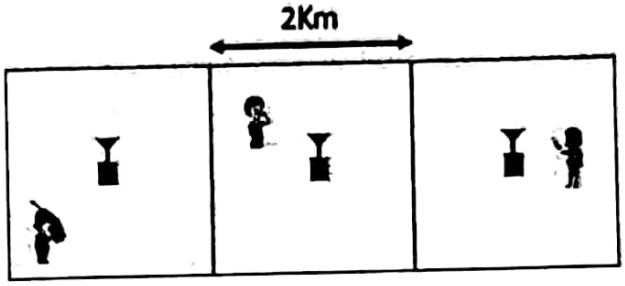
Solution

Quiz 1: Mobile Communication Systems

Consider a cellular system with hexagonal cells of radius R= 1km. Suppose that the minimum distance between the co-channel cell sites must be D= 6km to maintain the required carrier to interference ratio of 21dB.

a) Find the required reuse factor N.
b) If the total bandwidth of the system is 10MHz and each user requires 20KHz bandwidth for each call, find the number of channels that can be assigned equally to each cell.
c) How many users can be supported by the total system with a blocking probability of 1%. Assume each user generates 0.02 Erlang of traffic.
d) How many minutes per hour, on average, does each user talk on his/her phone?
e) Sketch four adjacent cell clusters and show a channel assignment for the clusters with the required reuse distance.
f) Draw and calculate worst case downlink SIR to the user in the middle cell for the following cell pattern. All BSs are transmitting on same channel and path loss exponent of system is 3.



(a) $R = 1Km$, $D = 6Km$, $N = ?$

$$Q = \frac{D}{R} = \sqrt{3N} \Rightarrow \frac{6}{1} = \sqrt{3N} \Rightarrow N = \frac{36}{3} \Rightarrow \boxed{N = 12}$$

(b) total bandwidth = 10MHz
each user requires = 20KHz , no. of channels equally to each cell ?

Number channels $C_T = \frac{B_T}{B_C} = 500$ channels

Number of Ch. Per cell $= C = \frac{C_T}{N} = \frac{500}{12} = 41.667 \approx 42$ Ch/cell

(c) users supported by total system?

$P_b = 0.01$; $A_u = 0.02$ Erlang ,

using Erlang B table for $P_b = 0.01$ & $A_u = 0.02$ & $C = 41$ OR 42

$A = 29.5$,

$U = A/A_u \Rightarrow U = \frac{29.5}{0.02} = 1475$ users/cell

$= 1475 \times 12$ users/cluster

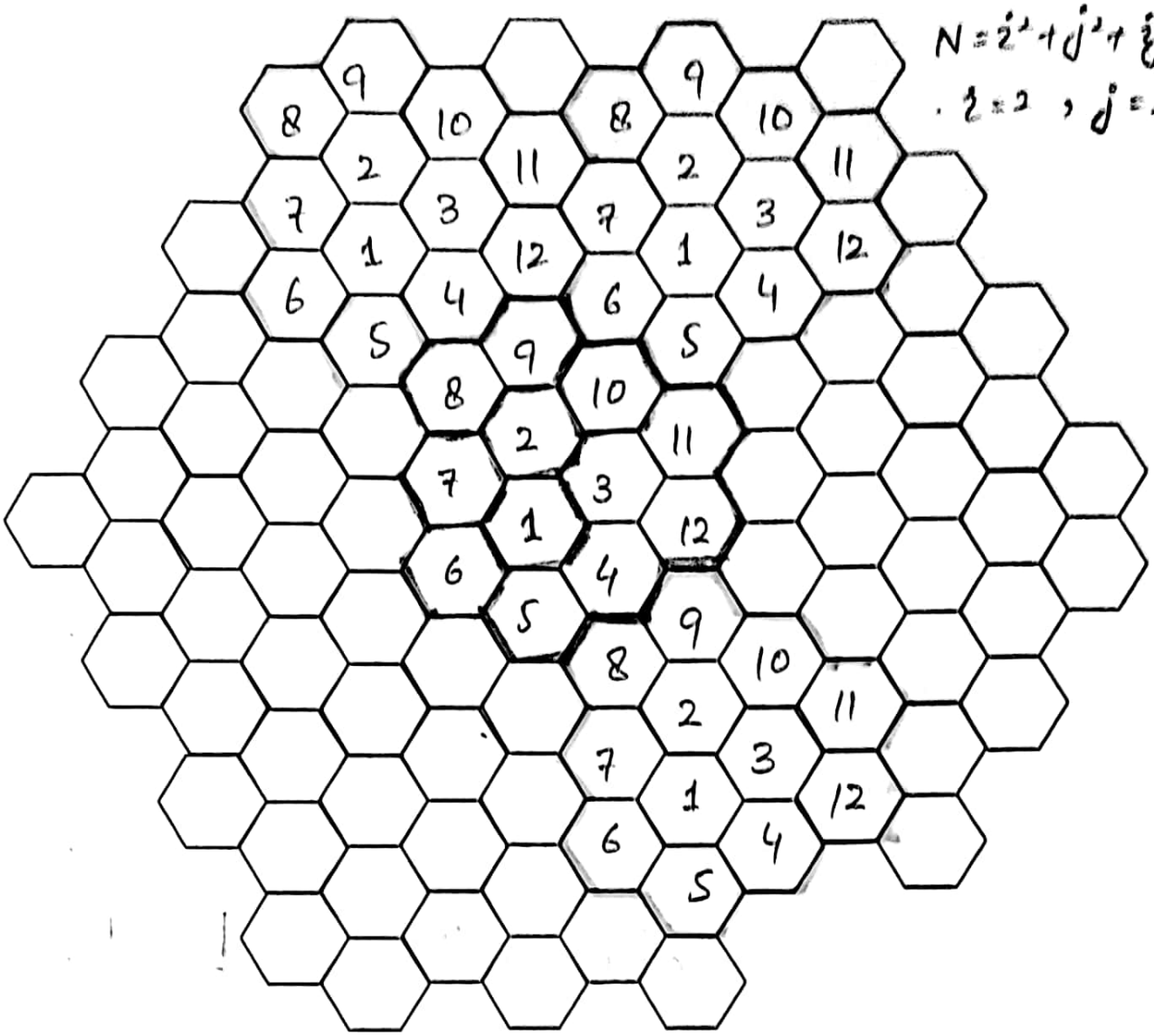
$= 17,700$

$N = 12$

$N = i^2 + ij + j^2$

$i = 2, \; j = 2$

e)



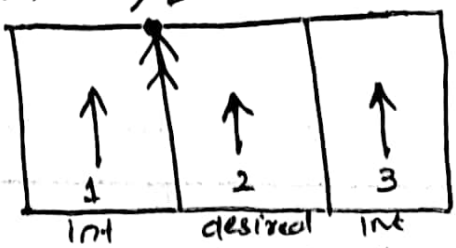
(d) How many mintues per hour?

$Au = \lambda H$

$H = Au / \lambda \Rightarrow H = 0.02 \times 60 = 1.2 \text{ min/hr}$ $\therefore \lambda = 1/60$

(f) Draw & Calculate worst case SIR ? (Downlink) ← worst case

path loss exponent, $n = 3$



$$SIR = \frac{P_{des,2}}{P_{int1} + P_{int2}} = \frac{d_2^{-n}}{d_1^{-n} + d_2^{-n}} = \frac{(\sqrt{2})^{-3}}{(\sqrt{2})^{-3} + (\sqrt{10})^{-3}}$$

$\therefore$ using pythagoras theorem. (right angle triangle)

$$= 0.9179.$$