

# 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	

CONTINUED

Student ID: .....

**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]

CONTINUED

Student ID: .....

**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	0	1	1	1	1	0
0	0	0	0	1	0	1	0	0
0	1	1	0	0	0	0	0	0
1	1	1	1	1	1	0	0	0
1	1	1	1	1	1	0	1	0
1	1	1	1	1	1	1	0	0
1	1	1	1	0	0	0	0	0

CONTINUED

Student ID: .....

- (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]

CONTINUED

Student ID: .....

- (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]

CONTINUED

Student ID: .....

## 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:  $E_b(\text{"user Alice"}, a)$   
M2. Server B to client A:  $E_a(\text{"user Alice"}, T_b)$   
M3. Client A to server B:  $E_b(\text{"user Alice"}, T_b, \text{data})$

where  $E_a$ ,  $E_b$  mean RSA encryption with the public keys of A and B respectively,  $a$  is A's public key, and  $T_b$  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.

CONTINUED

Student ID: .....

- (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]

CONTINUED

Student ID: .....

**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]

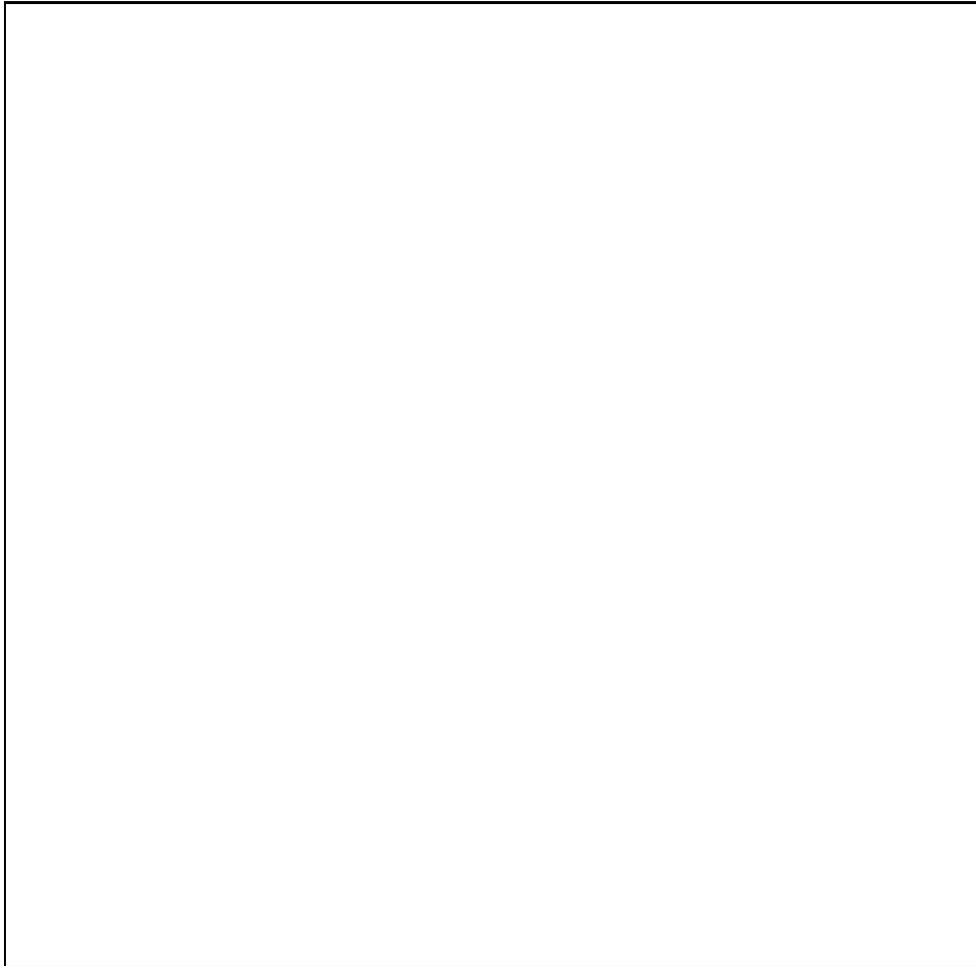
- (c) Explain how the efficiency will change for a wide-area link (hundreds or thousands of kilometres). A calculation is not required.

[2 marks]

CONTINUED

Student ID: .....

- (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]



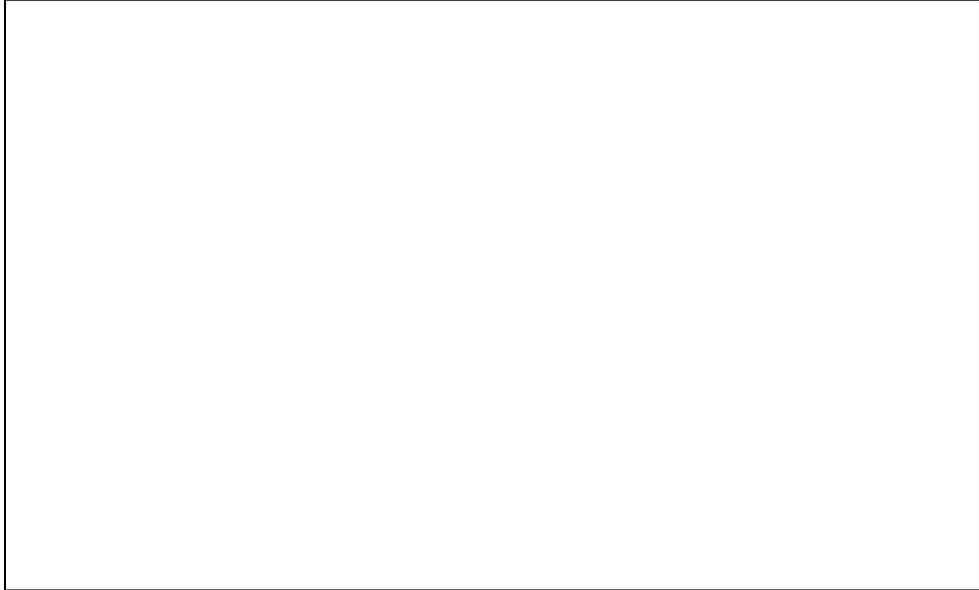
CONTINUED

Student ID: .....

**6. Local Area Networks**

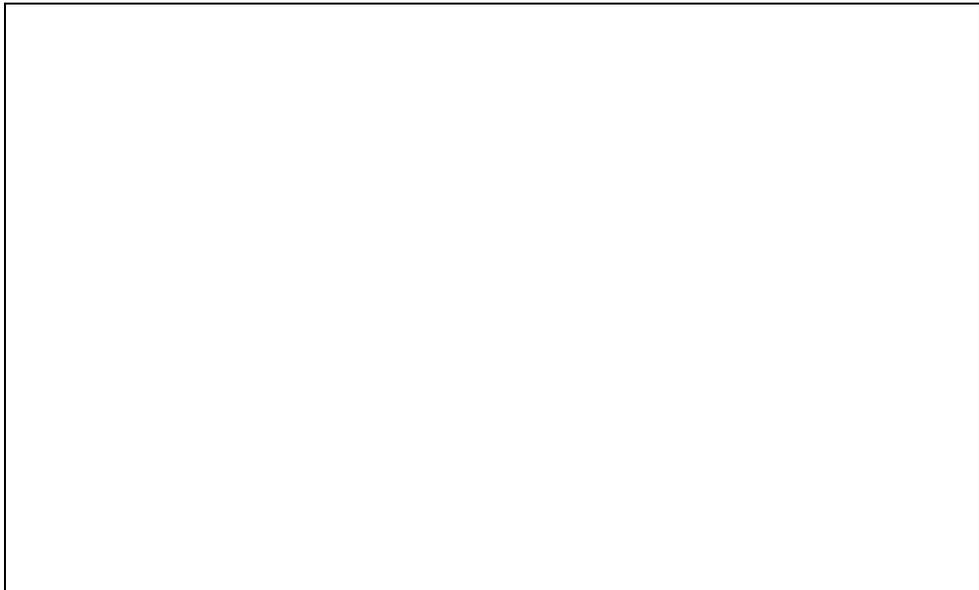
[10 marks]

- (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]



CONTINUED

Student ID: .....

- (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]

CONTINUED

Student ID: .....

**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]

CONTINUED

Student ID: .....

- (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]

CONTINUED

Student ID: .....

**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]

CONTINUED

Student ID: .....

- (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]

CONTINUED

Student ID: .....

- (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]

CONTINUED

Student ID: .....

**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]

CONTINUED

Student ID: .....

**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.

CONTINUED

Student ID: .....

**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.

CONTINUED

Student ID: .....

**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.

---