THE UNIVERSITY OF AUCKLAND

EXAMINATION FOR BSc GDipSci ETC 2001

COMPUTER SCIENCE

Data Communications Fundamentals

(Time allowed: **TWO** hours)

NOTES:

- Attempt ALL questions.
- Calculators are NOT permitted.
- 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.

Family Name .....

Given Names .....

Degree (BSc, GDipSci, etc) .....

Student Identification Number .....

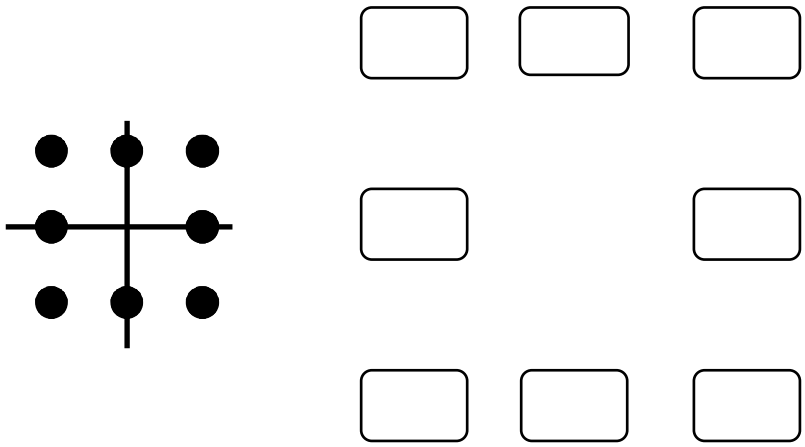
Departmental use only	
Exam total	

Family name .....

Given names .....

Question 1: Modulation and Constellation Diagrams

Consider the constellation in the left-hand side of diagram, where each circle represents a point of a signal constellation



(a) How many amplitudes and phases are in this constellation?

☐ Amplitudes ☐ Phases **[2 marks]**

(b) The right-hand diagram has rectangles corresponding in position to the constellation points of the left-hand diagram. Label each rectangle in the right-hand diagram with its amplitude and phase, for example **'A1'**.

• Label your amplitudes A, B, C, … etc. in order of increasing magnitude.

• Label your phases 0, 1, 2, … etc. in a counter-clockwise fashion. **[2 marks]**

(c) How many bits can each point in the above signal constellation carry when it is transmitted to a receiver? Why? **[2 marks]**

Family name .....

Given names .....

Question 2: Signal Levels and Propagation through Cables

An overland coaxial cable is being laid to transmit data. We are trying to find out at which distances we must install repeaters.

- The intended data rate is 10 Megabits per second, and the available bandwidth is 1 MHz.
- The data transmitter (and each repeater along the cable, consisting of a receiver and a transmitter) are able to inject a signal into the cable such that the signal-to-noise ratio at the transmitter end of the cable is 130 dB. That is, the signal power is 130 dB above the noise power.
- In the frequency band used for the transmission, the cable has an attenuation of 5 dB per 100 m.

(a) Show that the theoretical minimum signal-to-noise ratio that is required at the receiver or repeater input in order to support the intended data rate is 30dB. You may round up or down by up to 5% in your calculation if this is convenient. **[6 marks]**

(b) Given your result from (a), what is the theoretical maximum distance between repeaters? **[3 marks]**

Family name .....

Given names .....

Question 3: NRZI, Bit Stuffing, and Manchester Coding

A communication system transmits a bit stream of a random sequence of zeros and ones, i.e., with equal probabilities of the next bit being a 0 or a 1.

(a) Assume for this part of the question that the bit stream is to be encoded in NRZI, with the zeros coded as a transition in level. Further assume that you wish to use bit stuffing for clock recovery. You want to bit stuff such that the maximum length of a run of ones is five. Estimate of the percentage of extra bits added by the bit stuffing. **[3 marks]**

(b) For this part of the question, assume that Manchester coding is used instead of NRZI and bit stuffing. Give one advantage and one disadvantage of Manchester coding compared to NRZI with bit stuffing. **[4 marks]**

Question 4: Satellites

Which of the following statements is true and which one is false? Tick the appropriate box: **1 mark per correct answer [5 marks total]**

(a) The orbital period of a geostationary satellite is exactly 24 hours.
TRUE ☐ FALSE ☐

(b) In order to communicate with a geostationary satellite, an earth station must be located on the equator. TRUE ☐ FALSE ☐

(c) The equatorial plane is an imaginary plane that cuts the earth into two halves. If the equatorial plane is extended into space, the orbits of all geostationary satellites fall within that plane. TRUE ☐ FALSE ☐

(d) The possible footprint of a satellite gets larger if the height of the satellite's orbit increases. TRUE ☐ FALSE ☐

(e) A single low-earth orbit satellite (LEO) can be used to provide a continuous data link across the Pacific Ocean. TRUE ☐ FALSE ☐

Family name .....

Given names .....

Question 5: CRC Checksums

The bit string B=010011101 is to be protected by a CRC checksum. The generator polynomial for the calculation of the checksum is $x^4 + x^3 + 1$, i.e., its bit representation is 11001.

(a) calculate the CRC checksum for B (Hint to help you check your result: the quotient that you should obtain in the polynomial division of B padded by the appropriate number of zero bits to the right is 011100010). Show your working. **[6 marks]**

Question 5 continues

Family name .....

Given names .....

Question 5 continued

(b) Now assume that B gets corrupted in transit and becomes

$B' = 010111001$ (two bit errors: on the 4th and 7th bit).

Show by explanation and calculation how the receiver can detect that there is a problem. Show your working

(Hint: the quotient that you should obtain here is 011011000). **[6 marks]**

Family name .....

Given names .....

Question 6: Hamming Codes

Assume that you have a 12-bit Hamming code with the following makeup:

$$p_1\ p_2\ m_1\ p_3\ m_2\ m_3\ m_4\ p_4\ m_5\ m_6\ m_7\ m_8$$

where bits $p_1 \ldots p_4$ are the parity bits and $m_1 \ldots m_8$ are the data bits. The parity bits give even parity over the following data bits:

p_1**:** m_1, m_2, m_4, m_5, m_7

p_2**:** m_1, m_3, m_4, m_6, m_7

p_3**:** m_2, m_3, m_4, m_8

p_4**:** m_5, m_6, m_7, m_8

(a) Given the data word $m_1\ m_2\ m_3\ m_4\ m_5\ m_6\ m_7\ m_8$ = 11101011, what is the associated Hamming code? Show your working. **[3 marks]**

(b) Given the Hamming code 011111001001, does it contain an error? If so, presuming that a single bit is in error, which is the correct code that was sent? **[4 marks]**

(c) Given the Hamming code 010111101001, does it contain an error? If so, presuming that a single bit is in error, which is the correct code that was sent? **[4 marks]**

Family name .....

Given names .....

Question 7: Protocols

Two stations, A & B, are linked by a 1000km cable, with communication at 8Mbit/s. Flow control is by XON/XOFF.

(a) How many octets are in transit from B to A? **[2 marks]**

(b) What is the smallest buffer which will guarantee full use of the link? **[2 marks]**

(c) Over what maximum transmission distance would a 50,000 byte buffer ensure a link utilisation of 100%? **[2 marks]**

Question 8: Protocols

Station A sends a message to station B using a "stop & wait" protocol.

List four possible replies or other "responses" to the message. **[4 marks]**

Family name .....

Given names .....

Question 9: BISYNC

Two BISYNC messages are shown.

Some "codes" are

STX	Start of Text
ETX	End of Text
DLE	Data Link Escape

All other codes are as written

message 1 `STX a b c DLE STX p q r ETX`

message 2 `DLE STX a b c DLE STX p q r DLE ETX`

(a) What is the text which each message conveys? **[2 marks]**

(b) Explain the differences. **[2 marks]**

Question 10: TCP and IP.

The following tabe lists some of the fields of the headers of IP and TCP.

Mark each field as being part of its appropriate header and *briefly* indicate its function.

[8 marks]

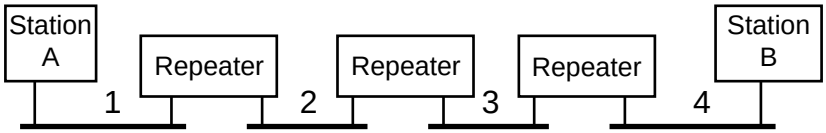
Field	IPv4	IPv6	TCP	Function
Hop Count				
checksum				
fragment offset				
version				
source address				
destination port				
Flow				
urgent pointer				

Family name .....

Given names .....

Question 11. LANs

A multi-segment IEEE 802.3 LAN links two stations separated by 2km of cable and has 4 segments. Assume that there is no other traffic on the link



(a). Signals between the stations are delayed by both the cables and by the repeaters. Estimate the end-to-end delay, comparing the delays from each of the two components. **[2 marks]**

(b) The two stations start transmitting at the same instant. In which field of the frames would you expect each station to detect the collision, and why? **[3 marks]**

(c) Station A **s**ends a message of 100 total bytes and station B one of 1000 total bytes. Bridges are now used to connect the LAN cables in the network. Describe the collisions which now occur. **[3 marks]**

Family name .....

Given names .....

Question 12: IP

An IPv4 packet is initially of length 4000 bytes and goes through links with MTU first 3200 bytes and then 1200 bytes.

(a) What packets arrive at the end of the final link? Show all relevant fields. **[8 marks]**
Show the final fragments and give relevant values in the fragment headers.

- *You must place your own appropriate headings on the columns.*
- *The table may have more space than you need for all of the fragments.*
- *Ignore the header size when calculating fragmentation*

Fragment				
1				
2				
3				
4				
5				
6				
7				
8				

(b) How would a change to IPv6 affect the packets which arrive? **[2 marks]**

Question 13: Routing

Explain how routing decisions for data messages differ in a network using datagrams, as compared with one using virtual circuits. **[4 marks]**

Family name .....

Given names .....

Question 14: Management

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

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

(b) SNMP get response **[2 marks]**

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