Project Report

Brac University

Department of Electrical and Electronics Engineering

Introduction to Communication Engineering Laboratory

EEE342

Group No: 12

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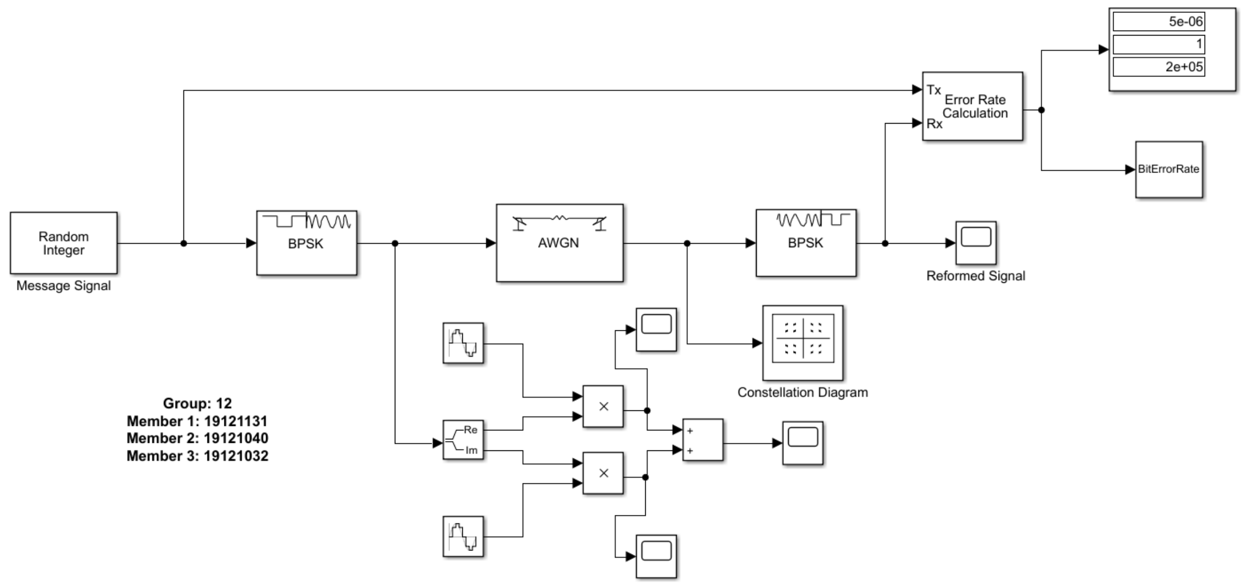
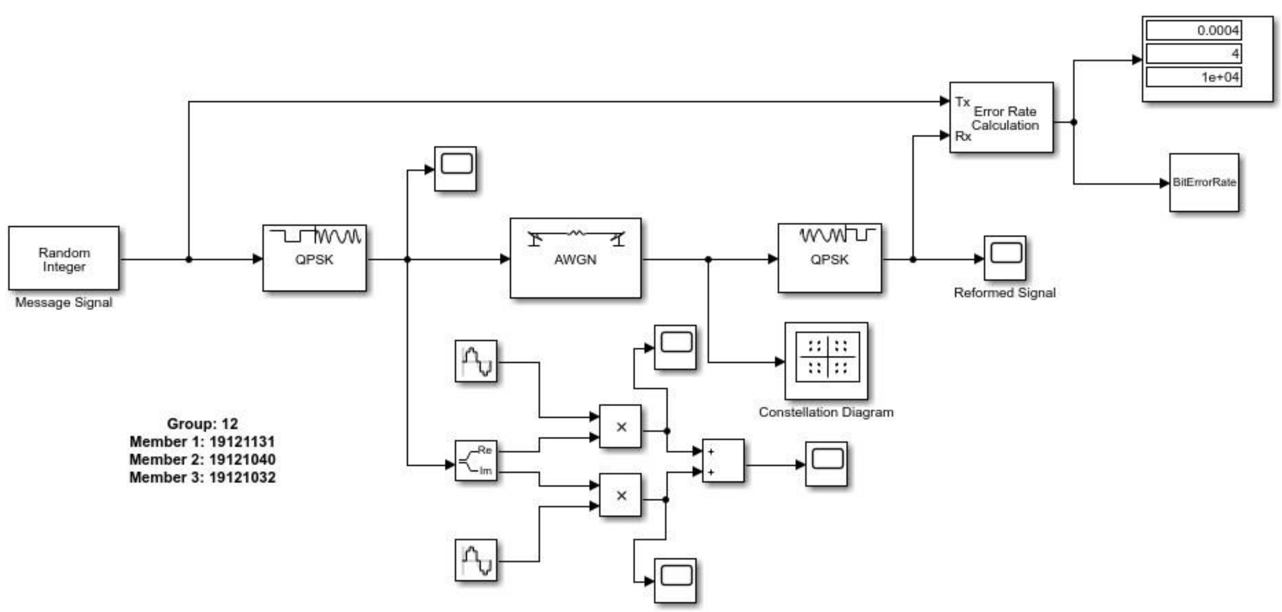
Date of submission: 31/09/2021

Design and simulation of a communication links using PSK

Simulink model: BPSK

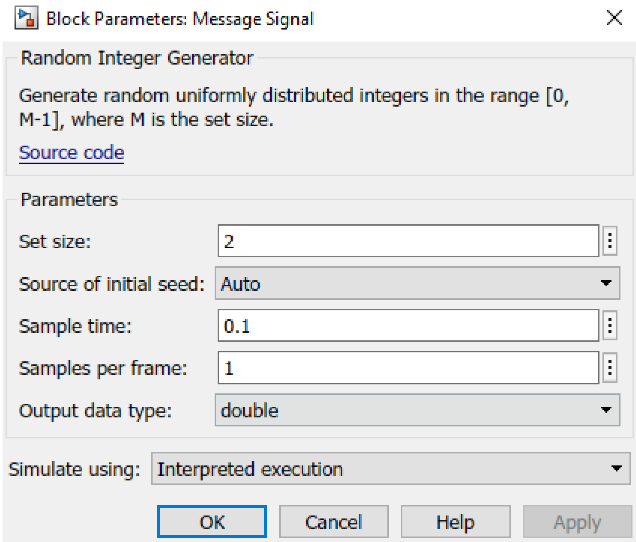


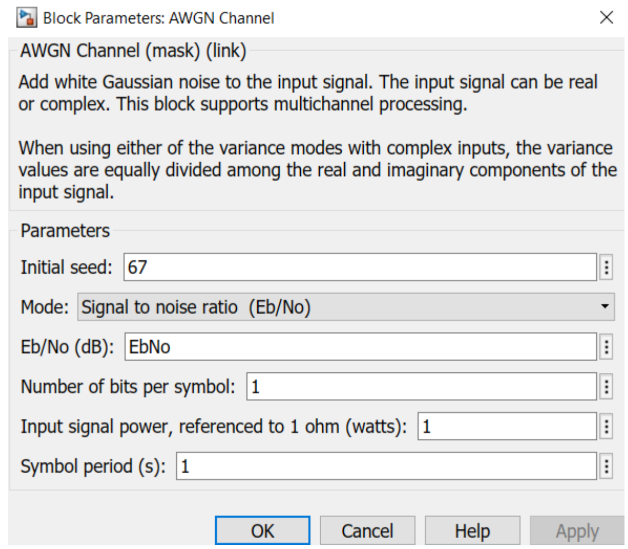
Simulation model: QPSK

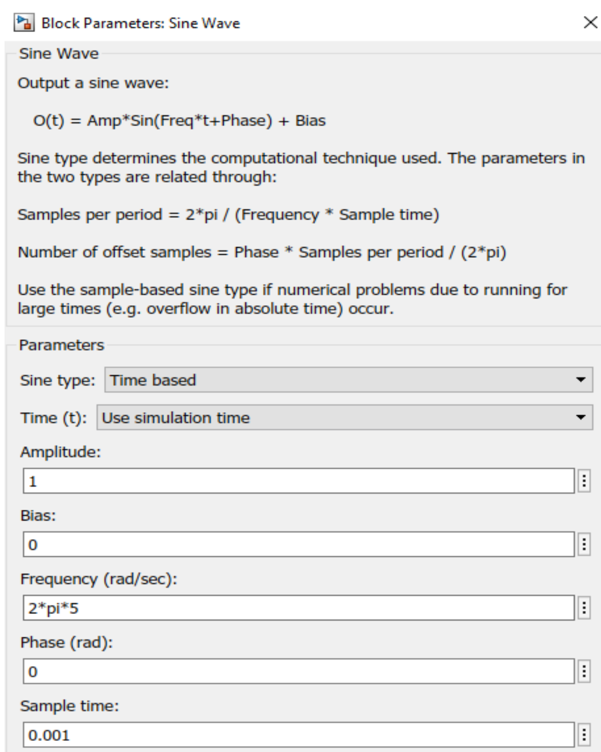


Block Parameters:

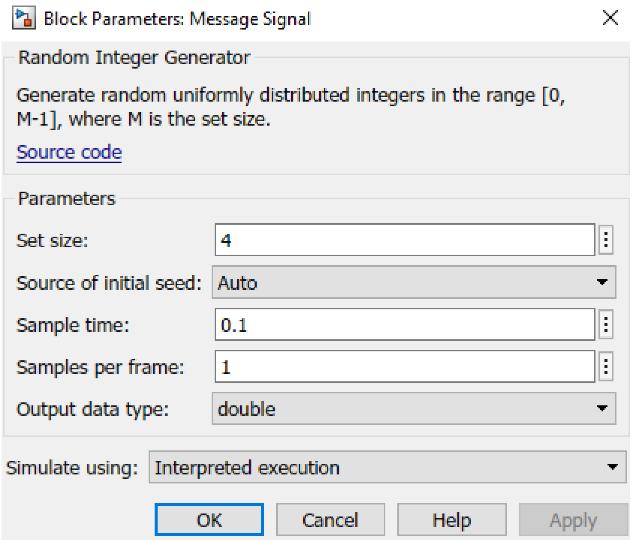
For BPSK:

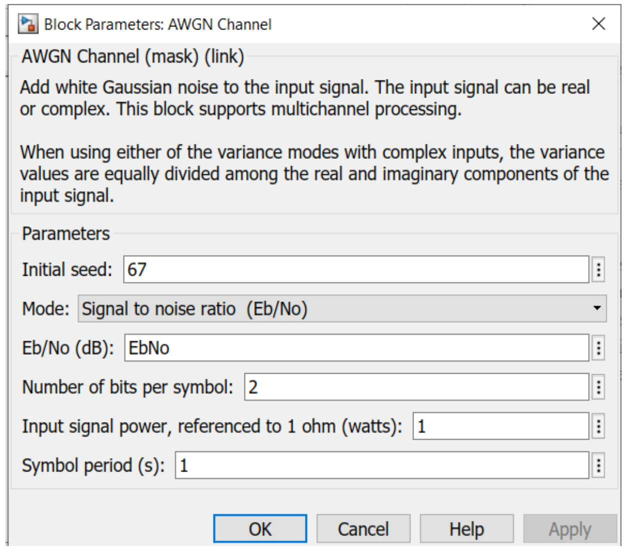


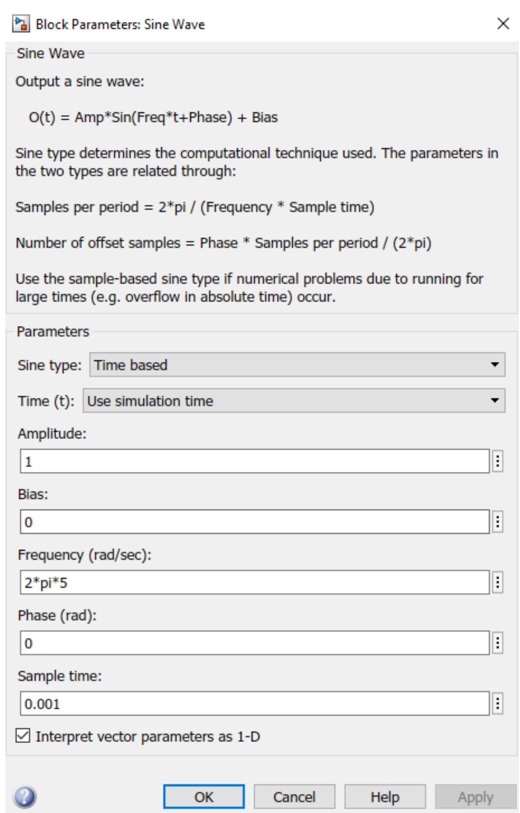




For QPSK:

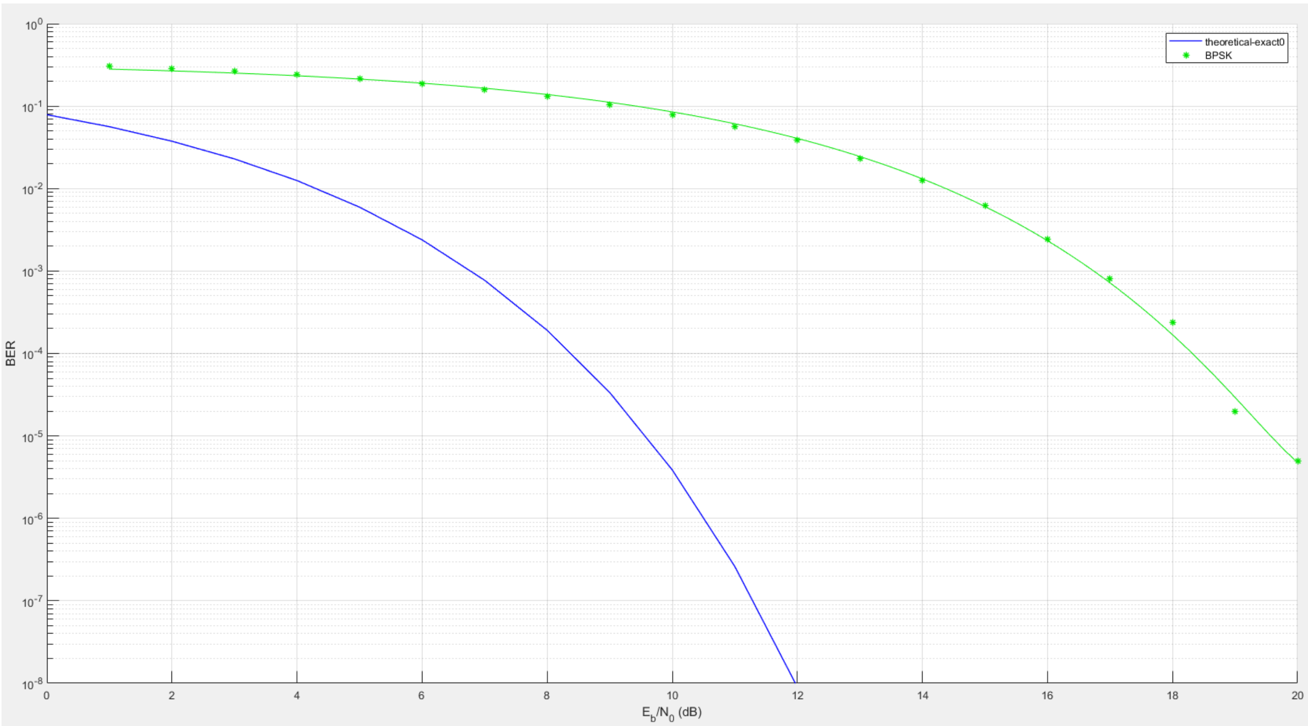

Block Parameters: Message Signal
Random Integer Generator
Generate random uniformly distributed integers in the range [0, M-1], where M is the set size.
Source code
Parameters
Set size: 4
Source of initial seed: Auto
Sample time: 0.1
Samples per frame: 1
Output data type: double
Simulate using: Interpreted execution
OK
Cancel
Help
Apply


Block Parameters: AWGN Channel
AWGN Channel (mask) (link)
Add white Gaussian noise to the input signal. The input signal can be real or complex. This block supports multichannel processing.
When using either of the variance modes with complex inputs, the variance values are equally divided among the real and imaginary components of the input signal.
Parameters
Initial seed: 67
Mode: Signal to noise ratio (Eb/No)
Eb/No (dB): EbNo
Number of bits per symbol: 2
Input signal power, referenced to 1 ohm (watts): 1
Symbol period (s): 1
OK
Cancel
Help
Apply

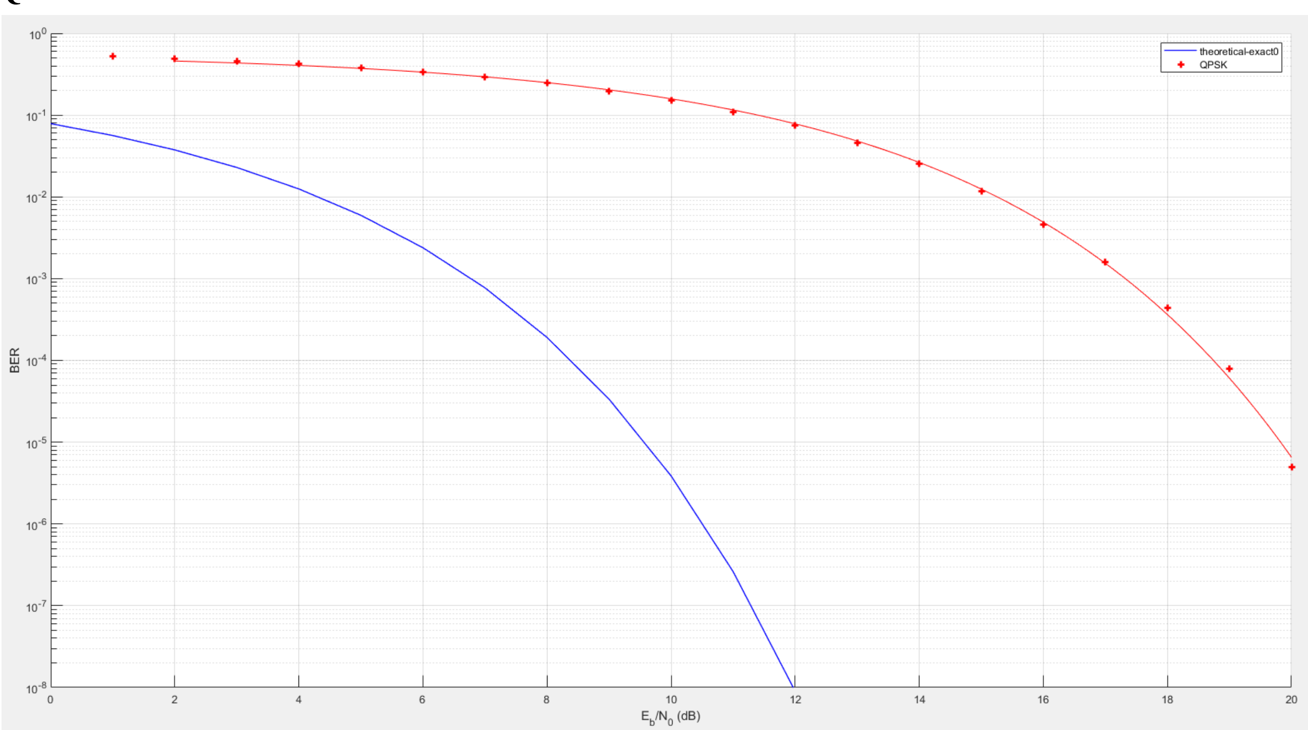

Block Parameters: Sine Wave
Sine Wave
Output a sine wave:
O(t) = Amp*Sin(Freq*t+Phase) + Bias
Sine type determines the computational technique used. The parameters in the two types are related through:
Samples per period = 2*pi / (Frequency * Sample time)
Number of offset samples = Phase * Samples per period / (2*pi)
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*5
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

Answer to the question no: 1

BPSK Performance curve:

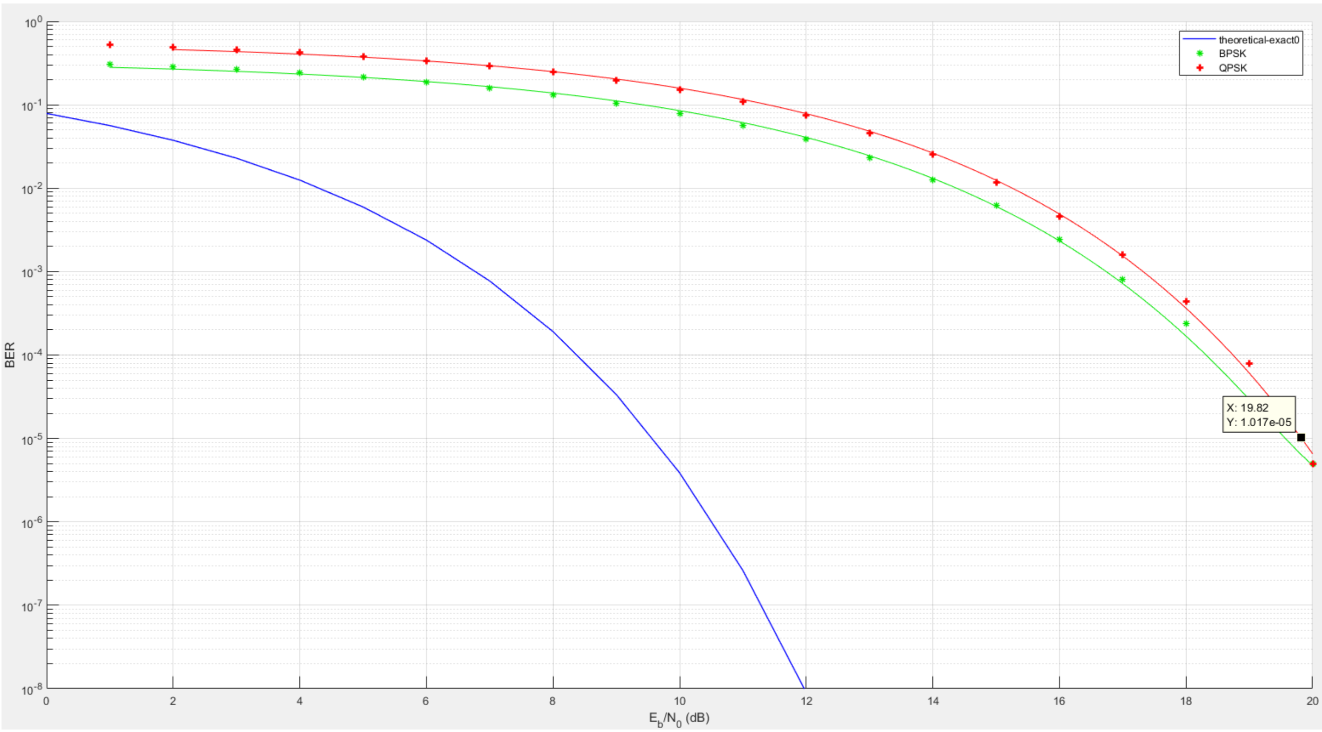


QPSK Performance curve:



Answer to the question no: 2

For BPSK, SNR ≈ 19.57
For QPSK, SNR ≈ 19.82



Answer to the question no: 3

In the same bandwidth, BPSK transmits 1 bit while QPSK transmits 2 bits. This means QPSK has a higher bandwidth efficiency compared to BPSK. However, from the BER vs SNR graph, it can be seen that for the same SNR, the Bit Error Rate (BER) is higher for QPSK compared to BPSK. It is easier to distinguish the signal from the noise of a 1 bit compared to 2 bits. QPSK is more susceptible to error than BPSK. Therefore for longer distances, QPSK requires a higher signal power to reach the same error levels as BPSK.

<u>Answer to the question no: 4</u>

BPSK simulated waveform for SNR 10:

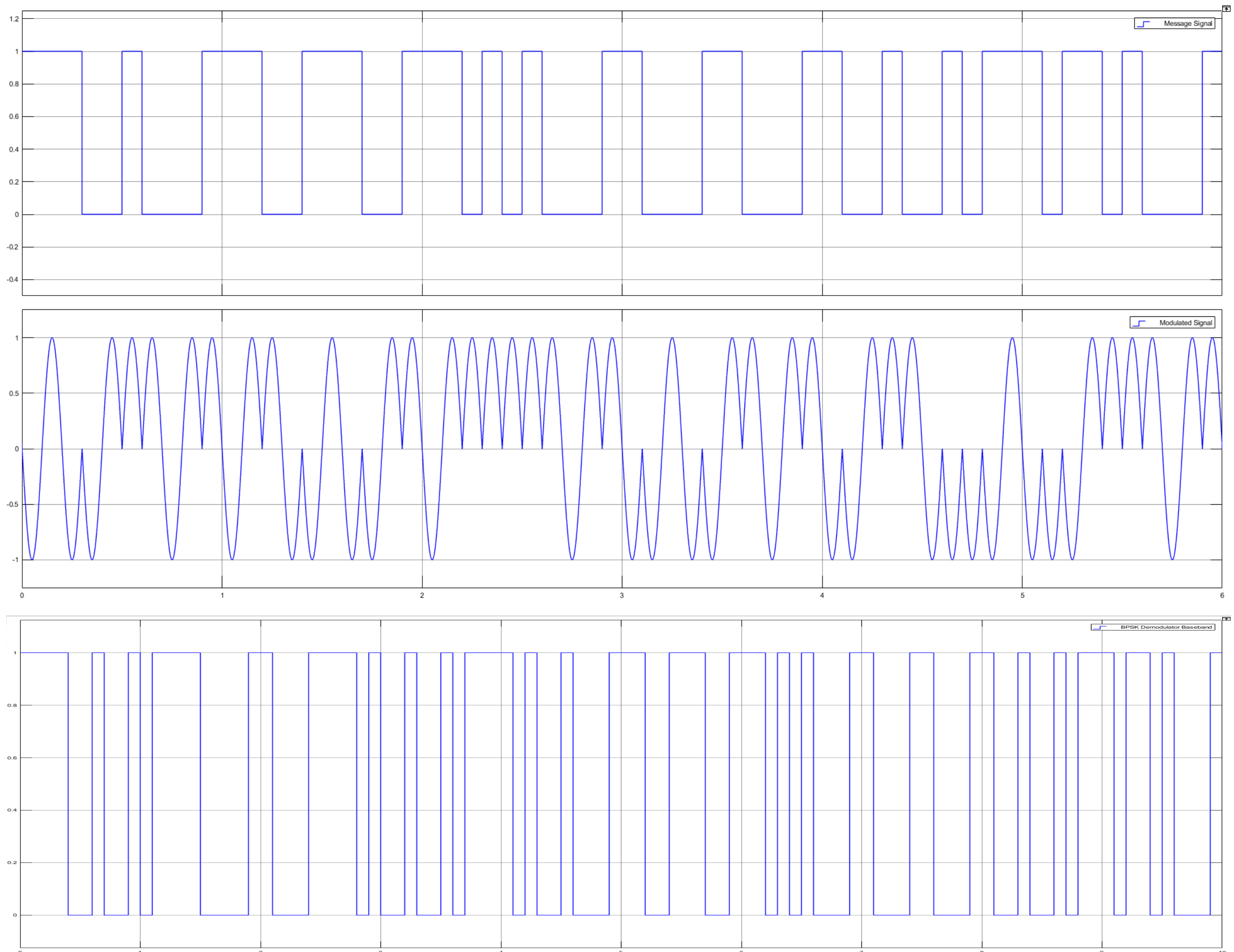


Figure: Message signal, modulated signal & demodulated signal in time domain

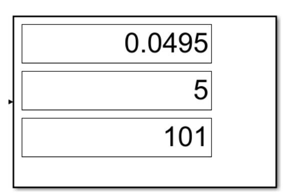


Figure: Display Parameters of Error Rate, Number of Errors Detected and Total Number of Symbols Compared

BPSK simulated waveform for SNR 30:

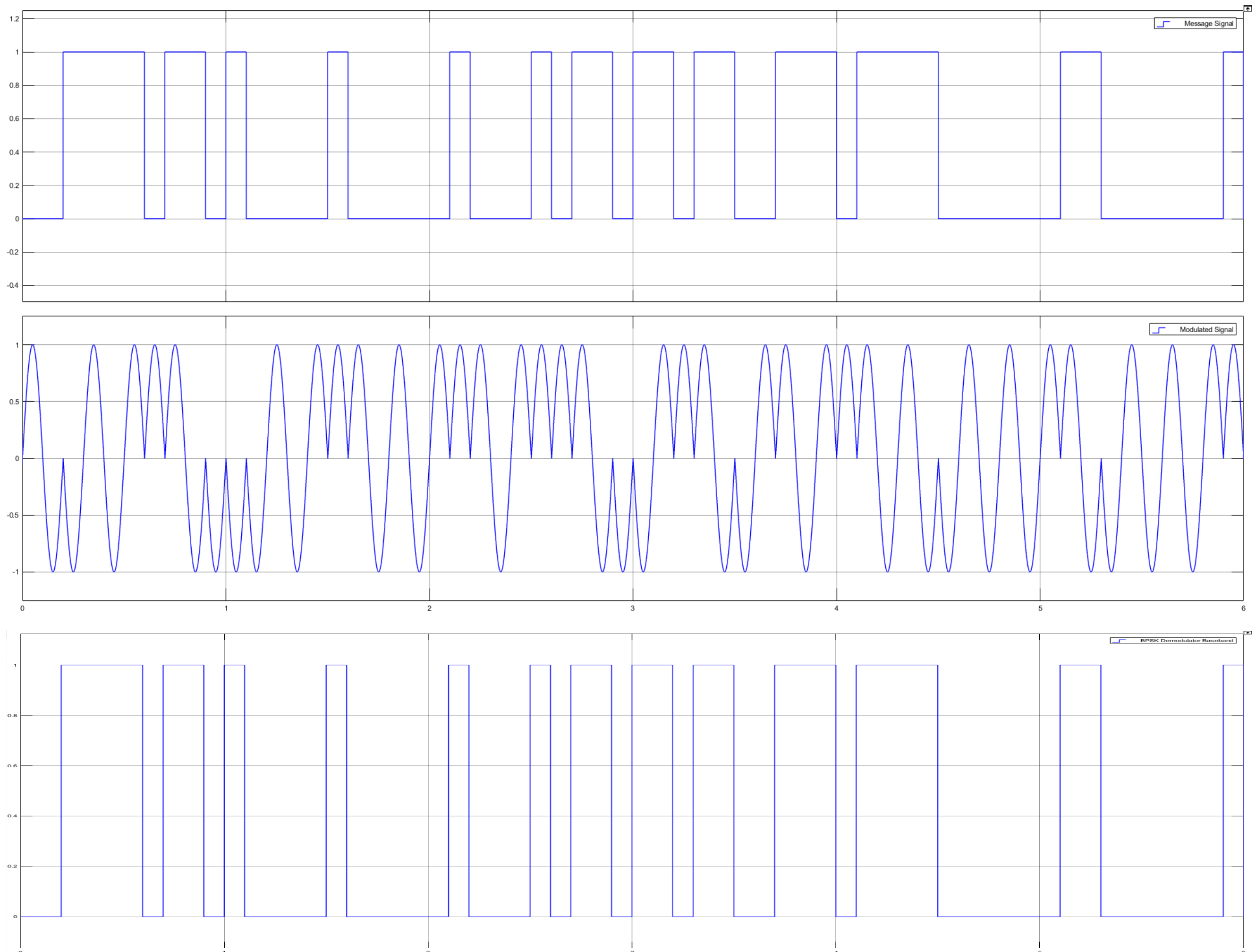


Figure: Message signal, modulated signal & demodulated signal in time domain

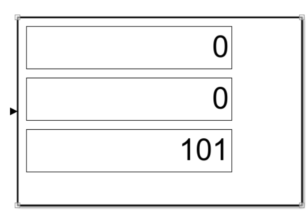


Figure: Display Parameters of Error Rate, Number of Errors Detected and Total Number of Symbols Compared

QPSK simulated waveform for SNR 10:

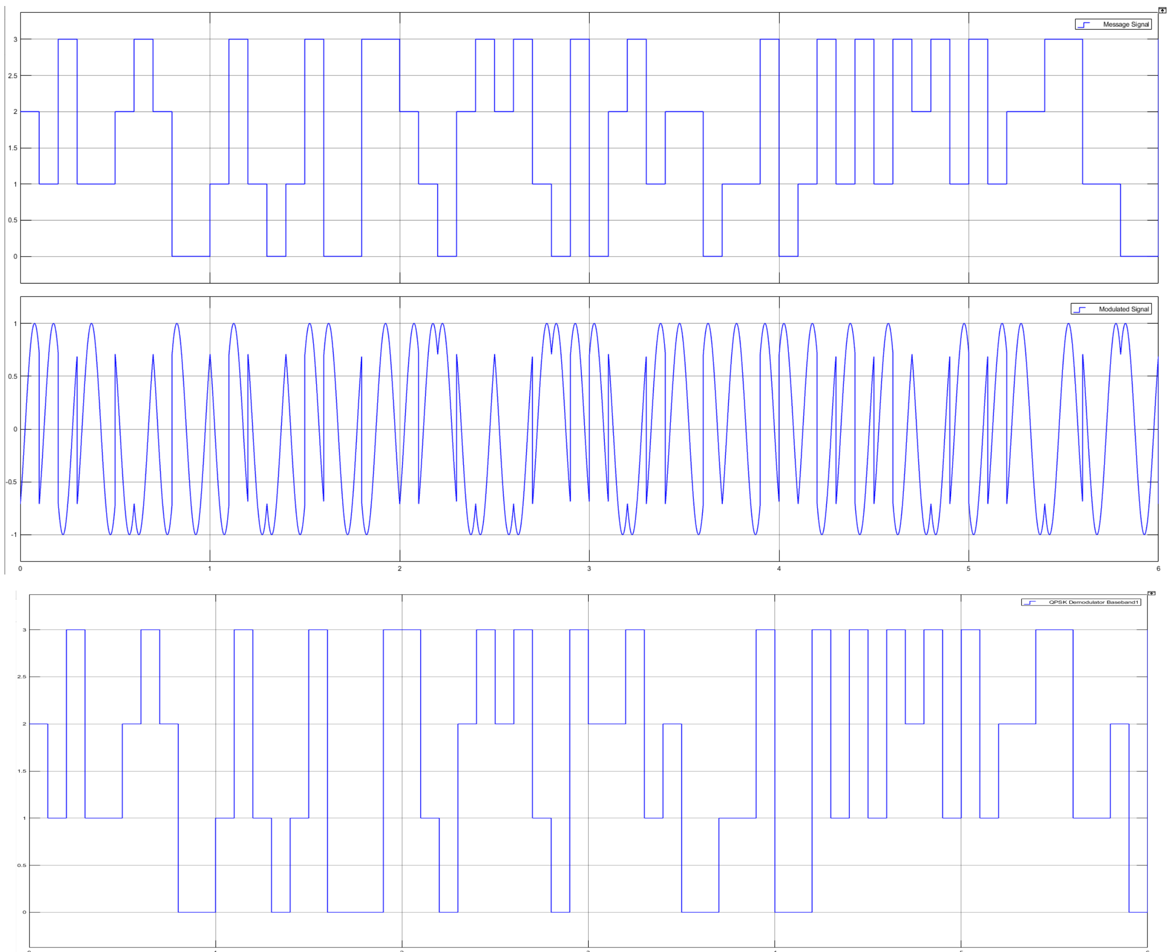


Figure: Message signal, modulated signal & demodulated signal in time domain

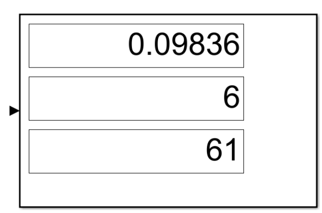


Figure: Display Parameters of Error Rate, Number of Errors Detected and Total Number of Symbols Compared

QPSK simulated waveform for SNR 30:

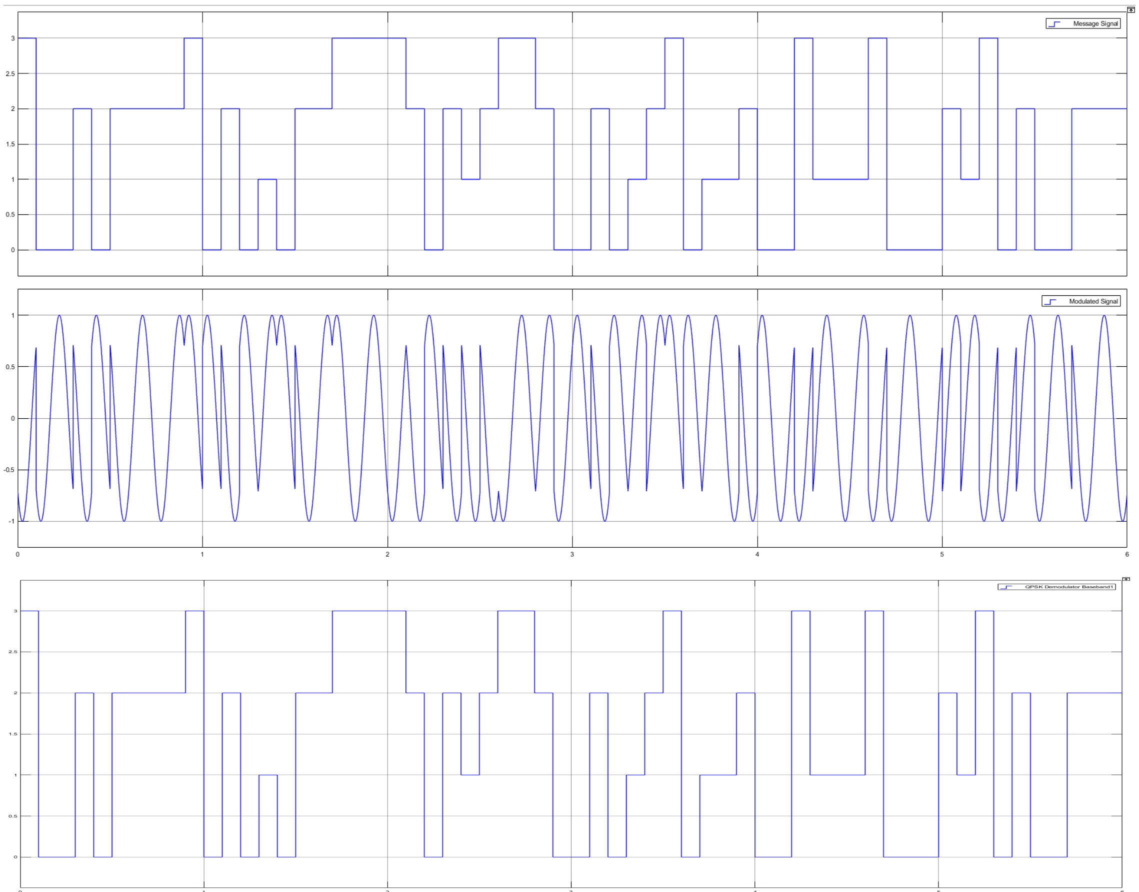


Figure: Message signal, modulated signal & demodulated signal in time domain

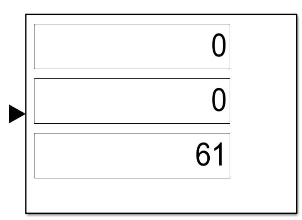
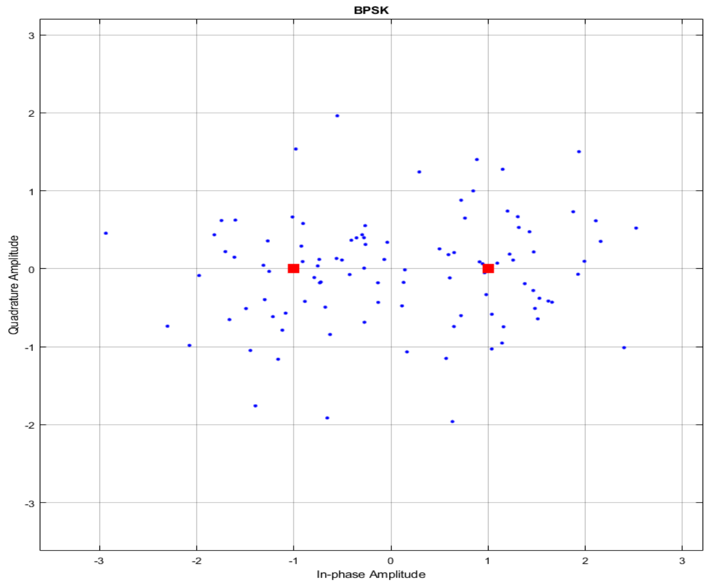


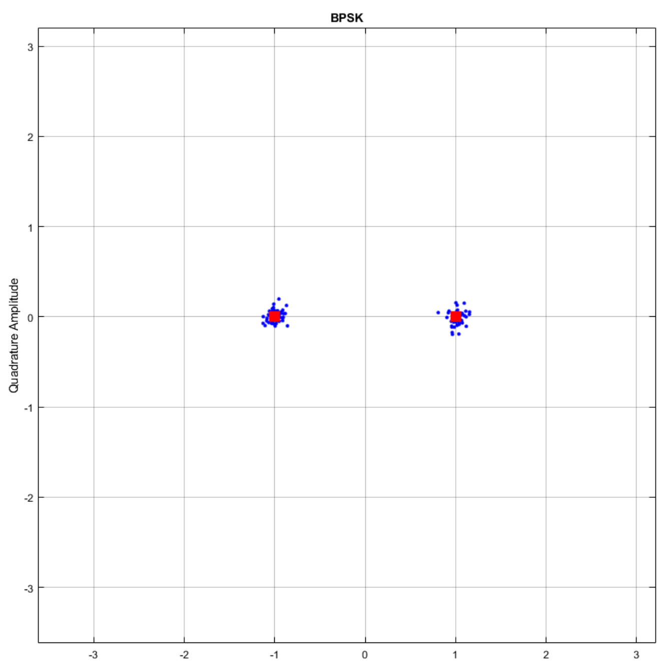
Figure: Display Parameters of Error Rate, Number of Errors Detected and Total Number of Symbols Compared

Answer to the question no: 5

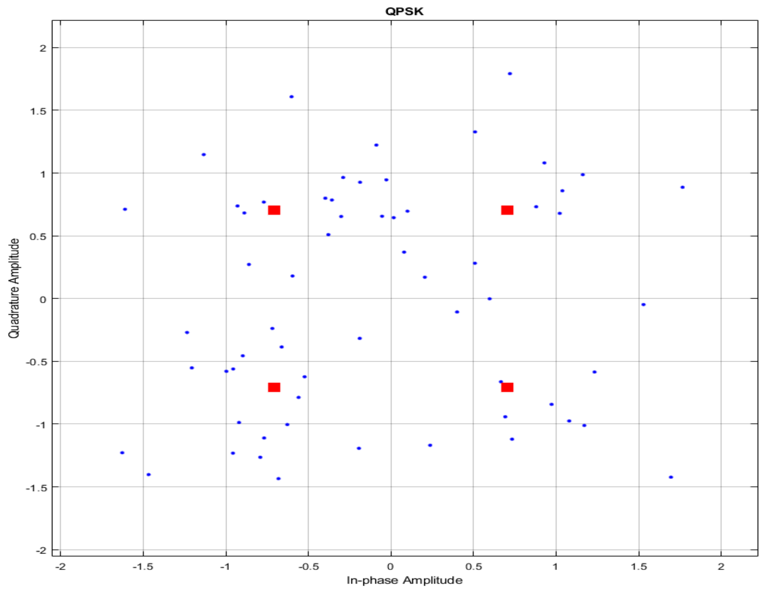
BPSK constellation diagram: SNR=10



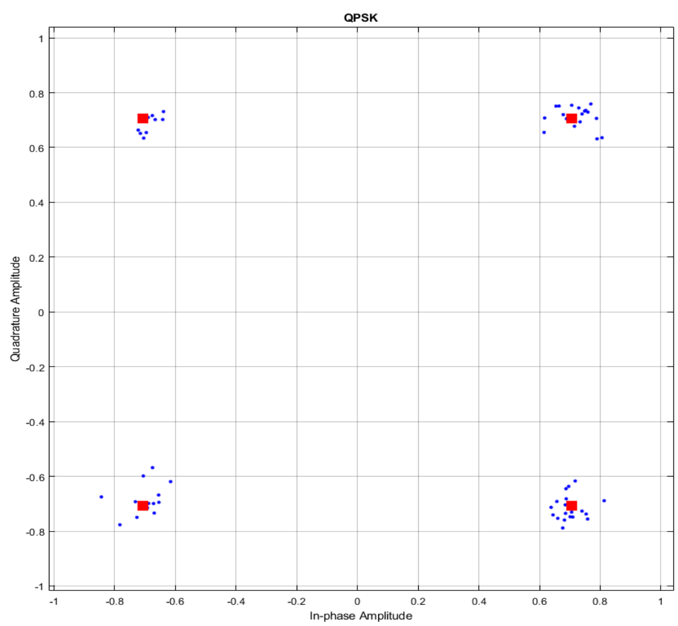
BPSK constellation diagram: SNR=30



QPSK constellation diagram: SNR=10



QPSK constellation diagram: SNR=30



Discussion:

In the PSK link, two different types of PSK are used. One is Binary Phase Shift Keying (BPSK) and the other is Quadrature Phase Shift Keying (QPSK). BPSK uses two phases separated by 180°, while QPSK uses four phases separated by 90°. QPSK can transmit twice as much data in the same bandwidth compared to BPSK. However, QPSK is more susceptible to noise as it is harder to distinguish the signal from the noise for 2 bits in QPSK compared to 1 bit of BPSK. The Bit Error Rate (BER) is a measure of the errors in bits per unit time. Higher the BER, higher the probability of error. When the noise is high, the signal to noise ratio (SNR), Eb/No is lower and the error rate is higher. This is because it is harder to distinguish the signal when the noise level increases. Therefore, for short range transmission links, QPSK is preferred as it has a higher bandwidth efficiency. For long range transmission links, noise would be higher and thus BPSK is preferred as it is less affected by noise.

To generate the BER vs SNR graph, the Error Rate Calculation block was used. It outputs the number of errors in the output. Then the output was taken into MATLAB using the To Workspace block, where the variable name was given BitErrorRate. Then using the BER tool, the theoretical graph and the actual experimental graph was plotted.

Reference:

Amplitude Modulation, AM Index & Modulation Depth - https://www.electronics-notes.com/articles/radio/modulation/amplitude-modulation-am-index-depth.php

Youtube video - 3 Modulation - https://www.youtube.com/watch?v=mfSWO3TpGq4

Understanding Modern Digital Modulation Techniques - https://www.electronicdesign.com/technologies/communications/article/21798737/understanding-modern-digital-modulation-techniques