Question 1: BPSK

Construct the BPSK Simulink model shown in Figure 1.

- Configure the Bernoulli Binary Generator:
  - Sample time: 1×10^{-6} (i.e., 1 Mbps data rate)

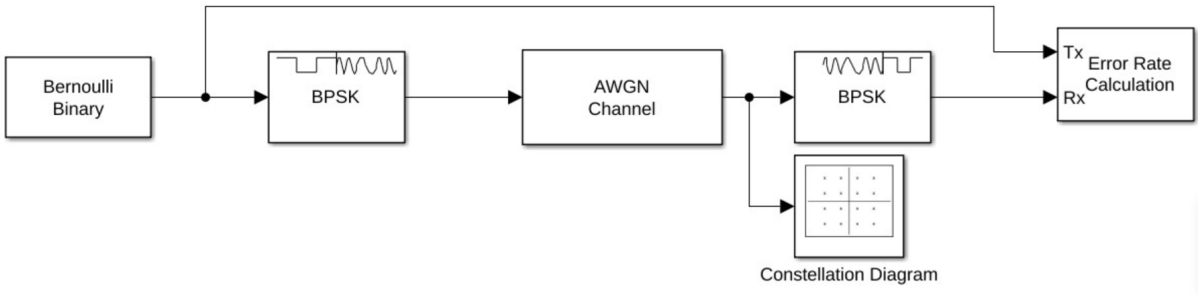

Figure 1: BPSK Simulink Model – Add description here

  - Samples per frame: 3000

- Observe the output using the Constellation Diagram block.
- Set the AWGN Channel block to `Eb/N0` mode with a value of 10 dB.
- Capture the received signal constellation (see Figure 3).
- Use the BPSK Demodulator followed by the Error Rate Calculator to compute the BER.
- The BER value is stored in the first element of the output vector `ErrorVec`.
- Compare the simulated BER with the theoretical BER of BPSK.

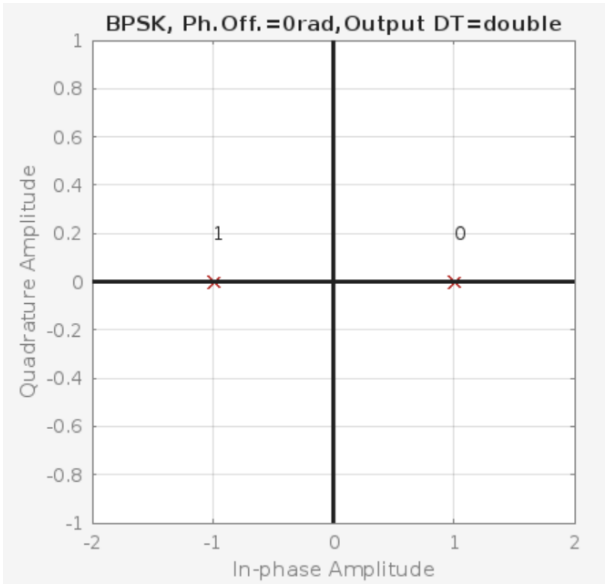

Figure 2: (Add description here)

Now, vary `Eb/N0` from 3 dB to 12 dB. Plot both the theoretical and simulated BER on the same graph, as shown in Figure 4.

Question 2: MPAM

Build the MPAM Simulink model shown in Figure 5, starting with $M = 8$ as an example.

Start with $M = 2$ (i.e., BPAM). Use the `Bit to Integer` block to map bits to M-ary symbols, with Number of Bits per Integer set to $\log_2(M)$.

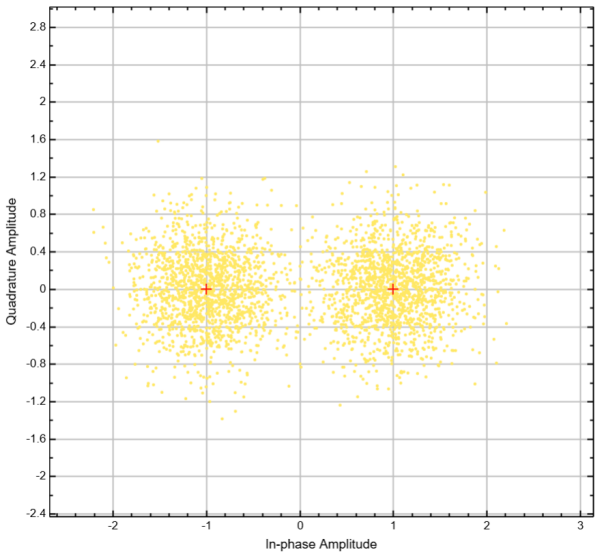

Figure 3: Received BPSK Constellation Diagram

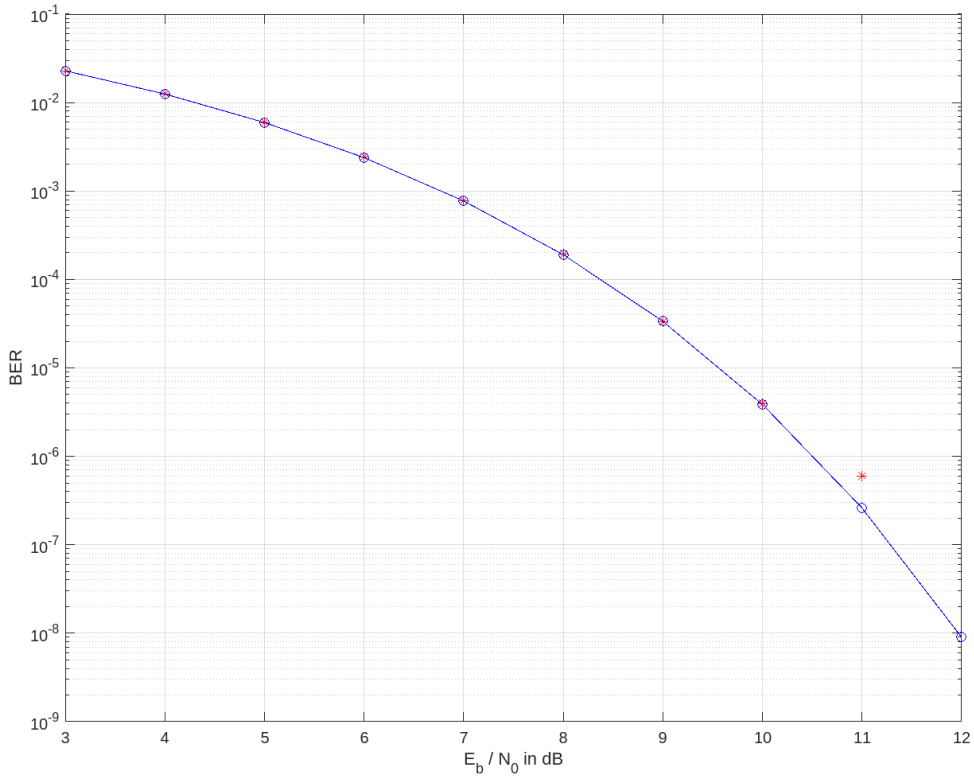

Figure 4: BER vs. Eb/N0 for BPSK

- View the BPAM constellation diagram using the appropriate scope.
- In the AWGN Channel block, set the Number of Bits per Symbol to $\log_2(M)$.
- For BPAM at 10 dB `Eb/N0`, obtain both theoretical and simulated BER. Confirm that results align closely with those of BPSK.
- Repeat the same steps for $M = 2, 4, 8$:
  - View and compare constellation diagrams.

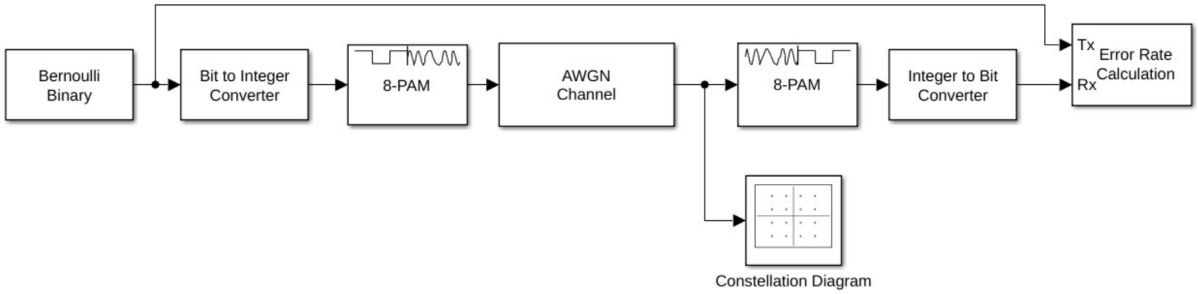

Figure 5: MPAM Simulink Model – Add description here

– Compute and compare theoretical vs. simulated BER.

Conceptual Prompt: Recall that as the modulation order M increases in M-PAM, the distance between adjacent symbols decreases while the signal power is fixed. This makes the system more sensitive to noise, thereby increasing the bit error rate. Observe how this is reflected in your BER plots.

Now vary `Eb/N0` from 3 dB to 15 dB in 2 dB increments. Plot both the theoretical and simulated BER curves for all $M = 2, 4, 8$ values on the same graph (see Figure 6).

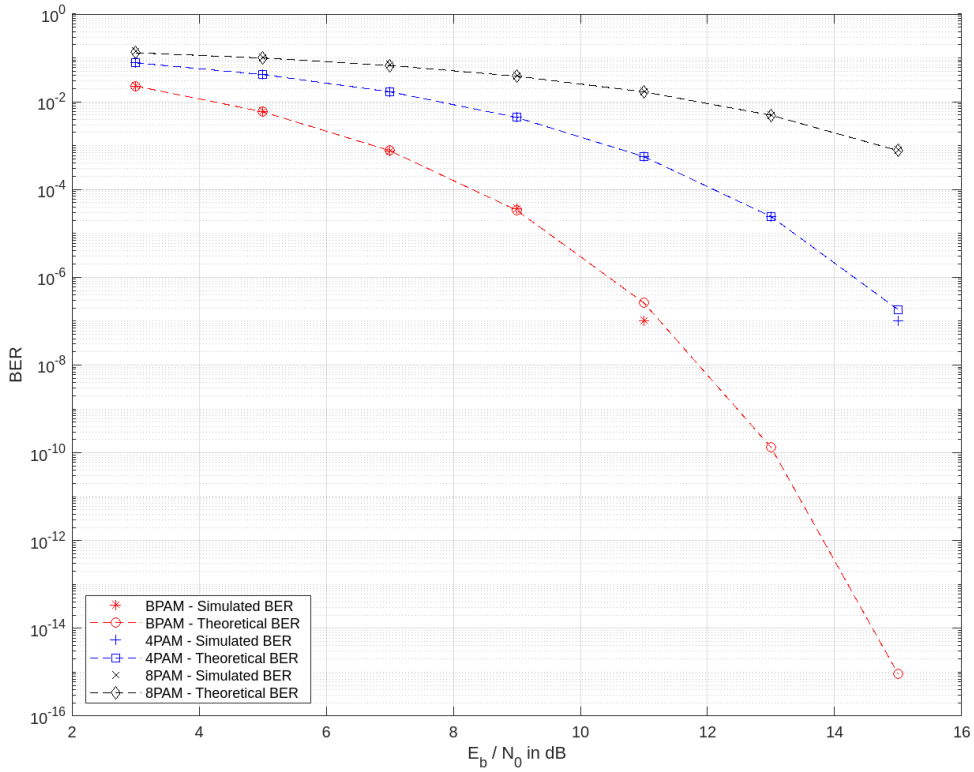

Figure 6: BER vs. Eb/N0 for MPAM

Reflection Questions (Answer briefly in your report):

a) Why does BER increase as M increases in M-PAM systems, even when `Eb/N0` is kept constant?

b) What is the trade-off between data rate and BER when choosing a higher-order M-PAM scheme?