THE UNIVERSITY OF AUCKLAND

EXAMINATION FOR BSc DipSci ETC 1998

COMPUTER SCIENCE

Data Communications Principles

(Time allowed: **TWO** hours)

NOTES:

- Attempt ALL questions.
- Parts A and B both carry 50% (total 100, for 70% of your final mark).
- Marks for each question are as shown.
- Answer each question in the space provided.
- You may use a supplementary book for longer answers where necessary, but for each longer answer must clearly indicate in the answer space of this question/answer paper that the book is used for that answer.
- Ensure that your name, student ID, degree and similar details are completed in the space below, *and* on the cover of the answer book if one is used.
- Enter your name on every page of this question/answer paper
- Marks for each question are as shown
- Calculators are NOT permitted.

Surname .....

Forenames .....

Degree (BSc, DipSc, etc) .....

Student Identification Number .....

Departmental use only	
Part A total	
Part B total	
Exam total	

Surname .....

Forenames .....

Part A

A1. You read that "*Ethernet is a very inefficient network because so much data is lost from data collisions*". Argue against this statement. **[4 marks]**

A2. A slotted ring network has a length of 2 km, a data rate of 10 Mbps and 200 repeaters (or stations), each of which contributes a latency of one bit. Assume a cable propagation velocity of 200 m/μs and ignore any special monitor latencies.

(a) What is the total ring latency? **[4 marks]**

(b) Each slot has a total length of 40 bits, consisting of one source address byte, one destination address byte, two data bytes, and control bits. How many slots are on the ring? (*The size of a slot is made slightly larger than usual to ease calculation.*) **[3 marks]**

A3. Give two reasons why local area networks usually discard failing messages while wide-area networks often retry them. **[2 marks]**

CONTINUED

Surname .....

Forenames .....

A4. Although the IEEE 802.3 and Ethernet standards are very similar, they are quite different in how they carry messages for other protocols (IP, AppleTalk, etc). What is this difference? **[3 marks]**

A5. Two stations on a 10BASE5 IEEE802.3 LAN are exchanging messages (requests and responses), with negligible separation between a request and its response and between one response and the next request. There is negligible other traffic. A "request" has 80 information bytes. (*Assume that an 802.3 message has an overhead of 40 octets in inter-record gap, preamble, addresses, FCS, etc and that there are negligible other delays.*)

(a) What sized *data block* should be transferred in the response message to ensure that user information (the data within the response) is transferred at $^2/_3$ the network rate **[4 marks]**

(b) Show that the maximum possible user data rate is about $^{15}/_{16}$ of the network rate. (You may leave the answer as an unsimplified fraction.) **[4 marks]**

The answer is about $^{10}/_{11}$! Making the request message 90 bytes gives an exact result.

Surname .....

Forenames .....

A6. While bridges can interconnect different types of IEEE networks, some features of 802.4 and 802.5 are difficult to handle over 802.3 networks. What are these features? **[3 marks]**

A7. (a) What is the "chip rate" in a spread spectrum system? **[2 marks]**

(b) Name one type of spread spectrum and explain how it spreads the signal over the available bandwidth. **[4 marks]**

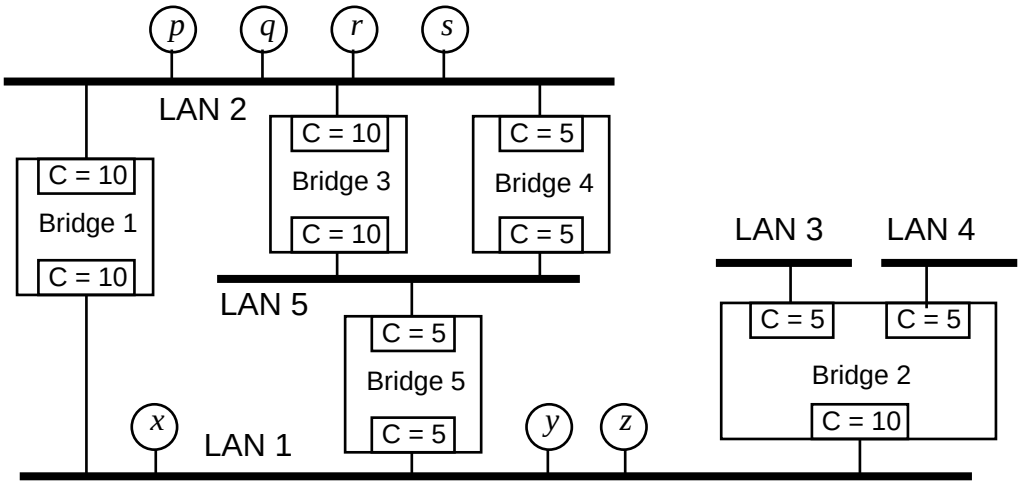
A8. A station receives an LLC frame with one of several possible DSAP values. Explain how the DSAP value is used to control the subsequent processing. **[3 marks]**

Surname .....

Forenames .....

A9. The diagram shows a system of several LANs interconnected with transparent bridges. The bridges have names such as "Bridge 4", which are used as the unique identifiers for the spanning tree algorithm. Each connection of a bridge to a LAN has an associated cost as shown, for example "C = 5". Two of the LANs are shown with connected stations or nodes (such as "*p*" and "*x*"). For all except part (a), assume that a network spanning tree has been built.

Answers to parts (b), (c) and (d) must include explanations or reasons.



(a) Assuming for this part that only Bridge 1 is operating, explain what messages are on what LANs in response to each of the messages in the following sequence.

In each case state what, if anything, the bridge learns about the network (the answer may be "nothing") Assume that the bridge has no initial knowledge. Information learned from one message may be used in handling later messages. **[6 marks]**

source → *dest*	*message is on LAN(s)*	*information learned by "Bridge 1"*
x → *y*		
p → *x*		
z → *y*		
z → *x*		
p → *z*		
s → *p*		

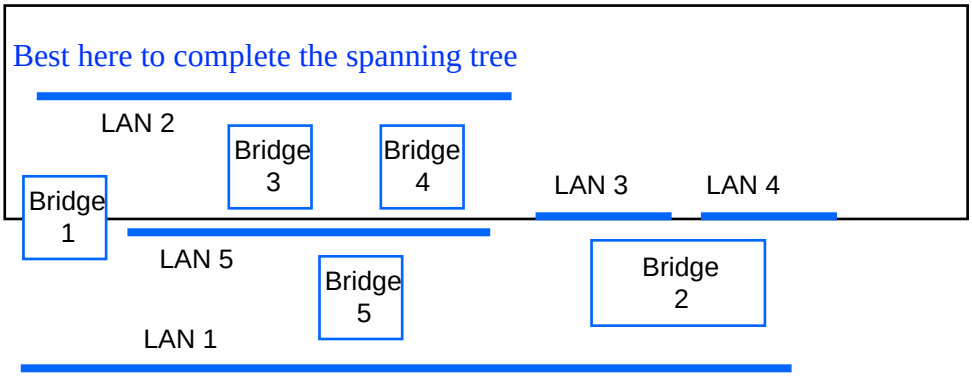
Surname .....

Forenames .....

(b) Which bridge will become the root bridge of the full network? **[2 marks]**

(c) Which will be the preferred connection between LAN 2 and LAN 5? **[2 marks]**

(d) How is LAN 5 connected to the rest of the network?. **[4 marks]**



Part B

B10. Describe how "NEXT" cancellation may be achieved.
What does "NEXT" stand for? **[2 marks]**

B11. For a given modulation scheme, E_b/N_0 denotes the ratio of the *energy per bit* to the *level of thermal noise per Hz* required to achieve some minimum error rate.
Give an expression for E_b/N_0 in terms of the signalling rate and temperature.
How is E_b/N_0 affected by temperature, i.e., will it increase or decrease with increasing temperature? **[2 marks]**

Surname .....

Forenames .....

B12. (a) Two standards exist for multiplexing multiple speech channels.
Draw diagrams showing the multiplexed frame for the American T1 standard and the European (ITU) E1 standard. Label your diagram fully. **[2 marks]**

(b) When the T1 or E1 streams are further aggregated, the various data streams are not necessarily in synchronism with one another.
• Give the term that is used to describe the resultant digital multiplexed hierarchy.
• What mechanism is used to overcome the slight variations that exist in the timing of these streams? **[2 marks]**

B13. Depict the waveform for an asynchronous ASCII encoded character.
Label the constituent parts of the waveform. **[2 marks]**

Surname .....

Forenames .....

B14. Given a bit sequence 101100 and corresponding bit-clock, draw corresponding waveforms for i) NRZ, ii) RZ, iii) BI-ϕ-L, iv) BI-ϕ-M, and v) NRZI? **[5 marks]**
(*The vertical lines may help you define bit boundaries*.)

i							
ii							
iii							
iv							
v							

B15. Given the divisor/generator $G(x)$ = 1101 and a message $M(x)$ = 111001, derive the quotient $(M(x)\times 2^3)/G(x)$ and remainder $R(x)$, assuming modulo 2 arithmetic.
Thus show the data message together with the redundancy check bits formed as a complete message. **[4 marks]**

B16. What are the two principal categories of error control used to overcome transmission

CONTINUED

Surname .....

Forenames .....

errors? **[2 marks]**

B17. In 1948 Shannon proposed a refined version of Hartley's measure (1928) of information content. Give Shannon's equation and explain all terms. **[2 marks]**

B18. The characters {*a*, *b*, *c*, *d*, *e*, *f*, *g*} issue from a source with probabilities:
$P(a) = 0.24$, $P(b) = 0.26$, $P(c) = 0.13$, $P(d) = 0.14$, $P(e) = 0.05$, $P(f) = 0.06$, $P(g) = 0.12$.
Derive a binary Huffman code which gives optimally efficient encoding for the source. **[4 marks]**

B19. Group 3 facsimile uses an encoding scheme referred to as a *modified Huffman code*.

Surname .....

Forenames .....

Describe what is meant by:

• make-up codes, and

• termination-codes. **[2 marks]**

B20. A data communications link may be characterised as being a *best effort* or *connectionless* link. What is meant by each of these terms? **[2 marks]**

B21. (a) How does *explicit* idle RQ error control differ from *implicit* idle RQ? Which is more efficient and why? **[2 marks]**

(b) How does *continuous RQ* differ from *idle RQ*? What two resources does *continuous RQ* require? **[2 marks]**

B22. Information frames of length 100 bits are to be transmitted over the following links

Surname .....

Forenames .....

using idle RQ and with a propagation velocity of 2×10^8m/sec.
Determine the link efficiency (utilisation) for each of the following:

(a) a 10km link with a BER of 10^{-4} and a transmission rate of 9600bps **[3 marks]**

(b) a 500m link with a BER of 10^{-6} and a transmission rate of 10Mbps **[3 marks]**

B23. Information frames of 1000 bits are to be transmitted over a 4000km link at a data rate of 2Mbps. Assuming a propagation velocity of 2×10^8m/sec, and a BER of 10^{-4}, determine the link efficiency for each of the following. Specifically show the effect of bit errors for each of the results obtained.

(a) Selective retransmission and a send window of 7. **[3 marks]**

(b) Go-back-N and a send window of 127. **[3 marks]**

B24. Use a Hamming code to encode the message 10110100101.

Surname .....

Forenames .....

- How many bit errors can be detected in the encoded message?
- How many can be corrected? **[3 marks]**