1. For path loss exponent n=3, find the frequency reuse factor and the cluster size that should be used for maximum capacity. The SIR of 15 dB is minimum required for satisfactory forward channel performance of a cellular system. There are six co-channel cells in the first tier, and all of them are at the same distance from the mobile. Use suitable approximations.

Solution:

Here,

Path loss exponent, n = 3

Number of co-channel cells, $i_o = 6$

First, let us consider a 7 – cell reuse pattern, i.e., N = 7

We know,

$Q = \sqrt{3N}$

or, $Q = \sqrt{3 \times 7}$

$\therefore \quad Q = \sqrt{21} = 4.583$

Also,

$$\frac{S}{I} = \frac{\left(\sqrt{3N}\right)^n}{i_o} = \frac{(Q)^n}{i_o} = \frac{(4.583)^3}{6} = 16.04$$

$$\therefore \left(\frac{S}{I}\right)_{dB} = 10\,log(16.04) = 12.05\,dB$$

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

Using equation, $N = i^2 + ij + j^2$, the next possible value of 'N' is 12 (i.e., i=j=2)

Using, N =12

We know,

$Q = \sqrt{3N}$

or, $Q = \sqrt{3 \times 12}$

$\therefore \quad Q = \sqrt{36} = 6$

Also,

$$\frac{S}{I} = \frac{\left(\sqrt{3N}\right)^n}{i_o} = \frac{(Q)^n}{i_o} = \frac{(6)^3}{6} = 36$$

$$\therefore \left(\frac{S}{I}\right)_{dB} = 10\,log(36) = 15.56\,dB$$

Since, this is greater than the min. required S/I,

N = 12 can be used.

2. A cellular service provider decides to use a digital TDMA scheme which can tolerate a signal to interference ratio of 15 dB in the worst case. Find the optimum value of N for

a) **Omni Directional antenna**
b) **120^o sectoring**
c) **60^o sectoring**

Use path loss exponent of 4

Solution:

Here,
Path loss exponent, n = 4
Minimum S/I = 15 dB
i.e., $\frac{S}{I} = (10)^{15/10} = 31.62$

a) For Omni – directional antenna

Number of co-channel interfering cells (i_o) = 6
We know,

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

Or, $31.62 = \frac{\left(\sqrt{3N}\right)^4}{6}$

$\therefore$ N = 4.59
The possible optimum value of N=7.

b) For 120^o sectoring

Number of co-channel interfering cells (i_o) = 2
We know,

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

Or, $31.62 = \frac{\left(\sqrt{3N}\right)^4}{2}$

$\therefore$ N = 2.65
The possible optimum value of N=3.

c) For 60^o sectoring

Number of co-channel interfering cells (i_o) = 1
We know,

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

Or, $31.62 = \frac{\left(\sqrt{3N}\right)^4}{1}$

$\therefore$ N = 1.87
The possible optimum value of N=3.