

City University of Hong Kong
Department of Electrical Engineering

EE4316 Mobile Data Networks

Solution to Test 1

1. The major difference between the two generations is that first generation systems are purely analog, whereas second generation systems are digital.

[1 mark]

$$2. S_r = \frac{P_{desired}}{\sum_i^{J_s} P_{interference,i}} = \frac{R^{-4}}{D^{-4} + (D+0.7R)^{-4}} = \frac{1}{(\frac{D}{R})^{-4} + (\frac{D}{R} + 0.7)^{-4}}$$

With a 7-cell reuse, we have $D/R = (3 \times 7)^{1/2} = 4.6$,

$S_r = 285$, or = 24.5dB

Hence, the 18dB requirement is satisfied.

[8 marks]

3.

- a. Area of a macro cell is proportional to R^2 . If the smaller cell has radius $R/2$, its area is proportional to $R^2/4$. Hence, the area of a smaller cell is a quarter of that of the macro cell. So, a macro cell can be split into 4 smaller cells.

[2 marks]

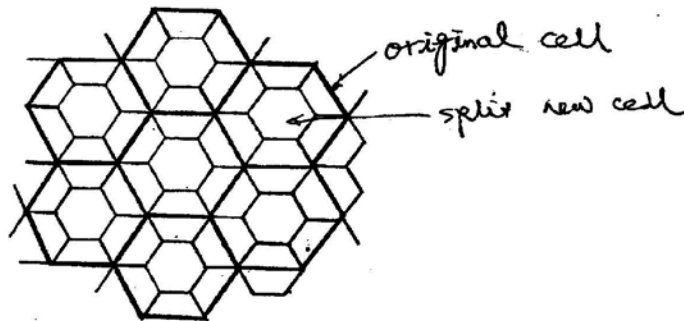
- b. Let P_{t1} and P_{t2} be the transmit power of the macro cell and smaller cell, respectively. The received power P_{r1} at the boundary of the macro cell is $P_{t1}R^{-3}$, while the received power P_{r2} at the boundary of the smaller cell is $KP_{t2}(\frac{R}{2})^{-3}$.

On the basis of equal received power, $KP_{t2}(\frac{R}{2})^{-3} = KP_{t1}R^{-3}$

Hence, $P_{t2} = \frac{P_{t1}}{8}$

[4 marks]

- c. The sketch is as below:



[6 marks]

4. Using the Erlang B table, the required number of channels in each individual cell are 53, 85, 96, respectively. Since non-uniform fixed channel allocation is used, the total number of channels in the cluster = 53+85+96= 234.

[4 marks]

5.

- a. For uniform channel density, number of channels per cell = $500 / 7 = 71$, the remaining channels are not used. Total number of channels available to the provider = $71 \times 100 = 7100$

[2 marks]

$$b. \frac{D_0}{R_0} = \sqrt{3 \times 7} = 4.6 = \frac{D_1}{R_1}$$

$$\text{using } D_1 = 3 R_0 \rightarrow \frac{3R_0}{R_1} = 4.6 \text{ and } R_0 = 1.53 R_1$$

$$\text{Area} = K R^2 \text{ and } \frac{A_0}{A_1} = \frac{K R_0^2}{K R_1^2} = (1.53)^2 \text{ and } A_1 = 0.425 A_0$$

If X is the number of channels, then

$$3 (0.425 X) + 7 (0.575 X) = 497 \text{ and } X = 497 / 5.3 = 93.7 \approx 94$$

For the micro cells: $0.425 X = 0.425 (93.7) = 40$ channels

For the macro cells: $0.575 X = 0.575 (93.7) = 54$ channels

[5 marks]

6. a. mean channel holding time = 2 minutes
mean service rate = 0.5 calls/minute

$$A = \frac{2.5 + 1.5}{0.5} = 8$$

$$E_{10}(8) = \frac{8^{10}/10!}{\sum_{j=0}^{10} 8^j/j!} = 0.1217$$

[3 marks]

$$b. S=10, S_R=1, S_c = 9$$

$$p_0 = \left[\sum_{j=0}^9 \frac{(\lambda_O + \lambda_H)^j}{j! \mu^j} + \frac{(\lambda_O + \lambda_H)^9 \lambda_H}{10! \mu^{10}} \right] = 4.45 \times 10^{-4}$$

$$B_O = p_9 + p_{10} = 0.2140$$

$$B_H = 0.0494$$

[7 marks]

7.

Time(s)	0	2.5	5	7.5	10	12.5	15	17.5	20
(i)	BS ₁	BS ₂	BS ₁	BS ₂	BS ₂	BS ₂	BS ₂	BS ₄	BS ₂
(ii)	BS ₁	BS ₁	BS ₁	BS ₁	BS ₂	BS ₂	BS ₂	BS ₄	BS ₂

[4 marks]

8.

a. $\theta_1 = \lambda_1 + (1 - B_2)\theta_2 p_{21} + (1 - B_3)\theta_3 p_{31}$
 $\theta_2 = \lambda_2 + (1 - B_1)\theta_1 p_{12} + (1 - B_3)\theta_3 p_{32}$
 $\theta_3 = \lambda_3 + (1 - B_2)\theta_2 p_{23} + (1 - B_1)\theta_1 p_{13}$

[2 marks]

b. Since three cells are symmetric,
 $\theta_1 = \theta_2 = \theta_3 = \theta$
 $B_1 = B_2 = B_3 = B$

So, it only needs to solve the following equations:

$$\theta = \lambda + (1 - B)\theta \frac{\nu}{\nu + \mu}, E\left(\frac{\theta}{\frac{1}{\mu} + \frac{1}{\nu}}, 85\right) = B$$

Using the approach as in the tutorial, $B=0.2069$

[12 marks]