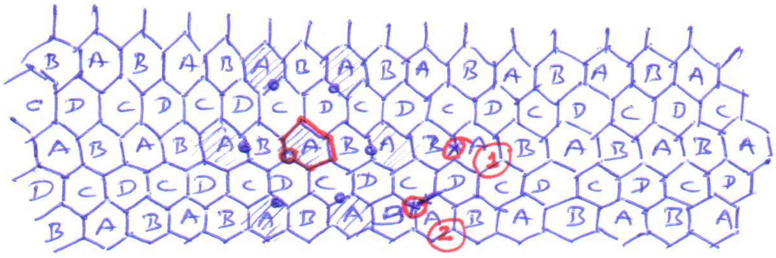
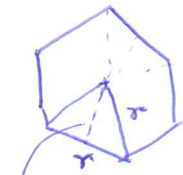
1.

(a)





$\sqrt{r^2 - \frac{r^2}{4}} = \frac{\sqrt{3}}{2} r$;

(b) For interferens as '•' and desired user as 'o'
the worst case uplink SINR (SIR) can be computed from 1st tier cells only

$$\underset{\text{(worst case)}}{SIR} = \frac{r^{-n}}{6 \times \left(3 \times \frac{\sqrt{3}}{2} r\right)^{-n}}$$

(c) For $r = 1$ km (1000m) and $n = 3$

$$SIR = \frac{(1.5 \times \sqrt{3})^3}{6} = \frac{27}{16}\sqrt{3} = \boxed{2.923}$$

$\Rightarrow SIR = \underline{4.66}$ dB

(d) 2nd Tier Interferens : Total = 12

Type 1 → distence $\overbrace{7 \times \frac{\sqrt{3}}{2}}^{6.06} r$; → 6 #s

Type 2 → distence $5r$; → 6 #s

$\therefore$ Interference contribution from $\underline{\text{only}}$ 2nd tier $= \boxed{6 \times \left(\frac{7\sqrt{3}}{2} r\right)^{-n} + 6\,(5r)^{-n}}$

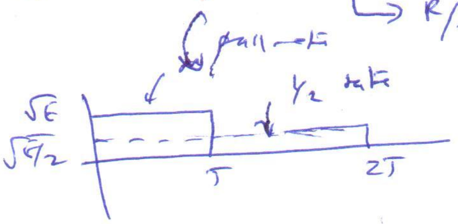
(e)
$$SIR = \frac{1 \times r^{-n}}{6\left\{\left(\frac{3}{2} \times \sqrt{3}\, r\right)^{-n} + \left(\frac{7\sqrt{3}}{2} r\right)^{-n} + (5r)^{-n}\right\}}$$

$0.057 + 0.0045 + 0.008$

$SIR = \boxed{2.4}$

$= \underline{3.8}$ dB

2. [7 marks] $w = T/T_c = 128$; 2 different rates $\to R$, $\to R/2$



(a) Pole Capacity

$$\frac{128 \times P}{(N-1)P} = 4$$ SIRR

-1-

$$\Rightarrow \boxed{N_p = 33}$$

(b) For 9dB noise rise (9 dB = ~~...~~ = 8 times σ^2)

$$4 = \frac{128P}{(N-1)P\left[1+\frac{1}{7}\right]}$$

$\therefore$ $(N-1)P + 7\sigma^2 = 8\sigma^2$

-2-

$$\Rightarrow \sigma^2 = \frac{(N-1)P}{7}$$

$$\Rightarrow (N-1) = \frac{32}{8/7} = 28$$

8

$$\therefore N = 28+1 = \boxed{29}$$

(c) For the higher-rate stream (rate R)

$$4 = \frac{128 \times P}{(N/2-1)P + N/2 \cdot P/2}$$

-2-

$$\Rightarrow \frac{3N}{4} = 33 \Rightarrow \boxed{N_p' = 44}$$

(d) For the lower rate stream (rate R/2) the spreading factor is $2w = 256$

$$4 = \frac{256 \times (P/2)}{(N/2-1)(P/2) + N/2 \cdot P}$$

-2- ≈ 43.33

$$\frac{3N}{4} - \frac{1}{2} = 32 \Rightarrow N_p'' = 32.5 \times \frac{4}{3}$$

32.5×4/3

practically the same !! $\boxed{\approx 44}$

3.

$$P[b] = \frac{E^k/k!}{\sum_{n=0}^{k} E^n/n!}$$

$k \rightarrow$ # of servers

$E \rightarrow$ offered Erlangs

$k = 2$ (given)

For 20% blocking, $P[b] = 0.2 = \frac{1}{5}$;

$$\frac{1}{5} = 0.2 = \frac{E^2/2}{1 + E + E^2/2}$$

$\Rightarrow \quad 1 + E + E^2/2 = \frac{5}{2}E^2$

$\Rightarrow \quad 2E^2 - E - 1 = 0$

$\Rightarrow$ only possible root is $E = 1$;

Ans: $\boxed{E = 1 \text{ Erlangs}}$

Tx Power $P_T = 10$ dBm;
1 m loss $= -42$ dB;
path loss exp $n = 2$;

4. [2 + 2 + 1.5 + 1.5 + 2 = 9 marks]

(a) (i) FDMA $\longrightarrow \dfrac{5\text{ MHz}}{100\text{ kHz}} = 50$ servers totally

with 1/4 reuse, $\dfrac{50}{4} = 12\frac{1}{2}$ servers / base-station

$N_{FDMA} \approx \boxed{12}$ (or 13)

(ii) TDMA $\longrightarrow \dfrac{5\text{ MHz}}{1\text{ MHz}} \times \underbrace{10}_{\#\text{ of slots}} \times \underbrace{\dfrac{1}{4}}_{\text{reuse}} = \dfrac{50}{4}$ as before

-2

$\therefore$ ||| $N_{TDMA} \approx \boxed{12}$ (or 13)

(iii) DS-CDMA $W = 512$; $SINR_{rqd} = 5\text{ dB} = 3.1623$

$\therefore$ Pole capacity $N_p = \dfrac{512}{3.1623} + 1 \approx \boxed{163}$

(b) Link Distance

FDMA	TDMA

Noise figure NF = 7 dB for all 3 receivers

-2

FDMA

- -112 dBm
- SINR = 5 dB
- -117
- NF = 7 dB
- -124
- 100 kHz (50)
- -174 dBm

$\therefore$ $-112\text{ dBm} = 10 - 42 - 20\log_{10} d$

$\Rightarrow d = 10^4 = \boxed{10\text{ km}}$

TDMA

- -102 dBm
- SINR = 5 dB
- -107
- NF = 7 dB
- -114
- 1 MHz (60)
- -174 dBm

$-102\text{ dBm} = 10 - 42 - 20\log d$

$\Rightarrow d = 10^{7/2} = \boxed{3.162\text{ km}}$

~~3.~~ DS-CDMA $\Rightarrow$ 1 user : (Recall $N_p = 163$)

4(c)

For $N = 1$: $P_1 = \frac{\sigma^2}{162}$;

———— -100 dBm $\Rightarrow$ map to σ^2

NF = 7 dB

———— -107.

5 MHz (67)

———— -174 dBm

$10 \log_{10} 162$

$\therefore \quad P_1 = -100 \text{ dBm} - 22.1 \text{ dB}$

-1.5

$= -122.1$ dBm

$-122.1 \text{ dBm} = 10 - 42 - 20 \log_{10} d$

$20 \log_{10} d = 90.1 \Rightarrow \boxed{d = 31.989 \text{ km}}$

$N=1$

4(d) For $N = 162$: $P_{162} = \sigma^2$;

$-100 \text{ dBm} = 10 - 42 - 20 \log_{10} d$

-1.5

$d = 10^{3.4} = \boxed{2.512 \text{ km}}$

$(N = N_p - 1)$

4(e) For same link ~~Budget~~ distance (as in (d))

FDMA requires

-2

$-112 = P_T - 42 - 20 \log_{10} 2512$

$\boxed{P_T \approx -2.0 \text{ dBm}}$

FDMA

TDMA requires

$-102 = P_T - 42 - 20 \log_{10} 2512$

$\boxed{P_T = 8 \text{ dBm}}$

TDMA