THE UNIVERSITY OF AUCKLAND

FIRST SEMESTER, 2002

Campus: City

COMPUTER SCIENCE

Data Communications Fundamentals

(Time allowed: **TWO** hours)

NOTES:

- Attempt ALL questions.
- Calculators are NOT permitted.
- Marks for each question are as shown.
- Start each question on a new page.
- Answer lengths should be in line with 1 minute per mark
- If the last page of this question paper is used to answer Question 2, it should be detached and tied on to the answer book.
- Most answers need some explanations — *no explanation* ⇒ *no mark*!

Question 1.

(a) While data communications protocols usually have strict rules for encoding data for physical transmission, some protocols include "symbols" which violate these rules.

(i) Why might these apparently invalid symbols be included? **[2 marks]**

(ii) Give two examples of such symbols, with explanations. **[4 marks]**

(b) The ASCII character string '{|}' (3 characters) is to be transmitted using either 8-bit Asynchronous (1 stop bit) or 8-bit SDLC transmission.

(i) Show the transmitted bits for *no* character parity (most-significant bit always 0), with the first bit transmitted at the left and later bits to the right for both Asynchronous and SDLC transmission. Indicate the character boundaries. **[4 marks]**

(ii) What changes occur if the character parity is changed to odd? **[4 marks]**

TOTAL = [14 marks]

Question 2.

The following table shows the LZW compression of a string, up to about the end of the first occurrence of "mississippi". Continue the compression of the second occurrence of "mississippi", as shown in passes 12 to 22 of the table, building on the dictionary etc which are shown. *Some* of the necessary entries are shown here. **[14 marks]**

You may answer this question by EITHER –

- *drawing a new table (starting at row 12) in your answer book, OR*
- *completing the copy of the table attached at the end of this question paper.*

It must detached from the question paper and tied to your answer book, ensuring that your name and ID number are included.

mississippimississippi						Dictionary	
Pass	**Input**	**Test String**	**Emit**	**Make Entry**	**Comment**	**Index**	**Contents**
1	**m**					0	256
2	**i**		**m**			…	ASCII
3	**s**		**i**			255	Codes
4	**s**		**s**			256	**mi**
5	**i**		**s**			257	**is**
6	**s**				'is' exists	258	**ss**
7	**s**		**257(is)**			259	**si**
8	**i**				'si' exists	260	**iss**
9	**p**		**259(si)**			261	**sip**
10	**p**		**p**			262	**pp**
11	**i**		**p**			263	**pi**
12	**m**					264	
13	**i**					265	
14	**s**					266	
15	**s**					267	
16	**i**					268	
17	**s**					269	
18	**s**					270	
19	**i**					271	
20	**p**					272	
21	**p**					273	
22	**i**					274	

Question 3.

An IPv4 packet is initially of length 3000 bytes and goes through links with MTU first 2000 bytes and then 1200 bytes.

What packets arrive at the end of the final link?

Show the final fragments and give relevant values in the fragment headers.

[8 marks]

Ignore the header size when calculating fragmentation

Question 4.

(a) What type of error handling (error detection or error correction) is provided by

(i) A single parity bit **[1 mark]**

(ii) A Hamming code **[1 mark]**

(iii) A Cyclic Redundancy Check **[1 mark]**

(iv) A checksum as for an IP frame **[1 mark]**

(b) A message is to be protected by a 16-bit checksum, with possible choices being

- a CRC-16
- a Fletcher checksum (sum-of-sums, modulo 255)
- a ones-complement sum, as used in TCP/IP

Comment on these choices, giving advantages and disadvantages of each. **[6 marks]**

TOTAL = [10 marks]

Question 5.

A square wave of frequency f has Fourier components at the fundamental frequency f, and at the *odd* harmonics $3f$, $5f$, $7f$, …, with the amplitude of the nth harmonic proportional to $1/n$.

(a) Sketch the frequency spectrum of a 1 MHz square wave. **[3 marks]**

(b) Sketch the frequency spectrum of a 100 MHz sinusoidal carrier, amplitude modulated by a 1 MHz square wave. **[3 marks]**

(c) A sequence of pulse bursts, as in the diagram, can be regarded as the amplitude modulation of a higher-frequency square wave "carrier" by a lower-frequency square wave "modulation".

By considering the Fourier components of both the carrier and modulation, or otherwise, describe the frequency spectrum of a repetitive pulse burst with "carrier" frequency 100 MHz and modulation of 5 MHz (both square waves). **[4 marks]**

TOTAL = [10 marks]

Question 6.

The following table lists some of the fields of the headers of IPv4, IPv6 and TCP. For each field, state its function and which protocol or protocols include it.

(i) checksum

(ii) flow label

(iii) fragment offset

(iv) ~~hop count~~ hop limit (changed at exam)

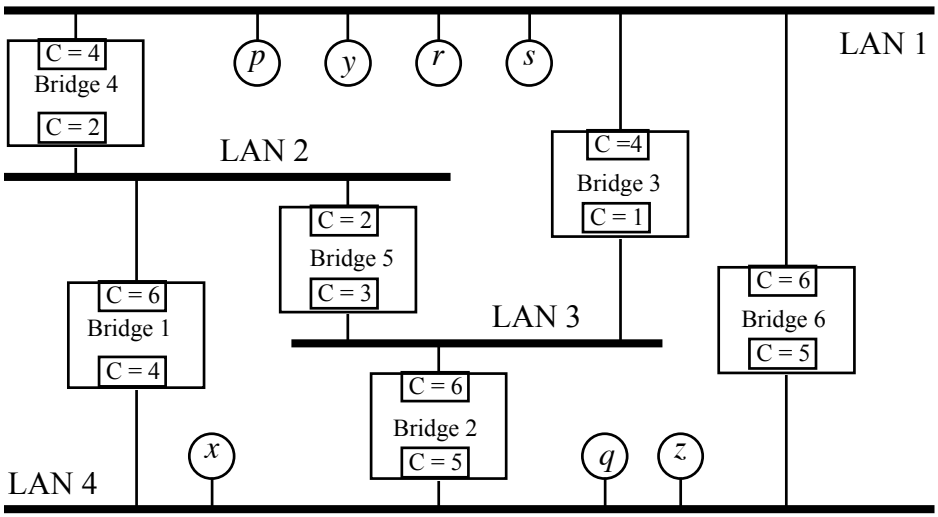
(v) sequence number

(vi) version

TOTAL = [12 marks]

Question 7.

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 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 at first that *only Bridge 6 is operating*, explain for the following sequence of messages,

(i) on which LANs each message appears.

(ii) what the bridge learns about the network (the answer may be "nothing"). **[6 marks]**

The bridge has no initial knowledge and information learned from one message is used in handling later messages.

	source		*dest*
1.	*p*	□	*r*
2.	*x*	□	*y*
3.	*r*	□	*s*
4.	*r*	□	*p*
5.	*x*	□	*p*
6.	*z*	□	*x*

(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) Draw the Spanning Tree for this network. **[4 marks]**

TOTAL = [12 marks]

Question 8.

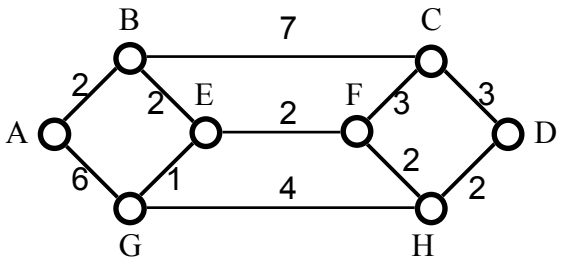
Use Dijkstra's algorithm to calculate the shortest path from A to D in the following network. While you may present your answer in any appropriate manner, it is enough to indicate the path added at each stage and its cost to the root.

For example if routing from D to B, acceptable answers for the first stages might be

connect H to D, cost to D = 2

connect C to D, cost to D = 3

connect F to H, cost to D = 4, and so on



TOTAL = [6 marks]

Question 9.

(a) Networks are sometimes subject to "congestion".

(i) Why, in the most general case, does congestion occur? **[2 marks]**

(ii) What is the general way of reducing congestion in a network? **[2 marks]**

(iii) How is congestion handled in TCP? **[4 marks]**

(b) An extreme form of congestion is "deadlock".

(i) What are the two types of deadlock? **[2 marks]**

(ii) Give one way of preventing deadlock. **[2 marks]**

(iii) If a deadlock does occur, give one way by which it may be broken. **[2 marks]**

TOTAL = [14 marks]

Appendix : Table of ASCII character codes

	□000	□001	□010	□011	□100	101	110	111
0000 0	**NUL**	**DLE**	**SP**	**0**	**@**	**P**	**`**	**p**
0001 1	**SOH**	**DC1**	**!**	**1**	**A**	**Q**	**a**	**q**
0010 2	**STX**	**DC2**	**"**	**2**	**B**	**R**	**b**	**r**
0011 3	**ETX**	**DC3**	**#**	**3**	**C**	**S**	**c**	**s**
0100 4	**EOT**	**DC4**	**$**	**4**	**D**	**T**	**d**	**t**
0101 5	**ENQ**	**NAK**	**%**	**5**	**E**	**U**	**e**	**u**
0110 6	**ACK**	**SYN**	**&**	**6**	**F**	**V**	**f**	**v**
0111 7	**BEL**	**ETB**	**'**	**7**	**G**	**W**	**g**	**w**
1000 8	**BS**	**CAN**	**(**	**8**	**H**	**X**	**h**	**x**
1001 9	**HT**	**EM**	**)**	**9**	**I**	**Y**	**i**	**y**
1010 A	**LF**	**SUB**	*****	**:**	**J**	**Z**	**j**	**z**
1011 B	**VT**	**ESC**	**+**	**;**	**K**	**[**	**k**	**{**
1100 C	**FF**	**FS**	**,**	**<**	**L**	****	**l**	**|**
1101 D	**CR**	**GS**	**-**	**=**	**M**	**]**	**m**	**}**
1110 E	**SO**	**RS**	**.**	**>**	**N**	**^**	**n**	**~**
1111 F	**SI**	**US**	**/**	**?**	**O**	**_**	**o**	**DEL**

ATTACHMENT FOLLOWS

Name ..... **ID Number** .....

Answer sheet for Question 2, COMPSCI 314 FC 2002.

(*If used, this sheet MUST be attached to the answer book, with your name and ID number completed.*)

mississippimississippi

Pass	Input	Test String	Emit	Make Entry	Comment
1	**m**				
2	**i**		**m**		
3	**s**		**i**		
4	**s**		**s**		
5	**i**		**s**		
6	**s**				‘is’ exists
7	**s**		**257(is)**		
8	**i**				‘si’ exists
9	**p**		**259(si)**		
10	**p**		**p**		
11	**i**		**p**		
12	**m**				
13	**i**				
14	**s**				
15	**s**				
16	**i**				
17	**s**				
18	**s**				
19	**i**				
20	**p**				
21	**p**				
22	**i**				

Dictionary

Index	Contents
0 … 255	256 ASCII Codes
256	**mi**
257	**is**
258	**ss**
259	**si**
260	**iss**
261	**sip**
262	**pp**
263	**pi**
264	
265	
266	
267	
268	
269	
270	
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272	
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274	