Chapter 15
Matlab Problems

15.1 Write a program to generate to generate $c(t = nT) = \pm 1$ PN sequence from a [3,1] shift register. Plot the following: (a) several periods of $c(nT)$, and (b) spectrum of $c(nT)$. Why does your spectrum differ from that of Fig. 15.1-2?

15.2 Write a program to output a DSB/DSSS signal that contains a two tone message and uses the PN generator of Prob. 15.1. Use the following parameters: $f_c = 100{,}000$ Hz, f_{m1}=20 Hz, f_{m_2}=30 Hz, A_c=10, A_{m_1}=1, A_{m_2}=0.5, and $Pg = 40$ dB, and a sample interval $T = 1\ \mu s$. Plot the time and frequency representations of the following signals: (a) message, and (b) the modulated signal with and without spreading. Zoom in on the transmitter output signals to see the effects of the spreading function.

15.3 Implement the code for a receiver with a synchronous detector that will detect the DSB/DSSS signal of problem 15.2. Plot the following signals in time and frequency: (a) message, (b) DSB with and without spreading, and (c) the receiver's output.

15.4 Using the parameters of Prob. 15.3 add a single tone jammer whose power is 100-500 times greater than the transmitted signal and whose carrier frequency is $f_c + 50$ Hz. Show the receive output and the effects of the jammer. What level of jammer power causes the receiver output signal to be distorted?

15.5 Implement a BPSK-DSSS transmitter and receiver using a [3,1] PN generator, a $Pg = 30$ dB, $r_b = 10$ bps, $f_c = 1$ kHz, and whose message is a uniformly distributed sequence of 1s and 0s. Use a receiver with a correlation detector. Verify the receiver output is the same as the original message sequence.

15.6 Determine the BER performance of the system in Prob. 15.5 for values of SNR from 0 to 10 dB in increments of 1 dB. For each value of SNR calculate the average P_{be} based on 1000-10,000 test cases. Then generate a plot of average P_{be} versus SNR. Overlay the simulated P_{be} averages against the theoretical curve for a conventional BPSK system. Show that the simulated and theoretical results are relatively similar.

15.7 Do Prob 15.6 but include an interfering signal that is the same as the primary signal except for the following: (1) the PN code has a one bit phase error, (2) a different message, and (3) a different noise source. How has interference affected the average value of P_{be}? Repeat except with both modulated signals having the same message sequence. What conclusions can be drawn?

15.8 Consider the system of Prob. 15.6, except there is a second transmitter with a [3,2] spreading code and different message source, but otherwise has the same parameters as the [3,1] one. Repeat Prob. 15.6 except generate P_{be} versus SNR for the first but includes simultaneous transmissions of the second. How much degradation of error performance is caused by the second user? How do your results compare with the theoretical value of P_{be} given by Eq. (19) of Sect. 15.1?

15.9 Do Prob. 15.8 with a spreading codes of [5,4,3,2] and [5,2] for users 1 and 2 respectively. To what degree does the larger spreading code affect error performance?