# CARLETON UNIVERSITY

**Department of Systems and Computer Engineering**

## SYSC4700 Telecommunications Engineering Winter 2014

## Term Exam – 13 February 2014

## Duration: 75 minutes

**Instructions:**

1. **Closed-book exam (no aid-sheet). No cell phones.**
2. **Write answers in the spaces provided on the question sheet.**
3. **If necessary, use both sides of a page.**

**Name:**

**Student Number:**

| Question | Mark | Max possible mark |
|---|---|---|
| 1 | | 155 |
| 2 | | 85 |
| Total | | 240 |

**Question 1 – Short Questions [155 points]**

**a)** **[5 pts]** What is the data rate for digital voice commonly used in the current wireless cellular networks?

**b)** **[15 pts]** What is the data rate when voice is digitized through PCM in wired telephone networks? How is that number obtained?

**c)** [**10 pts**] The PSD (power spectral density) of a signal X(t) is given as

$$S_X(f) = \begin{cases} N_0/2, & -400MHz \le f \le -390MHz \\ N_0/2, & 390MHz \le f \le 400MHz \\ 0, & elsewhere \end{cases}$$

Find the bandwidth of X(t).

**d)** [**10 pts**] Which one of the following numbers is a typical path-loss value in a cellular network, if a user is about 1 km away from BS: -1000 dB, -100 dB, -10 dB, 0 dB , 10 dB , 100 dB, 1000 dB?

**e)** **[10 pts]** What are the per cell shared peak rates that the upcoming 4G LTE-Advanced wireless networks will provide in the downlink for stationary (no or limited movement) applications?

**f)** **[15 pts]** Suppose that you are involved in the design of a next-generation cellular network

which targets to deliver a shared peak rate of 20 Gbps per base station in the downlink. Choose some appropriate values for the following:

- bandwidth
- spectral efficiency, and
- number of antennas (for MIMO gain)

**g)** **[10 pts]** Consider a wireless system operating in the 1133–1138 MHz band. The synch pulses are used; the highest modulation level is 128-QAM. The system supports 4x4 MIMO. Find the highest data rate (in bits/sec) that this wireless system can support.

**h)** **[10 pts]** State one reason why the telecom standards are beneficial for the vendors (such as Ericsson, Samsung, Apple)?

State one reason why the telecom standards are beneficial for the operators (Verizon, Bell Mobility, AT&T)?

**i)** **[5 pts]** The International Telecommunications Union (ITU) was founded in 1865. What application/service was being standardized at the time?

**j)** **[10 pts]** Give an example of a successful IEEE standard.

**k)** **[5 pts]** Give the acronym for the primary standards body for the Internet.

**l)** **[10 pts]** ADSL stands for “Asymmetric Digital Subscribers Line”. What does asymmetric mean in this context?

**m) [20 pts]** State two advantages of packet switching over circuit switching:

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State two disadvantages of packet switching over circuit switching:

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**n) [10 pts]** Briefly explain the major contribution of Claude Shannon? (Do not use any equations)

**o) [10 pts]** Who developed the noise model in digital communication systems?

**Question 2 – Link Budget and Path-Loss [85 pts]**

**a) [35 pts]** In a WLAN (wireless local area network), the path-loss is given as PL [dB] = 43 + $38\log_{10}(d)$ where $d$ is the distance between the access point (AP) and a user. The AP transmits at the same power level to all users. If the distance between the AP and a user $i$ is 8 times the distance between the AP and a user $j$, how many dB less power does user $i$ receive in comparison to user $j$?

**b) [25 pts]** The free-space path-loss is given as FSPL = $(4\pi/\lambda)^2 d^2$. If the carrier frequency is 2.5 GHz, for what distance between the transmitter and receiver a FSPL of 120 dB correspond? (Speed of light: $3x10^8$ m/sec.)

**c) [25 pts]** The free-space path-loss is given as FSPL = $(4\pi/\lambda)^2 d^2$. Propagation measurements in a city suggest a terrestrial path-loss of TPL = $(4\pi/\lambda)^2 d^{3.6}$. If a transmitter and a receiver are 1.5 km apart, how many dBs less power will be received in the city in comparison to space? Assume a carrier frequency of 700 MHz. (Speed of light: $3x10^8$ m/sec.)