Simulation Assignment 2

Principles of Digital Communications

Akhil Kumar Donka | EE22MTECH02003

Aim : To study Bit Error Rate vs SNR Analysis for MPAM, MPSK, MQAM with M = [2, 4, 16, 64, 256] with SNRs varied from 0dB to 16dB.

Results & Observations :

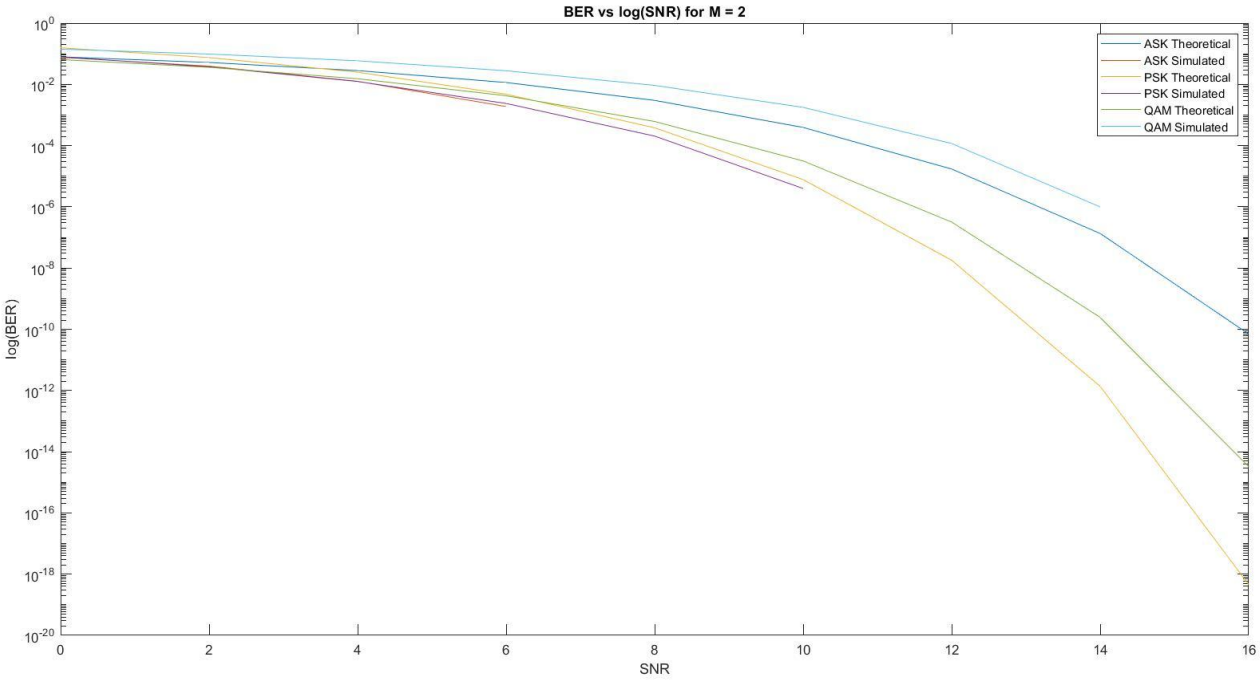
Theoretical Probability of Bit Error Expressions:

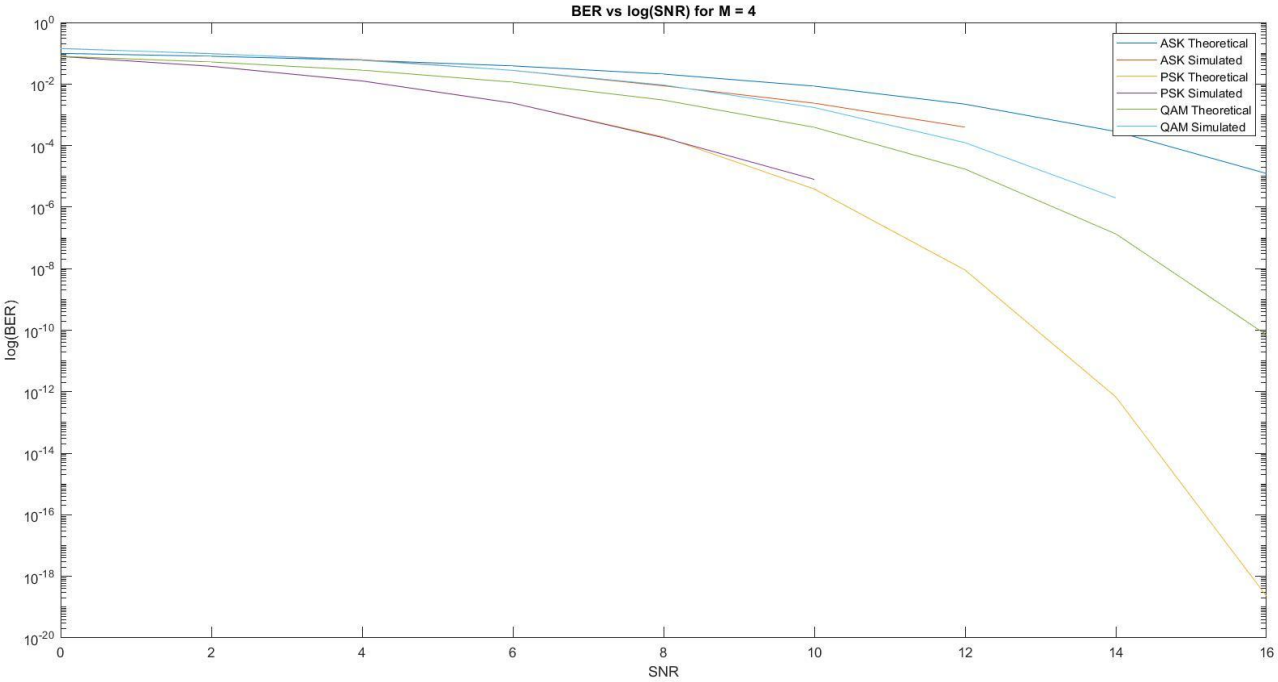
$$P_{be,MASK} = \frac{(M-1)}{M \log_2 M} erfc\left(\sqrt{\frac{(3\log_2 M)E_b}{(M^2-1)N_0}}\right)$$

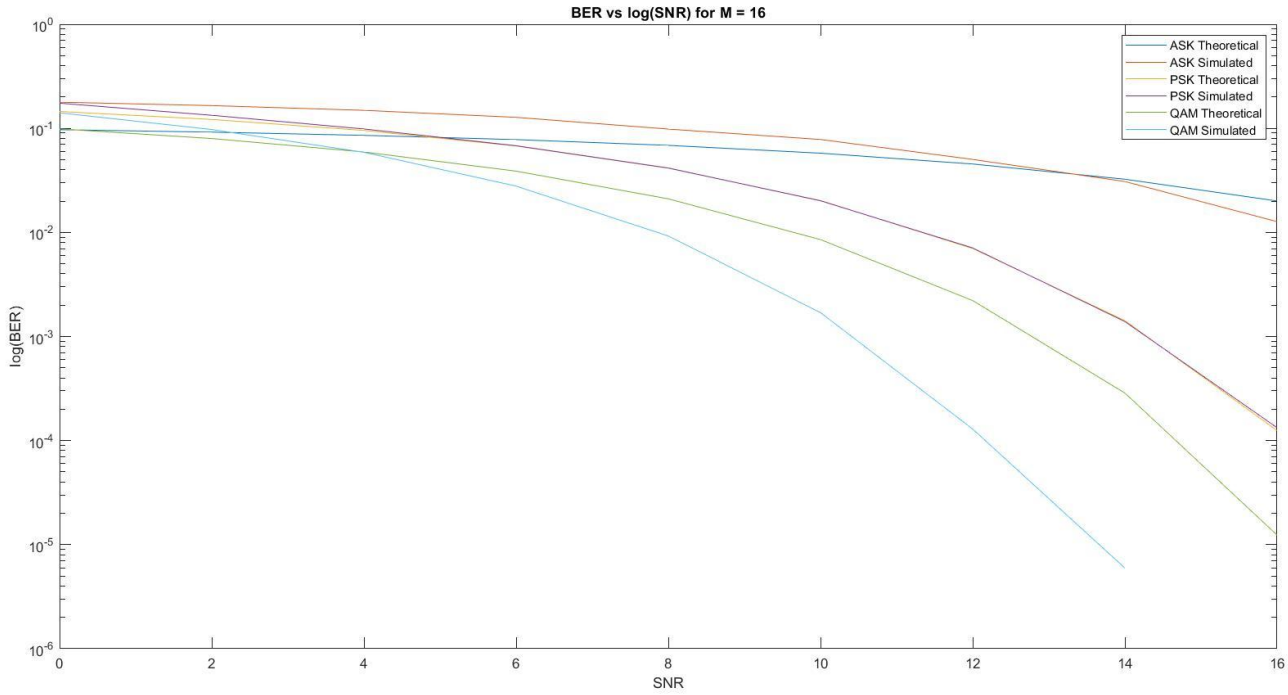
$$P_{se,MPSK} \cong erfc\left(\sqrt{(\log_2 M)\frac{E_b}{N_0}} \sin\left(\frac{\pi}{M}\right)\right)$$

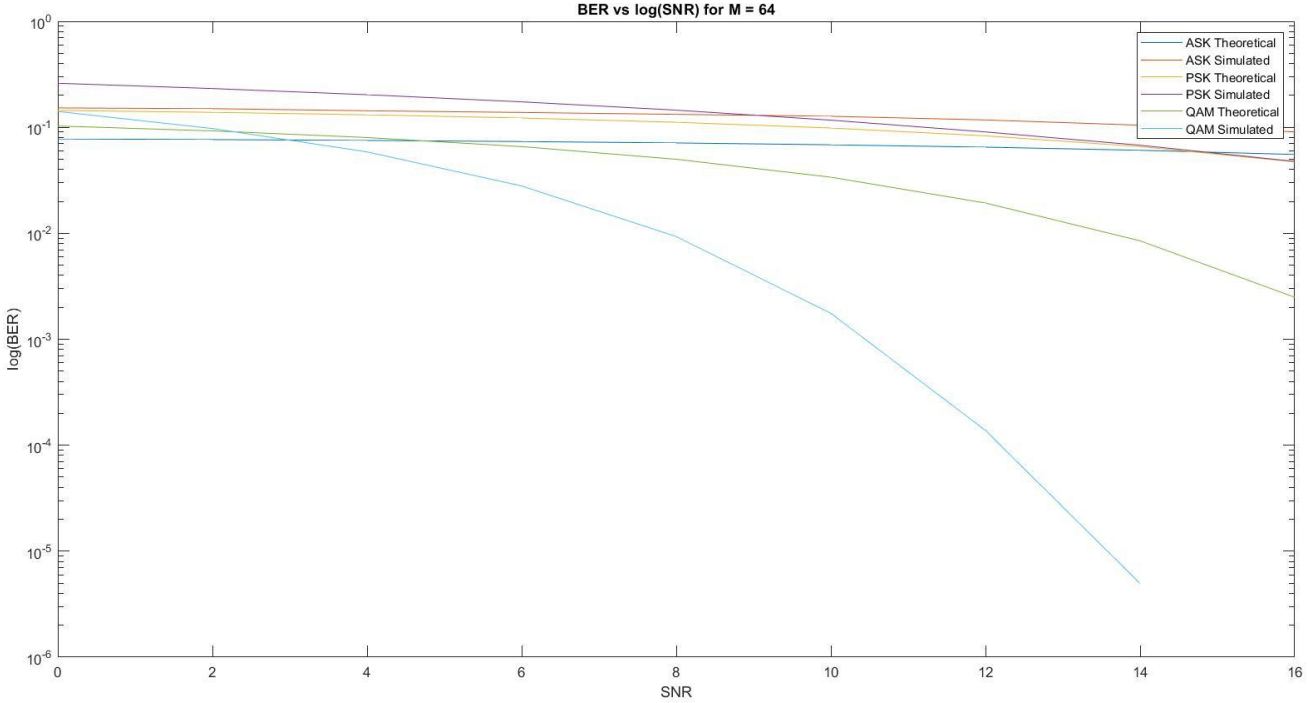
$$P_{be,MQAM} \cong 2\left(\frac{\sqrt{M}-1}{\sqrt{M}\log_2 M}\right) erfc\left(\sqrt{\frac{3\log_2 M}{2(M-1)}\frac{E_b}{N_0}}\right)$$

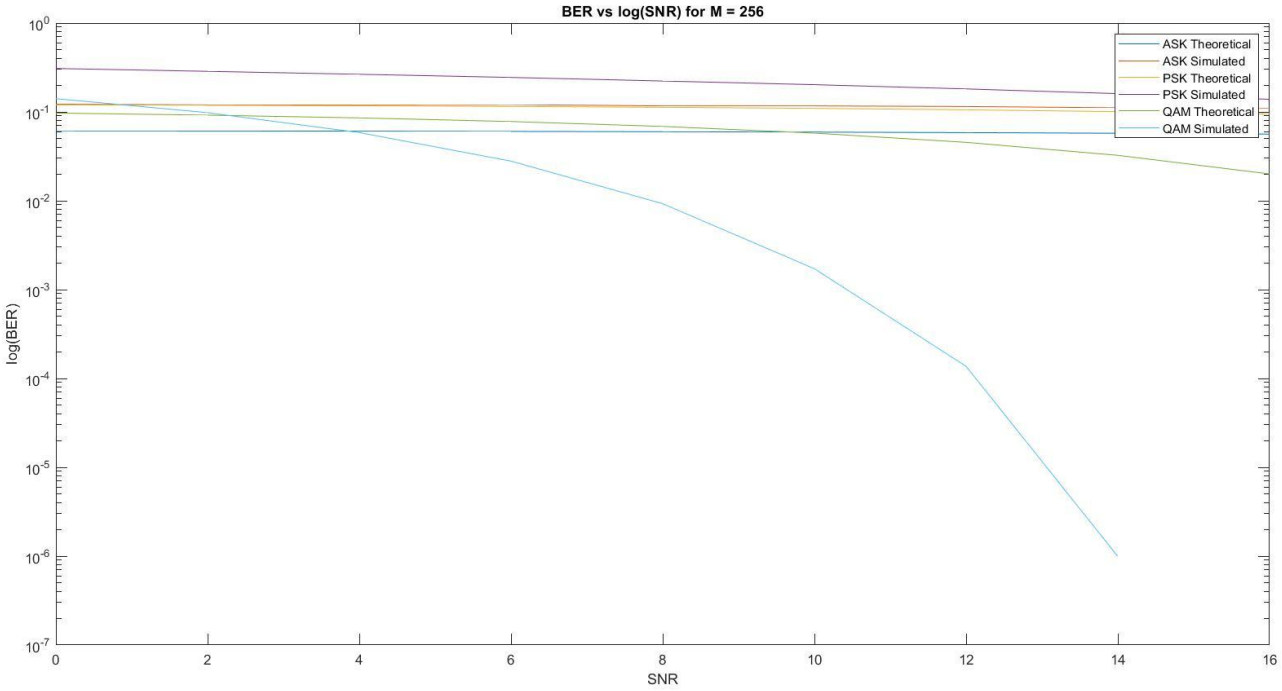
- Probability of Bit Error of the BPSK and QPSK are the same because the equation of probability of bit error for the both modulations are the same.
- It is observed that BER values are decreasing with the increasing of the SNR values and when the value of SNR increases the amount of noise is decreased and when the noise power decreases the BER values are also decreased.
- The BER and SNR values are inversely proportional to each other and also BER is proportional to noise power
- For a specific SNR value a specific modulation technique is produced a minimum BER value than the other techniques and it will also be said that the higher order modulation techniques are performed in higher SNR values compared to the others
- **From the analysis of Probability of Bit Error results for various digital modulation schemes, it will be concluded that under the low SNR condition the BPSK, QPSK and 4-QAM techniques provide the minimum Probability of Bit Error value**
- Below attached are semilog plots for analyzing the SNR vs BER of all three digital modulation schemes.


BER vs log(SNR) for M = 2
ASK Theoretical
ASK Simulated
PSK Theoretical
PSK Simulated
QAM Theoretical
QAM Simulated
log(BER)
SNR


BER vs log(SNR) for M = 4
ASK Theoretical
ASK Simulated
PSK Theoretical
PSK Simulated
QAM Theoretical
QAM Simulated
log(BER)
SNR


BER vs log(SNR) for M = 16
ASK Theoretical
ASK Simulated
PSK Theoretical
PSK Simulated
QAM Theoretical
QAM Simulated
log(BER)
SNR
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
0
2
4
6
8
10
12
14
16


BER vs log(SNR) for M = 64
ASK Theoretical
ASK Simulated
PSK Theoretical
PSK Simulated
QAM Theoretical
QAM Simulated
log(BER)
SNR
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
0
2
4
6
8
10
12
14
16


BER vs log(SNR) for M = 256
ASK Theoretical
ASK Simulated
PSK Theoretical
PSK Simulated
QAM Theoretical
QAM Simulated
log(BER)
SNR
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
2
4
6
8
10
12
14
16