

CSE370 Spring 2007 Wireless and mobile networking

Midterm

- This is a closed book exam.
- There are 3 problems with 25 points in total and an extra credit problem of 5 points.
- In class on Thursday, March 15th, 2007. Exam starts at 11:20am and ends at 12:40pm.

By signing below I declare that I follow the rule of academic integrity and finish the exam on my own, without the help of others and/or textbooks/notes.

Name _____

Signature _____

1. **CDMA.** (7pts) Consider a Direct Sequence CDMA system where user i uses the i th row of the following Hadamard matrix as its chipping sequence:

$$\begin{pmatrix} +1 & +1 & +1 & +1 \\ +1 & -1 & +1 & -1 \\ +1 & +1 & -1 & -1 \\ +1 & -1 & -1 & +1 \end{pmatrix}$$

Assume that user 1 and 3 are transmitting simultaneously:

user 1 data sequence: +1 -1 -1 +1

user 3 data sequence: +1 +1 -1 -1

(For this problem we will use the vector representation. Essentially a data bit of 1 is represented by +1 and a data bit of 0 is represented by -1.)

- (a) (2pts) Show the signal sent by each user and the signal received at the receivers.

- (b) (2pts) Assume that the receiver wants to extract information from user 3. Show how this is done.

(c) (1pts) How many error bits can be tolerated?

(d) (2pts) Can there be interference if all 4 users transmit simultaneously? Why?

2. **Mobile IP** (7pts)

(a) (2pts) Explain what is tunneling in Mobile IP.

(b) (2pts) What are the advantages and disadvantages of tunneling in Mobile IP?

(c) (3pts) What is reverse tunneling? Give one reason for reverse tunneling.

3. **CSMA** (5pts) In CSMA (Carrier Sense Multiple Access) for wireless networks, why can there still be collision even if a sender sensed an idle channel? (2pts) How to resolve this? (3pts)

4. **Coding** (6pts) Suppose we are using Reed Solomon code for wireless communication through a channel of capacity 56K (this means each second one can send through 56,000 bits). The adversary uses a one-time jammer and is able to jam the channel for up to 2 milliseconds (1 millisecond= 10^{-3} second). Now we have a password we want to send through this channel. This password is a sequence of 7 numbers. Each number is represented by 8-bits. Explain briefly how to use Reed Solomon code to successfully deliver this password. (3pts) And how long does it take. (3pts)

5. **Extra credit problem.** (5pts) The Hamming code (7, 4) takes a string of length 4 and outputs a codeword of length 7. This is by taking the multiplication of the input string with the encoding matrix:

$$H = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 1 \\ 0 & 1 & 1 & 1 \end{pmatrix}$$

For example, an input string $x = \begin{pmatrix} 1 \\ 0 \\ 1 \\ 0 \end{pmatrix}$ will be encoded to

$$Hx = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 1 \\ 0 & 1 & 1 & 1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \\ 1 \\ 0 \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \end{pmatrix}$$

Here sum is in fact XOR (i.e., sum with mod 2). The question is, how many flip errors can be detected by this code?