FIJI NATIONAL UNIVERSITY
College of Engineering, Science & Technology

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

BACHELOR OF ENGINEERING
(Telecom & Networking)

EEE794 – MOBILE AND PERSONAL COMMUNICATION SYSTEMS

SEMESTER 2, 2015

DAY/DATE: As timetabled DURATION : Three hours
ROOM: As timetabled

INSTRUCTION TO STUDENTS

1. You are allowed 10 minutes extra reading time during which you are **NOT** to write.
2. Answer **ALL** questions in Section A and in Section B
3. **Begin the answer to each Question** on a fresh page and use both sides of the sheet.
4. Write clearly the number of the question attempted on the top of each sheet
5. Write your candidate number at the top of each sheet & attach them.
6. Insert all written foolscaps, graph paper etc. in their correct sequence and secure with a string.
7. All sheets of paper on which rough/draft work has been done, cross it through and attach all of them to your answer scripts.
8. Where ever possible, draw clear neat diagrams

Total number of pages - 6

Section A
Answer ALL Questions

A1. Draw a block diagram of a mobile communication network. Explain the functions of each of the blocks. Indicate and name the different RF links associated with the network.

(6 marks)

A2. In mobile communication, explain what is meant by co-channel cells. Derive an expression for the distance between co-channel cells in terms of the radius of the cell and the *shift parameters*: i and j. [You may assume hexagonal cells].

(5 marks)

A cellular system uses $i = 3, j = 0$. The radius of a cell is 2.4 km. Calculate the minimum area that would be covered by an allotted frequency bandwidth.

(3 marks)

A3. The band 824 – 849 MHz is allocated to a *narrow band* FDD cellular system with two 30 KHz simplex channels to provide full duplex voice and control channel. Assume 1 MHz of spectrum is allocated to control channels, and the guard band is 10 kHz each for the voice channels. Compute the number of channels available per cell if the system uses (i) 4 cell, (ii) 7 cell, and (iii) 8 cell reuse technique. Give an equitable distribution of voice and control channels.

(6 marks)

A4. In an effort to analyze signal quality and co-channel interference, as a service engineer, you have been provided a channel scanning mobile receiver. Explain what measurements you will take. Also explain how you would interpret the measurements

(7 marks)

A5. Briefly explain what the following concepts refer to in mobile technology.

1. Vertical and horizontal handoffs
2. Network Controlled Handoff (NCHO)
3. Mobile Assisted Handoff (MAHO)
4. Mobile Controlled Handoff (MCHO)
5. Hard handoff
6. Soft handoff

(7 marks)

A6. A simple CDMA implementation scheme is shown in the diagram together with the received signal (Rx). If the PN code is (PN), retrieve the information bits. (use apace provided on page 5 and attach the sheet)

(6 marks)

PTO

Section B
Answer ALL questions

B1 *a*) In a cellular system R is the radius of the cell and D is the distance of the co-cells from the cell C where the mobile user (M) is located. In the worst case scenario, the distances of M from the co-channel transmitters are given by: Two transmitters are approximately D from M; two transmitters are approximately D – R from M and two transmitters are approximately D + R from M. In the diagram provided (page 5), mark M, the co-cells and the different distances for a seven cell cluster system

(3 marks)

b) Derive an expression for the signal to interference ratio $\left(\frac{S}{I}\right)$ at the receiver for a system using *omni-directional* antennas.

(3 marks)

c) Assuming that if the path loss exponent of the r.f. waves is 4, show that for analog communication, the performance of a seven cell cluster arrangement is not satisfactory. Suggest different ways by which this ratio can be improved and discuss the merits and demerits of the suggestions

(4 marks)

d) The system is now modified using 120° sector antennas.
In the sheet provided (page 5), indicate the location of M, the orientation of the antennas, and the antennas that would be contributing to the interference.

(3 marks)

e) Derive the new expression for the signal to interference ratio $\left(\frac{S}{I}\right)$ at the receiver and calculate its magnitude.

(3 marks)

f) If the minimum $\left(\frac{S}{I}\right)$ ratio of the new system is 23 dB, comment on the cluster size, and determine the optimum cluster size for this new sectored antenna configuration.

(4 marks)

B2. *a*) How is the transmitter power P_t related to EIRP. Write down the expression for the power density at a point P, a distance r away from the antenna. If the effective area of a receiver antenna at P is $G_r\ \lambda^2/(4\pi)$. Write down the power P_r from the receiver (Friis equation).

(2 marks)

b) The *Ground reflection (2-ray) model* has been found to be reasonably accurate for predicting the large scale signal strength over distances of several kilometers in mobile systems. Draw a diagram illustrating the 2-ray model, clearly indicating the two rays. Mark all the components, distances and lengths associated with this model.

(4 marks)

PTO

c) The total power density of the two rays at the receiver is $\frac{P_t G_t}{4\pi r^2}\left[\frac{4\pi h_T h_R}{\lambda r}\right]^2$
Assuming the 2-ray of transmission model, show that the propagation path loss at a receiver of height h_R at a distance r away from the transmitter of height h_T.is:

$$Path\ loss = 40\log r - 20\log h_T - 20\log h_R$$

(5 marks)

d) In a cellular system, the radius of a cell is 10 km. The base station (BS) of transmitter power 110W is connected to an antenna of height 30 m and gain 6 dBi by a 25 m coaxial cable which has a specification of signal attenuation of 5 dB/100 m. The receiver is assumed to be at the furthest point from the BS has a gain of 2dBi is at a height of 2 m. Calculate the power (in Watts) at the receiver.

(5 marks)

e) For satisfactory reception the threshold power is 2.75×10^{-7} mW. What modifications could be done to achieve satisfactory performance? Calculate the new values in the modified system.

(4 marks)

B3.*a*) Two of the popular multiple access techniques in different wireless communication systems are:
1) FDMA/FDD
2) TDMA/FDD.
Giving appropriate labeled diagrams explain the above two systems.

(5 marks)

b) Draw a typical TDMA frame structure and explain the functions of each component in the frame. In your diagram allocate different times for the different components (example: t_g – guard time). Define the *Frame Efficiency*.

(5 marks)

c) Consider TDMA system transmitting 120800 *symbols* in 2 ms in a frame.
The parameters of the transmission are: It has two reference bursts/frame, each 512 *symbols* and the preamble bursts have 290 *symbols*. The guard interval is 1.82 μs. It transmits data from 14 stations. Calculate the frame efficiency of the system.
If the *symbols* were *i*) B*PSK*, *ii*) QPSK how many information bits have been transmitted in each case?

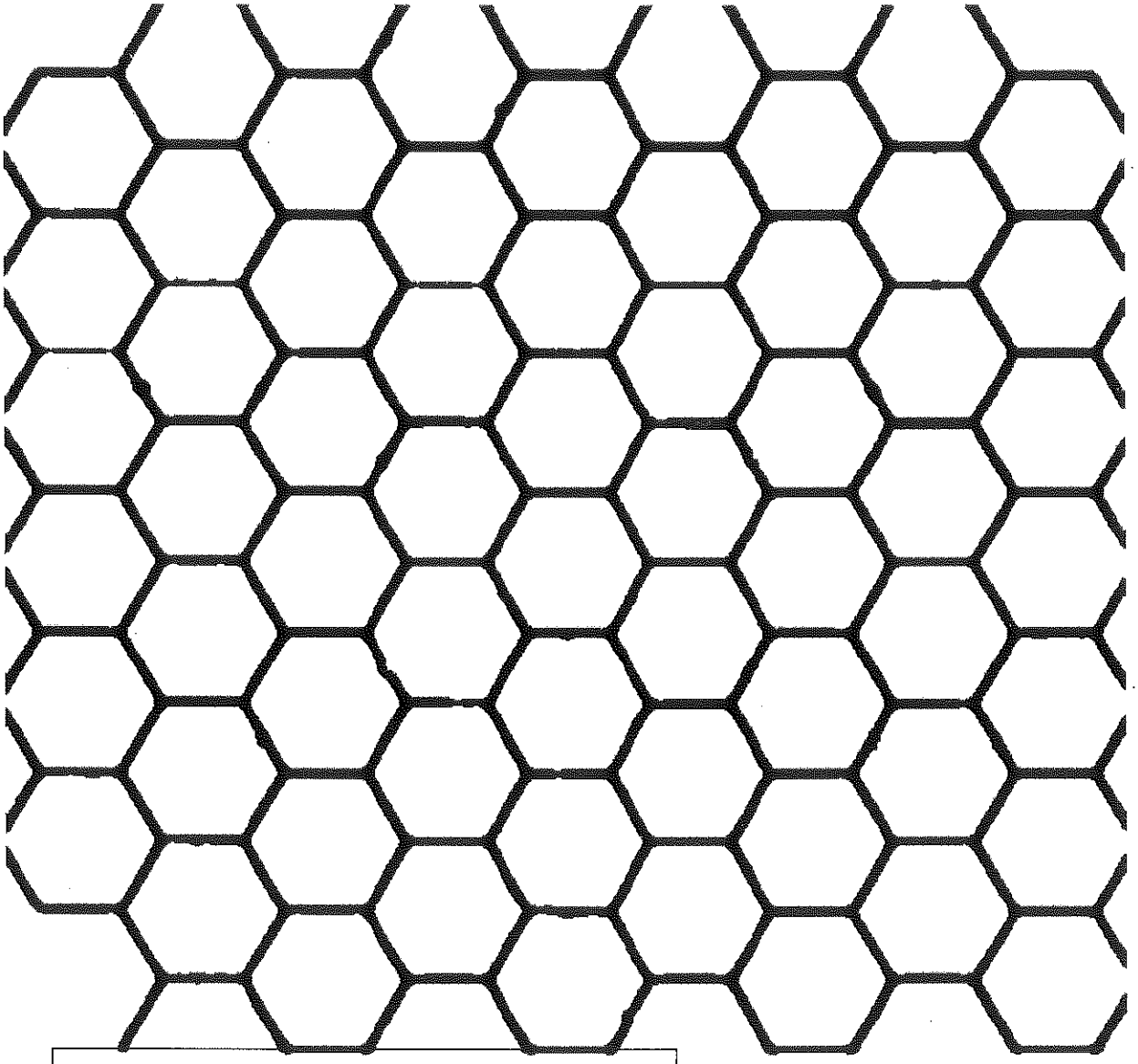
(7 marks)

d) Explain the near-far problem in CDMA

(3 marks

THE END

B1.



A6.