THE UNIVERSITY OF AUCKLAND

FIRST SEMESTER, 2005
Campus: City

COMPUTER SCIENCE

Data Communications Fundamentals

(Time allowed: TWO hours)

NOTE:

- Attempt all questions.
- Calculators are NOT permitted.
- Marks for each question are as shown.
- Write your answers in the spaces provided (extra pages are provided at the end of this paper)

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

Student ID: .....

Departmental Use Only					
Question	Marks allocated	Marks gained	Question	Marks allocated	Marks gained
1	8		8	5	
2	4		9	10	
3	6		10	8	
4	8		11	8	
5	8		12	8	
6	7		13	9	
7	4		14	7	
			Total	100	

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1. **Communications Modelling** [8 marks]

   A transmitter Tx is sending a long series of messages to a receiver Rx, over a high-speed wireless link. The raw bitrate is 900 Mb/s. The distance between the Tx and the Rx is 150 metres. The packet size is 56 bytes, for both data packets and for control packets. There are 40 bytes of user data in a data packet. The ARQ protocol is used for flow control. Estimate the user bandwidth of this link. To receive full marks, your answer must be within a factor of two of being correct, and you must show your work.

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2. **Communications Modelling** [4 marks]

Briefly describe *two* reasons why your answer to the previous question might overestimate the actual rate at which user data can be transferred. For full marks, your reasons must *not* be a mistake in your calculations, or an incorrect value for any of the link parameters.

3. **Physical Communication** [6 marks]

Compute the channel capacity of a $1kHz$ channel with a signal/noise ratio of $30dB$.

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4. **Protocols** [8 marks]

You want to send 100 high-resolution digital photos to your friend Alice by email. Each of your photo-messages will be about 1 MB in size. Fortunately, Alice has passed COMPSCI 314, so she has a good understanding of flow-control protocols. Unfortunately, Alice has a very small inbox in her email system: it's only 10 MB! She would like to see *no more than one* of your 1 MB photo-messages in her inbox, each time she reads her email. Alice reads her email approximately 2 to 20 times each week. You read your email about 1 to 5 times a day

Draw a diagram of a protocol for sending your 100 photo-messages (each of size 1 MB) to Alice. For full marks, your protocol diagram must clearly show what you and Alice should do if you receive an invalid message from each other, or if a timeout has occurred for either of you.

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5. **Protocols** [8 marks]

Briefly discuss the operation of the protocol you diagrammed in your answer to the previous question. To receive full marks, your discussion should use at least four of the following five terms appropriately: ARQ, sliding window protocol, timeout, ACK, NACK. Your discussion should also justify the length of time you chose for your timeouts, when you designed your protocol.

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6. **Encryption**

(a) Computer A and Computer B want to exchange messages using a public-key encryption process. *(You are not expected to describe any mathematical calculations that are used to derive and generate any keys.)*

i. Briefly describe the initial process that needs to take place. [1 mark]

ii. How will Computer A encrypt the message before sending it to Computer B? [1 mark]

iii. How will Computer B decrypt the message? [1 mark]

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(b) A hacker using Computer C intercepts the message, and also obtains both Computer A's and Computer B's public key. Will the hacker be able to decrypt the intercepted message? Explain why/why not. [2 marks]

(c) Explain the difference between public-key based and symmetric cryptosystems. Why can symmetric algorithms be less secure than asymmetric algorithms? [2 marks]

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7. **Compression**

(a) Derive a Huffman tree for the following message (include spaces, shown as ␣):

`the␣theme␣that␣they␣heard` [2 marks]

(b) Fill in the code set below with your resulting Huffman codes: [2 marks]

symbol	Huffman code
␣	
a	
d	
e	
h	
m	
r	
t	
y	

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8. **Error Detection**

A CRC code needs to be applied to the following 8-bit message: `01101101`. The generator polynomial is $x^3 + x$. What is the message that will be transmitted? *(Show your working.)* [5 marks]

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9. **LAN Interconnection**

(a) What is an Ethernet LAN segment? Your answer should explain how packets can be sent from one host to another, and how broadcast packets behave on the segment. [2 marks]

(b) Explain briefly how *bridges* can be used to connect several Ethernet LANs together to form a single 'extended' LAN. [2 marks]

(c) It is often useful to have one or more redundant bridges linking LANs. Explain briefly the protocol bridges use to avoid packet forwarding loops in an extended LAN. [3 marks]

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(d) What is meant by a Virtual LAN (VLAN)? What advantages can VLANs have over simple (extended) LANs? [3 marks]

10. **Routing Protocols**

(a) What is meant by *Link State* routing? Your answer should explain the terms *link state packet* and *reliable flooding*. [3 marks]

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(b) Explain briefly how a link state routing protocol such as OSPF works. Your answer should describe what happens when a link fails, then restarts after a few minutes. [3 marks]

(c) How does a link-state routing protocol ensure that the link state information it receives reflects the current state of a link, rather than its state at some earlier time? [2 marks]

11. **Fragmentation and Reassembly**

(a) What is meant by the *Maximum Transmission Unit (MTU)* for a link? [1 mark]

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(b) How does an IPv4 router handle datagrams which are larger than the MTU for their outbound link? Your answer should explain the fields in the IP header that are used in this process. [4 marks]

(c) Where are fragmented datagrams reassembled? [1 mark]

(d) How does IPv6 differ from IPv4 in the way it deals with fragmentation? [2 marks]

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12. **IP Addresses**

(a) An IP address has two parts, a *network* number and a *host number*. Explain how these two parts are used in an IP network. [2 marks]

(b) What is meant by *class-based* network addressing? Compare that with *CIDR* addressing. What advantages does CIDR network addressing have? [3 marks]

(c) Explain briefly how a host may discover the IP address for one of its interfaces using BOOTP. How would you use BOOTP to provide IP addresses in a network with many subnets interconnected by a router? [3 marks]

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13. **Protocol Layers**

(a) The *OSI Layered Protocol Model* has seven layers. What are the names and functions of layers two, three and four? [1 mark]

(b) At which OSI layer do the following protocols operate, and what services do they provide to the next higher layer? [6 marks]

IP (v4 and v6)

UDP

TCP

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(c) What services does ICMP provide? What OSI layer does it operate at? Give reasons to support your answer. [2 marks]

14. **TCP**

(a) TCP is a symmetrical protocol, in that it supports streams of data in both directions. Explain, and illustrate with a diagram, how a TCP connection is established between two hosts, A and B. [5 marks]

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(b) How does a TCP receiver, *host B*, inform a TCP sender, *host A*, that it has no buffer space left for incoming data bytes? [1 mark]

(c) What happens if a TCP sender, *host A*, ignores such an indication and continues to send data to its receiver, *host B*? [1 mark]

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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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