm.

$$C = 10 \log \frac{C}{0.001}$$

$$= 10 \log \left(\frac{10^{-13}}{0.001} \right)$$

$$= 10 \log \left(\frac{10^{-13}}{10^{-3}} \right)$$

$$= 10 \log \left(10^{-13} \times 10^{3} \right)$$

$$= 10 \log \left(10^{-10} \right)$$

~~$= 10 \log (0.0000000001)$~~

$$= 10 \log \left(1 \times 10^{-10} \right)$$

$$= 10 (-10)$$

$$\boxed{C = -100}$$

b) Noise power in dBm

$$N = 10 \log \left(\frac{N}{0.001} \right)$$

$$= 10 \log \left(\frac{0.06 \times 10^{-15}}{0.001} \right)$$

$$= 10 \log \left(\frac{0.06 \times 10^{-15}}{10^{-3}} \right)$$

$= 10 \log (0.06 \times 10^{-15} \times 10^{3})$

$= 10 \log (0.06 \times 10^{-12})$

~~$= 10 \log$~~

$= -13.2218 \times 10$

$\boxed{N = -132.218}$

c) Noise power density in dBm.

$N_0 = 10 \log (N/B)$

$= 10 \log \left(\frac{0.06 \times 10^{-15}}{60} \right)$

$= 10 \log (0.001 \times 10^{-15})$

$= 10 \log (1 \times 10^{-3} \times 10^{-15})$

$= 10 \log (1 \times 10^{-18})$

$= 10 \times -18$

$\boxed{N_0 = -180 dB}$

d) Energy per bit in dBJ

$E_b = 10 \log \left(\frac{C}{f_b} \right)$

$$= 10 \log \left(\frac{10^{-13}}{30 \times 10^{3}} \right)$$

$$= 10 \log \left(3.33 \times 10^{-18} \right)$$

$$= 10 (-17.47)$$

$$\boxed{E_b = -174.7 \text{ dB}}$$

e. Carrier-to-noise power ratio

$$= 10 \log \left(\frac{C}{N} \right)$$

$$= 10 \log \left(\frac{10^{-13}}{0.06 \times 10^{-15}} \right)$$

$$= 10 \log \left(\frac{10^{-13} \times 10^{+15}}{0.06} \right)$$

$$= 10 \log \left(\frac{10^{2}}{0.06} \right)$$

$$= 10 \log \left(\frac{10^{2}}{6 \times 10^{-2}} \right)$$

$$= 10 \log \left(\frac{10^{2} \times 10^{2}}{6} \right)$$

$$= 10 \log \left(\frac{10^{4}}{6} \right)$$

$$= 10 \log (1666.66)$$

$= 10 \times 3.221$

$= 32.21 \text{ dB}$

f.) Eb/N_0 ratio.

$$= 10\log\left(\frac{C}{N}\right) + 10\log\left(\frac{B}{f_b}\right)$$

$$= 32.21 + 10\log\left(\frac{60\times10^3}{30\times10^3}\right)$$

$$= 32.21 + 10\log(2)$$

$$= 32.21 + 10 \times 0.30$$

$$= 32.21 + 3$$

$$= 35.21 \text{ dB}$$