THE UNIVERSITY OF AUCKLAND

FIRST SEMESTER, 2008
Campus: Tamaki

COMPUTER SCIENCE

Data Communications Fundamentals

(Time allowed: TWO hours)

NOTE:

- Attempt *all* questions. Calculators are NOT permitted.
- Write *short* answers in the space provided (extra space for answers is available on pages 18 to 20).
- No marks will be awarded if you merely state a "yes" or "no" answer. To obtain full credit, your script must clearly explain *why* your answer is correct.
- If you require additional information in order to answer a question, you should make a reasonable assumption as required for your answer, and you should explain your assumption on your script.

Surname: .... Forenames: ....

Student ID: ....

Departmental Use Only					
Question	Marks allocated	Marks gained	Question	Marks allocated	Marks gained
1	8		6	10	
2	10		7	10	
3	10		8	10	
4	12		9	12	
5	10		10	8	
Total			Total	100	

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1. **Compression** [8 marks]
Assume that you wish to email a large file consisting entirely of strings of lower-case letters (26), plus the digits 0,1,2,3,4,5,6,7,8,9.

(a) How many bits do you need to store a file with n characters using an 8-bit ASCII code? [2 marks]

(b) Can you do it better? Present your solution and calculate the size of the compressed file. How much size reduction (percentage) have you obtained? [3 marks]

(c) What is the maximum number of characters one can code with your solution presented at (b)? [3 marks]

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2. **Parity check** [10 marks]

   (a) What is a two-dimensional parity check? [3 marks]

   (b) Calculate and write in the two-dimensional parity check for the data shown below, and then write the sequence of bits that are transmitted. [4 marks]

0	1	0	0	0	0	0	0
0	0	0	0	1	1	1	0
0	0	0	0	1	0	1	0
0	1	1	0	0	0	0	0
1	1	1	1	1	1	0	0
1	1	1	1	1	1	0	1
1	1	1	1	1	1	1	0
1	1	1	1	0	0	0	0

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(c) Calculate the increase in size – in absolute value and percentage – of the transmitted data using two-dimensional parity check. [3 marks]

3. **Protocol Layers** [10 marks]

(a) Explain in one or two sentences why protocols are designed in layers. [2 marks]

(b) Give two examples of an upper layer protocol and state which lower layer is below each one. [2 marks]

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(c) Which layers use physical addresses recognised by hardware? [2 marks]

(d) Which layers use logical addresses recognised by software? [2 marks]

(e) When data packets are sent through a network, how does the receiving system distinguish the various protocol layers in the incoming packet? [2 marks]

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4. **Security** [12 marks]

(a) What is the main difference between a normal coding scheme and a cryptographic code? [2 marks]

(b) What is the main difference between a public key system and a symmetric key system? [2 marks]

For parts c) to f), consider a security protocol in which three messages are exchanged:

M1. Client A to server B: **Eb("user Alice", a)**
M2. Server B to client A: **Ea("user Alice", Tb)**
M3. Client A to server B: **Eb("user Alice", Tb, data)**

where **Ea, Eb** mean RSA encryption with the public keys of A and B respectively, **a** is A's public key, and **Tb** is the time on B's clock when it receives M1. Assume that B's public key is known to everybody. Remember to explain your answers.

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(c) After the three messages, does B know that client A is definitely user Alice? [2 marks]

(d) After the three messages, does A know that server B is genuine? [2 marks]

(e) If a third system X has intercepted M1 and M2, can it read the data in M3? [2 marks]

(f) If X sends a bogus message similar to M3, can B detect that it is bogus? [2 marks]

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5. **Flow Control** [10 marks]

(a) Is flow control possible on a simplex link? If not, why not? [2 marks]

(b) Consider a stop-and-wait protocol designed for use over a 10 Mbit/s LAN, with a maximum distance of 1 km between stations. The travel time for 1 km is 5 microseconds. The time taken to send out a 1500 byte data packet and a short ACK packet is 1250 microseconds. Will the stop-and-wait method be efficient? Explain your answer. Note that a detailed calculation is *not* required. [2 marks]

(c) Explain how the efficiency will change for a wide-area link (hundreds or thousands of kilometres). A calculation is not required. [2 marks]

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(d) Explain how a sliding window protocol affects the efficiency (assuming no packets or ACKs are lost). Draw a simple diagram if you want. [2 marks]

(e) What is the simplest way for a sliding window protocol to handle lost ACKs? [2 marks]

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6. **Local Area Networks** [10 marks]

(a) Describe the main difference between CSMA/CD and CSMA/CA mechanisms. [2 marks]

(b) Which method is used on a wireless LAN? Why? [2 marks]

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(c) Why is there a maximum cable length allowed for any design of CSMA/CD? [2 marks]

(d) An Ethernet address is divided into two main parts. What are they? [2 marks]

(e) Why does an 802.11 wireless LAN frame contain more than two address fields in its header? [2 marks]

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7. **Switching and routing** [10 marks]

(a) Consider a device with four ports P1 to P4 connecting to different LANs. The device could be a bridge, a switch, or a router. A,B,C etc. are the addresses of devices connected on those LANs, arranged as follows:

P1: A, C, D, F
P2: B, E, H
P3: G
P4: I, J

Draw up a simple routing table for the central device.
(Hint: the first two lines are given.) [2 marks]

A: P1
B: P2

(b) How will a bridge, or a switch with bridging logic, create such a table? [2 marks]

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(c) What type of address will be in the resulting routing table? [1 mark]

(d) If there are several bridges or switches connected together, how will routing loops be avoided? [2 marks]

(e) How will a router create such a routing table? In this case, A, B, C etc. may be other routers. Give two specific examples of the method that might be used. [2 marks]

(f) What type of address will be in the resulting routing table? [1 mark]

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8. **IPv4 and IPv6** [10 marks]

(a) An IP address is best regarded as "just a binary number." What is the main difference between IPv4 and IPv6 addresses? [2 marks]

(b) An IPv4 header has a single 20-byte fixed part (and possibly some 'option' parts), while an IPv6 header has a 40-byte fixed part, and may have one or more 'extension headers.' Explain briefly why the IPv6 header uses extension headers in this way. [2 marks]

(c) Which fields in the IPv4 header are used when fragmenting and reassembling packets? At what point in the network are IPv4 packets fragmented and reassembled? [4 marks]

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(d) Why is the Identification field in the IPv6 Fragment Header 32 bits rather than 16 as in IPv4? [2 marks]

9. **Transport Protocols** [12 marks]

(a) What function does a *transport protocol* perform in a network? [2 marks]

(b) Briefly describe the UDP and TCP protocols. What are the main differences between them? [3 marks]

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(c) TCP is a *sliding window* protocol. How does its send-window size change when a TCP connection is started? How does the send-window change in response to changing network conditions? [4 marks]

(d) Why is TCP considered to be a "network-friendly" transport protocol? Is UDP a network-friendly protocol? Justify your answer. [3 marks]

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10. **Applications** [8 marks]

(a) What service is provided by `ssh`, the Secure Shell Application? Give at least two examples of what it can be used for. [2 marks]

(b) Briefly describe each of the three parts of the `ssh` architecture, i.e. how does `ssh` establish transport to a remote host, authenticate its user, and establish a channel to the remote host? [4 marks]

(c) An http connection can be opened securely (over TLS or SSL) using the `https:` scheme. In what important aspect does https differ from ssh? [2 marks]

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SPARE PAGE FOR EXTRA ANSWERS

Cross out rough working that you do not want marked.
Specify the question number for work that you do want marked.

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