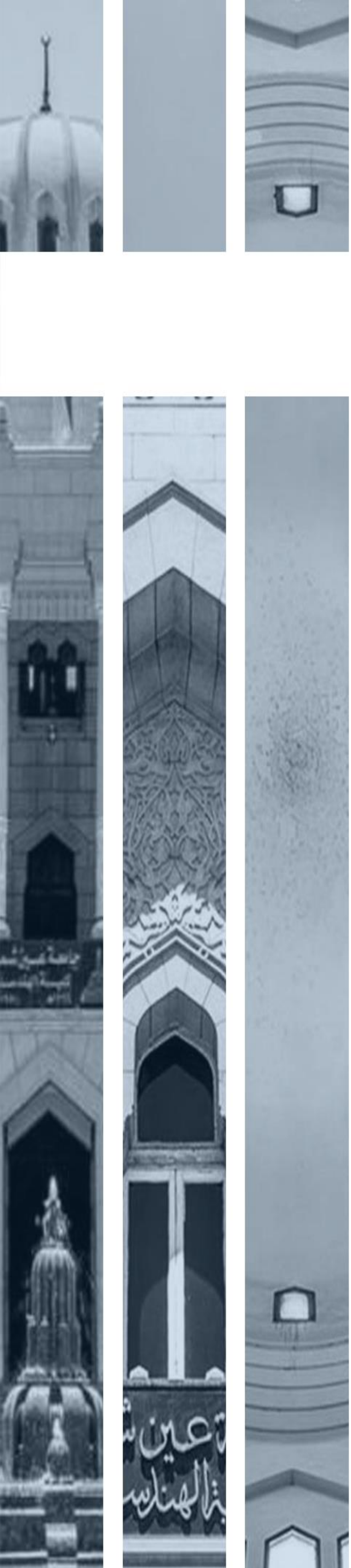

PROJECT

Program: **Senior 1 ECE**

Course Code: ECE 353s

Course Name:

Wireless Communication Networks

Ain Shams University
Faculty of Engineering
Spring Semester – 2024

Table of Contents

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Part A:

A) It is required to design using MATLAB, a simple planning tool for a service provider to produce the following design parameters:

1) Cluster Size.

2) Number of cells.

3) Cell radius.

4) Traffic intensity per cell, and traffic intensity per sector.

5) Base station transmitted power.

6) A plot for the MS received power in dBm versus the receiver distance from the BS.

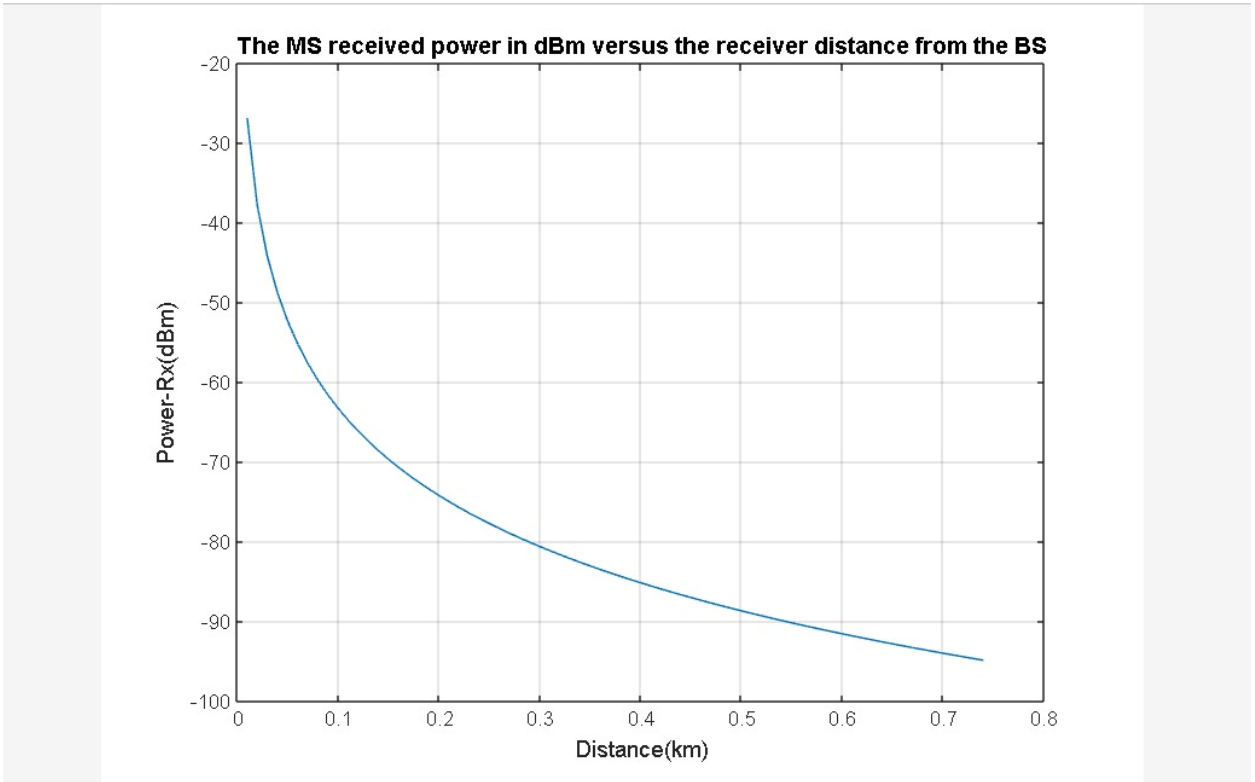
➢ The output :

untitled.m | Figure 1

Command Window

New to MATLAB? See resources for Getting Started.

```
Enter the GOS :
0.2
Enter the city area :
100
Enter the user density :
1400
Enter the min_SIR_db :
19
Enter the sectorization_method press 6 for omnidirectional or 2 for 120 degrees or 1 for 60 degrees:
2
Cluster Size: 7
Number of Cells: 69
Cell Radius: 0.75 km
Traffic Intensity per Cell: 51.00 Erlang
Traffic Intensity per Sector: 17.00 Erlang
Base Station Transmitted Power: 29.23 dBm
>> |
```



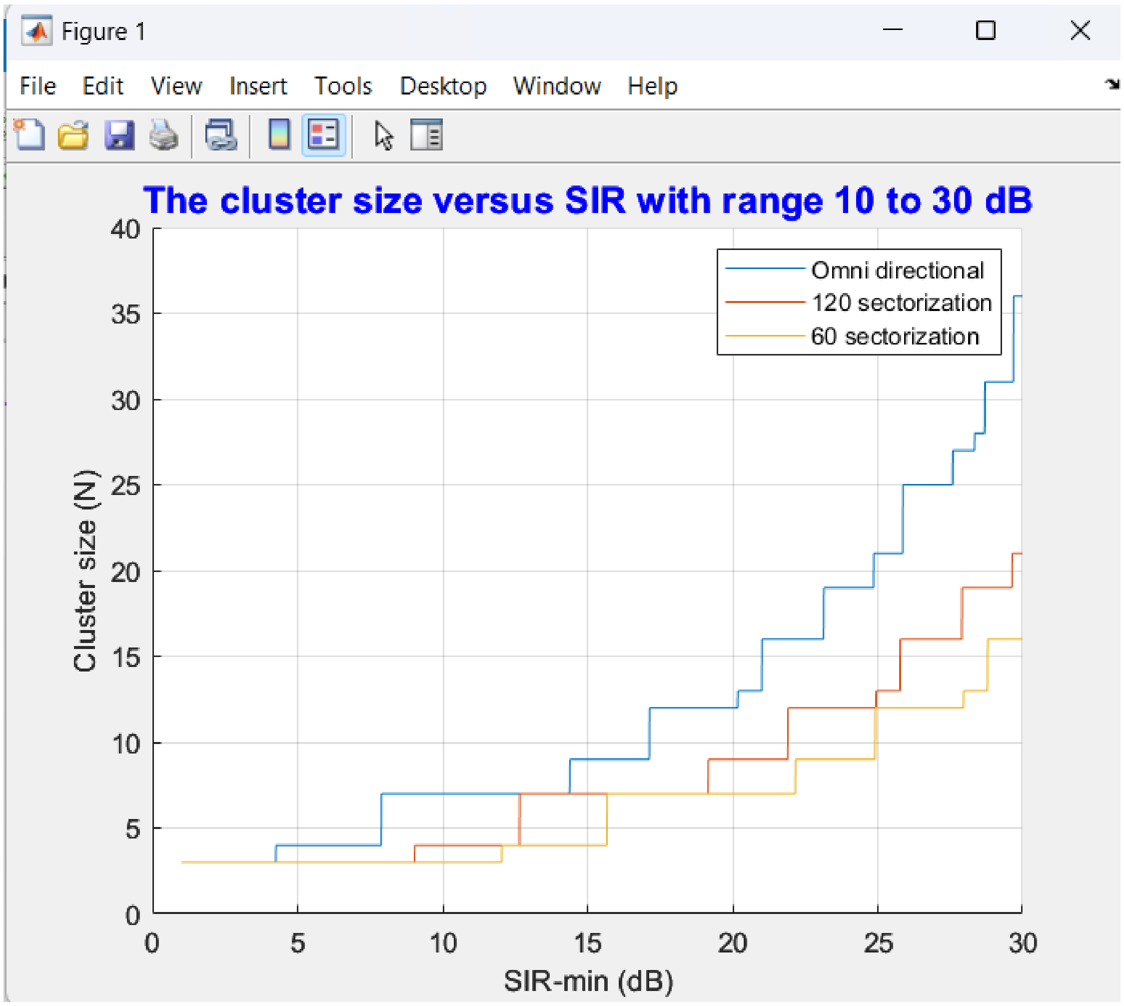
➢ Comment:

- ***with increasing the distance between Rx and Tx, the power received at the receiver decreases exponentially (hata model).***

Part B:

B) To validate your planning tool, it is required for a city area equal to 100 $km2$ to deliver the following figures with reasonable comments. Each figure should contain three curves for omni-directional, 120° sectorization and 60° sectorization designs.

1) Plot the cluster size versus $SIRmin$ with range from 1$dB\ to$ 30 dB.

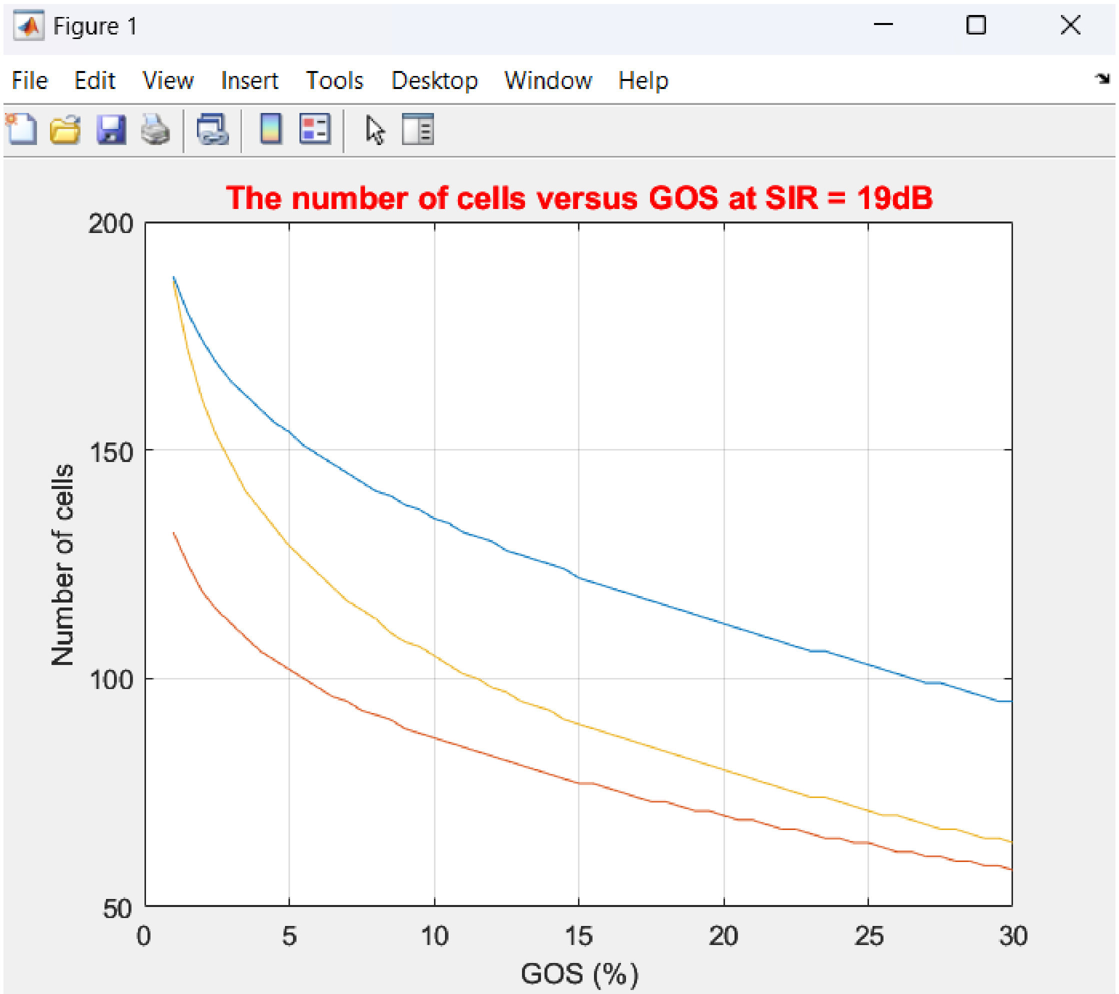


➢ Comment:

- ***there is step increase at odd number of the cluster and reaches N = 31 at SIR = 29 dB for omni directional***
- ***For 120 sectorization: it reaches N=19 at SIR=29 dB***
- ***For 60 sectorization: it reaches N = 16 at SIR = 29 dB***
- ***As the sectorization increase (number of sectors), the cluster size decreases.***

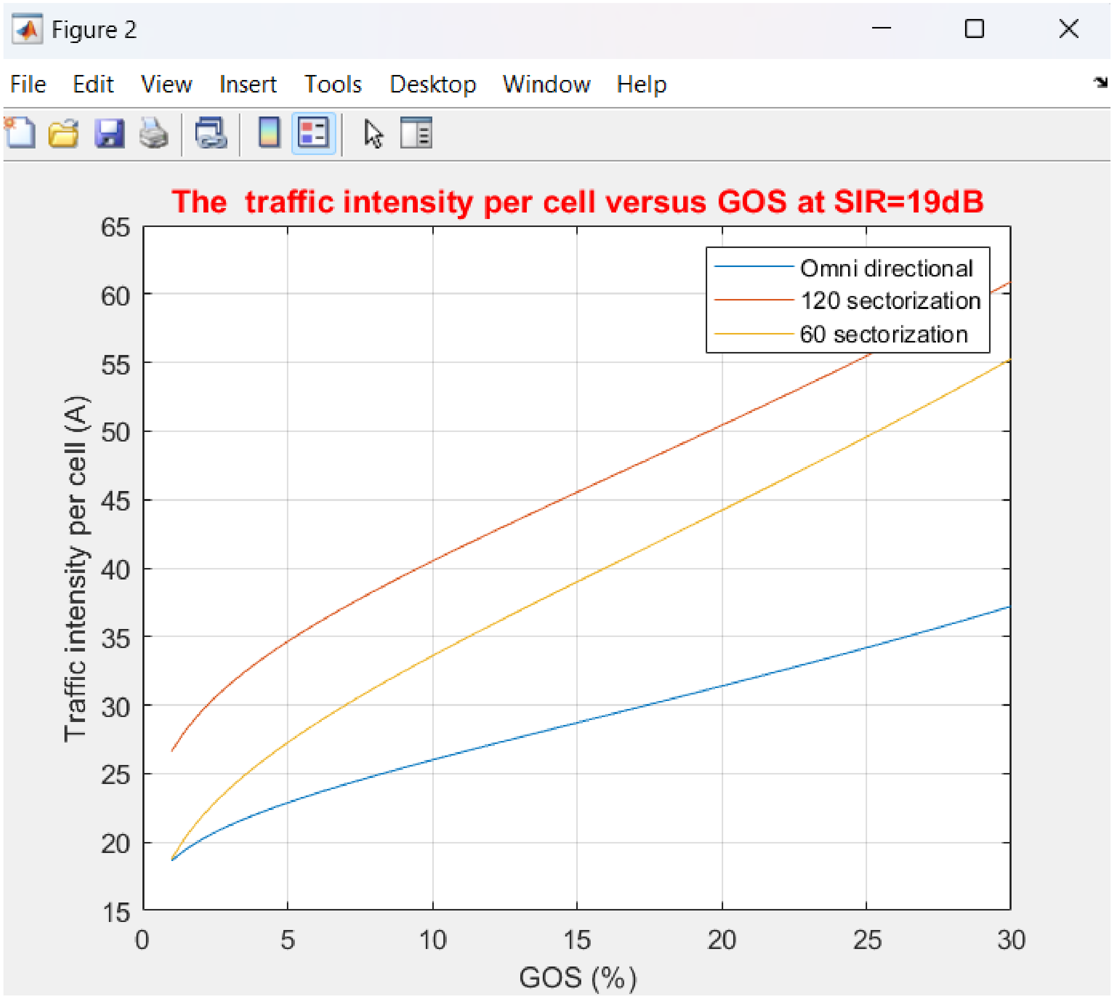
2) For $SIRmin$ = 19dB & user density= 1400 $users/km2$,

i) Plot the number of cells versus GOS (1% to 30%).



- *Comment:*
  - ***The number of cells decreases with increasing GOS.***
  - ***Number of the cells at 120° sectorization is lower than others.***
  - ***As sectorization increases cluster size (N) decreases, so capacity increases, so 60° has higher number of cells than 120°.***

ii) Plot the traffic intensity per cell versus GOS (1% to 30%).

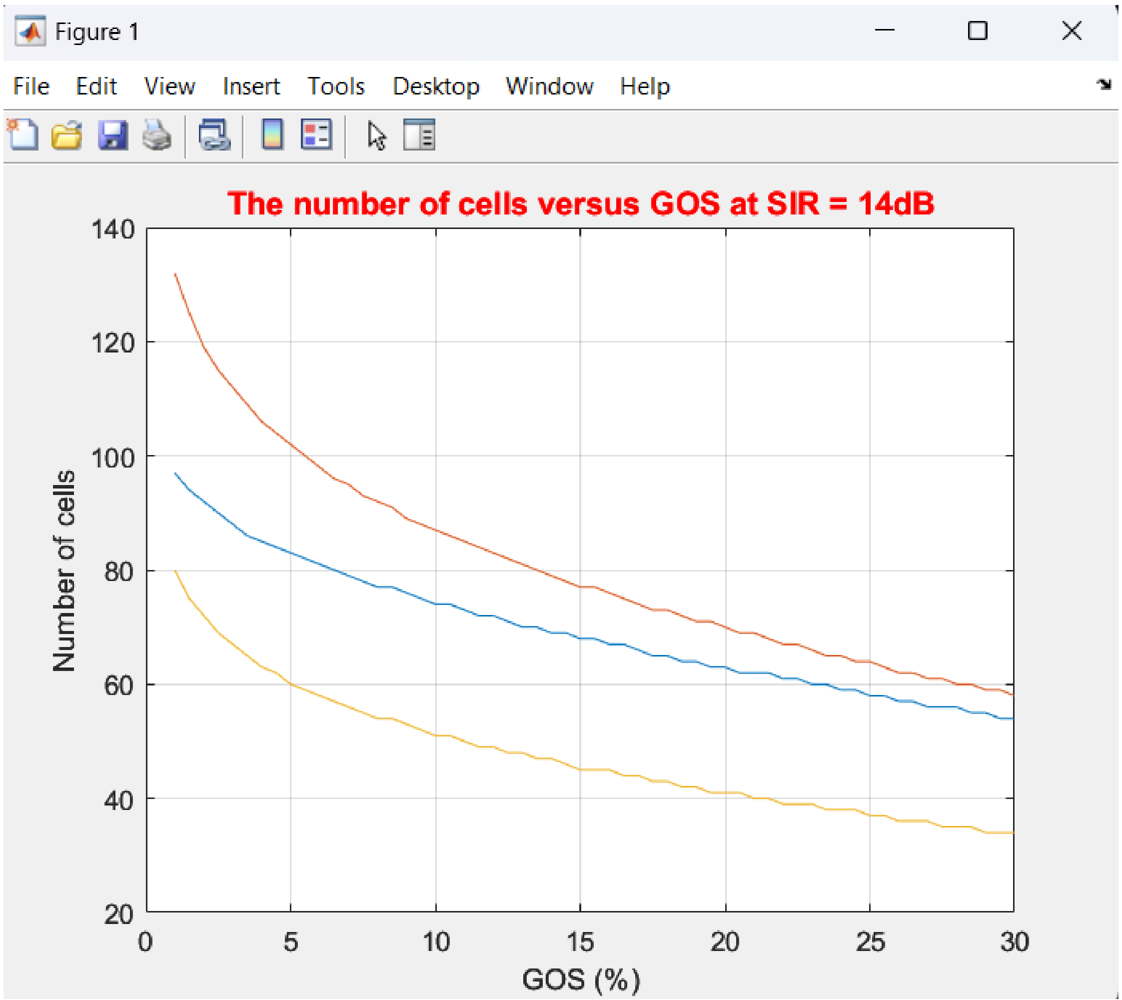


➢ *Comment:*

- ***The traffic intensity per cell increases when GOS increases.***
- ***Traffic intensity increases at sectorization (as interference decreases).***
- ***120° sectorization has higher traffic intensity/cell at SIR = 19dB***

3) At $SIRmin$ = 14dB & user density= 1400 $users/km2$,

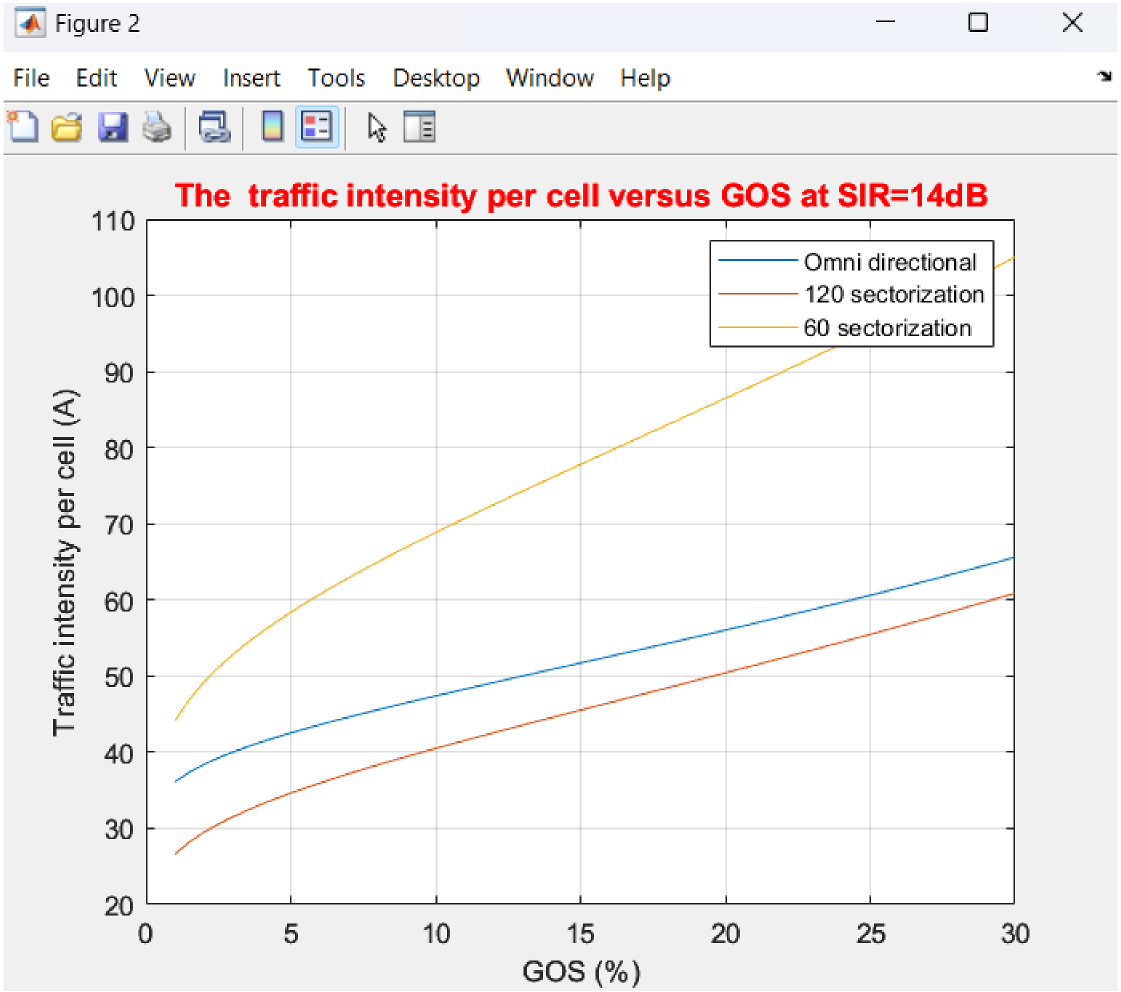
i) Plot the number of cells versus GOS (1% to 30%).



➢ *Comment:*

- ***With increasing the GOS and decreasing SIR, the number of cells decreases***
- ***With decreasing the SIR (interference increases) 120° sectorization will have higher number of cells than the others, and 60° sectorization will be the lowest.***

ii) Plot the traffic intensity per cell versus GOS (1% to 30%).

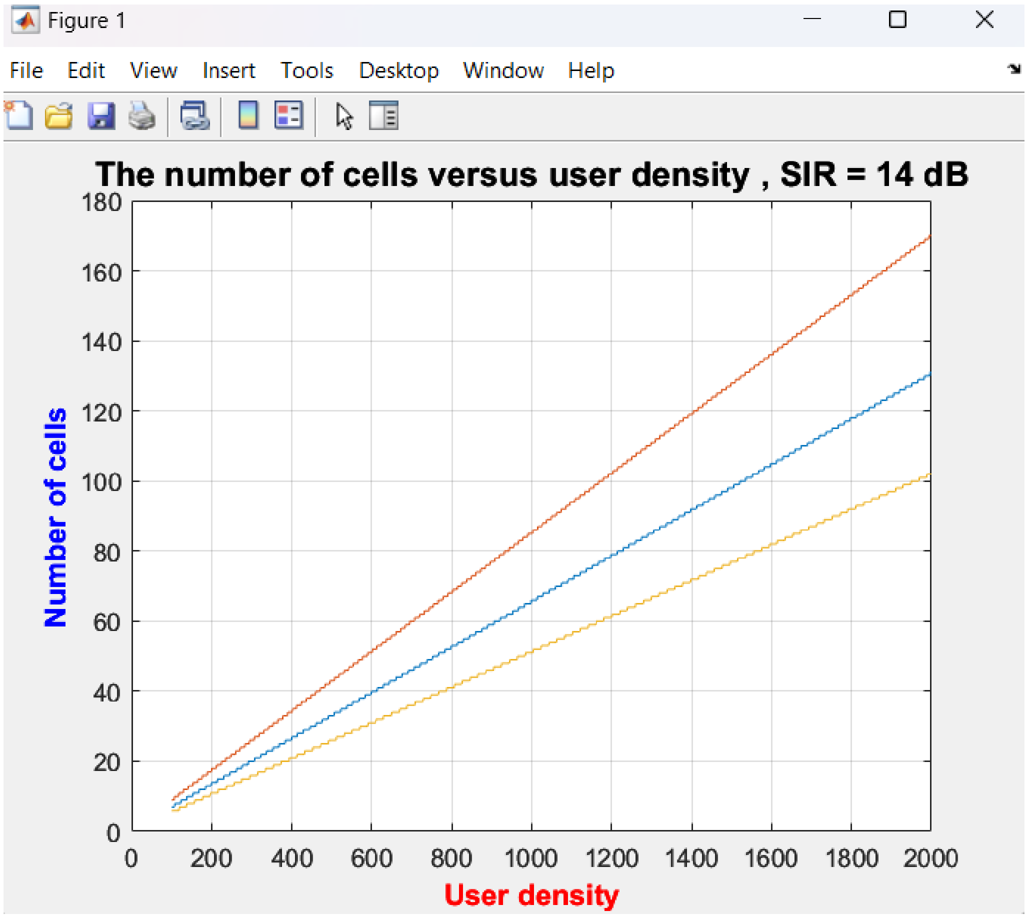


➢ *Comment:*

- ***With decreasing the SIR, the traffic intensity per cell increase (as cluster size decreased).***
- ***60° sectorization will have higher user density than others at SIR =14 dB (as we increased interference and 60° sectorization has lower interference so User density increases in 60° sectorization).***

4) At $SIRmin$ = $14dB$ & GOS= 2%,

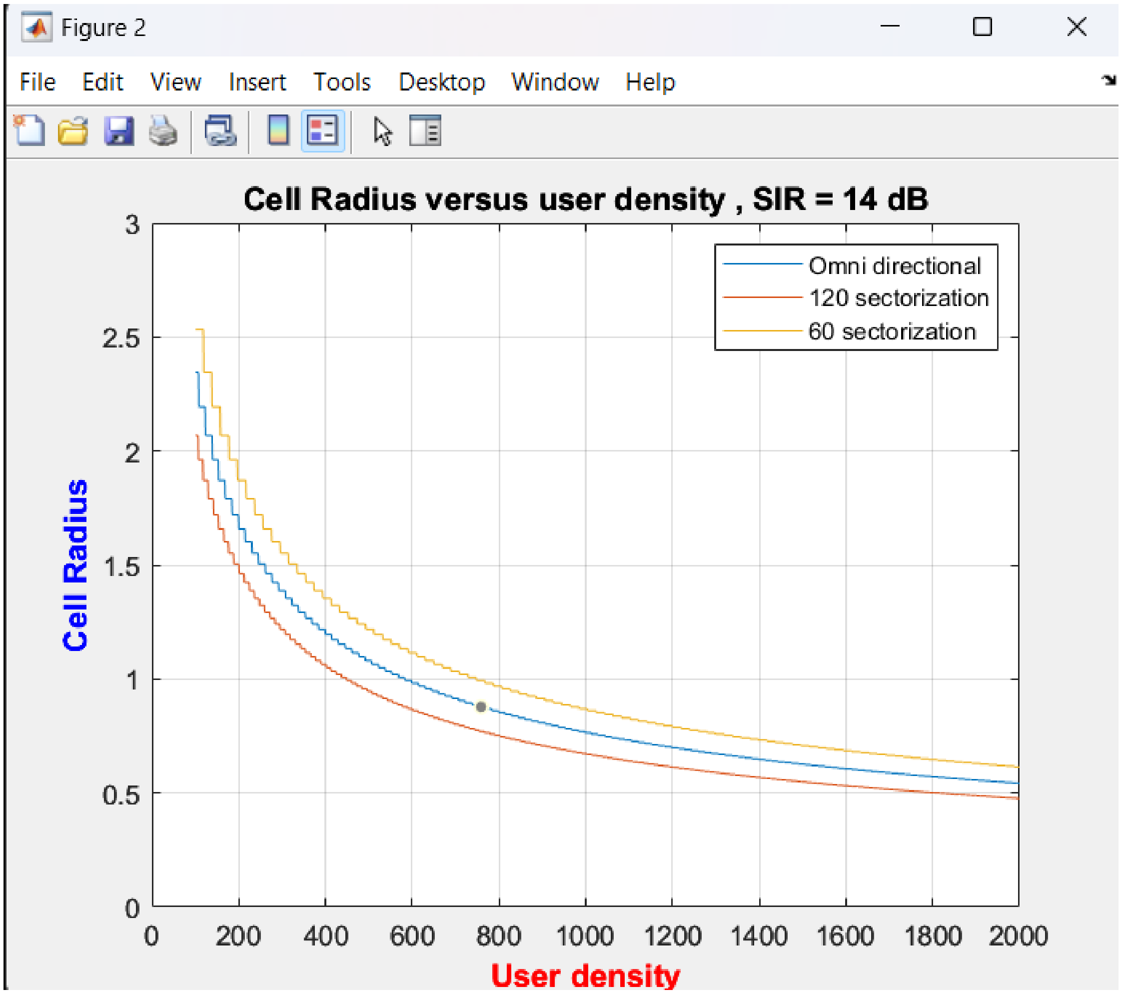
i) Plot the number of cells versus user density (100 to 2000 $users/km2$).



- *Comment:*

As user density increase the number of cells increase linearly and reach its highest at 120° sectorization at SIR = 14 dB

ii) Plot the cell radius versus user density (100 to 2000 $users/km2$).

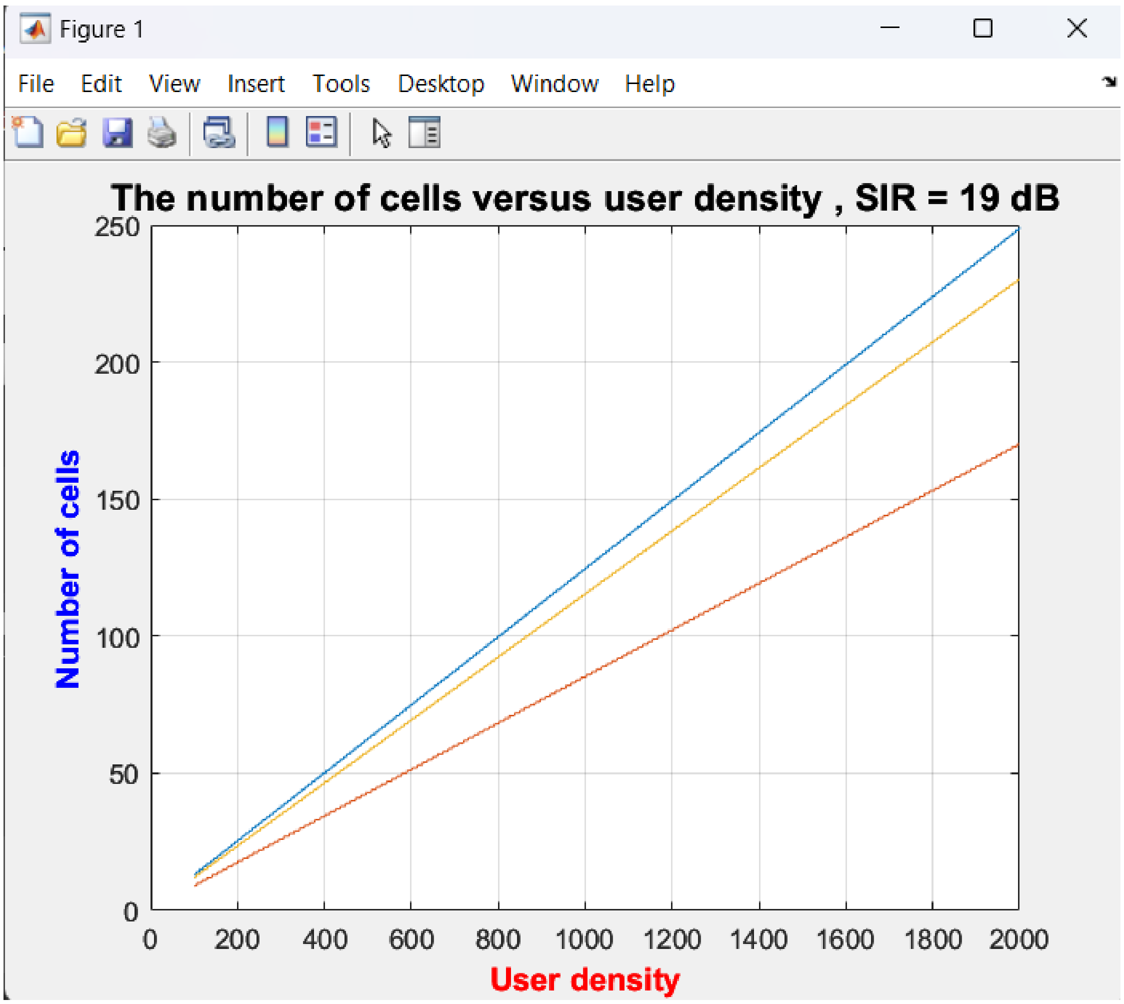


➢ *Comment:*

- ***As user density increases the cell radius decreases***
- ***60° sectorization has higher radius than the others at SIR = 14dB.***

5) At $SIRmin$ = 19dB & GOS= 2%,

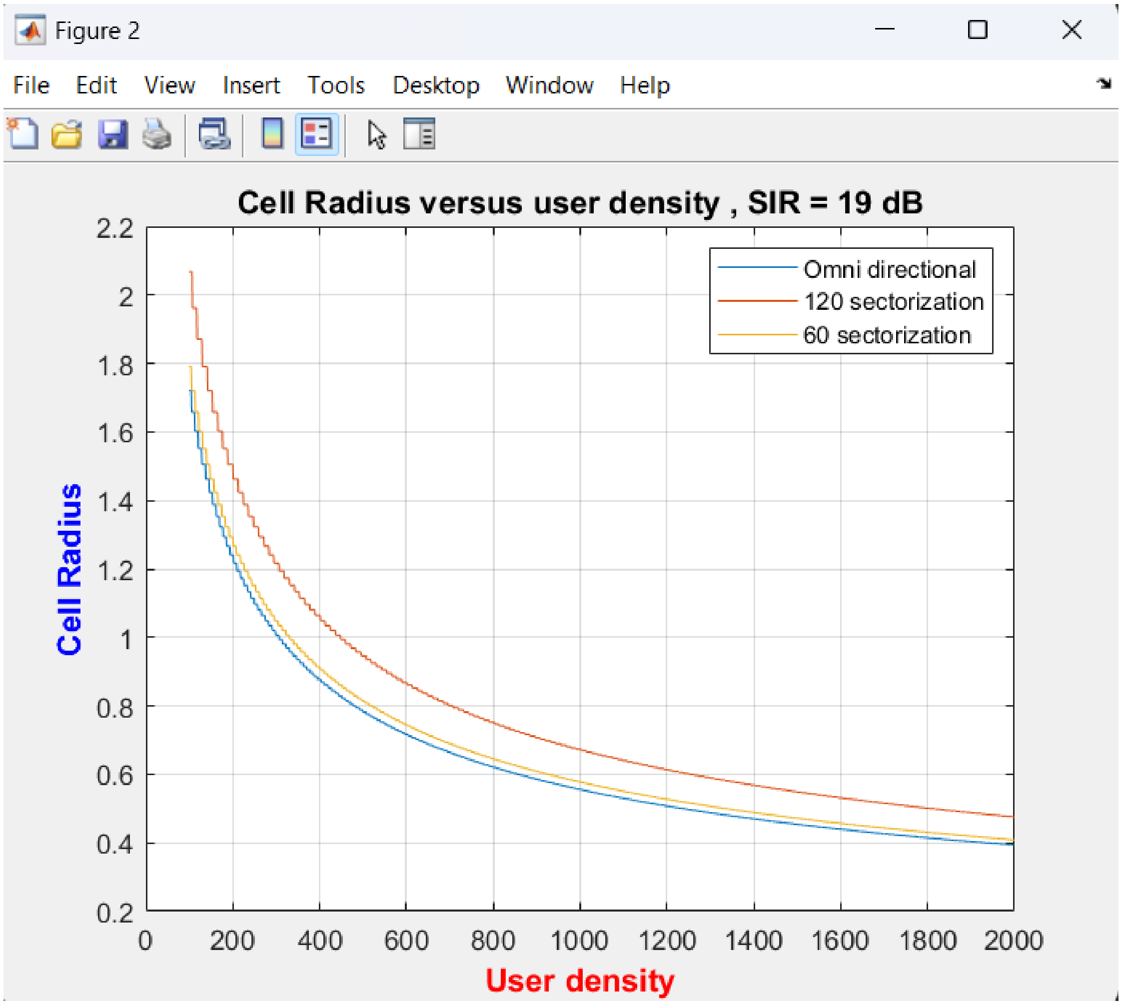
i) Plot the number of cells versus user density (100 to 2000 $users/km2$).



➢ *Comment:*

- ***With increasing the SIR to 19 dB the traffic intensity increases per cell and number of cells increases to get the same user density***
- ***Omni-directional sectorization has a higher number of cells than the others at SIR=19dB.***

ii) Plot the cell radius versus user density (100 to 2000 $users/km2$).



➢ *Comment:*

- ***with increasing the SIR to 19 dB the traffic intensity per cell decreases and cell radius decreases to get the same user density***
- ***120° sectorization has higher radius than the others at SIR = 19 dB***

Laws and mathematical equations used:

1. Cluster size: $N = \frac{(\sqrt[4]{io \times SIR}+1)^2}{3}$ — io is due to sectorization
2. Where: $N = ij + j^2 + i^2$ — i, j=0,1,2,3,4…
3. $K = \text{floor}(\frac{340}{N * no\ of\ sectors})$ — Channels per sector
4. $\Pr[\text{blocking}] = \frac{\frac{A^C}{C!}}{\sum_{k=0}^{C} \frac{A^k}{k!}}$ — C =K, A =Traffic/sector
5. A/cell = A/sector * number of sectors — Traffic/cell
6. Total users = user density * City area
7. **A** = Au * Total users — Total traffic
8. Number of cells = $\frac{\mathbf{A}}{A/cell}$
9. $R = \sqrt{\frac{2 * city\ area}{2\sqrt{3} * cells}}$ — Cell radius
10. Hata model: $L_U = 69.55 + 26.16 \log_{10} f - 13.82 \log_{10} h_B - C_H + [44.9 - 6.55 \log_{10} h_B] \log_{10} d$

For small or medium-sized city,

$$C_H = 0.8 + (1.1 \log_{10} f - 0.7) h_M - 1.56 \log_{10} f$$

where

- L_U = Path loss in urban areas. Unit: decibel (dB)
- h_B = Height of base station antenna. Unit: meter (m)
- h_M = Height of mobile station antenna. Unit: meter (m)
- f = Frequency of transmission. Unit: Megahertz (MHz)
- C_H = Antenna height correction factor
- d = Distance between the base and mobile stations. Unit: kilometer (km).