CARLETON UNIVERSITY
Department of Systems and Computer Engineering

SYSC4700   Telecommunications Engineering   Winter 2013

Term Exam – 15 February 2013

Duration: 80 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		20
2		32
3		30
Total		82

Question 1 [20 pts] – A/D Conversion and Time-Division Multiplexing

There is a high-speed line which can carry traffic at a rate 5.148 Mbits/sec. A number of analog voice signals will first be digitized and then will be multiplexed on to this high-speed line through TDM (time-division multiplexing). There is no control bits appended during the multiplexing operation.

There are two types of A/D conversion, low quality and high quality, with the below parameters.

- Low-Quality A/D Conversion: Sampling Rate = 6,000 samples/sec
  Quantizer: 64-level

- High-Quality A/D Conversion: Sampling Rate = 18,000 samples/sec
  Quantizer: 2048-level

Let us denote the users whose voice signals go through the low-quality A/D conversion as type-L users, and those whose voice signals go through the high-quality A/D conversion as type-H users.

(a) **[7 pts]** How many type-L users can be multiplexed on to the high-speed carrier?

(b) **[6 pts]** How many type-H users can be multiplexed on to the high-speed carrier?

(c) **[7 pts]** Next, consider the case where a mix of type-L and type-H users will be multiplexed. If there are n type-L users and n type-H users to be multiplexed, find n.

Question 2 [32 marks] – Short Questions

(a) [6 pts] Give two business values for operators that telecom standardization brings.

1)

2)

(b) [6 pts] Give two business values for vendors that telecom standardization brings.

1)

2)

(c) [4 pts] Write two types of standards bodies.

1)

2)

(d) [6 pts] What do the followings acronyms stand for?

1) ITU:

2) IETF:

(e) [4 pts] Give two examples for standards development organizations.

1)

2)

(f) [6 pts] Give three examples of highest impact telecom standards.

1)

2)

3)

Question 1 [30 marks] – Link Budget

In this question we will determine the maximum achievable transmission rate in the downlink of a cellular wireless network. Here are the specifications of interest:

- Base Station (BS) transmit power: $P_{TX} = 0.2$ W
- Transmitter (BS) antenna gain: $G_{TX} = 7$ dB
- Receiver (terminal) antenna gain: $G_{RX} = 3$ dB
- Quality requirement: SNR > 5 dB
- Receiver noise figure: $F = 3.98 = 6$ dB
- Ambient temperature: $T = 290^{o}$K
- Boltzmann constant: $k = 1.38 \times 10^{-23}$ joule/^{o}K
- Path loss (PL): $(4\pi f/c)^2 d^4$, where
  - Distance between BS and a wireless terminal: d
  - Speed of light: $c = 3 \times 10^8$ m/sec.
  - Carrier frequency: $f = 2$ GHz
- Maximum spectral efficiency according to Shannon's channel capacity theorem: $\mu_{\max} = \log_2(1 + \text{SNR})$ bits/sec/Hz.

Calculate the maximum achievable rate in bits/sec if a wireless terminal is 200 m away from the BS.

[**Help 1**: $P_{noise} = kTBF$ in linear scale.]

[**Help 2**: Note that B (bandwidth) is not given in the question; it is to be calculated.]

[**Help 3**: Some values are given in dB scale, while some others in linear.]