Wireless Communication

course project

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Mathematical Equations Used in Part(A):

- ***We start by cluster size***

  N= (1/3) * ((N_face * 10.^(SIRMIN / 10)).^(1 / n)).^2;
  N_face *=[1,2,6] determines the interferer according to the sectorization.*
  N_face *=6 for omnidirectional and so on cluster size can take only discrete values satisfying the equation* $(N = i2 + j2 + i * j)$ $i, j = 0,1,2,3\ldots(integers) \rightarrow N = 1,3,4,7,9,\ldots.$
  Then we calculate number of channels per cell and number of channels per sector.

- *Number of Channels per cell* $K=S/N$
  For sectored cells we need determine number of channels per sector
  $C = K/J$

  Where:
  - S is the total number of channels per cluster
  - K is the total number of channels per cell
  - C is the total number of channels per sector
  - N is number of cells per cluster
  - J is number of sectors per cell (due to ’60° sectorization J = 6 ’, ‘due to ’120° sectorization J =3 ’, ‘due to Omni directional J = 1’)

- ## Area of the cell (hexagonal cells)

  U=A/Au

  Area of the cell=U/Density of users

  Area of the cell= $\mathbf{1.5\sqrt{3}\,R^2}$

  ## Where:

A is the total traffic intensity per cell

A_u is the user traffic intensity

R is the radius of the cell

• From the GOS Erlang-B (blocked calls cleared) equation we find A

(traffic intensity for sector and Cell)

- We create a vector for $Asector$ and then calculate the probability of error for each value of it then we find the value of $Asector$ that satisfy the desired GOS.

$$\frac{\left(\frac{Asector^{C}}{C!}\right)}{\sum_{m=0}^{C}\frac{(Asector^{m})}{m!}} = \mathbf{GOS}, \quad A_{cell} = A_{sector} \times J$$

$$\frac{\frac{\left(\frac{Acell}{j}\right)^{C}}{C!}}{\sum_{m=0}^{C}\frac{\left(\frac{Acell}{j}^{m}\right)}{m!}} = \mathbf{GOS}$$

Where:

- **A = UλH is the average offered traffic intensity.**
- **U is the total number of users.**
- **λ is the average call arrival rate for each user.**
- **Au = λH is the average offered traffic intensity for each user.**
- **C is the number of channels.**

- **In your design, use the Hata model and assume urban-medium city**

but what is hata model?

Hata model, is a widely-used empirical formulation for predicting the propagation loss of radio waves in cellular networks over various terrains and at different frequencies.

PL = $69.55+26.16log10(fc)-13.82log10(ht)-CH+(44.9 -6.55log10(ht))log10(d)$

CH = $0.8+(1.1Log(f)-0.7)\ hr-1.56Log\ (f)$

PL(DB)= $69.55+26.16*log10(900)-13.82*log10(ht)-CH+(44.9-6.55*log10(ht))*log10(x(i))$ **in matlab code**

- **PL is the path loss in decibels (dB).**
- **F is the frequency in megahertz (MHz).**
- **ht is the height of the transmitting antenna in meters (m).**
- **hr is the height of the receiving antenna in meters (m).**
- **d is the distance between the transmitter and receiver in kilometers (km).**
- **CH is the Antenna Height Correction Factor.**

- **Base Station transmitted power**

BSpower = $\boldsymbol{MSsensitivity} + |\boldsymbol{PL}|$

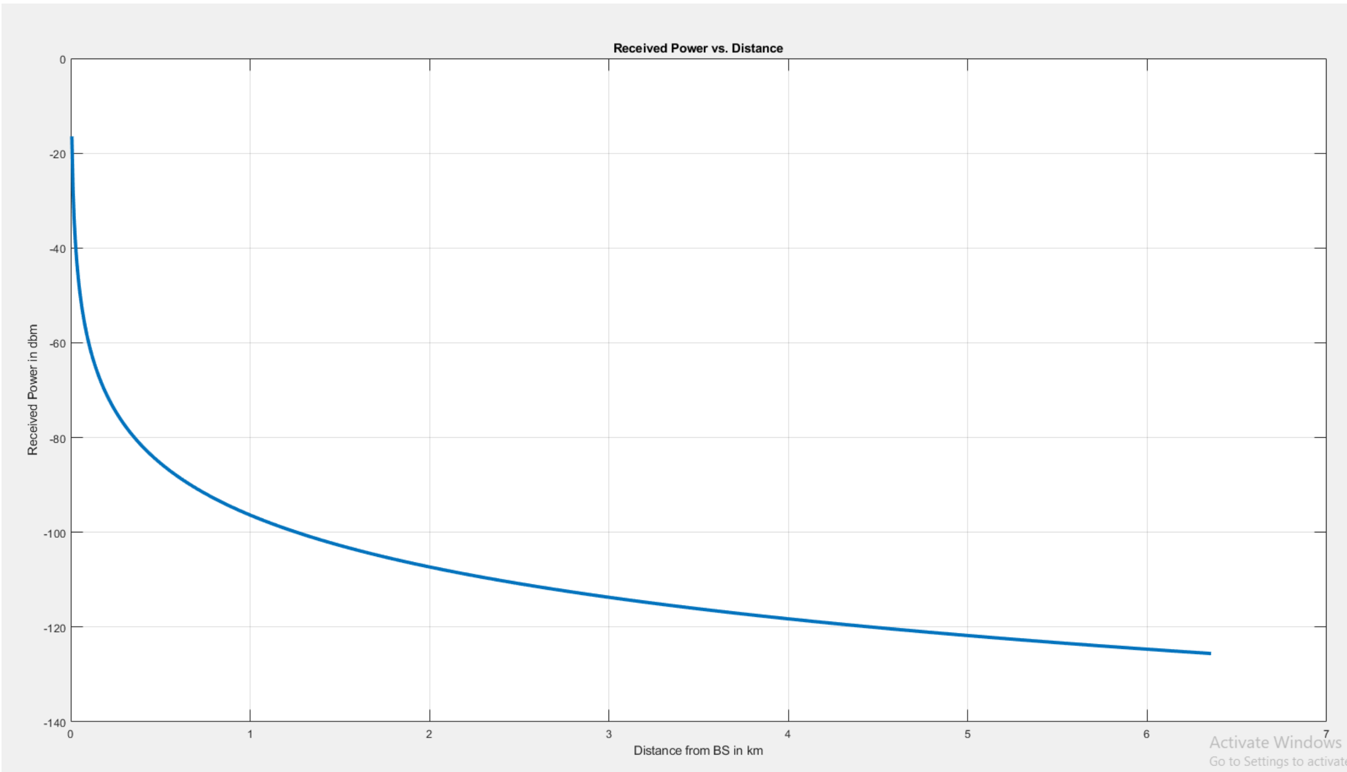
MS$\boldsymbol{S_{power}} = \boldsymbol{BSpower} - |\boldsymbol{PL}|$

So $PL(dB) = Pt(dB) - Pr\ (dB)$

All This mathematical information is used in MATLAB code (PartA_main_code) to generate the plot in MS Received Power Vs the Receiver Distance.

The code is segmented into number of functions For better usage and efficiency.

- **Plot for the MS received power in dBm versus the receiver distance from the BS.**

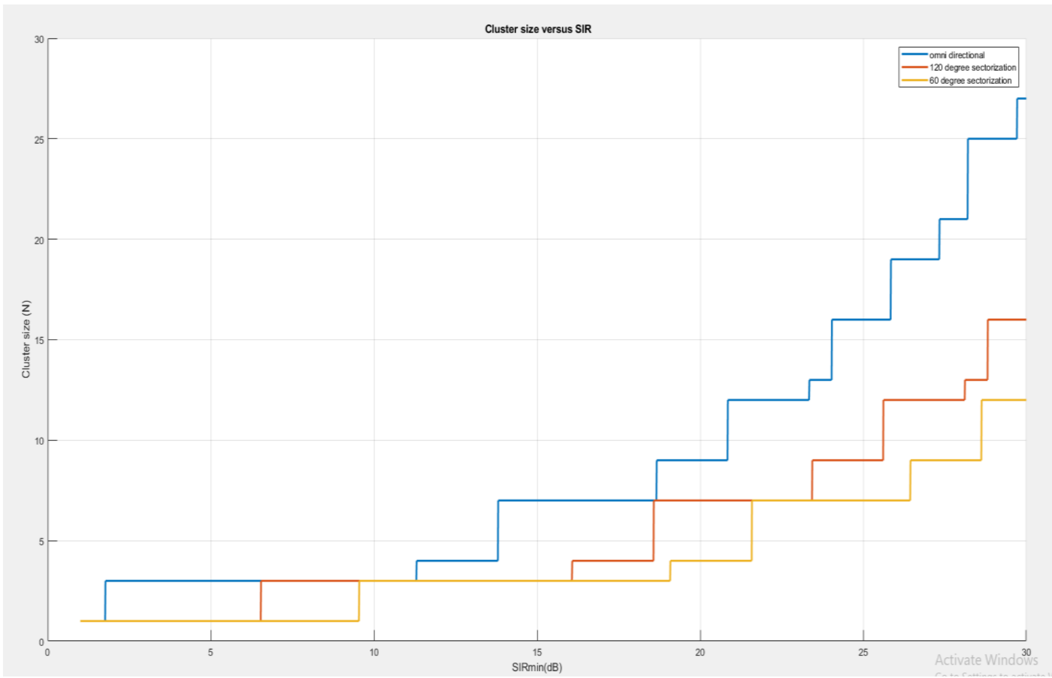



```
    disp('Design Parameters:');
    disp(['1) Cluster Size: ' num2str(clusterSize)]);
    disp(['2) Number of Cells: ' num2str(cellCount)]);
    disp(['3) Cell Radius: ' num2str(cellRadius) ' Km']);
    disp(['4) Traffic Intensity per Cell: ' num2str(trafficIntensityPerCell) ' Erlang']);
    disp(['5) Traffic Intensity per Sector: ' num2str(A_sec) ' Erlang']);
    disp(['6) Base Station Transmitted Power: ' num2str(baseStationPower) ' dBm'])
%end
enter the GOS: 0.01
enter the city area in KM^2: 100
enter the user density users/km^2: 50
enter the SIRmin IN dB: 33
enter the sectorizationMethod: 3
Design Parameters:
1) Cluster Size: 16
2) Number of Cells: 46
3) Cell Radius: 0.91734 Km
4) Traffic Intensity per Cell: 2.7329 Erlang
5) Traffic Intensity per Sector: 0.45549 Erlang
6) Base Station Transmitted Power: 32.4738 dBm
>>
```

Comment: Power received decreases as going further from the Mobile station "cell".

PART_B:

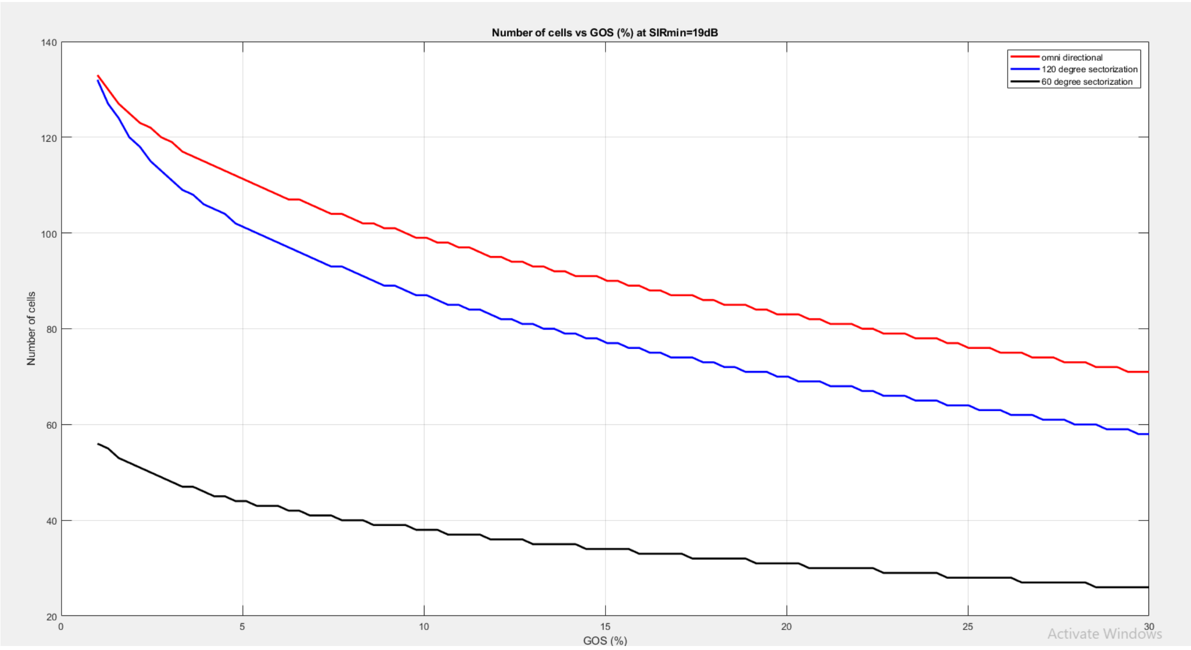
1) Plot the cluster size versus $SIRmin$ with range from $1dB\ to\ 30\ dB$.



Comment: Cluster size increases with SIRmin and increase with decreasing of number of sectors per cell but with acceptable values by the constrains of this equation: ($\boldsymbol{N} = \boldsymbol{i2} + \boldsymbol{j2} + \boldsymbol{i} * \boldsymbol{j}$)

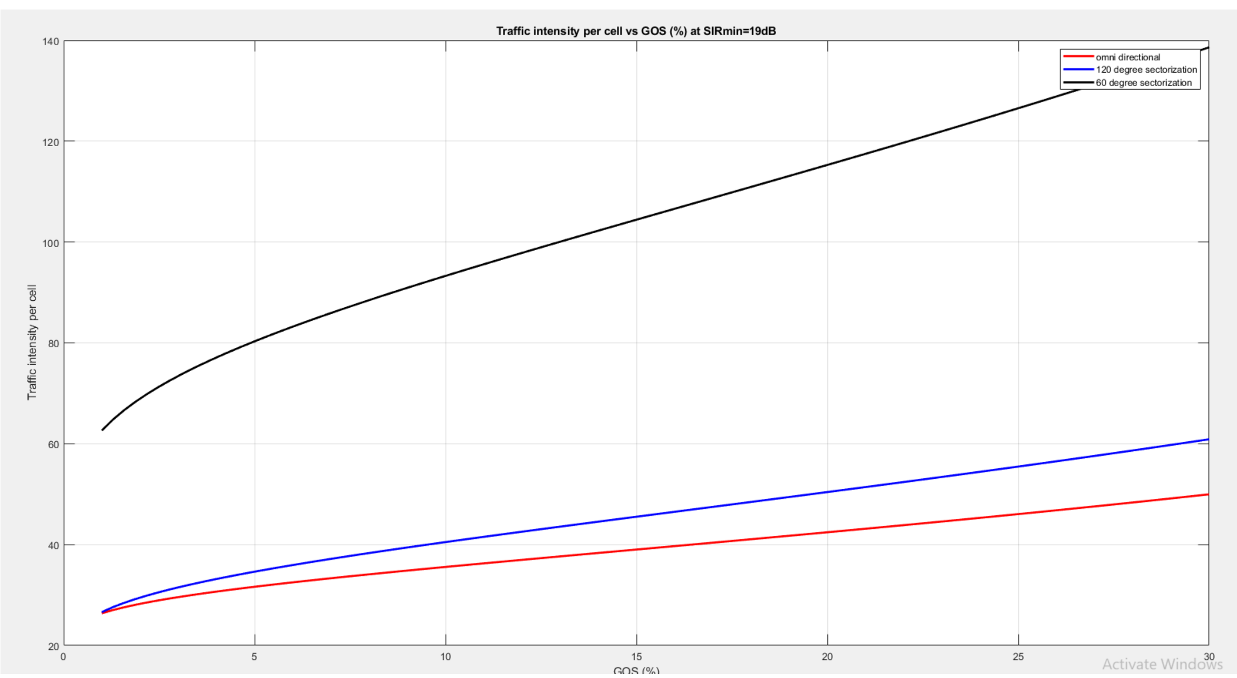
2) For $SIRmin$ = 19dB & user density= 1400 $users/km2$

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



Comment: As GOS increases “It’s means that Probability of blocking is high”, we need less number of cells.

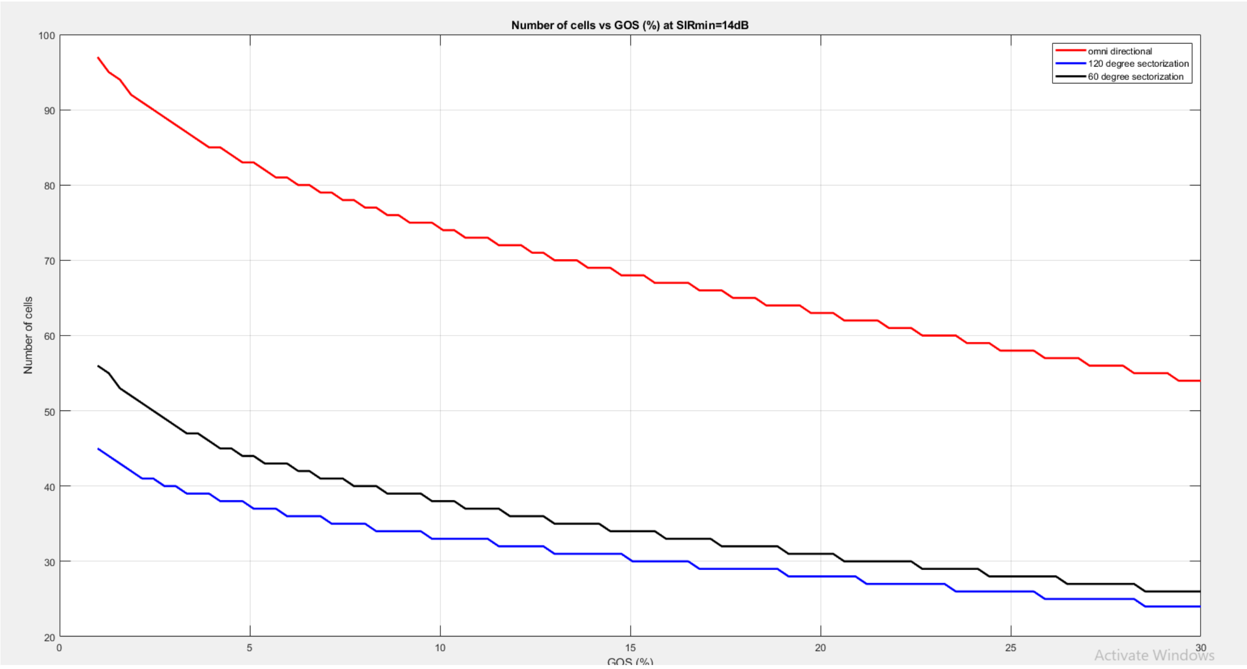
(ii) Plot the traffic intensity per cell versus GOS (1%to 30%).



Comment: As GOS spec relaxed so we can hold much higher intensity.

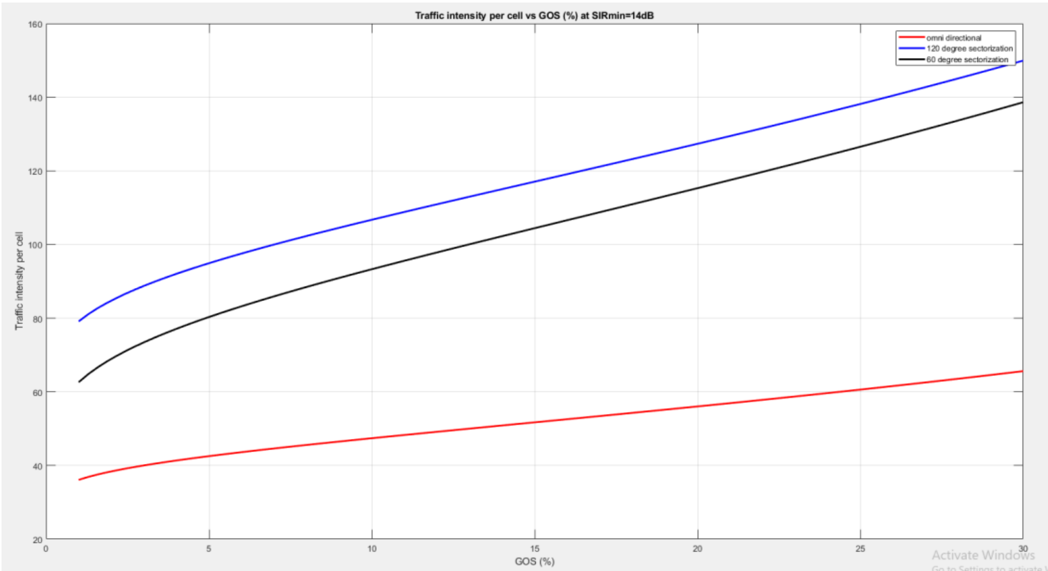
3) At $SIRmin$ = $14dB$ & user density= 1400 $users/km2$

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



Comment: As SIR decreases from "19dB to 14dB",So Number of cells decreased"eq.1". As GOS increases Number of cells decreases.

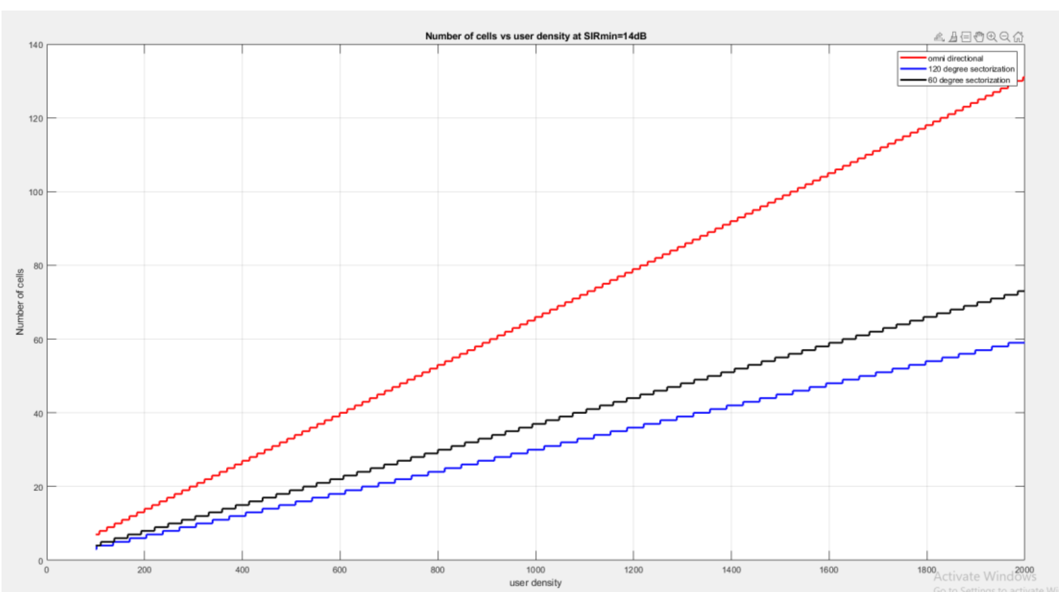
(ii) Plot the traffic intensity per cell versus GOS (1% to 30%).



Comment: As SIR decreases from “19dB to 14dB”, It’s affect on traffic intensity “got increased” specially on “omni&120 degree sectorization”. As GOS increases so we can hold much higher intensity.

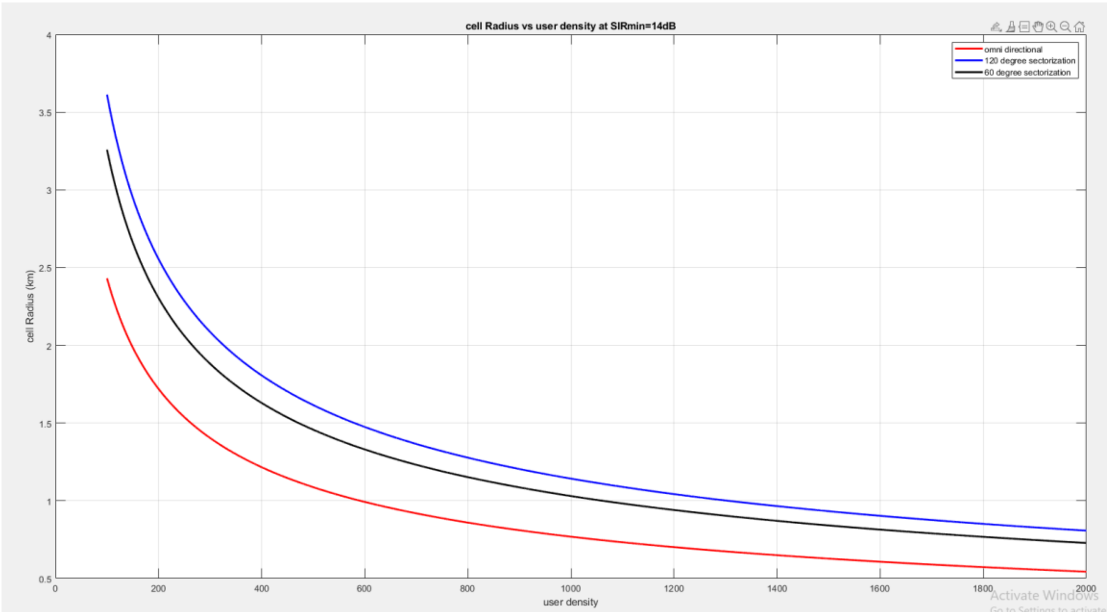
4) At $SIRmin$ = 14dB & GOS= 2%,

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



Comment: For higher density at the area, we need more cells to serve all these users using the concept of frequency reuse as the channels is limited.

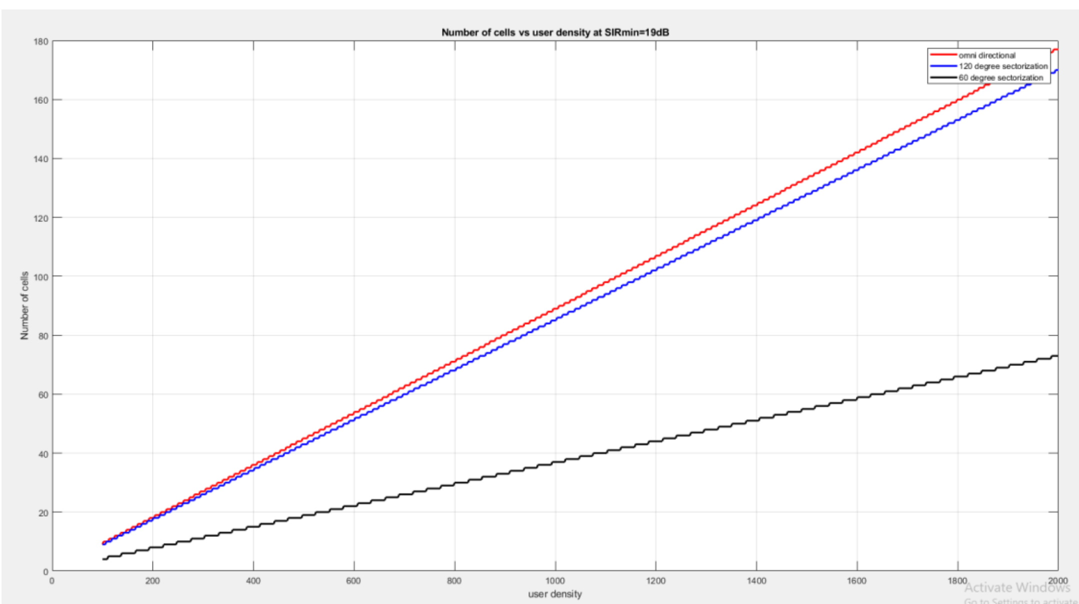
(ii) Plot the cell radius versus user density (100 to 2000 $users/km2$).



Comment: As we need more cells at the same area to serve the higher density, we need to reduce the area of the cell by reducing the radius.

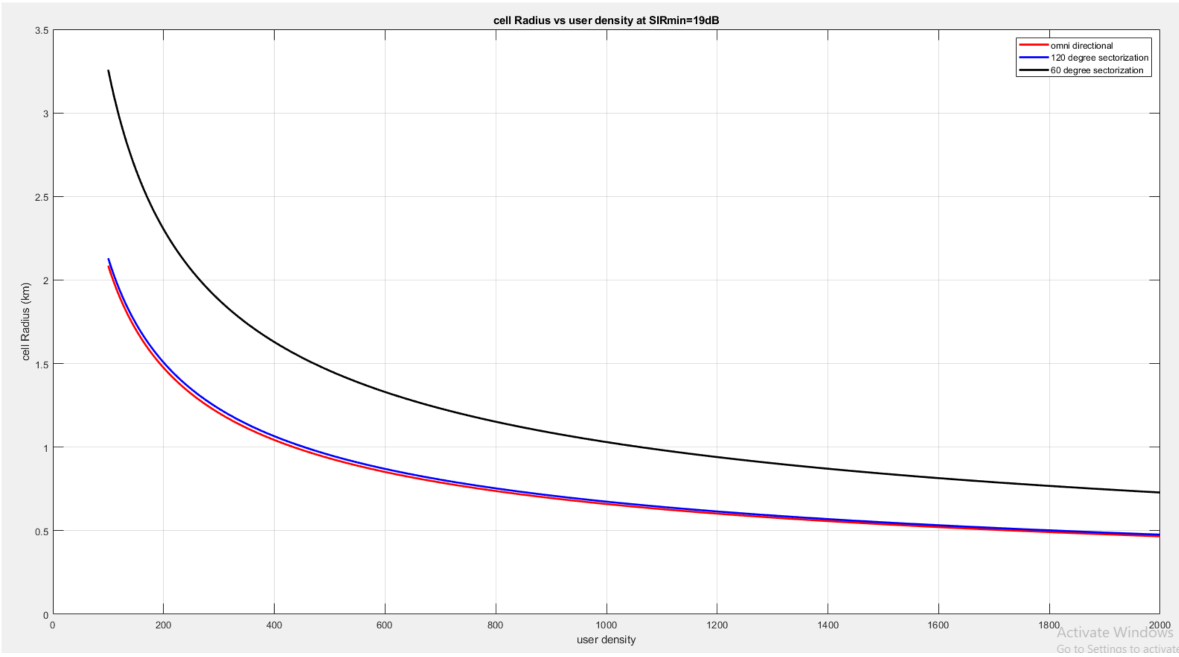
5) At $SIRmin$ = 19dB & GOS= 2%

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



Comment: As SIR increases from “14dB to 19dB” Number of cells increases

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



Comment: As SIR increases from “14dB to 19dB” Number of cells increases so to serve the same area we should reduce the area of the cell by reducing the radius.

BEST WISHES