THE UNIVERSITY OF AUCKLAND

EXAMINATION FOR BSc DipSci ETC 1999

COMPUTER SCIENCE

Data Communications Fundamentals

(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.
- 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.
- Calculators are NOT permitted.
- A table of queueing theory formulae is at the end of the question paper.

Family Name .....

Given Names .....

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

Student Identification Number .....

Departmental use only	
Part A total	
Part B total	
Exam total	

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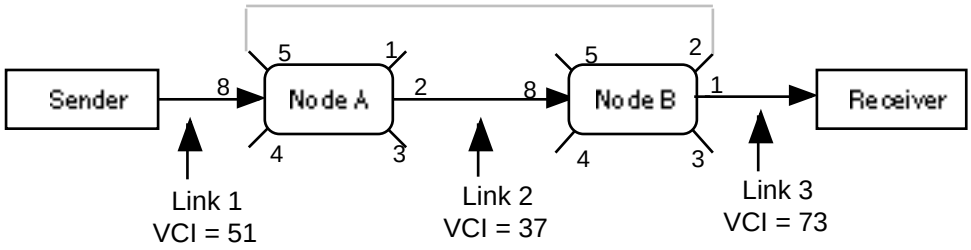
Part A

A1. A student thinks that in a token ring it is best to receive the entire token and examine it before either forwarding it to the next station or seizing it to allow this station to send. Comment on this choice. **[2 marks]**

A2. Two users communicate through a virtual circuit as shown. The ports of each node are numbered as in the figure (with the same values for both input and output). Although only a few physical links are shown, you should assume that all of the ports on the two nodes connect to other hosts or nodes.



(a) What routing table entries are needed in Nodes A and B to maintain the virtual circuit (sender to receiver) as shown by the *solid* lines in the figure? **[4 marks]**

	Input Line/Port	Input VCI	Output Line/Port	Output VCI
Node A				
Node B				

(b) The connection from node A to B is changed to that shown by the *dotted* line. What are the routing tables for the *reverse* circuit, from right to left? **[4 marks]**

	Input Line/Port	Input VCI	Output Line/Port	Output VCI
Node A				
Node B				

A3. Explain how routing decisions for data messages differ in a network using datagrams,

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as compared with one using virtual circuits. **[4 marks]**

A4. A token bus network is running with active stations whose addresses are A = 759, B = 113, C = 149 and D = 472.

A station E with address 262 enters the network in response to a message from one of the active stations. **[5 marks]**

		Dest Addr	Source Addr	Message Type	Other Data
(i)	E responds to what message?				
(ii)	E responds with what message?				
(iii)	E receives the Token message			Token	

(iv) What changes would result if E had the address 103?. **[2 marks]**

A5. How does a repeater differ from a bridge? **[2 marks]**

A6. In a token ring the station which raises the priority of a token is responsible for lowering the token priority. Why must the priority be lowered, rather than just leaving it at the higher value? **[2 marks]**

A7. A communications multiplexer is concentrating many lines into a single output line

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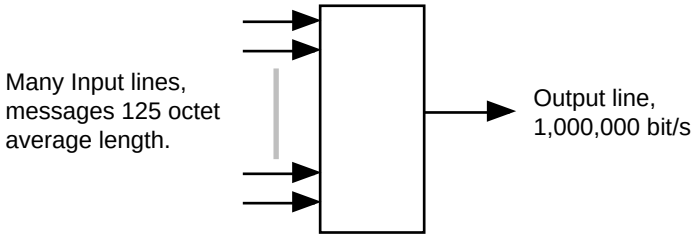
with a capacity of 1,000,000 bit/s. All of the messages or packets may be assumed to have an exponentially distributed length, with an average of 125 octets.



Complete the following table

Total packets/second	500	800	900	750	1000
utilisation ρ					
Average packets in multiplexer					

[4 marks]

A8. With regard to network management, explain each of the following terms, briefly describing their function and importance.

(i) MIB **[2 marks]**

(i) SNMP get request **[2 marks]**

(i) SNMP set request **[2 marks]**

A9. The diagram shows a system of several LANs interconnected with transparent bridges.

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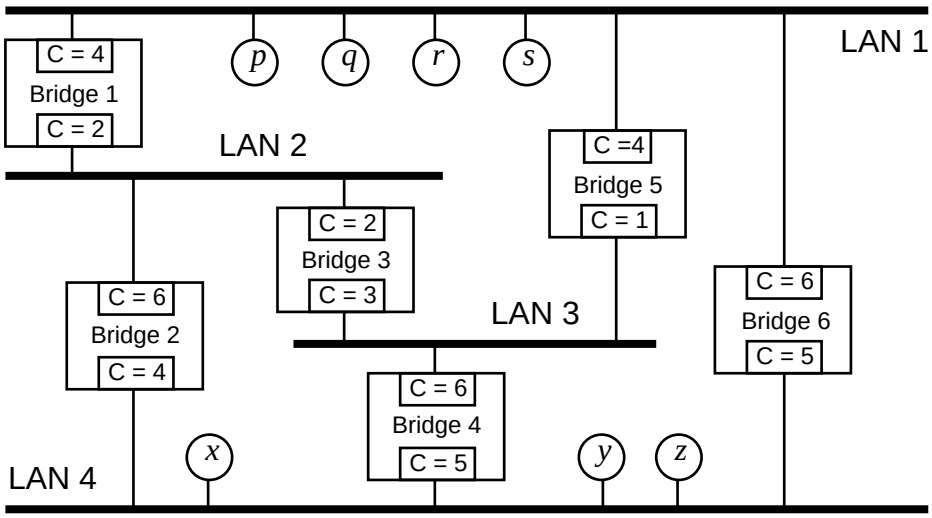
The bridges have names such as "Bridge 4", which are used as the unique identifiers for the spanning tree algorithm. Each bridge port has an associated cost as shown, for example "C = 5". Two of the LANs are shown with connected stations or nodes (such as "*p*" and "*x*").



(a) Assuming for this part that *only Bridge 6 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"). 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 6"*
p → *r*		
x → *q*		
r → *s*		
r → *p*		
x → *p*		
z → *x*		

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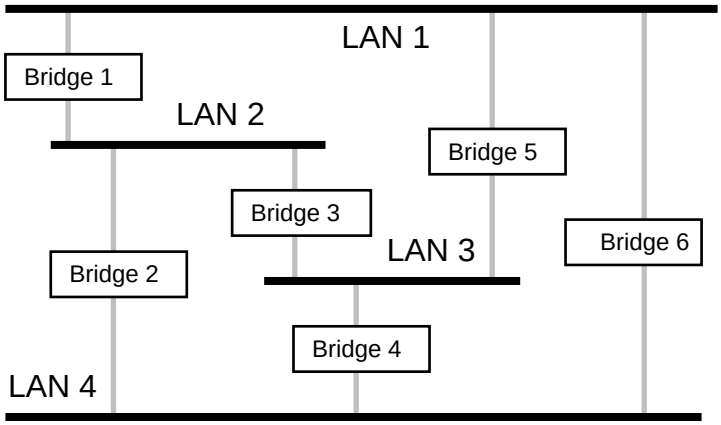
Q A9 continued

(b) Assuming that a network spanning tree has been built, which bridge will become the root bridge of the full network, and why? **[2 marks]**

(c) The diagram shows the network with only the LANs, bridges and possible connections. Mark the connections which are enabled to form the spanning tree.

(*Or you may mark the connections which are disabled, as long as the result is clear.*) **[4 marks]**



A10. A CSMA/CD network such as IEEE 802.3 or Ethernet employs a technique called "truncated binary exponential backoff".

Why is binary exponential backoff used and how does it achieve its result?

You do not have to explain its operation in great detail. **[3 marks]**

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Part B.

B11. What are the three lowest levels of the ISO reference model? **[1 mark]**

B12. What do i) the V-series recommendations, and
ii) the X-series recommendations pertain to, respectively? **[2 marks]**

V series	
X series	

B13. A 3 kHz bandwidth voice channel is found to have a 30db signal-to-noise level. What is the channel's capacity, and the units for capacity? **[2 marks]**

B14. Describe what is meant by Frequency Shift Keying (FSK). Sketch and label a graph to illustrate the spectral bandwidth requirements of a binary FSK modulated signal.
[2 marks]

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B15. Describe what is meant by companding?
Give an example of where is it used. **[2 marks]**

B16. When T1 or E1 streams are aggregated, the various data streams might be not absolutely in synchronism with one another. Give the term that is used to describe the resultant digital multiplexed hierarchy. **[1 mark]**

B17. Given a bit sequence `100110` and corresponding bit-clock, draw corresponding waveforms for i) NRZ, ii) RZ, iii) BI-φ-L, and iv) BI-φ-M? **[4 marks]**
(*The vertical lines may help you define bit boundaries*.)

i							
ii							
iii							
iv							

B18. What are the two principal categories of error control used to overcome transmission errors? **[2 marks]**

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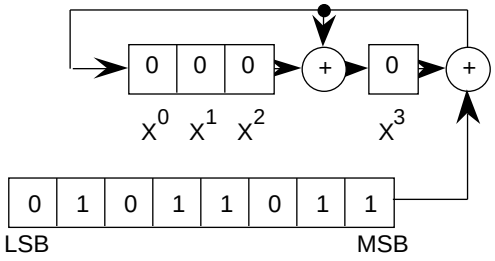
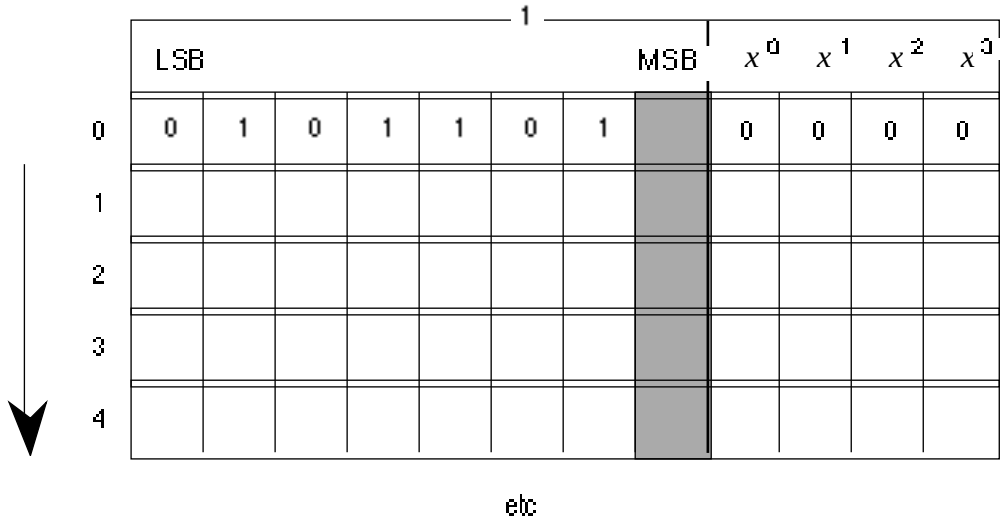
B19. Use a Hamming code to encode the message 11010110011. How many bit errors can be detected in the encoded message? How many can be corrected? **[4 marks]**

B20. The following simplified schematic shows an encoder with CRC register, encoding the binary message 11011010.



Complete the top 4 lines of the following table, where each row corresponds to the contents of the message and CRC registers respectively at bit-time intervals. The first line of the table shows the initial contents of the registers. **[4 marks]**



B21. Information frames of length 100 bits are to be transmitted over a 10 km link with a

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BER of 10^{-4} and a transmission rate of 9600 bps using idle RQ.

Assuming a propagation velocity of 2×10^8 m/sec, determine the link efficiency (utilisation) for the link. **[4 marks]**

B22. In 1948 Shannon proposed a refinement of Hartley's information measure (1928). Give Shannon's equation and explain all terms. **[2 marks]**

B23. The characters {a, b, c, d} issue from a source with probabilities:

$$P(a) = 0.5,\ P(b) = 0.25,\ P(c) = 0.125,\ P(d) = 0.125\ .$$

Compute the first order Shannon entropy (information rate) for the source. What are its units? **[4 marks]**

B24. Though Shannon's information measure is based on a probabilistic model, Cherry outlined an alternative interpretation of Shannon's definition.

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Briefly describe this alternative interpretation. **[2 marks]**

B25. T-complexity theory provides a formal definition of a strings complexity.
What are the units of this measure?
What does it stand for? **[2 marks]**

B26. Derive the binary variable-length T-code graph containing the maximal-length string: 1001011. What is the T-complexity of this string? **[4 marks]**

B27. What does UART stand for? What does USRT stand for? List two specific ways in

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which a UART differs from a USRT? **[3 marks]**

UART	
USRT	
Differences	

B28. How does *explicit* idle RQ differ from *implicit* idle RQ? Which is more efficient and why? **[2 marks]**

B29. What additional resources does *continuous RQ* require over *idle RQ* **[2 marks]**

B30. What is meant by *flow control*? **[1 mark]**

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Queueing formulae

Traffic intensity (or utilisation)	$\rho = \frac{\lambda}{\mu}$
Mean number in system	$N = \frac{\rho}{1-\rho}$
Number waiting in queue	$L_q = \frac{\rho^2}{1-\rho}$
Little's formula	$N = \lambda T$
Average time in system	$T = \frac{1}{\mu(1-\rho)} = \frac{1}{\mu - \lambda}$
Average time in queue	$W_q = \frac{\rho}{1-\rho}\frac{1}{\mu}$
Probability of exactly n customers in system	$P_n = (1-\rho)\rho^n$
Probability of over n customers in system	$P[N > n] = \rho^{n+1}$