Department of Electrical Engineering and Computer Science

LE/CSE 3213 Z: Communication Networks

Winter 2014 FINAL EXAMINATION

Saturday, April 12 — 2 to 4 PM

CB 129

SURNAME (printed):

FIRST NAME and INITIALS (printed):

York ID NUMBER:

SIGNATURE:

Please don't write anything within this box.

1	/ 10
2	/ 7
3	/ 8
4	/ 5
5	/ 10
6	/ 10
7	/ 8
8	/ 7
9	/ 5
TOTAL	/ 70

Instructions

- You may use a calculator, but you may **not** use a computer during the test or have any wireless device with you.
- The test is **closed-book**. You may not refer to any books or during the test except for the official SC/CSE 3213 Aid-Sheet provided with the exam.
- Write all answers on the question paper and hand in the question paper when you are done.
- Hand in **all pages** of the question paper, including pages that do not contain any answers.
- If you detach any pages from the question paper, write your name and student ID number on every detached page.
- Please print or write your answers **legibly**. What cannot be read cannot be marked.
- If you write anything you do not want marked, put a large X through it and write "rough work" beside it.
- Circle your final answer.

1. (10 points) Answer the following questions as clearly and concisely as you can:
   (a) (1 point) DNS runs on top of what protocol?

   (b) (1 point) What protocol is used to find physical addresses?

   (c) (1 point) The process of digitization consists of two main blocks. Name one of them.

   (d) (1 point) Name one example of a Nyquist pulse. Don't use acronyms.

   (e) (1 point) Quadrature signalling uses two carriers. How many degrees apart must be the phases of those carriers?

   (f) (1 point) How many wires does a simple UTP consist of?

   (g) (1 point) What is the Hamming distance between 0001100 and 0011111?

   (h) (1 point) What is the efficiency of 1-bit parity coding in the face of a random error vector model?

   (i) (1 point) Name an ARQ technique that is efficient when delay bandwidth is bad as long as probability of bit error is not too high.

   (j) (1 point) Name a MAC technique.

2. (7 points) TCP/IP/Control

   (a) (5 points) The table below shows the partial results from a network analyzer from the moment someone clicked on a new link to the moment the web page loaded. Each pertinent row and column is labelled (with Rx and Cx respectively) to allow easy reference to each table entry.

C1	C2	C3	C4	C5
Line	Source	Destination	Protocol	Info
R1	a.b.c.d	w.x.y.z	DNS	Standard query
R2	w.x.y.z	a.b.c.d	?	Standard response
R3	a.b.c.d	?	?	1127 > 80
R4	?	a.b.c.d	TCP	?
R5	?	e.f.g.h	?	?
R6	a.b.c.d	e.f.g.h	?	GET / HTTP/1.1
R7	?	?	TCP	80 > 1127
R8	e.f.g.h	a.b.c.d	HTTP	HTTP/1.1 200

   i) What should be in the table entry corresponding to (R2,C4)?

   ii) What should be in the table entry corresponding to (R3,C3)?

   iii) What should be in the table entry corresponding to (R4,C5)?

   iv) What should be in the table entry corresponding to (R5,C4)?

   v) What should be in the table entry corresponding to (R6,C4)?

   (b) (1 point) What protocol is used to obtain IP addresses?

   (c) (1 point) What protocol does NAT leverage to allow hosts to employ duplicate IP addresses?

3. (8 points) Communication over physical media.

   (a) (2 points) Sketch the attenuation in dB/km for a coax cable (y-axis) as a function of the log of distance (x-axis) (include the coordinate axes in your picture). Don't worry about numbers, just looking for qualitative correctness.

   (b) (2 points) Suppose that we wish to delay an optical signal by 1.5 nanoseconds (ns). How long a length of optical fiber in meters is needed to do this?

   (c) (4 points) A signal is to be sent through a network consisting of 3 links and 2 repeaters. Each repeater returns the signal to its original power of 1.5 Watts, but adds 0.2 Watts of noise power. Each link has a signal attenuation of 2 dB. What is the signal to noise ratio at the receiver in dB?

4. (5 points) Digitization

   (a) (2 points) A 5-bit A/D has a range of ±1.5 V. What is the change in sampled input voltage that would cause the A/D's output to change by 1 bit?

   (b) (3 points) How many A/D bits do I need to capture a signal with at least 60-dB signal-to-noise ratio if the A/D has a range of ±1.25 V and the input signal's standard deviation is 0.15 V?

5. (10 points) Baseband communications

   (a) (4 points) Sketch the block diagram of a baseband digital transmitter (input at left output at right) capable of operating without ISI. Each unique block you include is worth one point (if you put them in the right order).

   (b) (2 points) An 8-level symbol is used to communicate over a 23-kHz baseband channel. What is the maximum data rate that you could achieve without ISI in kbps?

   (c) (2 points) Sketch 101110 using polar NRZ encoding. Clearly correspond your waveform to the sequence and show signal levels.

   . 1 0 1 1 1 0

   (d) (2 points) Sketch 101110 using differential NRZ encoding. Clearly correspond your waveform to the sequence and show signal levels.

   . 1 0 1 1 1 0

6. (10 points) Modulation

   (a) (2 points) Sketch the constellation for 16-QAM.

   (b) (2 points) What is the maximum data rate that you can achieve through a 5.5-MHz bandpass channel using 32-QAM such that ISI is avoided?

   (c) (2 points) For a 128 point QAM constellation how many different signal levels do you need to use in each modulator branch?

   (d) (4 points) Sketch the block diagram of a 4-QAM (aka QAM or QPSK) modulator and demodulator (from which baseband data can be sampled) operating at a 1.2 GHz carrier. Clearly show and label all the inputs and outputs the modulator and demodulator.

7. (8 points) Error detection

   (a) (4 points) A 2.4 Mbps transmission experiences a bit error rate of 0.5×10^{-2}. It uses 000 to represent a 0 and a 111 to represent a 1. The receiver takes the three received bits and decides which bit was sent by taking the majority vote of the three bits. Find the probability that the receiver confuses a 0 for a 1.

   (b) (4 points) A 4-bit checksum scheme is used on the following binary message (the message is separated by dots only for your convenience): 0110.0011.1010. What is the binary code appended to this message?

8. (7 points) ARQ

   (a) (1 point) If I have 3-bits set aside for sequence numbering what's the biggest transmit window I can use in GBN?

   (b) (1 point) If I have 16-bits set aside for sequence numbering what's the biggest receive window I can use in SR assuming balanced send/receive windows?

   (c) (2 points) I wish to send over a channel with a bit error rate of 10^{-4} using 8000 bit frames. What kind of efficiency can I expect to achieve using selective repeat?

   (d) (3 points) A network operates at $R = 1.2$ Gbps with a propagation time of 11 μs. If my frames have 10,000 bits what window size can I use in GBN? Assume all other effects are negligible.

9. (5 points) MAC

   (a) (2 points) I have a two-terminal wireless communicator capable of sending 2000-bit frames at 2.7 Mbps while sensing the channel for carriers and collisions. What is the efficiency of this scheme if the units are separated by 20-km?

   (b) (2 points) An ALOHA scheme operates at 450 kbps and sends frames with an average length of 2000 bits. Every how many milliseconds should communicators in such a network be allowed to send a new frame if I wish to operate at maximum throughput?

   (c) (1 point) What's ALOHA throughput when the offered load reaches 0.3?