

1. $R_b = 4 \text{ Mbps} = 4 \times 10^6 \text{ bps}$

$$N_o = 10^{-11} \text{ W/Hz}$$

$$A = 20 \text{ mV} = 2 \times 10^{-2} \text{ V}$$

a. $T_b = \frac{1}{R_b} = \frac{1}{4 \times 10^6} = 2,5 \times 10^{-7} \text{ s}$

$$\text{BPSK} \rightarrow M = 2$$

$$T_s = T_b \cdot {}^2\log M = 2,5 \times 10^{-7} \cdot {}^2\log 2 = 2,5 \times 10^{-7} \text{ s}$$

$$\text{Periode sinyal} = \underline{\underline{2,5 \times 10^{-7} \text{ s}}}$$

$$R_s = \frac{1}{T_s} = \frac{1}{2,5 \times 10^{-7}} = 4 \text{ Mbps}$$

$$\text{Simbol rate} = \underline{\underline{4 \text{ Mbps}}}$$

$$r = 0,8$$

$$\text{BW} = (1+r) R_s = (1+0,8) \cdot 4 \text{ Mbps} = \underline{\underline{7,2 \text{ Mbps}}}$$

b. $A = \sqrt{\frac{2 E_s}{T_s}} \rightarrow A^2 = \frac{2 E_s}{T_s}$

$$E_s = \frac{A^2 T_s}{2}$$

$$= \frac{(2 \times 10^{-2})^2 \cdot 2,5 \times 10^{-7}}{2}$$

$$= 5 \times 10^{-11} \text{ J}$$

$$\begin{aligned}
 P_e &= Q \left(\sqrt{\frac{2E_s}{N_0}} \right) = Q \left(\sqrt{\frac{2.5 \times 10^{-11}}{10^{-11}}} \right) = Q(\sqrt{10}) \\
 &= Q(3,16) \\
 &= 0,0008 \\
 &= 0,08 \%
 \end{aligned}$$

c. $BW = (1+r) \frac{R_s}{2} = (1+0,8) \frac{4 \text{ Mbps}}{2} = 3,6 \text{ Mbps}$

$$\begin{aligned}
 P_e &= Q \left(\sqrt{\frac{A^2}{N_0 \cdot BW}} \right) = Q \left(\sqrt{\frac{(2 \times 10^{-2})^2}{10^{-11} \cdot 3,6 \times 10^6}} \right) \\
 &= Q(3,33) \\
 &= 0,0004 \\
 &= 0,04 \%
 \end{aligned}$$

2. $N = 8 \text{ bit}$

$$f_s = 30 \text{ kHz}$$

a. $f_s = f_N = 2 \cdot f_{\max}$

$$30 \text{ kHz} = 2 \cdot f_{\max}$$

$$f_{\max} = \underline{\underline{15 \text{ kHz}}}$$

b. Jumlah sampel = 30.000 sampel/s

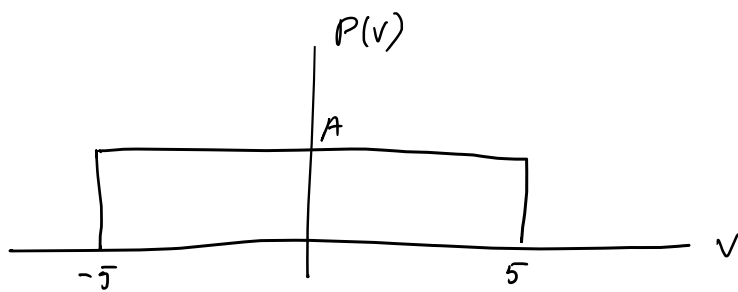
$$\text{Jumlah bit per sampel} = \underline{\underline{8 \text{ bit/sampel}}}$$

$$M = 2^N = 2^8 = 256 \text{ level}$$

c. $BR = 30.000 \text{ sampel/s} \times 8 \text{ bit/sampel}$
 $= \underline{\underline{240 \text{ kbps}}}$

d. $SQNR = 2^N \sqrt{\frac{3}{2}} = 2^8 \sqrt{\frac{3}{2}} = 313,53$
 $= 20 \log(313,53)$
 $= \underline{\underline{49,93 \text{ dB}}}$

3.



a. $L_H = 1$

$$A(5 - (-5)) = 1$$

$$10A = 1$$

$$A = \frac{1}{10}$$

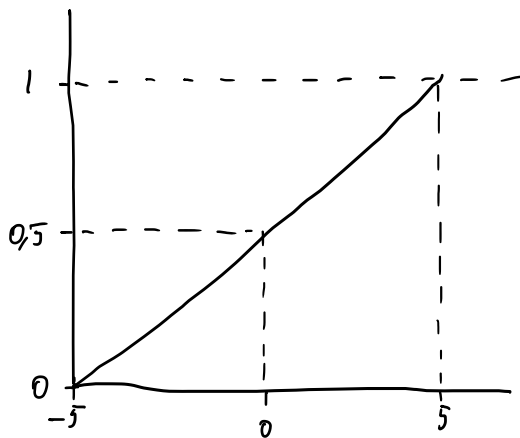
c. $L_H = 1 \cdot \frac{1}{10}$

$$P_e = 0,1$$

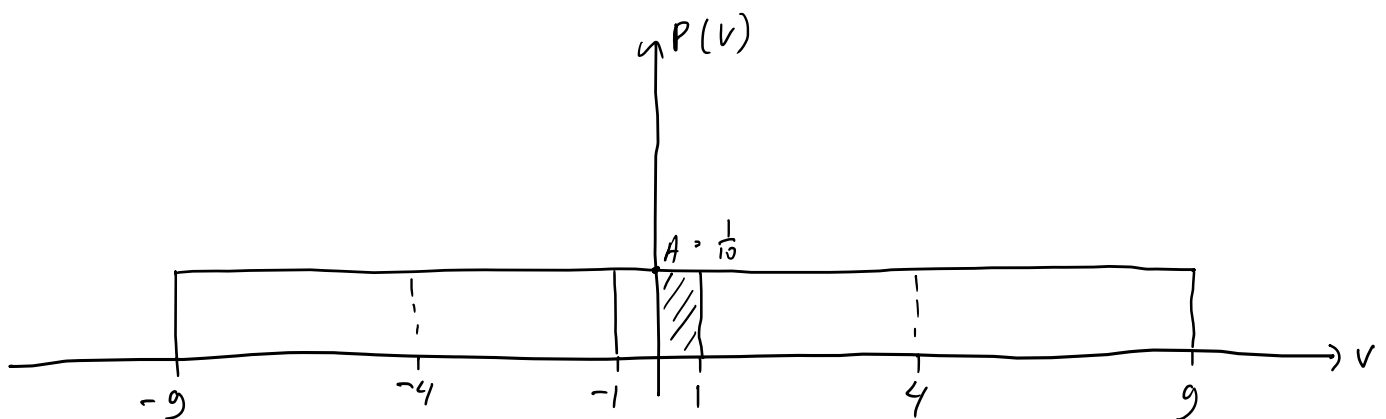
$$P_e = 10\%$$

$$Y = \int A dx = \int \frac{1}{10} dx = \frac{1}{10} x$$

Gambar CDF :



b.



Nilai Threshold = 0 V