Answers **(5)**	Coding Efficiency **(5)**	Viva **(5)**	Timely Completion **(5)**	Total **(20)**	Dated Sign of Subject Teacher

Expected Date of Completion:----------

Actual Date of Completion:----------

Experiment No: Group B-1

Problem Definition:

To implement a basic function of Code Division Multiple Access (CDMA) to test the orthogonally and autocorrelation of a code to be used for CDMA operation. Write an application based on the above concept.

1.1 Prerequisite:

Basic Concept of Code Division Multiple Access

1.2 Learning Objective:

1. To provides a high quality of voice with almost no noise during the calls.
2. To Understand working of CDMA through common channel.

1.3 Theory:

1.3.1 Introduction

CDMA is a channelization protocol for Multiple Access, where information can be sent simultaneously through several transmitters over a single communication channel.

It is achieved in below steps:

- A signal is generated which extends over a wide bandwidth.
- The code which performs this action is called spreading code.
- Later on, a specific signal can be selected with a given code even in the presence of

many other signals.

- It is mainly used in mobile networks like 2G and 3G.

1.3.2 How does CDMA work?

To see how CDMA works, we have to understand orthogonal sequences (also known as chips). Let N be the number of stations establishing multiple access over a common channel.

Then the properties of orthogonal sequences can be stated as follows:

1. An orthogonal sequence can be thought of as a 1xN matrix.

   Eg: [+1 -1 +1 -1] for N = 4.

2. Scalar multiplication and matrix addition rules follow as usual.

   Eg: 3.[+1 -1 +1 -1] = [+3 -3 +3 -3]

   Eg: [+1 -1 +1 -1] + [-1 -1 -1 -1] = [0 -2 0 -2]

3. Inner Product: It is evaluated by multiplying two sequences element by element and then adding all elements of the resulting list.
   - Inner Product of a sequence with itself is equal to N

     [+1 -1 +1 -1].[+1 -1 +1 -1] = 1 + 1 + 1 + 1 = 4
   - Inner Product of two distinct sequences is zero

     [+1 -1 +1 -1].[+1 +1 +1 +1] = 1-1+1-1 = 0
   - To generate valid orthogonal sequences, use a Walsh Table as follows:
   - Rule 1:

     $$W_1 = [+1]$$
   - Rule 2:

     $$W_{2N} = \begin{bmatrix} W_N & W_N \\ W_N & \overline{W_N} \end{bmatrix}$$

     Where $\overline{W_N}$ = Complement of W_N (Replace +1 by -1 and -1 by +1)

Example:

$$W_2 = \begin{bmatrix} +1 & +1 \\ +1 & -1 \end{bmatrix}$$

$$W_4 = \begin{bmatrix} +1 & +1 & +1 & +1 \\ +1 & -1 & +1 & -1 \\ +1 & +1 & -1 & -1 \\ +1 & -1 & -1 & +1 \end{bmatrix}$$

- Each row of the matrix represents an orthogonal sequence.Hence we can construct sequences for N = 2^M . Now let's take a look at how CDMA works by using orthogonal sequences.

1.3.3 Procedure:

1. The station encodes its data bit as follows.
    - +1 if bit = 1
    - -1 if bit = 0
    - no signal(interpreted as 0) if station is idle
2. Each station is assigned a unique orthogonal sequence (code) which is N bit long for N stations
3. Each station does a scalar multiplication of its encoded data bit and code sequence.
4. The resulting sequence is then placed on the channel.
5. Since the channel is common, amplitudes add up and hence resultant channel sequence is sum of sequences from all channels.
6. If station 1 wants to listen to station 2, it multiplies (inner product) the channel

sequence with code of station S2.

7. The inner product is then divided by N to get data bit transmitted from station 2.

1.3.4 :Example: Assume 4 stations S1, S2, S3, S4. We'll use 4×4 Walsh Table to assign codes to them.

C1 = [+1 +1 +1 +1]

C2 = [+1 -1 +1 -1]

C3 = [+1 +1 -1 -1]

C4 = [+1 -1 -1 +1]

Let their data bits currently be:

D1 = -1

D2 = -1

D3 = 0 (Silent)

D4 = +1

Resultant channel sequence = C1.D1 + C2.D2 + C3.D3 + C4.D4

= [-1 -1 -1 -1] + [-1 +1 -1 +1] + [0 0 0 0]+[+1 -1 -1 +1]

= [-1 -1 -3 +1]

Now suppose station 1 wants to listen to station 2. Inner

Product = [-1 -1 -3 +1] x C2

= -1 + 1 - 3 - 1 = -4

Data bit that was sent = -4/4 = -1.

1.3.5 Code:

```
import numpy as np c1=[1,1,1,1]

c2=[1,-1,1,-1]

c3=[1,1,-1,-1]

c4=[1,-1,-1,1]

rc=[]


print("Enter the data bits :")

d1=int(input("Enter D1 :"))

d2=int(input("Enter D2 :"))

d3=int(input("Enter D3 :"))

d4=int(input("Enter D4 :"))

r1=np.multiply(c1,d1)

r2=np.multiply(c2,d2)

r3=np.multiply(c3,d3)

r4=np.multiply(c4,d4)

resultant_channel=r1+r2+r3+r4;
```

```
print("Resultant Channel",resultant_channel)

Channel=int(input("Enter the station to listen for C1=1 ,C2=2, C3=3 C4=4 : "))

if Channel==1:

        rc=c1

elif Channel==2:

        rc=c2

elif Channel==3:

        rc=c3

elif Channel==4:

        rc=c4

inner_product=np.multiply(resultant_channel,rc)

print("Inner Product",inner_product)

res1=sum(inner_product)

data=res1/len(inner_product) print("Data bit

that was sent",data)
```

1.3.6 Assignment Questions:

1. What is CDMA?
2. Explain the features of CDMA?
3. What are advantages and disadvantages of CDMA?

Conclusion: The CDMA will allow many signals to be transmitted at the ssame channel at the same time.