CS-238
DATA COMMUNICATION & COMPUTER NETWORKS

Attempt 2 questions out of 3

Question 1

(a) Explain the following terms:

(i) Simplex

(ii) Half duplex

(iii) Full duplex

[3 marks]

(b) The *non-return-to-zero level* (*NRZ-L*) scheme encodes 0 with a high signal level and 1 with a low signal level. The *differential Manchester encoding scheme* always encodes a transition in the middle of an interval. In addition, it encodes 0 with a transition at the beginning of an interval, and 1 without such a transition. Determine the original bit streams (9 bits each) encoded by the two signals below.

NRZ−L　　　Differential Manchester

[4 marks]

(c) Explain the Two Army Problem, and its relevance to the question of closing a TCP connection.

[5 marks]

(d) Merkle's Puzzles consist of 20,000 cryptograms. The plaintext of each puzzle starts out with 128 zero bits, followed by a 16-bit puzzle number and then a 56-bit key. Each of the 200-bit cryptograms is encrypted using the Data Encryption Standard (DES) with a key whose final 22 bits are zeros. (We assume that one encryption operation takes 1μs and 2^{33} operations take about 3 hours on average.)

(i) In the context of DES, what are Merkle's Puzzles used for?

(ii) After receiving the Puzzles, what should the designated receiver do in order to establish a secure communication line with the sender?

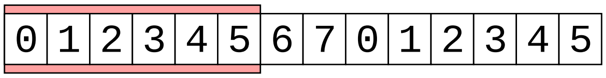
(iii) Why does the sender use keys ending with 22 zero bits to encrypt the cryptograms?

(iv) If the speed of computers increases and encryption operations take much less time, what would you do to make the Puzzles more secure?

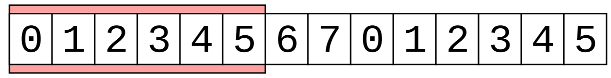
[7 marks]

(Question 1 continued on next page.)

(e) Consider two stations, A and B, communicating using a sliding window protocol. The protocol assumes the use of a 3-bit frame sequence number and a maximum window size of 6. Given initial window positions of A and B as shown below:



window at A



window at B

show both window positions after events at times T2, T4 and T6 respectively:

Time	Station A	Station B
T1	A transmits frame 0	No event
T2	A transmits frame 1	B receives frame 0
T3	A transmits frame 2	B sends acknowledge expecting frame 1
T4	A receives acknowledge expecting frame 1	No event
T5	A transmits frame 3	B receives frame 1
T6	A transmits frame 4	B receives frame 2

[6 marks]

Question 2

(a) Compare and contrast the Transport layer protocols TCP and UDP. In particular, how do they differ in the services offered to higher layer protocols (e.g. HTTP, FTP, NFS), and how does the choice of TCP or UDP affect the way those protocols are designed?

[6 marks]

(b) This question pertains to Huffman encoding. Assume that a message contains the characters given in the table below, occurring with the specified frequencies:

Char	**Frequency**
E	4%
K	37%
N	3%
O	21%
R	22%
T	6%
W	7%

(i) Construct the corresponding Huffman tree for this alphabet.

(ii) Construct the codewords for the alphabet, using 0 for a left child and 1 for a right child.

(iii) Calculate how many bits on average are required in order to transmit a character using the method you have developed.

[7 marks]

(c) (i) Why is email as defined in RFC 822 unsuitable for sending binary information such as images?

(ii) Briefly outline the mechanism which is used to allow us to send images via email.

(iii) Briefly outline the **Conditional GET** mechanism in HTTP.

[5 marks]

(d) A station needs to transmit a binary string 1101111 (b_1, b_2, $\ldots b_7$). The data string is:

- first extended to include, after b_7, a 4-bit frame check sequence, 1111, which is calculated using the Cyclic Redundancy Check (CRC) scheme with a divisor pattern 10011;
- then bit stuffed based on the ISO HDLC standard delimiter pattern 01111110;
- and finally framed with the ISO HDLC standard delimiter 01111110 at both ends.

(i) Verify that the frame check sequence, 1111, is calculated correctly, showing all steps of the modulo-2 operation concerned.

(ii) Work out the final frame to be transmitted in the form of a binary string.

[7 marks]

Question 3

(a) The *distributed routing algorithm* is used for packet routing in a subnet as shown below. Consider the current routing table of node E (Table 1), and the time delay vectors received from E by its neighbours (Table 2). All delays are measured in milliseconds.

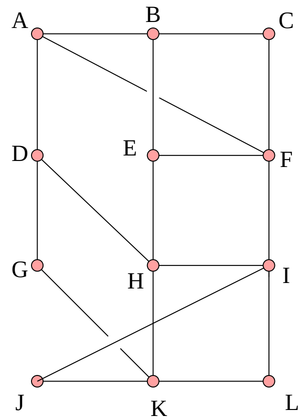


Table 1

E to	delay	via
A	5	B
B	3	B
C	9	B
D	11	H
E	0	–
F	8	F
G	19	H
H	5	H
I	6	H
J	8	H
K	9	H
L	10	H

Table 2

to	B	F	H
A	1	6	6
B	0	6	7
C	4	3	9
D	7	5	5
E	5	4	7
F	10	0	10
G	9	9	7
H	8	7	0
I	10	8	2
J	13	10	5
K	11	8	2
L	15	9	3

(i) The most recent delays measured by E are 7 for EB, 3 for EF, 8 for EH. Update the routing table for node E based on the new information.

(ii) Briefly discuss the advantages and disadvantages of this algorithm in comparison with centralised and isolated routing algorithms.

[6 marks]

(b) Medium access control:

(i) In CSMA/CD, why does a station wait for a *random* amount of time after a collision?

(ii) Ethernet imposes a minimum frame size of 64 bytes, and a maximum frame size of 1518 bytes. Why?

(iii) In wireless networks, what is the "hidden station problem"?

(iv) Explain briefly how 802.11's *Point Co-ordination Function* solves the MAC problem.

[7 marks]

(c) A code consists of the following five valid codewords: **00001, 00110, 11000, 10101, 11011**.

(i) Define the term *Hamming distance*, and state the Hamming distance of this code.

(ii) Let **j** be the number of bit errors which can be *detected* by using this code, and let **k** be the number of bit errors which can be *corrected* by using this code.
What are the values of **j** and **k**?

(iii) By adding one extra bit to each codeword in the original code, derive a new code which can be used to correct **k+1** bit errors.

[6 marks]

(d) (i) With the aid of a diagram, explain how four hosts can send data along a high bandwidth channel using *time division multiplexing*.

(ii) In the context of audio compression, what is meant by the following?

- Frequency masking
- Temporal masking

[6 marks]