Question 1

(a) In the context of the ISO 7-layer model (the reference model for OSI), name each layer in the correct order, and state in which layers the following functions are featured:

  (i) Congestion control;

  (ii) file transfer protocol (FTP);

  (iii) data compression;

  (iv) data encryption;

  (v) flow control.

  Medium Access Control (MAC) was not featured in the original 7-layer model, but later introduced into the model as a sub-layer. What is the main function of the MAC sub-layer, and where is it located in the 7-layer hierarchy?

  [8 marks]

(b) Assume the data bits 10101011 are to be transmitted. Create the total transmitted codeword if the Hamming single bit code is used for error detection, counting the bits from left to right. Assume that the penultimate bit (i.e., second from right) was inverted during the data transmission. Show step by step how the Hamming Single Bit Code can be used to detect and correct the transmission error.
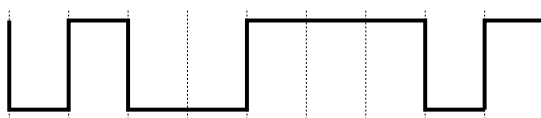
  [6 marks]

(c) Describe the basic functions of the transport layer in the context of the OSI Reference Model.

  Explain why the transport layer and the upper three layers are called true **end-to-end** layers, whereas the lower three layers are called **chained** layers.
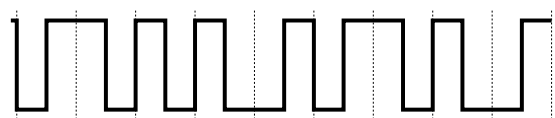
  There are four generic service primitives for the transport layer service. One of them is known as 'Request'. Name the other three.

  [7 marks]

(d) 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 encoded by the two signals below.

NRZ–L   Differential Manchester
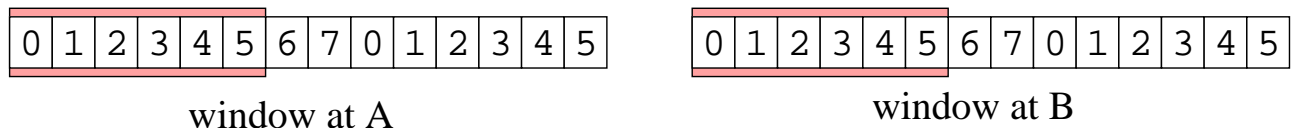
  [4 marks]

Question 2

(a) (i) Name two static routing techniques, explain their functionality and state one advantage and disadvantage for each technique.

   (ii) Explain which is meant by an Isolated Routing technique.

   (iii) Name and describe two Isolated Routing techniques, and discuss their advantages and disadvantages, giving one advantage and one disadvantage for each technique.

[9 marks]

(b) With the aid of one or more diagrams, describe the use of bridges and routers, and the differences between them.

[4 marks]

(c) Consider two DTEs, A and B, communicating using a sliding window protocol. It 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:

0	1	2	3	4	5	6	7	0	1	2	3	4	5

window at A

0	1	2	3	4	5	6	7	0	1	2	3	4	5

window at B

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

Time	DTE A	DTE 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]

(d) The RSA (MIT) public key encryption method is used with the following parameters:

p = 3,
q = 11,
n = $p * q$ = 33,
z = $(p - 1) * (q - 1)$ = 20

   (i) If the private key **d** is of value 7, what would be the public key **e**?

   (ii) Find another pair of (different) keys neither of which is of value 3.

   (iii) Briefly explain how to provide authentication with public key encryption.

[6 marks]

Question 3

(a) Draw a Huffman tree which can efficiently represent the following string:

CABAEACABCDEAEEFCEFF

Use a 1 for a left-transition and a 0 for a right-transition. Show the binary code for each letter (you do not need to show the resulting binary string). Assuming that the original string was represented as ASCII (7 bits per letter), what compression ratio would you have achieved? (There is no need to reduce the fraction).

[12 marks]

(b) In the context of the ISO message handling system (MOTIS) for electronic mails, describe the functions of user agents (UAs) and message transfer agents (MTAs).

The early email system developed for the ARPANET used the so-called RFC-822 standard that is exclusively ASCII-based and allows only text messages. Modern email systems continue to use RFC-822 for email transmission but many have facilitated binary transmission. What do you understand about the mechanism for transmitting binary messages through the email system?

[5 marks]

(c) State whether each of the following networks is capable of providing a transmission channel with guaranteed minimal speed. Explain your answers.

   (i) a CSMA/CD network;
  (ii) a Token Ring network;
 (iii) an X.25 network;
 (iv) an ATM network.

[8 marks]