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Don Bosco Institute of Technology
Department of Electronics and Telecommunication
Lab Manual
**Subject- Advance Communication Lab 1**

**Experiment-4**
**Title-Interference & System Capacity**

**Aim-** Design a cellular system (which will consider trade off between interference and system capacity) and analyze Its performance for different environment.

**Objectives:-** Students will design the cellular system by considering effect of interference for urban Suburban and Rural environment.
2. Analyze the performance of designed cellular system in urban ,Suburban and Rural environment.

**Learning Outcomes :**1.Student will able explain effect of interference on performance of cellular system.

2.With changing system scenario,students are able to understand how the system design parameters and requirements change for optimal performance.

**Theory :**

Susceptibility and interference problems associated with mobile communications equipment are because of the problem of time congestion within the electromagnetic spectrum. It is the limiting factor in the performance of cellular systems.

The interference can be divided into 2 parts: co-channel interference and adjacent channel interference.

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**Co-channel interference (CCI)**

For the efficient use of available spectrum, it is necessary to reuse frequency band-width over relatively small geographical areas. However, increasing frequency reuse also increases interference, which decreases system capacity and service quality. The cells where the same set of frequencies is used are call co-channel cells. Co-channel interference is the cross talk between two different radio transmitters using the same radio frequency as is the case with the co-channel cells. The reasons of CCI can be because of either adverse weather conditions or poor frequency planning or overly crowded radio spectrum.

If the cell size and the power transmitted at the base stations are same then CCI will become independent of the transmitted power and will depend on radius of the cell (R) and the distance between the interfering co-channel cells (D). If D/R ratio is increased, then the effective distance

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between the co-channel cells will increase and interference will decrease. The parameter Q is called the frequency reuse ratio and is related to the cluster size. For hexagonal geometry

Q = D/R =√3N .

From the above equation, small of 'Q' means small value of cluster size 'N' and increase in cellular capacity. But large 'Q' leads to decrease in system capacity but increase in transmission quality. Choosing the options is very careful for the selection of 'N', the proof of which is given in the first section.

The Signal to Interference Ratio (SIR) for a mobile receiver which monitors the forward channel can be calculated as

$$SIR = \frac{S}{I} = \frac{S}{\sum_{i=1}^{i_0} I_i}$$

The average received power at a distance *d* from the transmitting antenna is approximated by

$$P_r = P_0 \left(\frac{d}{d_0}\right)^{-n}$$

and in the dB expression as

$$P_r(dBm) = P_0(dBm) - 10n\log\left(\frac{d}{d_0}\right)$$

where P0 is the power received at a close-in reference point in the far field region at a small distance do from the transmitting antenna, and 'n' is the path loss exponent.

Let us calculate the SIR for this system

If Di is the distance of the i-th interferer from the mobile, the received power at a given mobile due to i-th interfering cell is proportional to (Di )^−n (the value of 'n' varies between 2 and 4 in urban cellular systems).

Let us take that the path loss exponent is same throughout the coverage area and the transmitted power be same, then SIR can be approximated as,

$$\frac{S}{I} = \frac{R^{-n}}{\sum_{i=1}^{i_0} (D_i)^{-n}}$$

Case 1-

Considering first layer of interfering cells. If all the interfering base stations are equidistant from the

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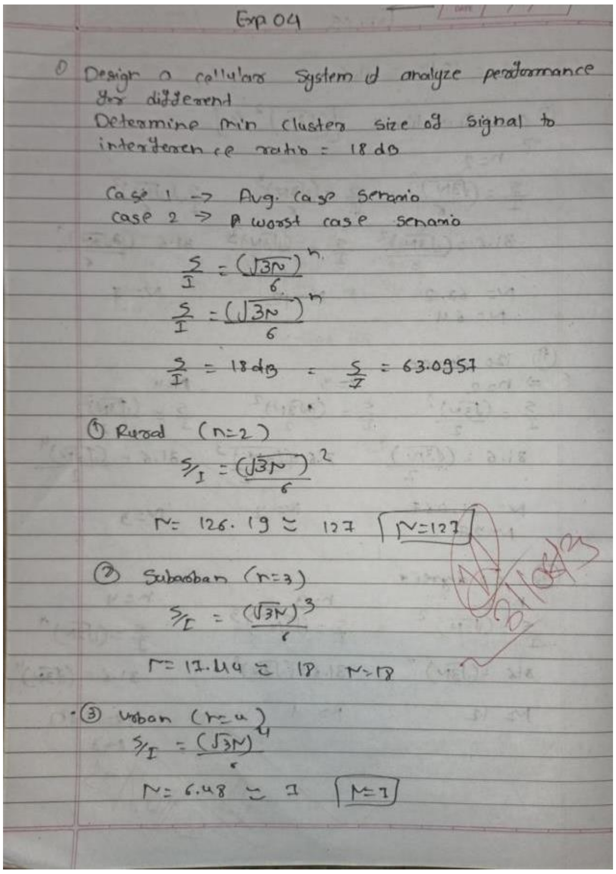
desired base station (by D between cell centers)

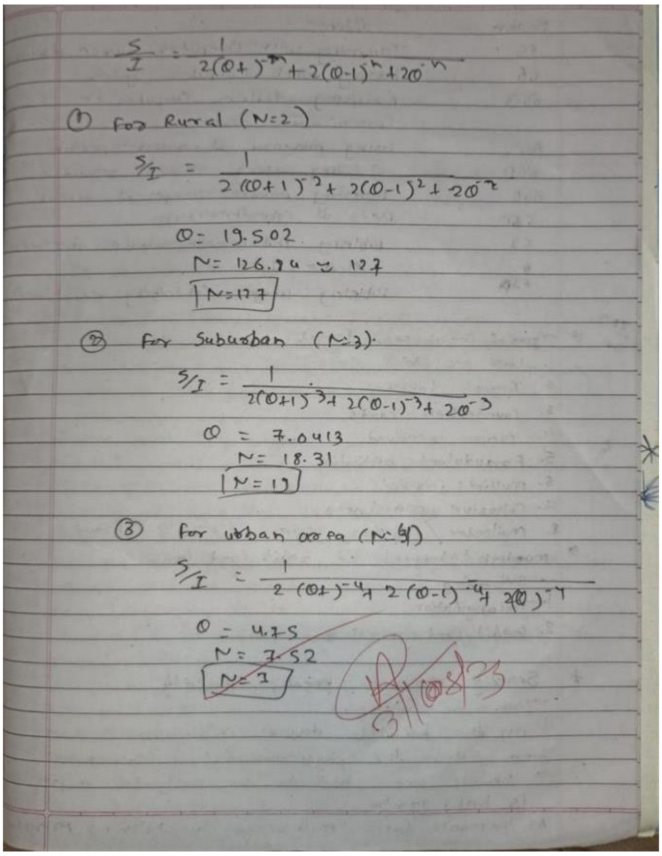
$$\frac{S}{I} = \frac{\left(\frac{D}{R}\right)^n}{i_0} = \frac{(\sqrt{3N})^n}{i_0}$$

Example-

Determine the minimum cluster size for a cellular system designed for urban,suburban,rural area with an acceptable value of S/I=15dB. Assume co-channel interference at the mobile unit from the six equidistant co-channel cell.

**Solved Problem :**



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**Code:**

```
import numpy as np
import matplotlib.pyplot as plt


for i in range(1,11):
for j in range(1,11):
if i>j:
m += 1
N.append((i ** 2) + (j*i) + (j**2))

m = 0
N = []
M = np.sort(N)[::-1]
m = np.argsort(N)[::-1]

R = []
S = []
U = []
R1 = []
S1 = []
Liberation Serif;Times New RomanU1 = []
sig= []

for k in range(len(M)):
Q = np.sqrt(3 * M[k])
R.append(10 * np.log10((Q ** 2) / 6))
S.append(10 * np.log10((Q ** 3) / 6))
U.append(10 * np.log10((Q ** 4) / 6))

R1.append(-10 * np.log10(2 * ((Q ** -2) + (Q + 1) ** -2 + (Q-1)** -2)))
S1.append(-10 * np.log10(2 * ((Q ** -3) + (Q + 1) ** -3 + (Q-1)** -3)))
U1.append(-10 * np.log10(2 * ((Q ** -4) + (Q + 1) ** -4 + (Q-1)** -4)))
sig.append(18) plt.figure(figsize = (12,6))

plt.subplot(1,2,1)
```

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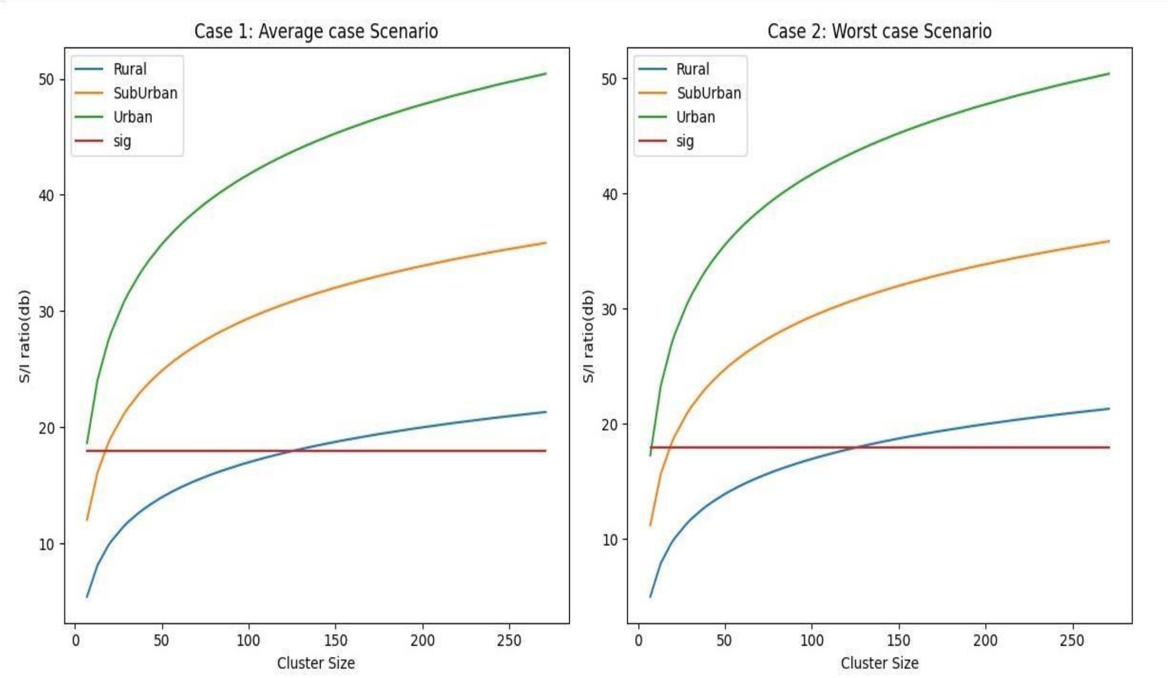
```
plt.plot(M,R,label="Rural")
plt.plot(M,S,label="SubUrban")
plt.plot(M,U,label="Urban")
plt.plot(M,sig,label='sig')
plt.xlabel("Cluster Size")
plt.ylabel("S/I ratio(db)")
plt.title("Case 1: Average case Scenario")
plt.legend()

plt.subplot(1,2,2)
plt.plot(M,R1,label="Rural")
plt.plot(M,S1,label="SubUrban"
plt.plot(M,U1,label="Urban")
plt.plot(M,sig,label='sig')
plt.xlabel("Cluster Size")
plt.ylabel("S/I ratio(db)")
plt.title("Case 2: Worst case Scenario")
plt.legend()

plt.tight_layout()
plt.show()
```

**OUTPUT IMAGE**



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**Conclusion:** From the above experiment we concluded that depending upon the area, the cell size varies and
hence the capacity. For rural areas, the cell size is much greater than urban areas andhence less interference. Also, depending upon the position of mobile towers, signal to interference ratio varies.