New York University  
Computer Science Department  
Courant Institute of Mathematical Sciences

Course Title: Data Communication & Networks  
Instructor: Jean-Claude Franchitti  
Course Number: g22.2662-001

Assignment #3

I. Due Dates:

- Answers to Problems 1-6 due on Thursday October 5, 2017 at the beginning of class.
- Program solutions (i.e., answer to Question V.7) due on Thursday October 19, 2017 at the beginning of class.

II. Objectives

1. Experiment with Data Encoding and Transmission.
2. Program using sockets.

III. References

1. Slides and handouts posted on the course Web site

IV. Software Required

1. Microsoft Word
2. Win Zip as necessary

V. Assignment

1. Problem 1:

   Develop algorithms for generating each of the codes of NRZI, Bipolar-AMI, Pseudoternary, Manchester, Differential Manchester, B8ZS, and HDB3 from NRZ-L.

2. Problem 2:

   The following describes a signal encoding technique.

   Binary data is represented as input $a_m$ for $m = 1, 2, 3, \ldots$

   A new set of binary numbers is then produced as follows:
\[ b_0 = 0 \]
\[ b_m = (a_m + b_{m-1}) \mod 2 \]

These numbers are then encoded as:

\[ c_m = b_m - b_{m-1} \]

On reception, the original data is recovered via

\[ a_m = c_m \mod 2 \]

(a) Confirm that the received values of \( a_m \) are equal to the transmitted values of \( a_m \).
(b) What kind of encoding is this?

3. Problem 3:

One positive side effect of bipolar encoding is that a bipolar violation (i.e., two consecutive + pulses or two consecutive – pulses separated by any number of zeros) indicates to the receiver that an error occurred in transmission. However, upon receipt of such a violation, the receiver does not know which bit is in error (i.e., the receiver only knows that an error has occurred).

For the received bipolar sequence \( + - 0 + - 0 - + \), which has one bipolar violation, construct two scenarios that will produce this same received bit pattern. Each of the two scenarios should involve a different transmitted bit stream with one transmitted bit being converted via an error.

4. Problem 4:

Considering the bit pattern 01100, encode this data using ASK, BFSK, and BPSK.

5. Problem 5:

Assuming a required bit error rate of \( 10^{-6} \), what SNR ration is required to achieved a bandwidth efficiency of 1.0 for ASK, FSK, PSK, and QPSK?

6. Problem 6:

Consider an audio signal with spectral components in the range 300 to 3000 Hz. Assume that a sampling rate of 7000 samples per second is used to generate a PCM signal.
(a) For SNR = 35 dB, what is the number of uniform quantization levels needed?
(b) What is the required data rate?

7. Programming Assignment:

In an OO programming language of your choice, implement at least two of the following applications:

1. Multi-Threaded Web Server
2. UDP Pinger
3. Mail User Agent
4. Multi-Threaded Web Proxy Server

For each one of two of the applications you are implementing, identify and implement two enhancements or special features of your choice. Please include design level details along with the code for your applications.

See the Socket Programming Assignments at the end of Chapter 2 of the textbook for more information and feel free to leverage the code provided for all or parts of the applications.

VI. Deliverables

1. Electronic:

Your assignment solution file and program report/code must be emailed to the course grader. The assignment solution and program report/code must be created and sent by the beginning of class as per the corresponding due date. After the class period, the assignment is late. The email clock is the official clock.

2. Cover page and other formatting requirements:

The cover page supplied on the next page must be the first page of your assignment solution and program report submission.

Fill in the blank area for each field.

NOTE:

The sequence of the hardcopy submission for the assignment solution and program report is:

1. Assignment solution / program report cover sheet
2. Actual assignment solution / program report sheet(s)
VII. Sample Cover Sheet:

Name __________________________ Date: ____________  
(last name, first name)  
Section: ____________  

Assignment 3

Assignment Solution / Program Report Layout (25%)

- Assignment solution / program report are neatly assembled on 8 1/2 by 11 paper.  
- Cover pages with your name (last name first followed by a comma then first name); username and section number with a signed statement of independent effort is included.  
- File names are correct.

Proper Program Documentation Provided:

- Assignment solution / program report include the details mentioned in section V above.  
- Assumptions are provided when required.  
- Program code is properly commented.

Total in points (100 points total): ________________

Professor’s Comments: