Experiment 1: Study on the effect of frequency reuse in cellular communication

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Aim:

To study the effect of frequency reuse in cellular communication and to prove that capacity of a cellular system increases with frequency reuse.

Theory:

In the cellular concept, frequencies allocated to the service are re-used in a regular pattern of areas, called 'cells', each covered by one base station. In mobile-telephone nets these cells are usually hexagonal. 2 A set of C different frequencies {f1, ..., fC} are used for each cluster of C adjacent cells. Cluster patterns and the corresponding frequencies are re-used in a regular pattern over the entire service area. This criterion is known as frequency reuse.

To understand the frequency reuse concept, consider a cellular system which has a total of S duplex channels available for use. If each cell is allocated a group of k channels ($k < S$), and if the S channels are divided among N cells into unique and disjoint channel groups which each have the same number of channels, the total number of available radio channels can be expressed as $S = kN$. The N cells which collectively use the complete set of available frequencies is called a cluster. If a cluster is replicated M times within the system, the total number of duplex channels, C, can be used as a measure of capacity and is given by $C = MkN = MS$.

Problem statement 1:

Find the capacity improvement in a cellular system when frequency reuse is applied. Compare the result without frequency reuse. Use the following parameters:

i. Total bandwidth = 30MHz
ii. Channel bandwidth = 50kHz
iii. Let the total area = 2000 sq.km; area of a cell=2 sq.km
iv. Single Cell covering the entire area
v. N=5

Algorithm:

If N=1, then number of cluster is 1, hence frequency reuse doesn't happen in this case, and capacity of the system is same as no of channels in 1 cluster. If N>1 then frequency reuse concept come into play, here the cluster with same frequency range is repeated to cover the entire geographical area. Here capacity of system is increased (than it was for N=1). Hence service provider can serve a greater number of customers by this concept.

Code:

```
clc
clear all
close all
B=30*1000000; b=50*1000;
N = input ("Enter the value of N:");
Area = input ("Enter the geographical area to be covered:");
cluster_size=N;
no_of_channel=(B/b);
if(N~=1)
    no_of_cluster=(Area)/N;
else
    N=1;
    no_of_cluster=1;
end
Total_no_of_channel=no_of_cluster*no_of_channel;
capacity=Total_no_of_channel;
fprintf('no_of_ch=%d.\n',no_of_channel);
fprintf('cluster_size=%d.\n',cluster_size);
fprintf('Total_no_of_channel=%d.\n',Total_no_of_channel);
fprintf('Channel capacity=%d.\n',capacity);
```

Output:

Enter the value of N:5

Enter the geographical area to be covered:2000

no_of_ch=600.

cluster_size=5.

Total_no_of_channel=240000.

Channel capacity=240000.

Problem statement 2:

Plot the graph of Channel bandwidth Vs Capacity, for the following values:

i. Get total bandwidth from the user. Let the range of input be 20MHz to 100MHz.
ii. Let the total area = 2000 sq.km; area of a cell=2 sq.km
iii. Channel bandwidth = 20:20:200 kHz
iv. N=3, 4, 7, 9, 12

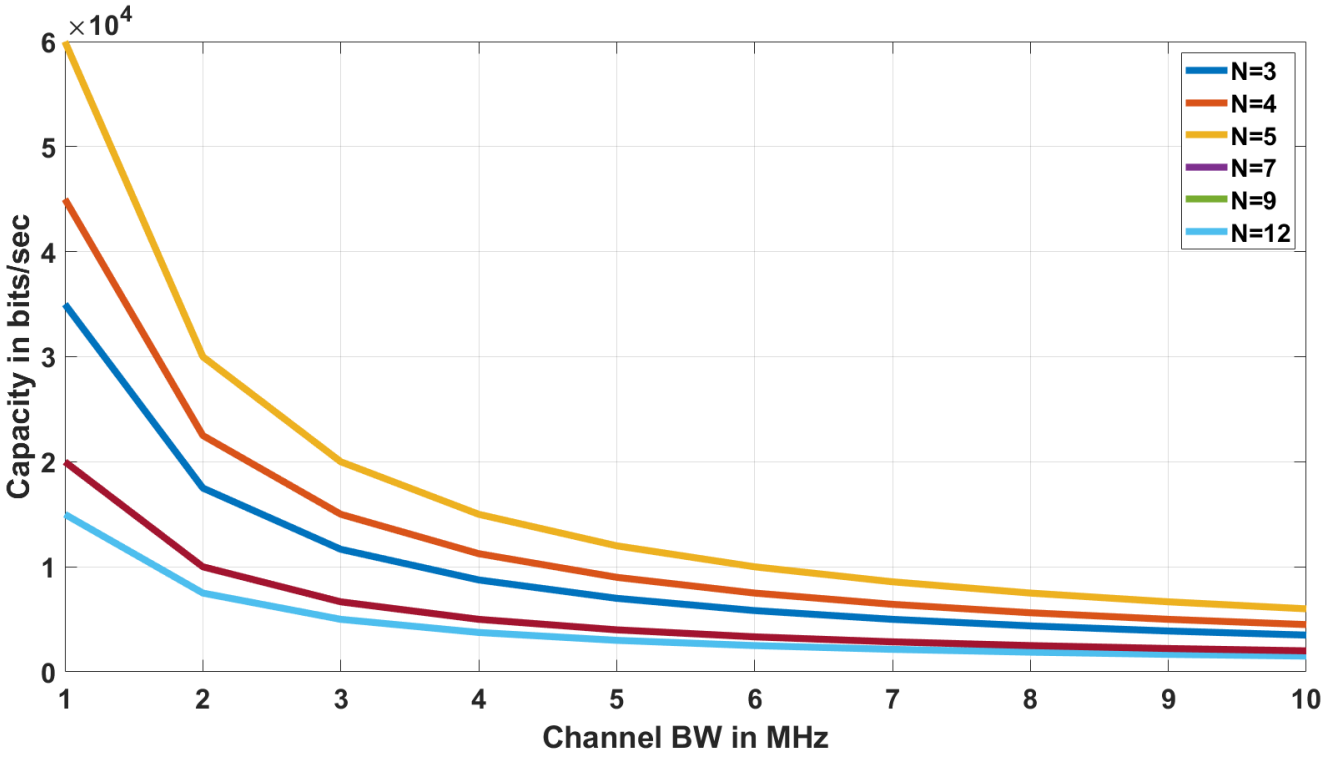
Algorithm:

No of channels = (Total Bandwidth)*(Frequency reuse factor)/ (Channel Bandwidth)

Code:

```
c = (20:20:200);
b = input("enter the bandwidth: ");
b*1000000;
n = [3,4,7,9,12];
a = input("enter the area: ");
a;
ca = input("enter area of cell: ");
ca;
for i=1:length(n)
 K =(b./c)*n(i);
 no_of_cluster = (a/2);
 capacity = K *no_of_cluster;
 plot(capacity,'LineWidth',5);
 xlabel("Channel BW in MHz",'FontSize',20,'FontWeight','bold');
 ylabel("Capacity in
bits/sec",'FontSize',20,'FontWeight','bold');
 legend('N=3','N=4','N=5','N=7','N=9','N=12');
 set(gca,'FontSize',20,'FontWeight','bold');
 grid on;
 hold on;
end
```

Output:



Inference:

If N increases channel bandwidth decreases.

Problem statement 3:

Plot the graph of Cell Radius vs Capacity, for the following values:

i. Total Bandwidth = 1800 MHz; Channel bandwidth = 200 kHz.
ii. Cell radius = 100:100:1000 m
iii. N=3, 4, 7, 9, 12
iv. Total area = 2100 km^2

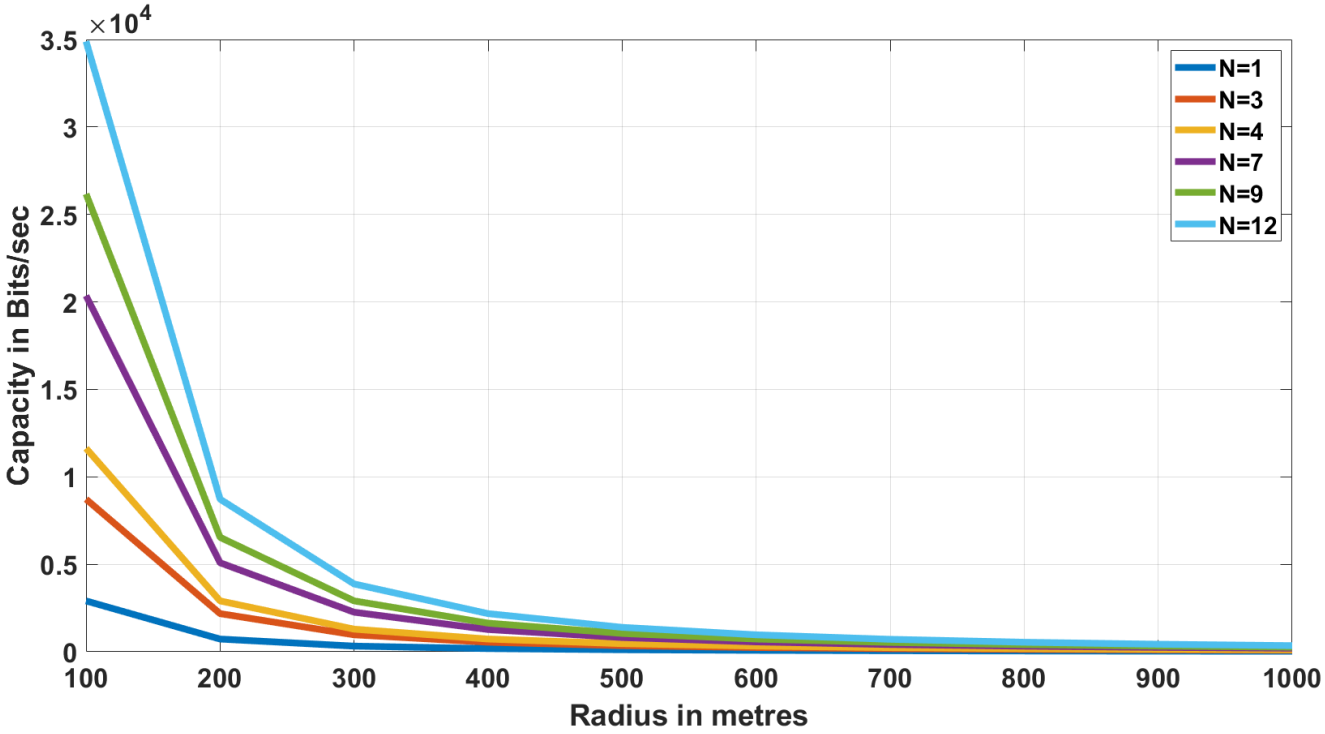
Algorithm:

Number of clusters= (total area)/ (2*(sqrt(3))*radius of single cell) And
Capacity of System= (Number of Channels)*(Number of clusters)

Code:

```
clc
clear all
r=100:100:1000;
Total_BW=1800*1000000;
channel_BW=50*1000;
N=[1,3, 4, 7, 9, 12];
Total_Area=2100;
for i=1:6
Cluster_Area=2.6*r.^2;
M=Total_Area./(Cluster_Area);
S=N(i)*(Total_BW./channel_BW);
C=M*S;
plot(r,C,'linewidth',5);
legend("N=1","N=3","N=4","N=7","N=9","N=12")
xlabel("Radius in metres",'FontSize',20,'FontWeight','bold')
ylabel("Capacity in
Bits/sec",'FontSize',20,'FontWeight','bold');
set(gca,'FontSize',20,'FontWeight','bold');
grid on;
hold on;
end
hold off;
```

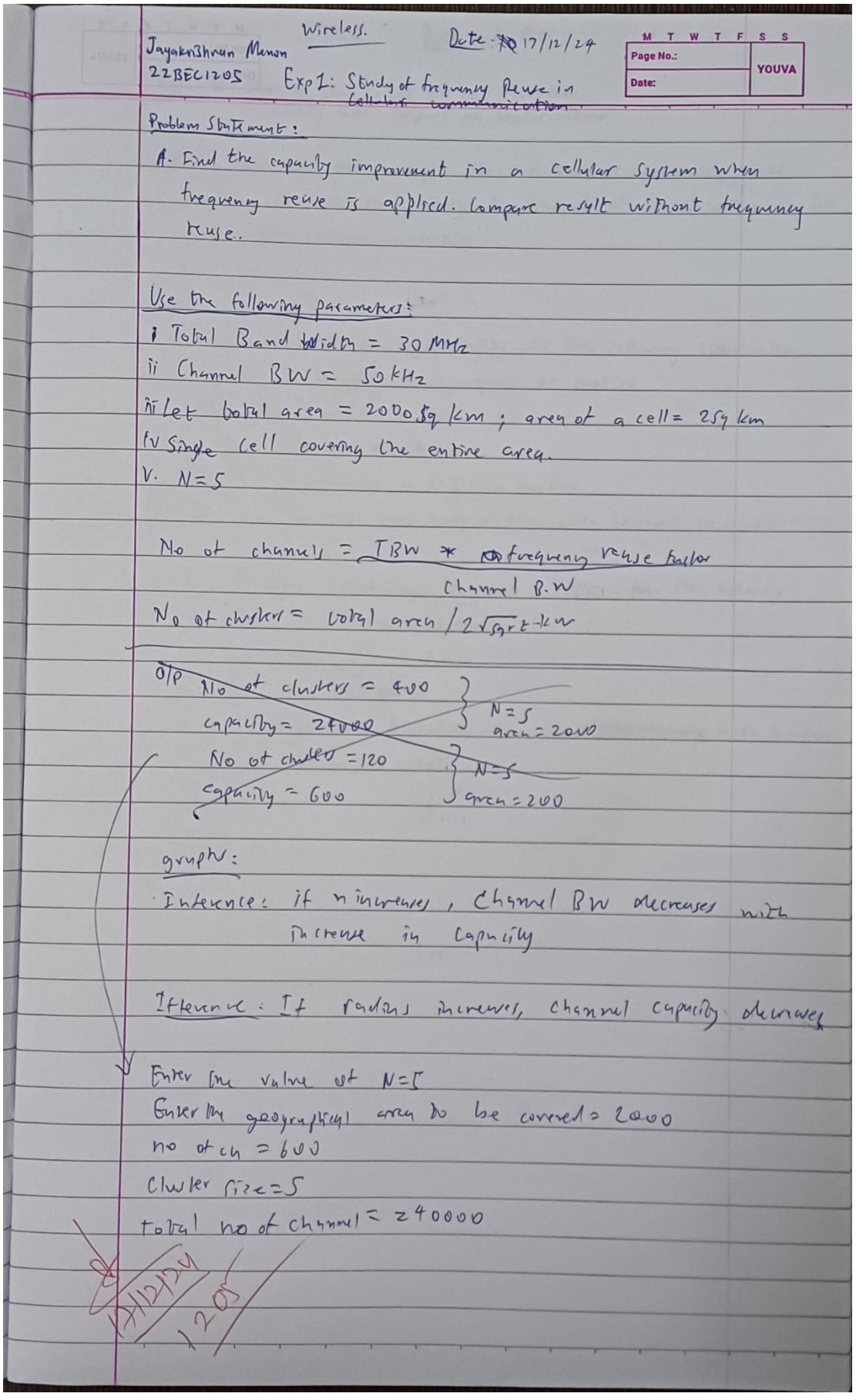
Output:



Inference:

Radius decreases capacity increases.

Output Verification:



Wireless.

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Date: 17/12/24

Exp 1: Study of frequency Reuse in ~~cellular communication~~

Problem Statement:

A. Find the capacity improvement in a cellular system when frequency reuse is applied. Compare result without frequency reuse.

Use the following parameters:

i Total Bandwidth = 30 MHz
ii Channel BW = 50 kHz
iii Let total area = 2000 Sq km ; area of a cell = 25 sq km
iv Single cell covering the entire area.
v. N = 5

No of channels = $\frac{\text{TBW} * \text{frequency reuse factor}}{\text{channel B.W}}$

No of cluster = total area / $2\sqrt{\text{sqrt-kw}}$

O/p No of clusters = 400
capacity = 24000
N = 5
area = 2000

No of cluster = 120
capacity = 600
N = 5
area = 200

graph:

Inference: if n increases, Channel BW decreases with increase in capacity

Inference: If radius increases, channel capacity decreases

Enter the value of N = 5
Enter the geographical area to be covered = 2000
no of ch = 600
Cluster size = 5
total no of channel = 240000

17/12/24
1205

Observation and Result:

The effects of frequency reuse in cellular communication was simulated and verified using MATLAB.