

UNIVERSITY OF LONDON  
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 1996

BEng Honours Degree in Computing Part II  
MEng Honours Degrees in Computing Part II  
for Internal Students of the Imperial College of Science, Technology and Medicine

*This paper is also taken for the relevant examinations for the  
Associateship of the City and Guilds of London Institute*

PAPER 2.10

COMMUNICATIONS

Wednesday, May 1st 1996, 4.00 - 5.30

*Answer THREE questions*

For admin. only: paper contains  
4 questions  
3 pages (excluding cover page)

**Section A**      *(Use a separate answer book for this Section)*

- 1    The Bel 209 standard for Quadrature Amplitude Modulation (QAM) specifies twelve phase angles, four of which have two amplitudes.
  - a    A typical 9600 bps modem uses QAM to transmit digital data over an analogue channel
    - i     Why is it not necessary to send a reference signal when using this sort of modulation?
    - ii    If we are to achieve the stated bit rate, what is the required baud rate of the channel?
    - iii   What steps can be taken in designing the constellation diagram of QAM to improve bit error detection?
  - b    QAM combines Phase Shift Keying and Amplitude Shift Keying both of which are used to send digital data over an analogue carrier. Radio stations, however, need to transmit analogue data (voice and music) over an analogue carrier. Why do radio stations use Frequency and Amplitude modulation rather than Phase modulation?
  - c    Radio is bad enough but Television is even worse. Consider a digitised picture of 480 x 500 picture elements each of which can take on one of 32 intensities. We wish to send a sequence of such pictures at the rate of 30 pictures per second over a 4.5MHz channel that suffers from a signal to noise ratio of 30dB. Determine whether we will be successful in our quest

*The three parts carry, respectively, 40%, 25%, 35% of the marks.*

- 2    A particular ethernet network is operating at 10mbps over a thin coaxial cable of length 500m. There are a number of stations along the length of the cable and in particular there is one at each end. Transmission frames are in the usual format with a number of preamble bytes, a start byte, 12 address bytes, Length and data bytes and are terminated by a 32 bit CRC. All information is encoded using Manchester Encoding.
  - a
    - i     Why is essential that a NRZ encoding is used on an ethernet?
    - ii    Describe Manchester Encoding and give one advantage and one disadvantage of this encoding scheme
  - b    If we assume that the propagation of a signal in the coaxial cable is roughly  $2 \times 10^8$  m/s
    - i     What is the minimum time a station must listen to the cable to determine whether a collision has occurred and why?
    - ii    What are the two functions of the preamble bytes and what is the baud rate of the channel during the transmission of the preamble?
    - iii   How many bytes would you expect there to be in the preamble, and why?

*The two parts carry, respectively, 30%, 70% of the marks.*

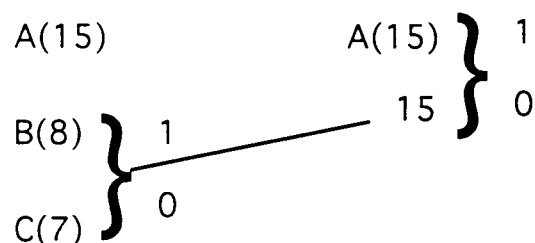
**Section B** (Use a separate answer book for this Section)

- 3a It has been suggested that a Huffman-coded ASCII text data stream is Huffman-coded again in order to improve the compression.
- Explain how this might be organised.
  - Explain whether or not any additional compression would be obtained.
  - How else might English language ASCII text be encoded using Huffman coding to attempt to increase the amount of compression ?
- b The British chocolate industry has decided it needs a new advertising slogan to increase sales for next April. You are working for an American chocolate company and need to find out what the British slogan is.

By monitoring normal internet communications between the British chocolate manufacturers you have deduced that the Huffman table they use is as follows:

A	111
E	10
G	0001
R	001
S	110
T	01
X	0000

You guess that this coding has been derived using the standard textbook scheme such that a one is used to select the most frequent of a pair of letters and that in the event of duplicate frequencies the original takes precedence over combinations. For example the letters A, B, C might have been encoded as follows:



Work out the order of the frequencies of the letters (A, E, G, R, S, T, X) in the original Huffman table.

Not being advanced students of communications, you guess that the British chocolate manufacturers have used a monoalphabetic substitution cypher to encrypt their secret slogan. Even worse you bet that they are using the same Huffman table to send the encrypted messages as they use to send the unencrypted ones.

You have managed to intercept the following encrypted message:

ABCAD DEAFB DBCADF DGGC BA DBCADF

What does it say ?

*The two parts carry equal marks.*

*Turn over ...*

- 4a Explain how a cyclic redundancy check (crc) can be added to a frame of data in order to detect 15-bit burst errors.

When does a crc fail to spot an error burst ?

- b It has been suggested that a second crc-check is added to a crc-checked piece of data but using a different generator polynomial to the first check. The idea is that the second check will catch any errors missed by the first check and the first check will catch any errors missed by the second check.
- i) Explain whether using two checks will reduce the chance of a corrupt frame being accidentally accepted.
  - ii) Explain whether or not two polynomials could be chosen that when used together will spot any burst error.
- c Explain what factors must be taken into consideration when deciding on an appropriate frame length to use over a communication link.

*The three parts carry, respectively, 30%, 40%, 30% of the marks.*

*End of paper*