THE UNIVERSITY OF AUCKLAND

FIRST SEMESTER, 2004

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 the answer to each question on a new page.
- Answer lengths should be in line with 1 minute per mark
- Most answers need some explanations — *no explanation → no mark*!

Question 1.

A packet on an IEEE 802.3 *or* Ethernet network is seen to start with the following octets, each given in hexadecimal on the top line of the diagram.
(*These octets do not include the preamble and start delimiter.*
Below each octet is a sequential number so that you can identify it in your answers.)

00	00	66	33	B5	49	00	00	A7	12	36	B7	60	00	AA	AA	03	00	00	00	08	00	48	45	4C	50
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

(i) What octet numbers are occupied by the source address? **[2 marks]**

(ii) What is the hexadecimal value of the length/type field? **[2 marks]**

(iii) What can you say about the value of the FCS (or CRC)? **[2 marks]**

(iv) How does the length/type value affect the interpretation of the payload? **[2 marks]**

(v) What are the first four octets of the user data? **[2 marks]**

Question total = 10 marks

Question 2.

An IPv4 packet is initially of length 4000 bytes and goes through two links, the first with MTU = 3200 bytes and the second withMTU = 1200 bytes.

(i) Show the fragments that are received, with all of the values that are important for reassembly/defragmentation. **[8 marks]**

Present your answer as a table with a row for each received fragment and a column for each value associated with fragmentation/reassembly.

Ignore the IPv4 headers added during fragmentation. For example if a packet of 2000 octets were to be sent over a path with MTU=1500, assume that there would be one packet of 1500 octets and one of 500 octets, rather than one of (20+1480) and one of (20+520).

(ii) Comment on how the fragment sizes might change with an IPv6 network. **[2 marks]**

Question total = 10 marks

Question 3.

An important recent development in networking is the Virtual LAN, or VLAN.

(i) Briefly describe how VLANs differ from traditional LANs.
(Say what a VLAN does and how it appears to users, *but not how it works*.) **[3 marks]**

(ii) Give three (3) advantages of VLANs. **[3 marks]**

(iii) Discuss how a VLAN is implemented if all of its stations are connected to a single switch. **[4 marks]**

(iv) Briefly discuss the implementation of a VLAN across several connected switches. **[4 marks]**

Question total = 14 marks

Question 4.

State whether each of the following fields is a part of the header for IPv4, IPv6, or TCP (some may belong to more than one), and briefly state the function of each.

(i) hop count **[1 mark for each each part]**
(ii) checksum
(iii) fragment offset
(iv) version
(v) source address
(vi) destination port
(vii) flow
(viii) urgent pointer

Question total = 8 marks

Question 5.

A bit string is protected by a CRC checksum with generator polynomial $x^4 + x^2 + 1$, (or, the generator bit vector is 10101).

Check whether the received message 1 1 0 0 1 0 1 1 0 0 1 0 is correct or in error. Show your working (*Hint: the quotient should be* 1 1 1 1 1 0 1 0.)

Question total = 6 marks

Question 6.

(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 with the parity (most significant) bit always 0.

(i) Show the transmitted bits for Asynchronous transmission with the first bit transmitted at the left and later bits to the right. Show the character boundaries. **[2 marks]**

(ii) As for part (i) above, but using SDLC/HDLC transmission. **[2 marks]**

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

Question total = 14 marks

Question 7.

A particular Hamming Code is described as (12, 8) code and both detects and corrects single bit errors.

(i) Explain the significance of the "(12,8)" description, including any relationship between the two numbers. **[2 marks]**

(ii) Explain how a (14,10) Hamming code differs from a (12,8) code. **[1 mark]**

(iii) A (14, 10) Hamming code uses *odd* parity for each of its parity groups. The received codeword is 1111 1111 1111 11. Correct the *single* error (if any) in the received word and extract the corrected data bits (deleting the parity bits).

You must state the bit order. **[4 marks]**

(iv) What change would allow the (14, 10) code to detect double bit errors? **[1 mark]**

Question total = 8 marks

Question 8.

Use Dijkstra's algorithm to calculate the shortest path from A to G in the following network, assuming that each link has the cost shown beside it.

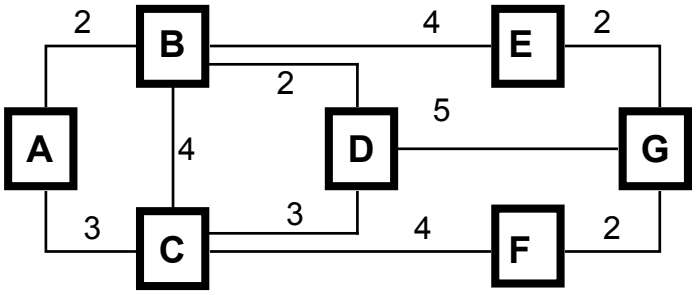
While you may present your answer in any appropriate manner, it is enough to indicate the path added at each stage and its cost to the root.

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

connect D to B, cost to B = 2

connect A to B, cost to B = 2

connect C to B, cost to B = 4, and so on



Question total = 8 marks

Question 9.

When a user message of about 1000 bytes is sent over TCP/IPv4 and Ethernet we find that different amounts of the message (and headers etc) are covered by checksums at each level of the protocol stack.

(i) Describe and explain these differences in checksum coverage. **[6 marks]**

(ii) Explain what changes to checksumming might occur if the transfer used IPv6 rather than IPv4? **[2 marks]**

Question total = 8 marks

Question 10.

(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 (apart from increasing its capacity or bandwidth)? **[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]**

Question total = 14 marks

Appendix : Table of the ASCII character set

row (suffix bits)		Column (prefix bits)							
binary	**hex**	**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