Department of Electrical Engineering
IIT Madras, Chennai 600 036.

EE 5141 Introduction to Wireless and Cellular Communications
Feb – May 2021

Computer Assignment Submission Instructions

- Submit the assignment as a team of two students
- Please submit the following
  - Required plots
  - Include brief explanation of observations, as appropriate
  - Listing of code written by you
- The submitted file should be in .pdf format
- Mention name and roll number of both team members
- Use following naming convention for file
  - roll_number_assign#.pdf
    (Use roll number of one of the team members)
  - Example: EE20M001_cassign2.pdf
- Assignment submission via Moodle
  - Instructions given by TAs
  - Do not send via email
- Honour Code:
  - Add this line to your assignment and an electronic signature
  - I certify that this assignment submission is my own work and not from obtained from any other source

Prof. David Koilpillai
koilpillai@ee.iitm.ac.in
Phone: +91-44-2257-4405
FAX: +91-44-2257-0120

Department of Electrical Engineering
IIT Madras, Chennai 600 036.

EE 5141: Introduction to Wireless and Cellular Communications
Feb – May 2021

Computer Assignment 2 (Due date: March 1, 2021)

1. The task is to build a QPSK modem and study the Bit Error Rate (BER) and Symbol Error Rate (SER) performance using Monte-Carlo simulations, as given in the Figure 1a. Generate a random sequence of about 512 QPSK symbols and apply pulse shaping with an SRRC pulse (roll off $\alpha = 0.35$), as generated in Computer Assignment 1. Use Gray Coding for the QPSK symbols.

Bits	00	01	10	11
QPSK Symbol	$e^{j\frac{\pi}{4}}$	$e^{j\frac{3\pi}{4}}$	$e^{-j\frac{\pi}{4}}$	$e^{-j\frac{3\pi}{4}}$

The symbol rate is 25 K symbols/sec.

(a) Assume that the obtained signal after receiver filter is down-sampled to one sample per symbol. Plot the received symbols for the case when $\frac{E_b}{N_0} = 6\ dB$. This will show the constellation points in the presence of noise.

(b) BER / SER simulation
- Generate AWGN with different variance values (by varying α in Figure 1b)
- Pass the desired signal and noise through a matched receive filter (same SRRC filter as used in transmitter) using the block diagram given in Figure 1b.
- Apply coherent detection and compute BER and SER for $\frac{E_b}{N_0}$ in the range [0, 14 dB] in steps of 2 dB, using 500 bursts for averaging. (Measure P_s and P_n and convert to $\frac{E_b}{N_0}$, given that for QPSK with SRRC Tx and Rx filters, then $\frac{P_s}{P_n}\ (dB) - 3\ dB = \frac{E_b}{N_0}\ (dB)$

(c) Plot BER vs $\frac{E_b}{N_0}$ and SER vs $\frac{E_s}{N_0}$

(d) In the BER plot, include the analytical computation of the BER for coherent QPSK given by $BER = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$. Refer Rappaport Appendix F for definition of Q-function. Verify that the BER plot (simulations) and the BER curve (analytical computation of BER) are in agreement.

Prof. David Koilpillai
koilpillai@ee.iitm.ac.in
Phone: +91-44-2257-4405
FAX: +91-44-2257-0120

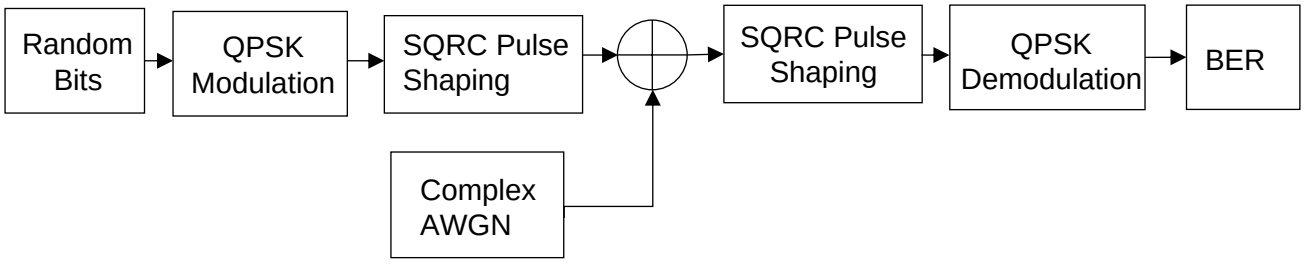

Figure 1a: Block diagram for simulation of BER performance in AWGN

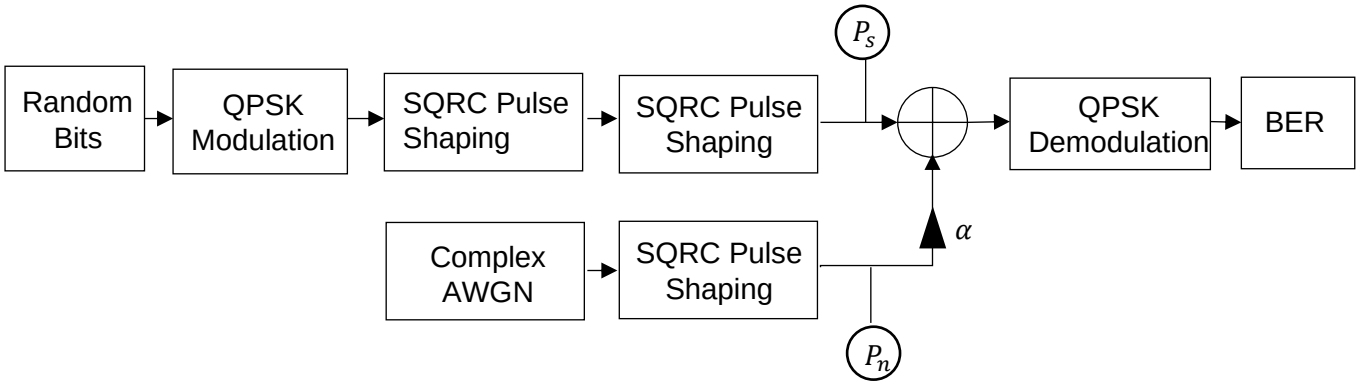

Figure 1b: Equivalent diagram to enable measurement of $\frac{P_s}{P_n}$

Prof. David Koilpillai
koilpillai@ee.iitm.ac.in
Phone: +91-44-2257-4405
FAX: +91-44-2257-0120