

# CARLETON UNIVERSITY

## Department of Systems and Computer Engineering

**SYSC 4700**

**Telecommunications Engineering**

**Winter 2008**

### Assignment 1

**Posting date: Friday, 25 January 2008**

**Due date: 4:00 pm, Monday, 04 February 2008 (in box outside ME 4438)**

#### Question 1 [10 points]

Consider an upcoming xDSL standard as an access technology over the copper telephone lines (i.e., last-mile access). Here are some relevant specifications:

- This standard uses the DMT (discrete multitone modulation) technology with 4 KHz tones (i.e., channels).
- There is 1 KHz guard band between neighboring tones.
- The downstream portion uses the spectrum band between 2.000 MHz and 7.119 MHz.
- Spectral efficiency is 9 bits/sec/Hz.

**(a) [6 points]** Find the downstream rate in bits/sec (assuming the pulse shape that yields the highest spectral efficiency).

**(b) [4 points]** Find the minimum required SNR at the user modem to facilitate this system using the Shannon channel capacity formula.

**Question 2 [10 marks]**

Consider a high-quality analog-to-digital converter (ADC) for voice signals with the following specifications:

- The ADC captures the detail in the voice signal up to 13 KHz.
- 2048 levels are used for quantization.

Next, consider a time-division multiplexing scheme (TDM) which combines the digital output from 20 users whose analog data is digitized through the above described ADC scheme. A TDM frame consists of samples from 20 users plus three bits for synchronization purposes.

**(a) [6 points]** Find the line speed (in bits/sec) to carry this TDM traffic.

**(b) [4 points]** Assuming that M-ary QAM modulation is used, find M if the line has 1.2 MHz of bandwidth (indicate what pulse shape you assumed in this design).