PABNA UNIVERSITY OF SCIENCE AND TECHNOLOGY

Lab Report

Faculty of Engineering and Technology

Department of Information and Communication Engineering

Course Code**: ICE-4104**

Course Title**: Cellular and Mobile Communication Sessional**

Submitted By:
Name: Sumaiya Khatun
Roll: **190620**
Registration No: **1065345**
Session: **2018-19**
Dept. of **ICE**, **PUST**

Submitted To:
Dr. Md. Imran Hossain
Associate Professor,
Department of **ICE,**
PUST

Submission Date:

Signature

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Experiment No: 01

Name of the Experiment: If a total of 33 MHz of bandwidth is allocated to a particular FDD cellular telephone system which uses two 25 kHz simplex channels to provide full duplex voice and control channels, compute the number of channels available per cell if a system uses (a) 4-cell reuse, (b) 7-cell reuse (c) 12-cell reuse. If 1 MHz of the allocated spectrum is dedicated to control channels, determine an equitable distribution of control channels and voice channels in each cell for each of the three systems.

Theory:

Frequency Reuse:

Cellular radio systems rely on an intelligent allocation and reuse of channels throughout a coverage region. Each cellular base station is allocated a group of radio channels to be used within a small geographic area called a cell. Base stations in adjacent cells are assigned channel groups which contain completely different channels than neighboring cells. The base station antennas are designed to achieve the desired coverage within the particular cell. By limiting the coverage area to within the boundaries of a cell, the same group of channels may be used to cover different cells that are separated from one another by distances large enough to keep interference levels within tolerable limits. The design process of selecting and allocating channel groups for all of the cellular base stations within a system is called frequency reuse or frequency planning.

Given,

Total bandwidth =33 MHz

Channel bandwidth = 25 * 2 simplex channels = 50 kHz/duplex channel

Total available channels = 33,000000/50000 = 660 channels

(a) For N= 4,

Total number of channels available per cell = 660/4 = 165 channels.

Allocated spectrum =1MHz=1000000Hz

Total control channel =Allocated channel/Channel bandwidth

=1000000/50000 = 20

Control channel =Total control channel/N

=20/4 = 5

Voice Channel = Total number of channels available per cell
- Control channel = 165-5 = 160

(b)For N=7,
Total number of channels available per cell = 660/7 = 95 channels.
Control channel =Total control channel/N
=20/7= 3
Voice Channel = Total number of channels available per cell
- Control channel = 94-3 = 91

(c)For N = 12,
Total number of channels available per cell = 660/12 = 55 channels.
Control channel =Total control channel/N
=20/12 = 2

Voice Channel = Total number of channels available per cell
- Control channel = 55-2 = 53

Source Code:

```
clc;
clear all;
close all;
TotalBandwidth=33000000;
ChannelBandwidth=25000*2;
disp(['Channel Bandwidth = ',num2str(ChannelBandwidth)]);
TotalAvailableChannel=(TotalBandwidth/ChannelBandwidth);
disp(['Total Available Channel = ',
num2str(TotalAvailableChannel)]);

AllocatedSpectrum=1000000;
TotalControlChannel=AllocatedSpectrum/ChannelBandwidth;
disp(['Total Control Channel = ',num2str(TotalControlChannel)]);

N=[4 7 12];
for i=1:3
    Channel_per_cell=round(TotalAvailableChannel/N(i));
    disp(['For n=',num2str(N(i))]);
    disp(['Available channels per cell =
',num2str(Channel_per_cell)]);
```

```
    controlChannel=round(TotalControlChannel/N(i));
    disp(['Total control channel = ',num2str(controlChannel)]);

    voiceChannel=Channel_per_cell-controlChannel;
    disp(['Total Voice Channel = ',num2str(voiceChannel)]);
end
```

Output:

Channel Bandwidth = 50000
Total Available Channel = 660
Total Control Channel = 20
For n=4
Available channels per cell = 165
Total control channel = 5
Total Voice Channel = 160
For n=7
Available channels per cell = 94
Total control channel = 3
Total Voice Channel = 91
For n=12
Available channels per cell = 55
Total control channel = 2
Total Voice Channel = 53

Experiment No: 02

Name of the Experiment : If a signal to interference ratio of 15 dB is required for satisfactory forward channel performance of a cellular system, what is the frequency reuse factor and cluster size that should be used for maximum capacity if the path loss exponent is (a) n= 4 , (b) n = 3? Assume that there are 6 co-channels cells in the first tier and all of them are at the same distance from the mobile. Use suitable approximations.

Theory:

Co-channel Interference and System Capacity:

Frequency reuse implies that in a given coverage area there are several cells that use the same set of frequencies. These cells are called co-channel cells, and the interference between signals from these cells is called co-channel interference. Unlike thermal noise which can be overcome by increasing the signal-to-noise ration(SNR), co-channel interference cannot be combated by simply increasing the carrier power of a transmitter This is because an increase in carrier transmit power increases the interference to neighboring co-channel cells. To reduce co-channel interference, co-channel cells must be physically separated by a minimum distance to provide sufficient isolation due to propagation.

(a) n = 4

First, let us consider a 7-cell reuse pattern.

Co-channel cell = 6

Frequency reuse factor, Q = $\sqrt{3N}$ = 4.583.

SNI = $10log\frac{Q^n}{6}$ = 75.3 = 18.66 dB>15 dB

Since this is greater than the minimum required S/I, N = 7 can be used.

b) n = 3 First, let us consider a 7-cell reuse pattern.

SNI = $10log\frac{Q^n}{6}$ = 12.05 dB<15 dB

Since this is less than the minimum required S/I, we need to use a larger N.

The next possible value of N is 12, (I = j = 2).

Frequency reuse factor, Q = $\sqrt{3N}$ = 4.583.   here, N=12

SNI = $10log\frac{Q^n}{6}$ = 15.5 >15 dB

Since this is greater than the minimum required S/I, N = 12 can be used.

Source Code:

```
clc;
clear all;
close all;
Given_SNI=15;          %signal to interference ratio 15dB
Cluster_size=7;

n=[4,3];

for a=1:2
    disp(['For n = ',num2str(n(a))]);
    Freq_Reuse_Factor=sqrt(3*Cluster_size);
    disp(['Frequency Reuse Factor =
',num2str(Freq_Reuse_Factor)]);

    signal_to_noise_interference_ratio =
10*log10((Freq_Reuse_Factor^n(a))/6);

    if signal_to_noise_interference_ratio> Given_SNI
        disp(['SNI Ratio =
',num2str(signal_to_noise_interference_ratio)]);
        disp('Cluster size = 7 can be used.');

    else
        signal_to_noise_interference_ratio =
10*log10((Freq_Reuse_Factor^n(a))/6);
        disp(['SNI Ratio =
',num2str(signal_to_noise_interference_ratio)]);
        disp('Cluster size 7 can not be used.')

        i=2; j=2;
        N= (i^2)+(i*j)+(j^2);
        disp(['The possible cluster size = ',num2str(N)]);
        Freq_Reuse_Factor=sqrt(3*N);
        disp(['Frequency Reuse Factor =
',num2str(Freq_Reuse_Factor)]);
        signal_to_noise_interference_ratio =
10*log10((Freq_Reuse_Factor^n(a))/6);
        disp(['SNI Ratio =
',num2str(signal_to_noise_interference_ratio)]);
    end
```

```
end
```

Output:

For n = 4
Frequency Reuse Factor = 4.5826
SNI Ratio = 18.6629
Cluster size = 7 can be used.
For n = 3
Frequency Reuse Factor = 4.5826
SNI Ratio = 12.0518
Cluster size 7 cannot be used.
The possible cluster size = 12
Frequency Reuse Factor = 6
SNI Ratio = 15.563

Experiment No: 03

Name of the Experiment: How many users can be supported for 0.5% blocking probability for the following number of trunked channels in a blocked calls cleared system? (a) 1, (b) 5, (c) 10, (d) 20, (e) 100. Assume each user generates 0.1 Erlangs of traffic.

Theory:

Cellular radio systems rely on trunking to accommodate a large number of users in a limited radio spectrum. The concept of trunking allows a large number of users to share the relatively small number of channels in a cell by providing access to each user, on demand, from a pool of available channels. In a trunked radio system, each user is allocated a channel on a per call basis, and upon termination of the call, the previously occupied channel is immediately returned to the pool of available channels.

The grade of service (GOS) is a measure of the ability of a user to access a trunked system during the busiest hour. The busy hour is based upon customer demand at the busiest hour during a week, month, or year. The busy hours for cellular radio systems typically occur during rush hours, between 4 p.m. and 6 p.m. on a Thursday or Friday evening. The grade of service is a benchmark used to define the desired performance of a particular trunked system by specifying a desired likelihood of a user obtaining channel access given a specific number of channels available in the system.

The traffic intensity offered by each user is equal to the call request rate multiplied by the holding time.
That is, each user generates a traffic intensity of A_u Erlangs given by

$$A_u = \lambda H \quad \text{------------ 1}$$

where H is the average duration of a call and k is the average number of call requests per unit time.
For a system containing U users and an unspecified number of channels, the total offered traffic intensity A, is given as

$$A = UA_u \quad \text{--------------2}$$

Source Code:

```
clc;
clear all;
close all;
GOS=0.5/100;
Au=0.1;
c=[1 5 10 20 100];
A=[0.005 1.13 3.96 11.1 80.9];

for i=1:5
    user=floor(A(i)/Au);
    if user<1
        user=ceil(A(i)/Au);
    end
    disp(['For channel ',num2str(c(i))]);
    disp(['User = ',num2str(user)]);
end
```

Output:

For channel 1
User = 1
For channel 5
User = 11
For channel 10
User = 39
For channel 20
User = 110
For channel 100
User = 809

Experiment No: 04

Name of the Experiment: An urban area has a population of 2 million residents. Three competing trunked mobile networks (systems A, B, and C) provide cellular service in this area. System A has 394 cells with 19 channels each, system B has 98 cells with 57 channels each, and system C has 49 cells, each with 100 channels. Find the number of users that can be supported at 2% blocking if each user averages 2 calls per hour at an average call duration of 3 minutes. Assuming that all three trunked systems are operated at maximum capacity, compute the percentage market penetration of each cellular provider.

Source Code:

```
clc;
clear all;
close all;
GOS=2/100;
Au=2*(3/60);     %generated traffic intensity
population=2000000;
c=[19 57 100];  %channel
A=[12 45 88];  %offered traffic intensity
cell=[394 98 49];
user=['A' 'B' 'C'];

for i=1:3
    u=A(i)/Au;
    Users_support=u*cell(i);
    disp(['Number of users that support ',num2str(user(i)),' =
',num2str(Users_support)]);

    percentage_market_penetration =
(Users_support/population)*100;
    disp(['Percentage market penetration =
',num2str(percentage_market_penetration)]);
end
```

Output:

Number of users that support A = 47280
Percentage market penetration = 2.364
Number of users that support B = 44100
Percentage market penetration = 2.205
Number of users that support C = 43120
Percentage market penetration = 2.156

Experiment No: 05

Name of the Experiment: A certain city has an area of 1,300 square miles and is covered by a cellular system using a 7-cell reuse pattern. Each cell has a radius of 4 miles and the city is allocated 40 MHz of spectrum with a full duplex channel bandwidth of 60 kHz. Assume a GOS of 2% for an Erlang B system is specified. If the offered traffic per user is 0.03 Erlangs, compute (a) the number of cells in the service area, (b) the number of channels per cell, (c) traffic intensity of each cell, (d) the maximum carried traffic; (e) the total number of users that can be served for 2% GOS, (f') the number of mobiles per channel, and (g) the theoretical maximum number of users that could be served at one time by the system.

Source Code:

```
clc;
clear all;
close all;
area=1300;
radius=4;
allocated_spectrum=40000000;
channel_bandwidth=60000;
frequency_reuse_factor=7;
GOS=2/100;
Offered_traffic_intensity=84;
offered_traffic_per_user=0.03;

%a
Each_cell_covers=2.5981*(radius)^2;
Total_num_of_cell=round(area/Each_cell_covers);
disp(['The number of cells in the service area =
',num2str(Total_num_of_cell)]);

%b
channels_per_cell=round(allocated_spectrum/(channel_bandwidth*fr
equency_reuse_factor));
disp(['The number of channels per cell =
',num2str(channels_per_cell)]);

%c
disp(['As total number of channel per cell is 95 and GOS is 0.02
then the offered traffic intensity will be
',num2str(Offered_traffic_intensity)]);
```

```
%d
maximum_carried_traffic =
Total_num_of_cell*Offered_traffic_intensity;
disp(['Maximum carried traffic =
',num2str(maximum_carried_traffic)]);

%e
total_nb_of_user=maximum_carried_traffic/offered_traffic_per_use
r;
disp(['Total number of user = ',num2str(total_nb_of_user)]);

%f
Nb_of_channels=channels_per_cell*frequency_reuse_factor;
Nb_of_mobiles_per_channel=floor(total_nb_of_user/Nb_of_channels)
;
disp(['Number of mobiles per channels =
',num2str(Nb_of_mobiles_per_channel)]);

%g
theoretical_maximum_number_of_user=channels_per_cell*Total_num_o
f_cell;
disp(['Theoretical maximum numbers of users =
',num2str(theoretical_maximum_number_of_user)]);
```

Output:

The number of cells in the service area = 31
The number of channels per cell = 95
As total number of channel per cell is 95 and GOS is 0.02 then the offered traffic intensity will be 84
Maximum carried traffic = 2604
Total number of user = 86800
Number of mobiles per channels = 130
Theoretical maximum numbers of users = 2945

Experiment No: 06

Name of the Experiment: If a transmitter produces 50 watts of power, express the transmit power in units of (a) dBm, and (b) dBW. If 50 watts is applied to a unity gain antenna with a 900 MHz carrier frequency, find the received power in dBm at a free space distance of 100 m from the antenna, what is P (10 km)? Assume unity gain for the receiver antenna.

Theory:

The free space propagation model is used to predict received signal strength when the transmitter and receiver have a clear, unobstructed line-of-sight path between them. Satellite communication systems and microwave line-of-sight radio links typically undergo free space propagation. In satellite link there is no obstruction between the transmitter and the receiver.

As there is no obstruction, we are able to calculate the signal strength of the received signal.

The free space power received by a receiver antenna which is separated from a radiating transmitter antenna by a distance d, is given by the Friis free space equation,

$$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L} \qquad \text{.............................(1)}$$

Where P_t is the transmitted power

$P_r(d)$ is the received power

G_t is the transmitter antenna gain

G_r is the receiver antenna gain

d is the T-R separation distance in meters

λ is the wavelength in meters

L is the system loss factor not related to propagation (L≥ 1)

The miscellaneous losses L (L≥ 1) are usually due to transmission line attenuation, filter losses, and antenna losses in the communication system. A value of L = I indicates no loss in the system hardware.

The gain of an antenna is related to its effective aperture, A_e by

$$G = \frac{4\pi A_e}{\lambda^2} \qquad \text{.................................(2)}$$

Where A_e is effective aperture and λ is related to the carrier frequency by

$$\lambda = \frac{c}{f} = \frac{2\pi c}{W_c} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where f is the carrier frequency in Hertz
W_c is the carrier frequency in radius per second
c is the speed of light given in meter/second

An isotropic radiator is an ideal antenna which radiates power with unit gain uniformly in all directions, and is often used to reference antenna gains in wireless systems. The Effective Isotropic Radiated Power (EIRP) is defined as,

$$EIRP = P_t G_t \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The path loss, which represents signal attenuation as a positive quantity measured in DB, as defined as the difference between the effective transmitted power and the received power, and may or may not include the effect of the antenna gains. The path loss for the free space model when antenna gains are included is given by

$$\mathrm{PL}(dB) = 10log\frac{P_t}{P_r} = -10log\left[\frac{G_t G_r \lambda^2}{(4\pi)^2 d^2}\right] \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

When antenna gains are excluded, the antennas are assumed to have unity gain, and path loss is given by

$$\mathrm{PL}(dB) = 10log\frac{P_t}{P_r} = -10log\left[\frac{\lambda^2}{(4\pi)^2 d^2}\right] \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

The far-field, or Fraunhofer region, of a transmitting antenna is defined as the region beyond the far-field distance $\mathrm{d_f}$, which is related to the largest linear dimension of the transmitter antenna aperture and the carrier wavelength. The Fraunhofer distance is given by

$$\mathrm{d_f} = \frac{2\mathrm{D}^2}{\lambda} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

where D is the largest physical linear dimension of the antenna. Additionally, to be in the far-field region, $\mathrm{d_f}$ must satisfy

$$\mathrm{d_f} \gg D \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7.1)$$

And

$$\mathrm{d_f} \gg \lambda \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7.2)$$

For path loss models, d can't be 0. For this reason, large-scale propagation models use a close-in distance d_0, known received power reference point. The received power, $P_r(d)$, at any distance $d > d_0$. The reference distance must be chosen such that it lies in the far-field region, that is $d_0 \geq d_f$ and d_0 is chosen to be smaller than any practical distance used in the mobile communication system. Thus using equation 1), the received power in free space at any distance grater than d_0 is given by,

$$P_r(d) = P_r(d_0)\left(\frac{d_0}{d}\right)^2 \qquad d \geq d_0 \geq d_f \quad \ldots\ldots\ldots\ldots\ldots\ldots(8)$$

Equation 8 may be expressed in units of dBm or dBW by simply taking the logarithm of both sides and multiplying by 10. For example, if is in units of dBm, the received power is given by,

$$P_r(d)dBm = 10\log\left[\frac{P_r(d_0)}{0.001W}\right] + 20log(\frac{d_0}{d}) \qquad d \geq d_0 \geq d_f$$

Source Code:

```
clc;
clear all;
close all;
Transmitted_power=50;
Carrier_freq=900*10^6;
Transmitter_gain=1;
Receiver_gain=1;
distance=100;
do=10*10^3;

Transmitted_power_in_dBm=
round(10*log10(Transmitted_power*10^3));
disp(['Transmitted power in dBm is
',num2str(Transmitted_power_in_dBm)]);

Transmitted_power_in_dbW= round(10*log10(Transmitted_power));
disp(['Transmitted power in dBW is
',num2str(Transmitted_power_in_dbW)]);

lamda=(3*10^8)/(Carrier_freq);
pr_mw=((Transmitted_power*Transmitter_gain*Receiver_gain*(lamda^
2))/(((4*3.1416)^2)*(distance^2)*1))*1000;
received_power_in_dbm = 10*log10(pr_mw);
disp(['Received power in dBm is
',num2str(received_power_in_dbm)]);

pr_10km = received_power_in_dbm+(20*log10(distance/do));
disp(['Received power at 10km is  ',num2str(pr_10km)]);
```

Output:

Transmitted power in dBm is 47
Transmitted power in dBW is17
Received power in dBm is -24.5369
Received power at 10km is-64.5369

Experiment No: 07

Name of the Experiment: Determine the path loss of a 900MHz cellular system in a large city from a base station with the height of 100m and mobile station installed in a vehicle with antenna height of 2m. The distance between mobile and base station is 4Km.

Theory:

The Hata model is an empirical formulation of the graphical path loss data provided by Okumura, and is valid from 150 MHz to 1500 MHz. Hata presented the urban area propagation loss as a standard formula and supplied correction equations for application to other situations.

The standard formula for median path loss in urban areas is given by

$$\mathrm{L50(Urban)} = 69.55 + 26.16 * \log10(\mathrm{fc}) - 13.82 * \log10(\mathrm{hte}) - \mathrm{a(hre)} + \left(44.9 - 6.55 * \log10(\mathrm{hte})\right) * \log10(\mathrm{d}) \quad \text{-------------} \quad (1)$$

where is the frequency (in MHz) from 150 MHz to 1500 MHz,
hte is the effective transmitter (base station) antenna height (in meters) ranging from 30 m to 200 m,
hre is the effective receiver (mobile) antenna height (in meters) ranging from 1 m to 10 m,
d is the T-R separation distance (in km), and
a(hre) is the correction factor for effective mobile antenna height which is a function of the size of the coverage area.
For a small to medium sized city, the mobile antenna correction factor is given by

$$\mathrm{a(hre)} = 1.1(\mathrm{logf} - 0.7)\mathrm{hre} - (1.56\mathrm{logfc} - 0.8)\mathrm{dB} \text{ -------------}(2)$$

For a large city, it is given by
a(hre) = 8.29(log1.54hre)^2 -1.1dB for fc<=300MHz ------------- (3)
a(hre) = 3.2(log11.75hre)^2 -4.97dB for fc>=300MHz ------------- (4)

To obtain the path loss in suburban area the standard Hata formula is modified as
L50(dB) = L50(urban)-2[log(fc/28)]^2-5.4 -------------(5)

for path loss in open rural areas, the formula is modified as
L50(dB) = L50(urban)-4.78log(fc)^2-18.33logfc-40.98 -------------(5)

Source Code:

```
clc;
clear all;
close all;

hre=2;
hte=100;
fc=900;
d=4;

a_hre=3.2*(log10(11.75*hre))^2-4.97;
Lp=69.55+26.16*log10(fc)-13.82*log10(hte)-a_hre+(44.9-
6.55*log10(hte))*log10(d);
disp('Loss path');
disp(Lp);
```

Output:

Loss path
  137.2930

Experiment No: 08

Name of the Experiment: Determine the path loss between base station (BS) and mobile station (MS) of a 1.8GHz PCS system operating in a high-rise urban area. The MS is located in a perpendicular street to the location of the BS. The distances of the BS and MS to the corner of the street are 20 and 30 meters, respectively. The base station height is 20m.

Source Code:

```
clc;
clear all;
close all;
fc=1.8;
hb=20;
d=sqrt((20)^2+(30)^2)/1000;
disp(d);
PathLoss=135.41+(12.49*log10(fc))-(4.99*log10(hb))+((46.82-
2.34*log10(hb))*log10(d));
disp(['PathLoss ',num2str(PathLoss)]);
```

Output:

0.0361

PathLoss 68.9368

Experiment No: 09

Name of the Experiment: A mobile is located 5 km away from a base station and uses a vertical λ /4 monopole antenna with a gain of 2.55 dB to receive cellular 3 radio signals. The E-field at 1 km from the transmitter is measured to be V/rn. The carrier frequency used for this system is 900 MHz.
(a) Find the length and the gain of the receiving antenna.
(b) Find the received power at the mobile using the 2-ray ground reflection model assuming the height of the transmitting antenna is 50 m and the receiving antenna is 1.5m above ground.

Source Code:

```
clc;
clear all;
close all;
T_R_distance = 5;
E_field = 10^(-3);
f = 900;
do=1000;
lamda=(3*10^8)/(900*10^6);

ht=50;
hr=1.5;
d=5*10^3;

%a

length_of_antenna = lamda/4;
gain = (10^(2.55/10));
effective_aperture=(gain*(lamda)^2)/(4*3.1416);
disp([Gain is ',num2str(gain)]);

%b
Er_d = (2*E_field*do*2*3.1416*ht*hr)/(lamda*d^2);
disp(['Electric Field ',num2str(Er_d)]);

pr_d=((Er_d^2)/(120*3.1416))*effective_aperture;
received_power_at_5km_distance = 10*log10(pr_d);
disp(['Received power at distance in dBW
',num2str(received_power_at_5km_distance)]);

received_power2=10*log10(pr_d*1000);
```

```
disp(['Received power at distance in dBm
',num2str(received_power2)]);
```

<u>Output:</u>

Gain is 1.7988
Electric Field 0.0001131
Received power at distance in dBW-122.6788
Received power at distance in dBm -92.6788

Experiment No: 10

Name of the Experiment: A hexagonal cell within a 4-cell system has a radius of 1.387 km. A total of 60 channels are used within the entire system. If the load per user is 0.029 Erlangs, and λ= call/hour, compute the following for an Erlang C system that has a 5% probability of a delayed call: (a) How many users per square kilometer will this system support? (b) What is the probability that a delayed call will have to wait for more than 10s? (c) What is the probability that a call will be delayed for more than 10 seconds?

Source Code:

```
clc;
clear all;
close all;
radius = 1.387;
cluster = 4;
total_channel = 60;
channel_per_cell = total_channel/cluster
each_cell_covers = 2.5981*radius^2
traffic_per_user = 0.029;
t = 10;
blocking_probability = 5/100;


disp('(a)')
traffic_intensity = 9;
no_of_user =
floor(traffic_intensity/(traffic_per_user*each_cell_covers))

disp('(b)')
lembda=1; %Au = lembda/H_holding time
holding_time = (traffic_per_user/lembda)*60*60
probability_to_wait = exp(-(channel_per_cell -
traffic_intensity)*t/holding_time)*100

disp('(c)')
probability_of_delay = blocking_probability *
probability_to_wait
```

Output:

channel_per_cell = 15

each_cell_covers =4.9981

(a)

no_of_user = 62

(b)

holding_time =104.4000

probability_to_wait =56.2867

(c)

probability_of_delay =2.8143