# THE UNIVERSITY OF AUCKLAND

EXAMINATION FOR BSc DipSci ETC 1997

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.
- 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.

**Family Name** .....

**Given Names** .....

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

**Student Identification Number** .....

| Departmental use only | |
|---|---|
| Part A total | |
| Part B total | |
| Exam total | |

Candidate's Name.....

## Part A

**A1.** Describe Pulse Amplitude Modulation (PAM). **[2 marks]**

**A2.** There are two standards for multiplexing digital speech channels.
Draw and label fully a diagram showing the multiplexed frame for
*either* (a) the American T1 standard
*or* (b) the European (ITU) E1 standard. **[2 marks]**

**A3.** 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]**

**A4.** What is the basic unit of transmission in the synchronous digital hierarchy (SDH)? **[1 mark]**

**A5.** Define what is meant by i) a *tributary unit*, and
ii) a *virtual container*? **[2 marks]**

CONTINUED

Candidate's Name.....

**A6.** Illustrate how an E1 connection at 2Mbps may be derived from an E4 link running at approximately 140Mbps, using an *add-drop multiplexer*. **[2 marks]**

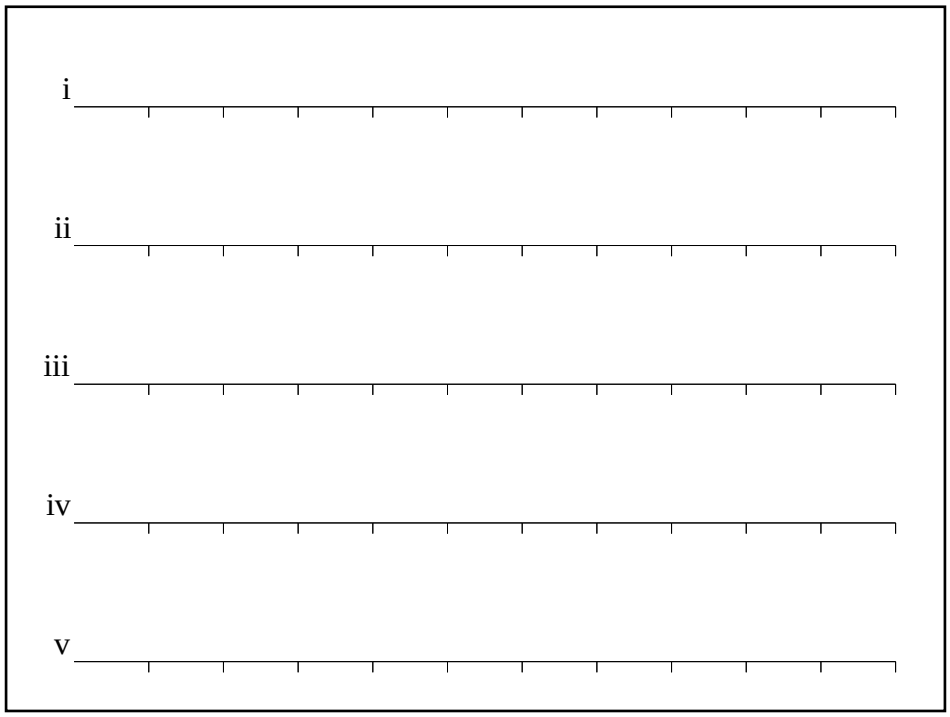
**A7.** Using diagrams, show what is meant by i) *simplex*,
ii) *duplex*? **[2 marks]**

**A8.** Show the format of an ASCII character encoded for asynchronous transmission. Label the various parts of the waveform. **[2 marks]**

CONTINUED

Candidate's Name.....

**A9.** Given a bit sequence 101101 and corresponding bit-clock, draw the corresponding waveforms for i) NRZ, ii) RZ, iii) BI-φ-L, iv) BI-φ-M, and v) NRZI. **[5 marks]**




**A10.** What are the two principal strategies for error control that may be used to overcome transmission errors? **[2 marks]**

**A11.** Draw a schematic circuit showing how an even parity check bit might be derived for the 7 data bits of an ASCII character. **[2 marks]**

Candidate's Name.....

**A12.** Describe how frame synchronization may be achieved in bit oriented synchronous data transmission.

What is bit stuffing? When is it used and why? **[2 marks]**

**A13.** Give two specific aspects in which a UART differs from a USRT. **[2 marks]**

**A14.** 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. **[3 marks]**

Candidate's Name.....

**A15.** Given a set of characters {*a, b, c, d, e, f, g*} with respective source probabilities

$$P(a) = P(b) = 1/4,\ P(c) = P(d) = P(e) = 1/8,\ P(f) = P(g) = 1/16$$

derive a binary Huffman code which gives optimally efficient encoding of the source. (Assume that the source symbols appear independently of one another.) **[3 marks]**

**A16.** Shannon defined a quantity called the *source entropy* which measures the expected average rate of information from a source.

Give Shannon's equation and calculate the entropy for the source in Question A15.

What are the units of entropy? **[3 marks]**

Candidate's Name.....

**A17.** Group 3 facsimile uses an encoding scheme referred to as a *modified Huffman* code.
Explain i) why is it called this,
ii) what are make-up codes, and
iii) what are termination-codes. **[2 marks]**

**A18.** A data communications link may be described as being *best effort* or *connectionless*.
What is meant by this? **[2 marks]**

**A19.** How does *explicit* idle RQ error control differ from *implicit* idle RQ?
Which is more efficient and why? **[2 marks]**

**A20.** A 200 km long communications link operates at 10 Mbps, with a frame size of 1250 octets and idle RQ protocol. Calculate the link utilization assuming a propagation velocity of $2\times10^8$ metres/sec and a negligible error rate. Express the link utilization as a percentage. **[3 marks]**

Candidate's Name.....

**A21**. How does *continuous RQ* differ from *idle RQ*?
What two resources does *continuous RQ* specifically require? **[2 marks]**

**A22.** What is meant by *flow control*?
Give the names of two established flow control methods. **[2 marks]**

Candidate's Name.....

## Part B

**B23.** 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]**

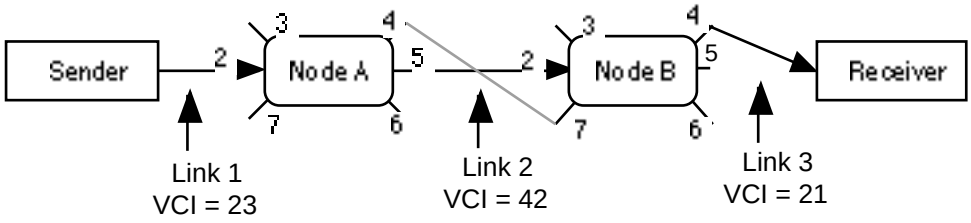
**B24.** Although the IEEE 802.3 and Ethernet standards are very similar, they are quite different in how they carry messages for other protocols (IP, AppleTalk, etc). What is this difference? **[2 marks]**

**B25.** Ethernet (or IEEE 802.3), Token Bus (IEEE 802.4) and FDDI all provide a preamble at the start of each data or MAC frame. IEEE 802.5 Token Ring does not include a preamble—why is it different from the other networks? **[2 marks]**

**B26.** Explain why the token rotation time for a token bus network is usually much greater than that for a token ring network where the physical data rate, physical network size and number of stations are all similar. **[2 marks]**

CONTINUED

**B27.** 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 new routing tables? **[4 marks]**

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

**B28.** 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]**

CONTINUED

Candidate's Name.....

**B29.** (a) What is the significance of each combination of the "Address Recognised" and "Frame Copied" bits of the IEEE 802.5 Token Ring frame? **[4 marks]**

| Address Recognised | Frame Copied | Meaning |
|---|---|---|
| 0 | 0 | |
| 0 | 1 | |
| 1 | 0 | |
| 1 | 1 | |

(b) Give one other use for the Address Recognised bits. **[1 mark]**

**B30.** Explain why a network using datagrams must handle out-of-order packet arrival, whereas one using virtual circuits can expect in-order packet delivery. **[4 marks]**

**B31.** Give two reasons why local area networks usually discard failing messages while wide-area networks often retry them. **[2 marks]**

Candidate's Name.....

**B32.** (a)Why does the performance of an Aloha network deteriorate at high loadings?

**[2 marks]**

(b) Why does changing Aloha to "slotted Aloha" improve the performance? **[2 marks]**

(c) Most networks control which station can transmit at a particular time, for example by requiring a station to obtain a token before it can transmit. What form of control is provided in Aloha and slotted Aloha protocols? **[1 mark]**

**B33.** How should a token bus station remove itself from the network? **[4 marks]**

Candidate's Name.....

**B34.** Explain how routing decisions for data messages differ in a network using datagrams, as compared with one using virtual circuits. **[4 marks]**

**B35.** (a) State three user advantages in using ISDN as opposed to traditional communications techniques. **[3 marks]**

(b) Protocols such as X.21 and X.25 use "in-band" signalling, whereas ISDN uses "out-of-band" signalling. Briefly contrast the two methods and state why out-of-band signalling might be preferred. **[3 marks]**