Experiment 2: To Analyse the Effect of Cell Handover Probability & Impact of Sectorization

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Aim:

To understand and analyse the cell handover probability in a cellular network and the impact of sectorization on the signal interference ratio.

Theory:

In wireless and mobile communication systems, the efficient management of resources is crucial to ensure seamless connectivity and optimal performance. Two key concepts in this domain are cell handover probability and sectorization, which significantly influence the performance of cellular networks.

Cell handover, also known as handoff, is the process by which a mobile device transitions from one cell to another during an ongoing call or data session. This mechanism is essential to maintain continuous service as users move across the coverage areas of different base stations. Accurate prediction and management of handover probabilities are crucial to reduce call drops and ensure a smooth user experience. Poorly managed handovers can lead to increased latency, packet loss, or call termination.

Sectorization is a technique used to enhance network performance by dividing a cell into smaller segments or sectors. Each sector is served by a dedicated antenna with a specific directional beam, usually covering 120° or 60° segments. This approach reduces interference and increases the capacity of the cellular network. Sectorization can increase the frequency of handovers, as users move between sectors within the same cell. This necessitates efficient handover algorithms to mitigate potential disruptions. Conversely, by improving SINR, sectorization reduces interference-related handovers, improving overall network stability.

Problem statement 1:

Find the call handover probability for the following specifications and plot it against varying speed of mobile:

i. Cell radius = 500m
ii. Average holding time = 3 min
iii. Speed of the mobile 5:5:50 km/hr

Code:

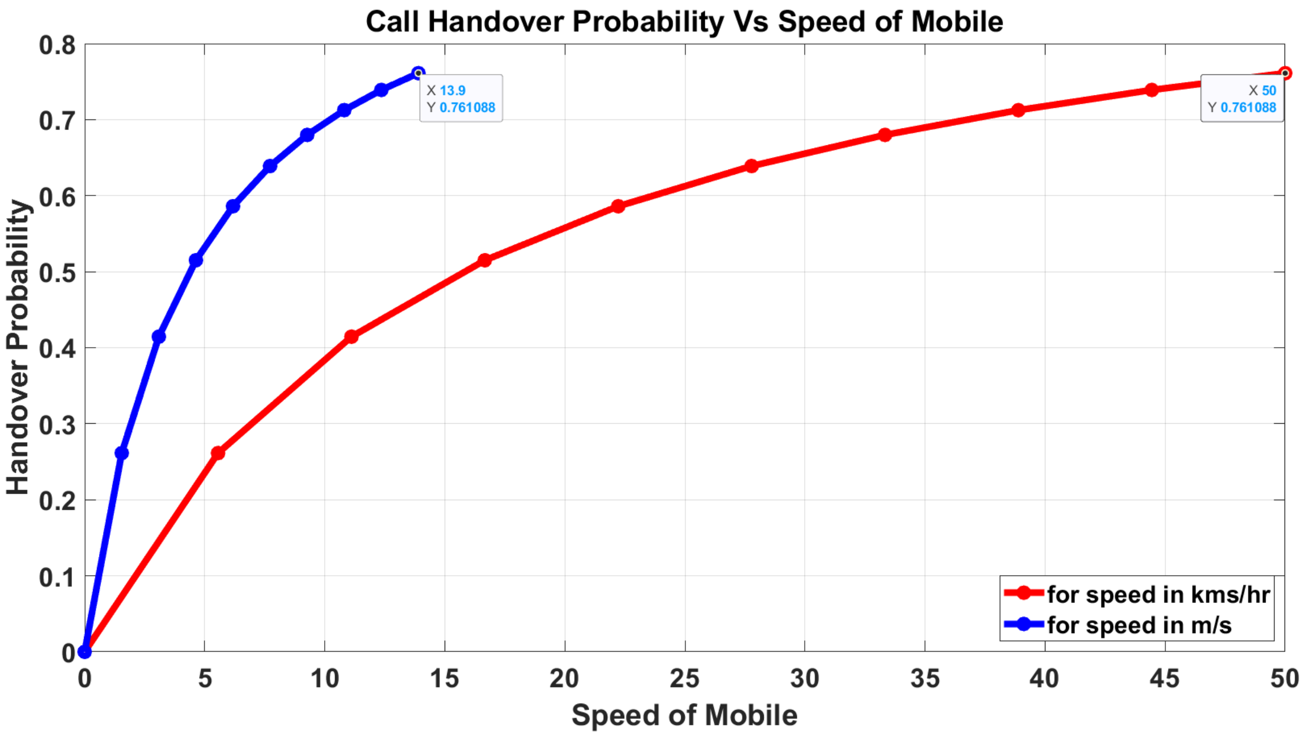
```
clc
clear all
R = input("Radius in metres: ");
H = input("Avg Hold Time in minutes: ");
S = input("Speed in kilometer/hour: ");
radius = R; %metres
AvgHoldTime = H*60; %minutes converted to seconds
Speed = linspace((0*0.278),(S*0.278),10); %5 to 50 km/hr
converted to metre/second (Speed Array)
u = 1/AvgHoldTime; %inverse of Holding time
n = 2*Speed/(pi*radius); %value
Handover_Probability = n./(n+u); %Handover Probability Array
plot(Speed./0.278,
Handover_Probability,'LineWidth',5,'color','r','Marker','o');
hold on;
plot(Speed,
Handover_Probability,'LineWidth',5,'color','b','Marker','o');
grid on;
title("Call Handover Probability Vs Speed of Mobile");
legend('for speed in kms/hr','for speed in
m/s','Location','southeast')
xlabel("Speed of Mobile");
ylabel("Handover Probability");
set(gca,'FontSize',20,'FontWeight','bold');
```

Output:

Radius in metres: 500

Avg Hold Time in minutes: 3

Speed in kilometer/hour: 50



Inference:

Call handover probability increases with increase in the speed of the mobile.

Problem statement 2:

Plot handover probability Vs. cell radius for the following:

i. Speed of the mobile = 60 km/hr
ii. Average holding time = 3 min
iii. Cell radius = 100:100:1000 m.

Algorithm:

Hand off probability = n/(n+u) Where n=2v/pi*R
V is velocity of user R is radius of cell
u is inverse of hold time.

Code:

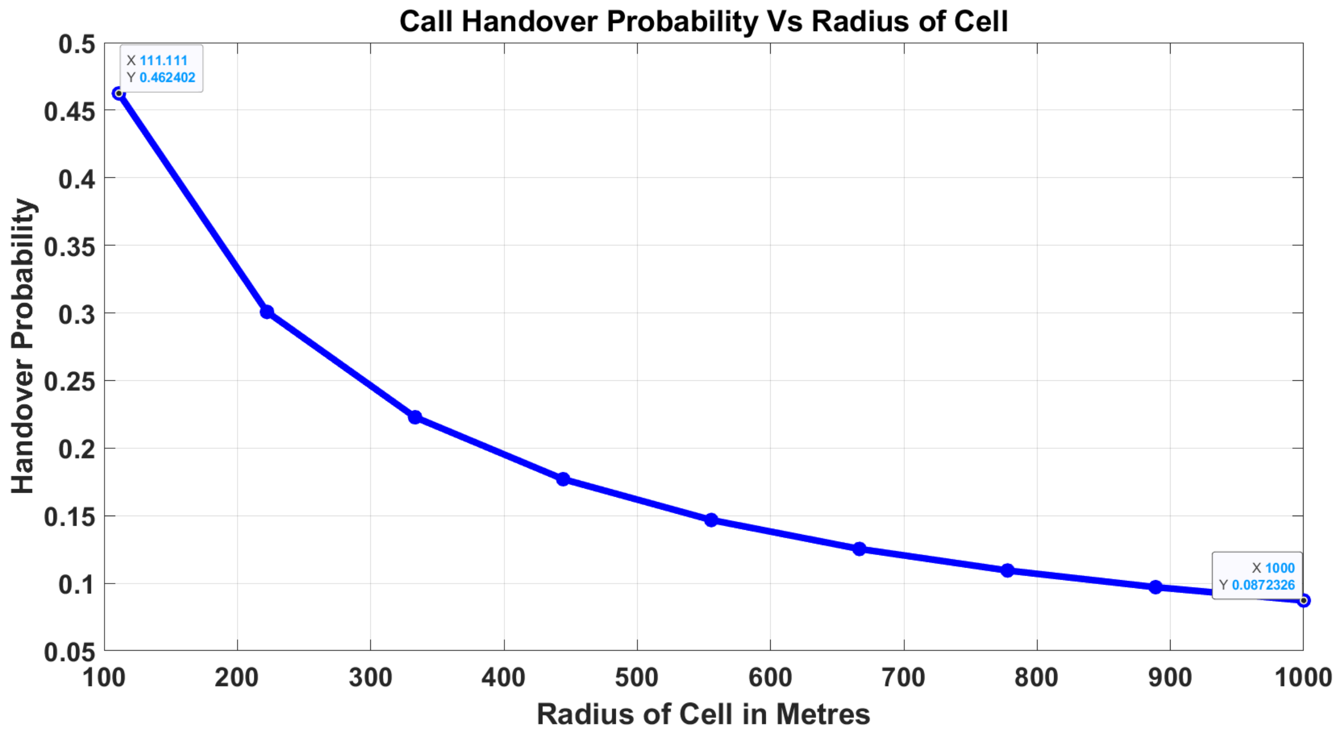
```
clc
clear all
R = input("Radius in metres: ");
H = input("Avg Hold Time in minutes: ");
S = input("Speed in kilometer/hour: ");
radius = linspace(0,R,10); %metres
AvgHoldTime = 3*H; %minutes converted to seconds
Speed = S*0.278; %60 km/hr converted to metre/second (Speed
Array)
u = 1/AvgHoldTime; %inverse of Holding time
n = 2*Speed./(pi*radius); %value
Handover_Probability = n./(n+u); %Handover Probability Array
plot(radius,
Handover_Probability,'LineWidth',5,'color','b','Marker','o');
grid on;
title("Call Handover Probability Vs Radius of Cell");
xlabel("Radius of Cell in Metres");
ylabel("Handover Probability");
set(gca,'FontSize',20,'FontWeight','bold');
```

Output:

Radius in metres: 1000

Avg Hold Time in minutes: 3

Speed in kilometer/hour: 60



Inference:

Call handover probability decreases with increase in the radius of the cell.

Problem statement 3:

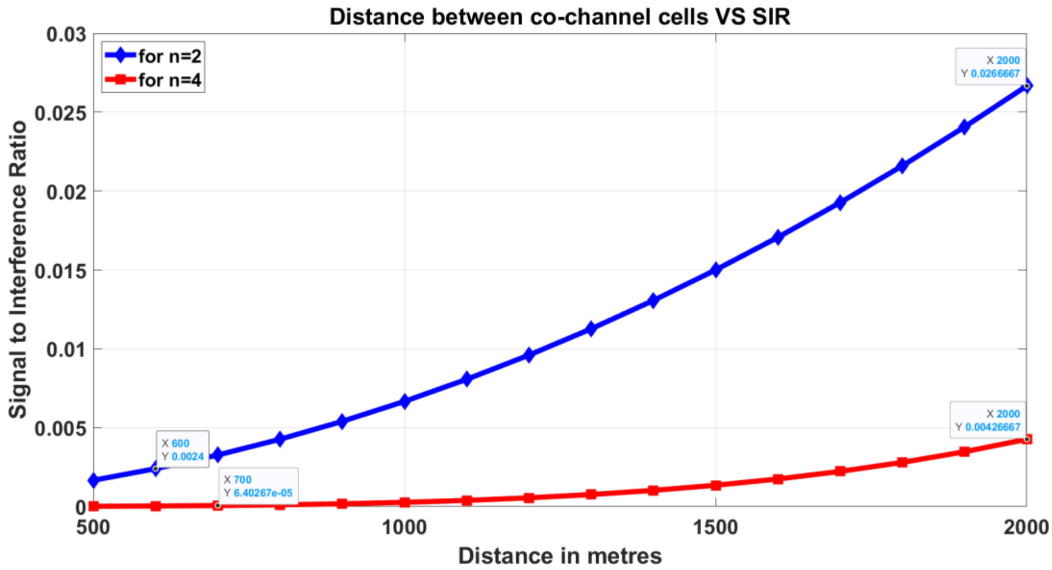
Plot distance between co-channel cells Vs. SIR. Use the following values:

i. D = 500:100:2000m
ii. R = 5km
iii. n = 2, 4
iv. N= 5,7

Code:

```
clc
clear all
close all
D=500:100:2000;
R=5000;
n1=2;
n2=4;
%N=5,7;
SIR1=((D./R).^(n1))/6;
SIR2=((D./R).^(n2))/6;

plot(D,SIR1,'LineWidth',5,'color','b','Marker','diamond');
hold on
plot(D,SIR2,'LineWidth',5,'color','r','Marker','square');
grid on;
title("Distance between co-channel cells VS SIR");
xlabel("Distance in metres");
ylabel("Signal to Interference Ratio");
legend('for n=2','for n=4','Location','northwest')
set(gca,'FontSize',20,'FontWeight','bold');
```

Output:



Inference:

Signal to Interference Ratio increases with increase in distance between co-channel cells.

Problem statement 4:

Create a table to display the SIR for the following cases: 1.

i. n=3

ii. N=5,7,19

iii. No sectorization

iv. 60° sectorization

v. 120° sectorization

Code:

```
n = 3;
N1 = 5;
N2 = 7;
N3 = 19;
i1 = 6;
i2 = 1;
i3 = 2;
SIR11 = (((3.*N1).^(n/2))/i1);
SIR12 = (((3.*N1).^(n/2))/i2);
SIR13 = (((3.*N1).^(n/2))/i3);
SIR21 = (((3.*N2).^(n/2))/i1);
SIR22 = (((3.*N2).^(n/2))/i2);
SIR23 = (((3.*N2).^(n/2))/i3);
SIR31 = (((3.*N3).^(n/2))/i1);
SIR32 = (((3.*N3).^(n/2))/i2);
SIR33 = (((3.*N3).^(n/2))/i3);
Sectorization = ['No sectorization';"60 degree
sectorization";"120 degree" + ...
    " sectorization";"No sectorization";"60 degree
sectorization";"120 degree " + ...
    "sectorization";"No sectorization";"60 degree
sectorization";"120 degree sectorization"];
SIRDb =
[SIR11;SIR12;SIR13;SIR21;SIR22;SIR23;SIR31;SIR32;SIR33];
N = [N1;N1;N1;N2;N2;N2;N3;N3;N3];
t1 = table(Sectorization,N,SIRDb)
```

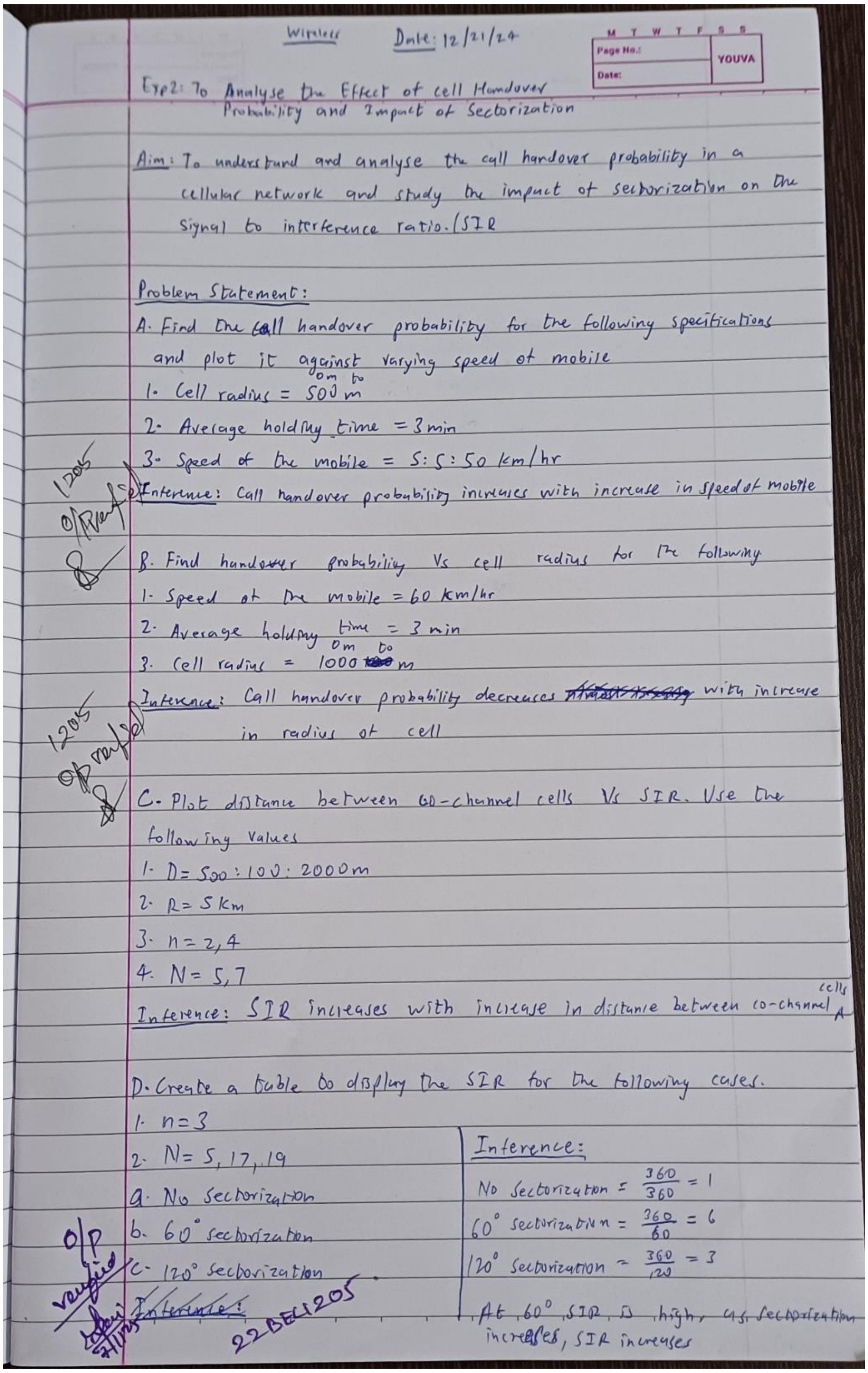
Output:

```
Command Window
>> untitled

t1 =

  9×3 table

          Sectorization             N      SIRDb
    ___________________________    __    ______

    "No sectorization"              5    9.6825
    "60 degree sectorization"       5    58.095
    "120 degree sectorization"      5    29.047
    "No sectorization"              7    16.039
    "60 degree sectorization"       7    96.234
    "120 degree sectorization"      7    48.117
    "No sectorization"             19    71.723
    "60 degree sectorization"      19    430.34
    "120 degree sectorization"     19    215.17

fx >>
```

Inference:

At 60 degrees, Signal to Interference Ratio is highest. As Sectorization increases, SIR increases

Output Verification: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Exp2: To Analyse the Effect of cell Handover Probability and Impact of Sectorization

Aim: To understand and analyse the call handover probability in a cellular network and study the impact of sectorization on the signal to interference ratio. (SIR

Problem Statement:

A. Find the call handover probability for the following specifications and plot it against varying speed of mobile

1. Cell radius = 0m to 500 m
2. Average holding time = 3 min
3. Speed of the mobile = 5:5:50 km/hr

Inference: Call handover probability increases with increase in speed of mobile

1205 O/P verified

B. Find handover probability Vs cell radius for the following

1. Speed of the mobile = 60 km/hr
2. Average holding time = 3 min
3. Cell radius = 0m to 1000 m

Inference: Call handover probability decreases ~~almost linearly~~ with increase in radius of cell

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C. Plot distance between co-channel cells Vs SIR. Use the following values

1. D = 500 : 100 : 2000m
2. R = 5 Km
3. n = 2, 4
4. N = 5, 7

Inference: SIR increases with increase in distance between co-channel cells

D. Create a table to display the SIR for the following cases.

1. n = 3
2. N = 5, 17, 19

a. No Sectorization
b. 60° sectorization
c. 120° sectorization

~~Inference:~~

Inference:

No Sectorization = $\frac{360}{360} = 1$

60° sectorization = $\frac{360}{60} = 6$

120° sectorization = $\frac{360}{120} = 3$

At 60°, SIR is high, as sectorization increases, SIR increases

O/P verified

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Observation and Result:

Hence, the cell handover probability in a cellular network and the impact of sectorization on the signal interference ratio were analyzed and understood and verified using MATLAB.