1. **Probability of error for M-ary PAM**

   Consider the case of M-ary PAM signals in which the possible signal points are

   $$s_m = \sqrt{\mathcal{E}_g} A_m, \quad m = 1, 2, \ldots M,$$

   where $\mathcal{E}_g$ is the energy of basic signal pulse $g_T(t)$ and the amplitude values are expressed as

   $$A_m = (2m - 1 - M), \quad m = 1, 2, \ldots, M.$$

   Derive the probability of error for M-ary PAM transmitted over an AWGN with power spectral density $\frac{N_0}{2}$.

2. **Performance of the binary PAM receiver**

   Consider the case of binary PAM signals in which the two possible signal points are $s_1 = -s_2 = \sqrt{\mathcal{E}_b}$, where $\mathcal{E}_b$ is the energy per bit. The prior probabilities are $P(s_1) = p$ and $P(s_2) = 1 - p$.

   (a) Determine the metrics for the optimum MAP detector when the transmitted signal is corrupted with the AWGN with power spectral density $\frac{N_0}{2}$.

   (b) Derive the probability of error and plot it as a function of signal to noise ratio.

3. Read the section 9.5 **(Linear Block Codes)** from the book.

4. **Linear block codes**

   A $(5, 2)$ code is defined by

   $$\mathcal{C} = \{00000, 10100, 01111, 11011\}.$$

   If the mapping between the information sequences and codewords is given by

   $$\begin{aligned} 00 &\longrightarrow 00000 \\ 01 &\longrightarrow 01111 \\ 10 &\longrightarrow 10100 \\ 11 &\longrightarrow 11011 \end{aligned}$$

   (a) Verify that the code is linear.

   (b) Find the generator matrix G for the code.

   (c) Find the minimum distance of the code.

   (d) Find the parity check matrix H for the code.

   (e) Verify that for every codeword $c \in \mathcal{C}$ we have $cH' = \mathbf{0}$.

5. **Hamming Codes**

   The parity check matrix of a hamming code with length 7 is given by

   $$H = \begin{pmatrix} 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 1 & 0 \end{pmatrix}$$

   (a) Determine the rate of the code.

   (b) How many errors is this hamming code capable of correcting?