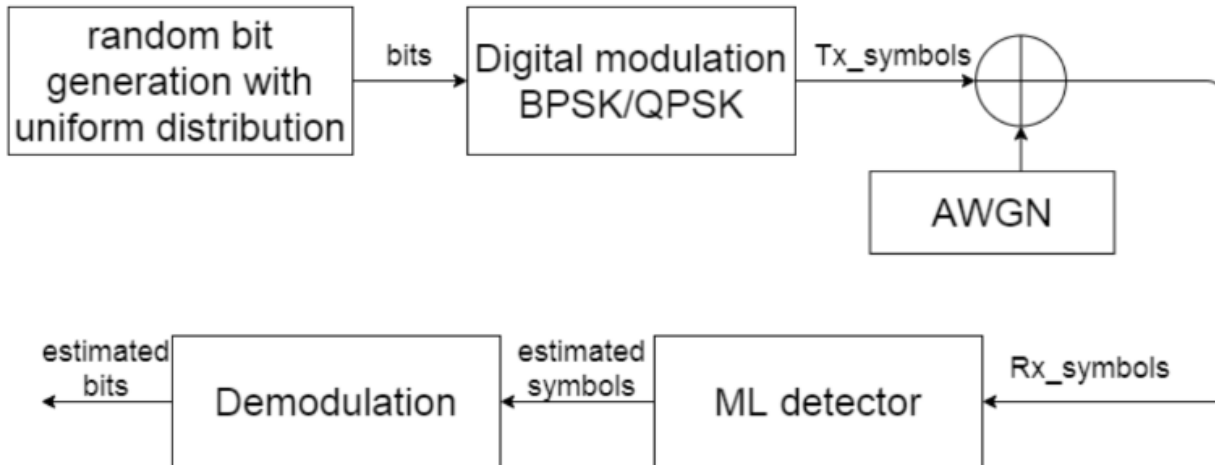


## Assignment 4

Communication Systems Lab  
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**Aim :** To study Bit error rate(BER) and symbol error rate(SER) performance of BPSK and QPSK digital modulation schemes

**Block Diagram :**



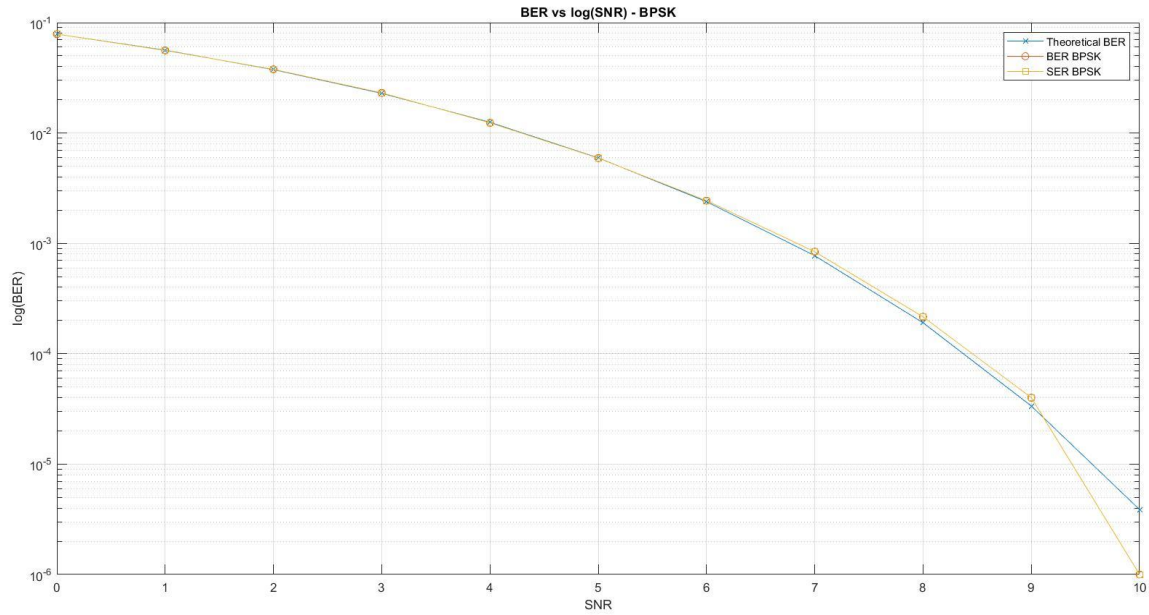
**Observations :**

- QPSK devices modulate input signals by  $0^\circ$ ,  $90^\circ$ ,  $180^\circ$ , and  $270^\circ$  phase shifts. BPSK devices modulate input signals by  $0^\circ$  and  $180^\circ$  phase shifts.
- QPSK modulation consists of two BPSK modulations on in-phase and quadrature components of the signal.
- From the below attached plots, we can observe that, BERs for BPSK & QPSK are the same.
- Minimum Bit error rates are observed at around 12dB for both BPSK & QPSK.
- For implementing BPSK & QPSK, we have used the minimum distance rule to make decisions at the receiver.
- Original signal bits are added with AWGN noise to form the received bits.
- In the case of QPSK, we have to map two bits at a time to the signal set of cardinality 4.  
 $\{00, 01, 11, 10\} \Rightarrow \{0, 1, 3, 2\} \Rightarrow \{1+1i, -1+1i, -1-1i, 1-1i\}$
- From the plots, it is verified that:  
@ 5dB SNR for QPSK : **BER = 0.006, SER = 0.011**

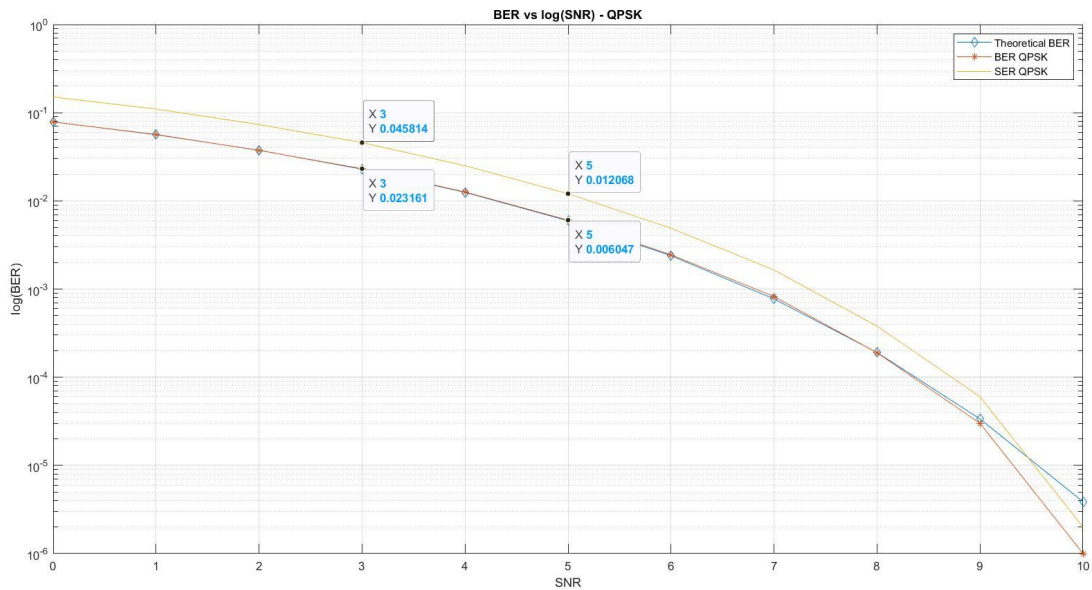
Theoretical BER and SER Expressions used for the schemes :

| Modulation | $P_s(\gamma_s)$                   | $P_b(\gamma_b)$                   |
|------------|-----------------------------------|-----------------------------------|
| BPSK       |                                   | $P_b = Q(\sqrt{2\gamma_b})$       |
| QPSK       | $P_s \approx 2Q(\sqrt{\gamma_s})$ | $P_b \approx Q(\sqrt{2\gamma_b})$ |

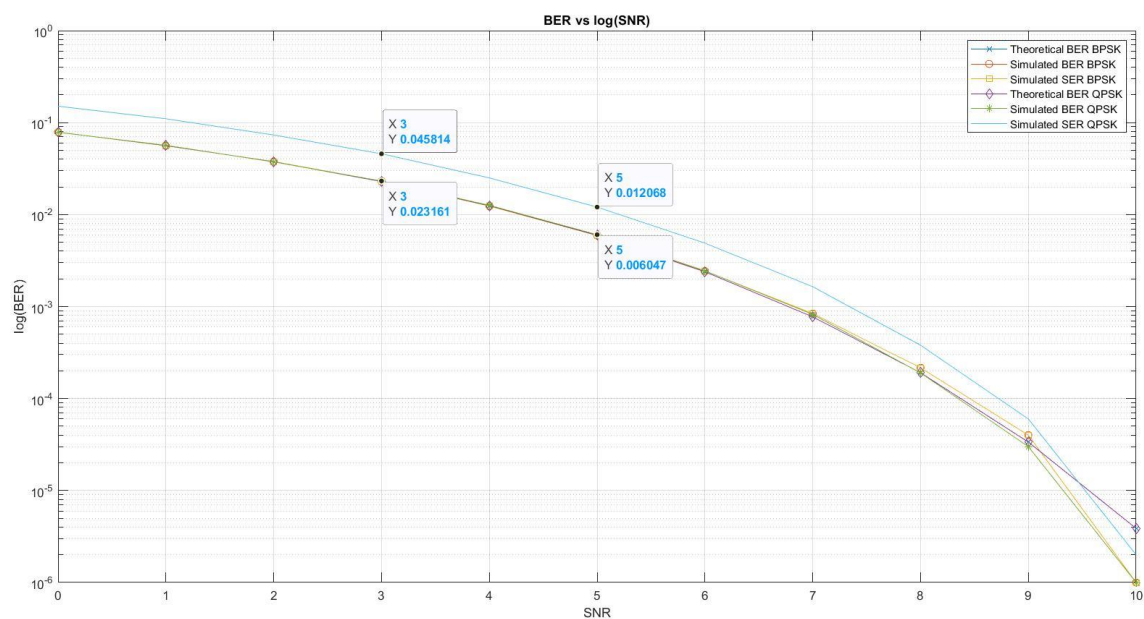
Results :



Theoretical vs Simulated Plots for BER & SER of BPSK Scheme



Theoretical vs Simulated Plots for BER & SER of QPSK Scheme



Comparing BER & SER of both the Schemes