Experiment No. 7

To demonstrate the performance of CDMA system

Problem Statement:

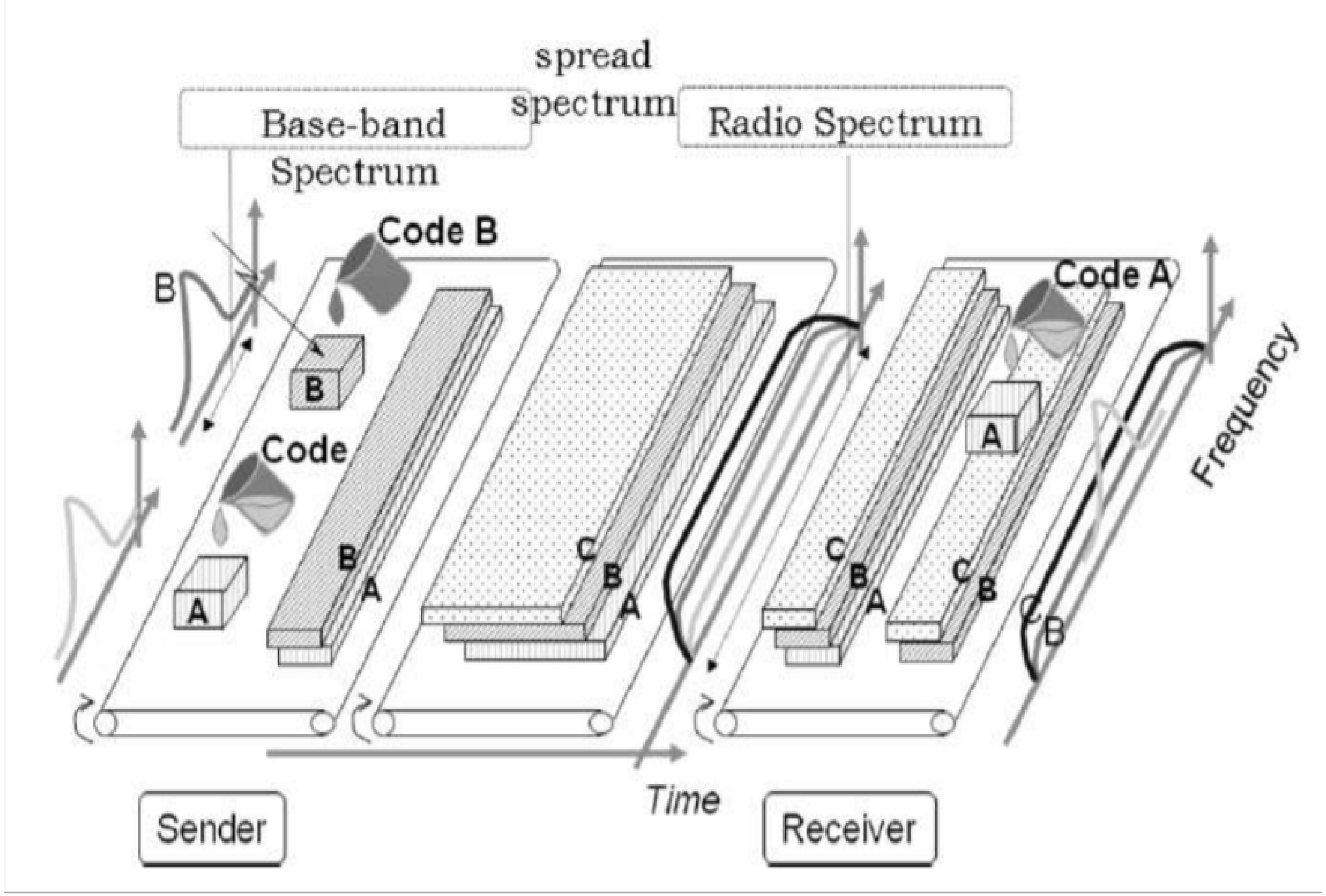
Write a MATLAB code for generation of PN Sequences and DSSS

CDMA:

- Code Division Multiple Access system is very different from time and frequency multiplexing.
- In this system, a user has access to the whole bandwidth for the entire duration.
- The basic principle is that different CDMA codes are used to distinguish among the different users.
- Techniques generally used are direct sequence spread spectrum modulation DS – CDMA, frequency hopping or mixed CDMA.
- Here, a signal is generated which extends over a wide bandwidth. A code called spreading code is used to perform this action. Using a group of codes, which are orthogonal to each other, it is possible to select a signal with a given code in the presence of many other signals with different orthogonal codes.

- CDMA allows up to 61 concurrent users in a 1.2288 MHz channel by processing each voice packet with two PN codes.
- There are 64 Walsh codes available to differentiate between calls and theoretical limits.
- Operational limits and quality issues will reduce the maximum number of calls somewhat lower than this value.
- In fact, many different "signals" baseband with different spreading codes can be modulated on the same carrier to allow many different users to be supported.
- Using different orthogonal codes, interference between the signals is minimal.
- Conversely, when signals are received from several mobile stations, the base station is capable of isolating each as they have different orthogonal spreading codes.

- The following figure shows the technicality of the CDMA system. During the propagation, we mixed the signals of all users, but by that you use the same code as the code that was used at the time of sending the receiving side. You can take out only the signal of each user.


spread
spectrum
Base-band
Spectrum
Radio Spectrum
Code B
B
B
Code
A
B
A
C
B
A
C
B
A
C
B
Code A
A
C
B
Frequency
Time
Sender
Receiver

CDMA Capacity:

- CDMA Capacity The factors deciding the CDMA capacity are − Processing Gain Signal to Noise Ratio Voice Activity Factor Frequency Reuse Efficiency Capacity in CDMA is soft, CDMA has all users on each frequency and users are separated by code.
- This means, CDMA operates in the presence of noise and interference.

Centralized Methods

- Centralized Methods The band used in CDMA is 824 MHz to 894 MHz 50MHz + 20MHzseparation.
- Frequency channel is divided into code channels.
- 1.25 MHz of FDMA channel is divided into 64 code channels.

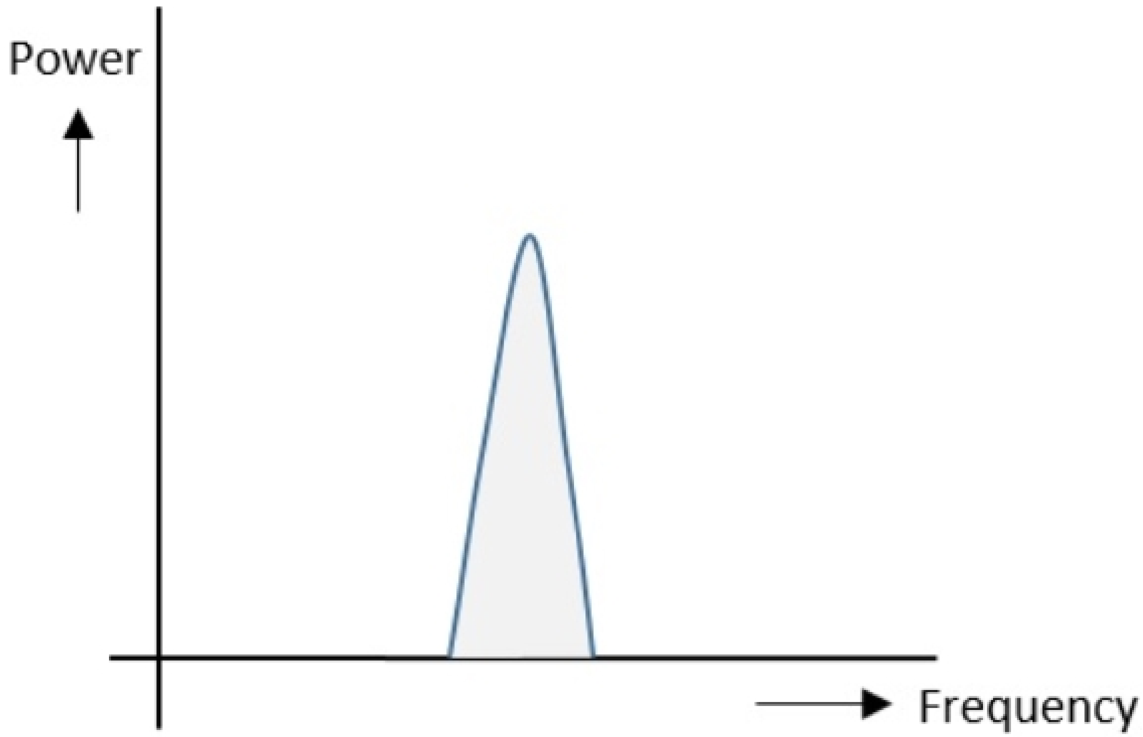
- Processing Gain CDMA is a spread spectrum technique.
- Each data bit is spread by a code sequence. This means, energy per bit is also increased. This means that we get a gain of this.
- P gain = 10log W/R
- W is Spread Rate
- R is Data Rate
- For CDMA P gain = 10 log 1228800/9600 = 21dB
- This is a gain factor and the actual data propagation rate.
- On an average, a typical transmission condition requires a signal to the noise ratio of 7 dB for the adequate quality of voice. Translated into a ratio, signal must be five times stronger than noise.
- Actual processing gain = P gain - SNR = 21 – 7 = 14dB CDMA uses variable rate coder The Voice Activity Factor of 0.4 is considered = -4dB.
- Hence, CDMA has 100% frequency reuse. Use of same frequency in surrounding cells causes some additional interference. In CDMA frequency, reuse efficiency is 0.67 70 = -1.73dB

Pseudo-Noise Sequence

- A coded sequence of **1s** and **0s** with certain auto-correlation properties, called as **Pseudo-Noise coding sequence** is used in spread spectrum techniques.
- It is a maximum-length sequence, which is a type of cyclic code.

Narrow-band and Spread-spectrum Signals

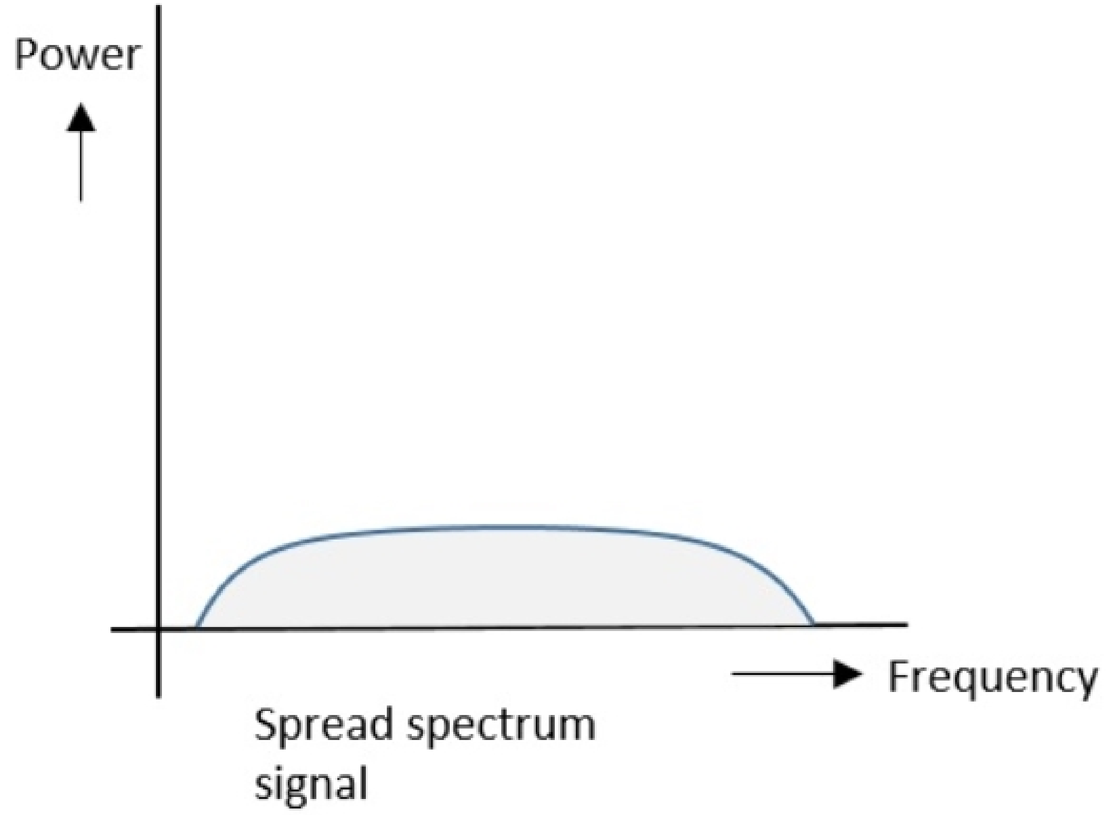
- Both the Narrow band and Spread spectrum signals can be understood easily by observing their frequency spectrum as shown in the following figures.
- Narrow-band Signals
- The Narrow-band signals have the signal strength concentrated as shown in the following frequency spectrum figure.



Narrow-band Signal

Following are some of its features −

- Band of signals occupy a narrow range of frequencies.
- Power density is high.
- Spread of energy is low and concentrated.
- Though the features are good, these signals are prone to interference.
- Spread Spectrum Signals
- The spread spectrum signals have the signal strength distributed as shown in the following frequency spectrum figure.


Power
Frequency
Spread spectrum
signal

Following are some of its features −

- Band of signals occupy a wide range of frequencies.
- Power density is very low.
- Energy is wide spread.
- With these features, the spread spectrum signals are highly resistant to interference or jamming. Since multiple users can share the same spread spectrum bandwidth without interfering with one another, these can be called as **multiple access techniques**.

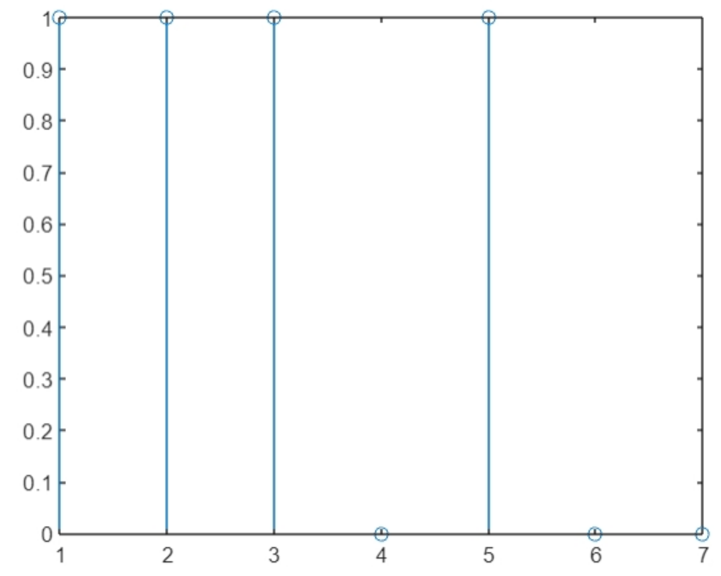
Advantages of Spread Spectrum

- Following are the advantages of spread spectrum −
- Cross-talk elimination
- Better output with data integrity
- Reduced effect of multipath fading
- Better security
- Reduction in noise
- Co-existence with other systems
- Longer operative distances
- Hard to detect
- Not easy to demodulate/decode
- Difficult to jam the signals

Part a) PN sequence generation(MATLAB code)

/MATLAB Drive/pn_n.m

```matlab
f=3;
N=(2^f)-1;
s1=1;
s2=1;
s3=1;
for i=1:N
        s0(i)= xor(s3(i),s1(i));
    s1(i+1)= s0(i);
    s2(i+1)= s1(i);
    s3(i+1)= s2(i);
end
pn_seq=s3(1:N)
disp(pn_seq)
stem(pn_seq)
```



Command Window

```
    1     1     1     0     1     0     0

    1     1     1     0     1     0     0
```

Part b) DSSS Generation

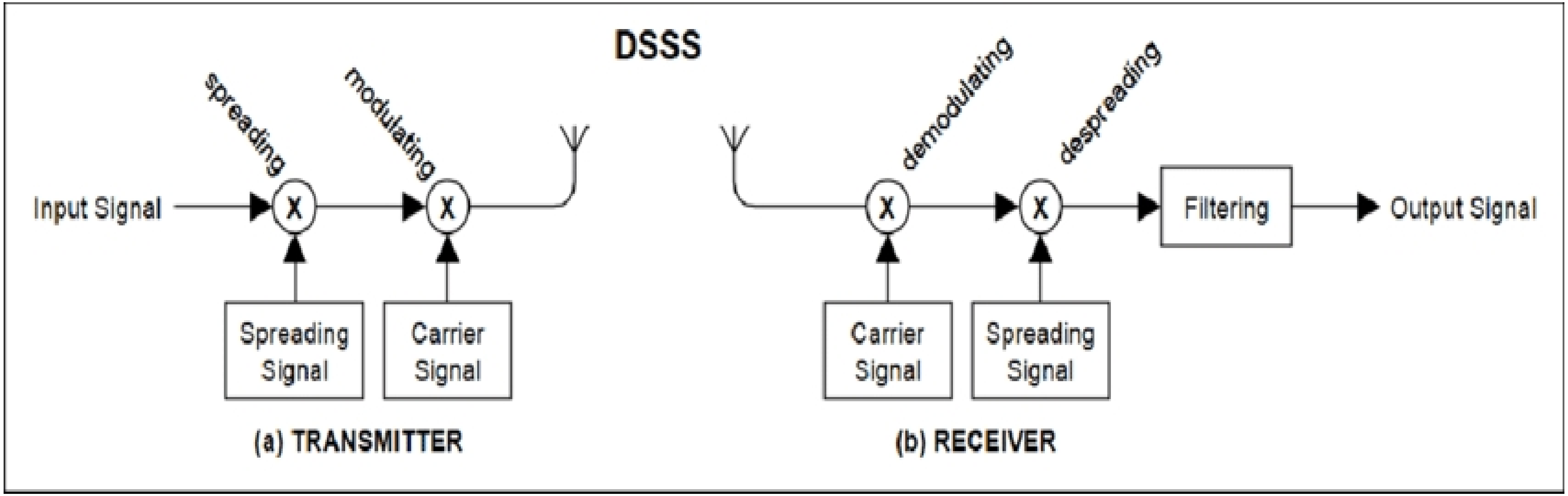
```
% Content for reference:
clc;
clear;
close all;
N=7;
c=[0 0 1 0 1 1 1];
```

- % Binary to polar mapping

```
for i=1:length(c)
    if c(i)==0
        cm(i)=-1;
    else
        cm(i)=1;
    end
end
```

- %Information bearing signal
-
- b=randi([0 1],1,2);

Block diagram of DSSS:



```
%DSSS baseband mapping
m=[];
for k=1:length(b)
   if b(k)==0
       mm=-cm;
   else
       mm=cm;
   end
   m=[m mm];
end

% NRZ pulse Shaping
i=1;
l=1/N;  % Chip duration
S=700;  % sample per bit
t=0:1/S:length(b)-1/S; %time

for j= 1:length(t)
    if t(j)<=l
        y(j)=m(i);
    else
        i=i+1;
        l=l+1/N;
    end
end
```

```
figure(1);
subplot(311);
plot(t,y);
axis([0 length(b) -2 2]);
xlabel('time');
ylabel('amp');
title('DSSS baseband signal')

% Carrier
c1=cos(2*pi*10*t);
subplot(312);
plot(t,c1);
axis([0 length(b) -2 2]);
xlabel('time');
ylabel('amp');
title('Sinusoidal signal')

% DSSS BPSk
x=y.*c1;
subplot(313);
plot(t,x);
axis([0 length(b) -2 2]);
xlabel('time');
ylabel('amp');
title('DSSS BPSK')
```

Thank you