SEMESTER 8 EXAMINATIONS, SESSION 2021 - 2022

for the Degree of

Bachelor of Engineering

Date: 15th March 2022 Time: 12:15 – 1:45 pm

TF-4304 Mobile and Wireless Network Systems

Time allowed: One (1) hour

Instructions to candidates:

Answer **ALL** questions.

Three questions carry 15, 10, and 5 marks respectively.

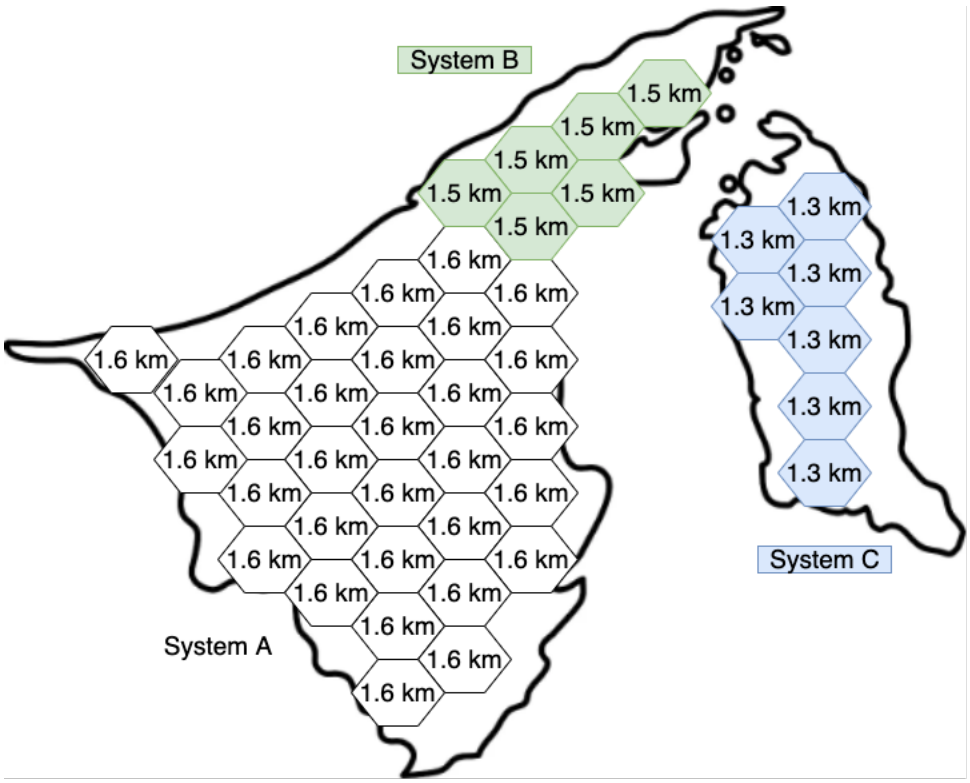
This paper has 4 pages including this cover.

Use the Erlang table provided at link in the class notes.

Please write your name and registration number on this paper.

Answer **ALL** questions.

Q1 An urban area has a population of two million residents with a total frequency bandwidth of 28.4MHz and with two 25 KHz simplex channels to provide full duplex voice and control channels for the cellular network and a reuse factor as N= 7. Three competing trunked mobile networks (systems A, B, and C) provide cellular service in this area shown in below Figure. System A has 394 cells with a cell radius of 1.6 km, system B has 98 cells with a cell radius of 1.5 km, and system C has 416 cells with a cell radius of 1.3 km. What geographic area is covered by each mobile network, how many channels per network? Find the number of users that can be supported at 2% blocking if each user averages two calls per hour at an average call duration of three minutes. Assuming that all three trunked systems are operated at maximum capacity, compute the percentage market penetration of each cellular provider.



[10 marks]

Q2 Consider a cellular radio system with hexagonal cells and cluster size. Since a hexagonal shape is assumed, the number of co-channel cells in the t^{th} tier of co-channel cells is 6t, regardless of the cluster size. Assume that the mobile and base stations are equipped with omnidirectional antennas, all base stations are located at the center of the cells and transmit the same power level, and all cells have the same radius. Assume that the power received P_r at distance d from the transmitting antenna is given where P_t is the transmitted power and n is the path loss exponent.

$$P_r = P_t \frac{1^n}{d}$$

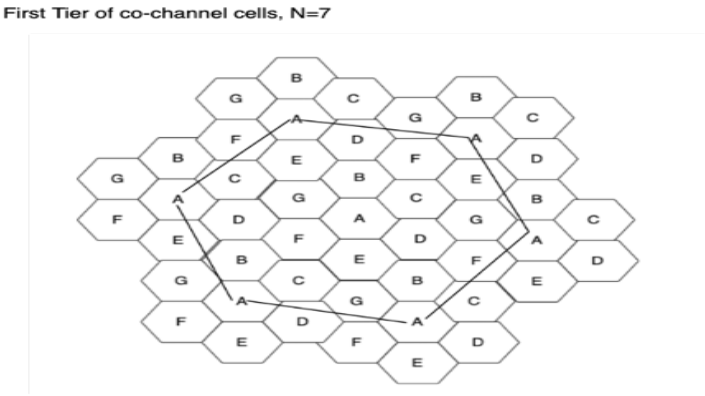


Figure 1

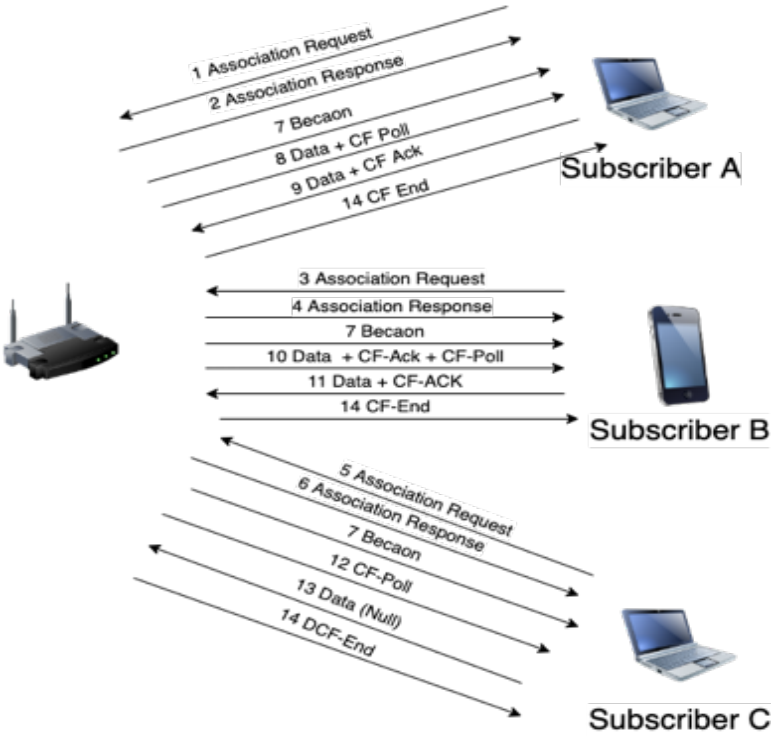
(a) Assume that the power received at a particular mobile can be modeled as the sum, $\sum_{i=1}^{M} I_i$, where I_i is the interference caused by the i^{th} base station. Present the results for cluster size 7 and path loss exponent 4.

(b) Let us suppose that only the base stations in the first one tier produce significant interference. Interference signals from base stations in more distant tiers are assumed to be negligible. Compute the signal-to-interference ratio at the mobile when only the first tier is considered, with t=1.

(c) Analyze adjacent-channel interference on the forward link of a cellular system consisting of two subscribers and a BS wherein one subscriber is ten times closer to BS than the other one and with the same characteristics as the system in part (a).

[15 marks]

Q3 Consider the sequence of actions within a BSS depicted in below Figure. Draw a timeline, beginning with a period during which the subscribing devices connect to a Point Co-ordinator, however, if medium is busy, the Point Co-ordinator ending with a period in which the CF-End is broadcast. Show the transmission periods and the gaps.


1 Association Request
2 Association Response
7 Becaon
8 Data + CF Poll
9 Data + CF Ack
14 CF End
Subscriber A
3 Association Request
4 Association Response
7 Becaon
10 Data + CF-Ack + CF-Poll
11 Data + CF-ACK
14 CF-End
Subscriber B
5 Association Request
6 Association Response
7 Becaon
12 CF-Poll
13 Data (Null)
14 DCF-End
Subscriber C

[5 marks]

END

Q1)

15/30

28.4 MHz

25 kHz

N = 7

$$A_{cluster} = \frac{N 3\sqrt{3} R^2}{2}$$

$$= \frac{394 (3\sqrt{3}) (1.6)^2}{2}$$

$$= 2620 km^2$$

$$B_{cluster} = \frac{N 3\sqrt{3} R^2}{2}$$

$$= \frac{(98) 3\sqrt{3} (1.5)^2}{2}$$

$$= 573 km^2$$

$$C_{cluster} = \frac{N 3\sqrt{3} R^2}{2}$$

$$= \frac{(416) 3\sqrt{3} (1.3)^2}{2}$$

$$= 1830 km^2$$

~~7 channels per network~~

~~System A~~

N = 7

Duplex = 25 kHz × 2

= 50 kHz

$$= \frac{28.4\text{ MHz}}{50\text{ kHz}}$$

= 568

Total no. of channels per cell $= \frac{568}{7}$

= 81 channels per network

System A

C = 81

$A_u = MH = 2 \times \left(\frac{3}{60}\right) = 0.1$ Erlangs

GOS = 0.02, C = 81

A = ~~52 Erlangs~~

A = 56.1

$U = \frac{A}{A_u}$

$= \frac{56.1}{0.1}$

= 561

= 561 × 394

= 221034 users

System B

C = 81

A_u = 0.1 Erlangs

A = 56.1

U = 561

= 561 × 98

= 54978 users

System C

C = 81

A_u = 0.1

A = 56.1

$U = \frac{56.1}{0.1}$

= 561 × 416

= 233376

Total number of users

= 221034 + 233376 + 54978

= 509388

System A

percentage market penetration = $\frac{221034}{2000000} \times 100$

= 11.1%

System B

= $\frac{54978}{2000000} \times 100$

= 2.75%

System C

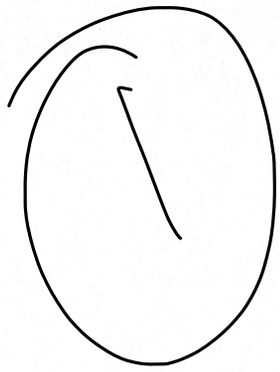
= $\frac{233376}{2000000} \times 100$

= 11.7%

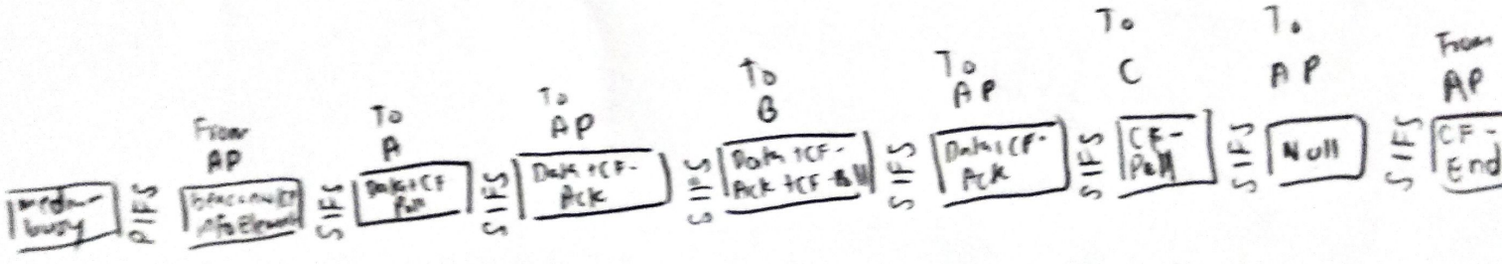
10

Q2

N = 7



Q3



PIFS - Point Coordinator

SIFS - Shortest