Computer Science Department

1999 Examinations

B228, C329, D15 Questions

Answer THREE questions

(Electronic calculators may be used in this examination)

1. a) Communications services may be classified as *Connection Oriented* or *Connectionless*. Briefly summarise the principle differences between these two service classes.

[3 marks]

b) Network technologies which provide error recovery are often considered to be unsuitable for isochronous applications such as packet voice. Briefly outline reasons which support this view.

[4 marks]

c) One reason the designers of *Asynchronous Transfer Mode* (ATM) adopted a small packet size was to minimise end-to-end delay.

i) Draw a diagram to show how transmitting a given quantity of data in several small packets across a store-and-forward network gives a lower end-to-end delay than transmitting the same data in a single large packet.

[4 marks]

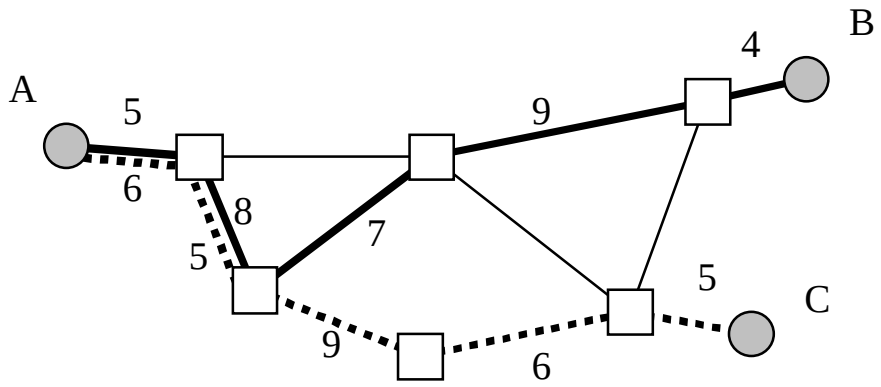
ii) Give two *dis*advantages of adopting a small packet size.

[2 marks]

[Question 1 is continued on the next page]

[Question 1 continued]

d) The diagram below shows two *virtual circuits* (VC) from host *A* to hosts *B* and *C*. The diagram also shows the *virtual circuit identifiers* (VCI) which have been allocated to the two VCs.



i) What is a VC? Briefly outline the actions that are performed when a VC is set up.

[2 marks]

ii) Explain the purpose of VCIs, their scope and how they are processed at network switches.

[5 marks]

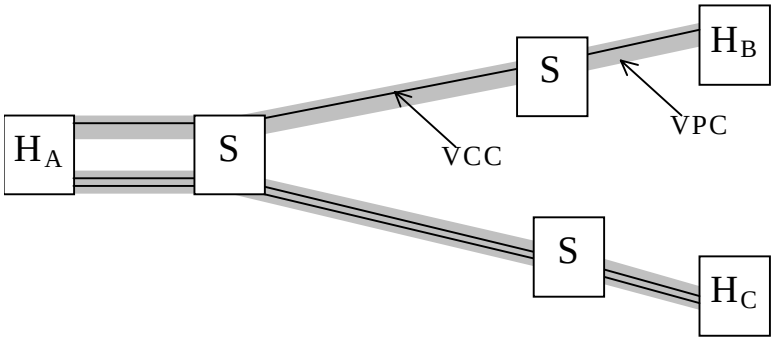
iii) Why might the use of VCs and VCIs be a good choice for networks which employ a small packet size?

[2 marks]

[Question 1 is continued on the next page]

[Question 1 continued]

e) *Asynchronous Transfer Mode* (ATM) uses both *Virtual Path Connections* (VPC) and *Virtual Channel Connections* (VCC). The diagram below shows three hosts (H_X) and three ATM switches (*S*) with two VPCs (shaded) and three VCCs set up.



i) Briefly explain the roles of VPCs and VCCs especially with respect to; how and when they are set up, how they are identified and how the identifiers are processed at the switches.

[7 marks]

ii) What are the advantages of having this two-level hierarchy of VCs?

[4 marks]

2. a) i) What is meant by *synchronous framing*?

[2 marks]

ii) The following data is to be sent using *transparent, bit-synchronous framing* over a serial link. Write down the bits that would appear on the link clearly indicating any additional bits and flags.

1	1	0	1	0	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	1
↑																				

First bit transmitted

[3 marks]

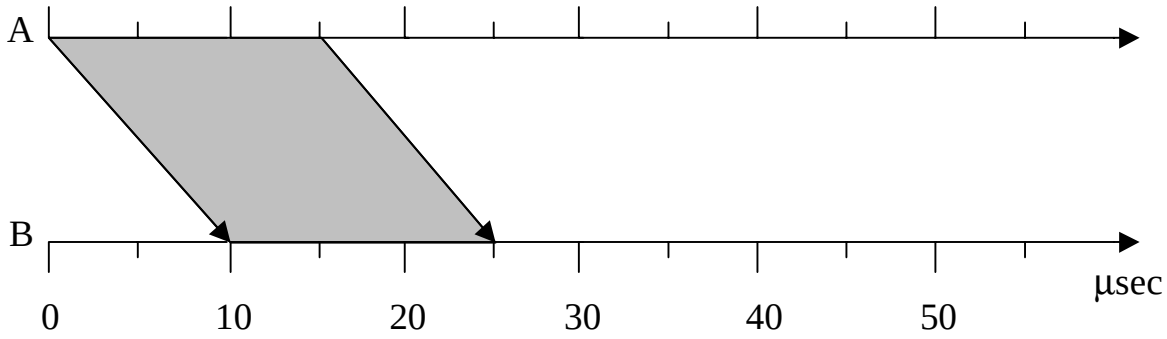
iii) The Ethernet LAN uses *Manchester Encoding*. How does this work and why is it well-suited to synchronous framing?

[5 marks]

[Question 2 is continued on the next page]

[Question 2 continued]

b) A LAN uses the *Carrier-Sense, Multiple Access with Collision Detection* (CSMA-CD) algorithm to control access to the medium. The LAN uses copper wire so that the propagation speed is about 2×10^8 m/s. Data is transmitted at 100Mbps. The time-sequence diagram below shows a single frame being transmitted between two stations *A* and *B* at extreme ends of the LAN.



i) How long is the LAN cable (in metres) and how many bits are there in the frame?

[2 marks]

ii) With the aid of a diagram like the one above, explain how, with the given frame-length, a station may fail to detect a collision. How long should the cable be if this problem is to be avoided?

[8 marks]

c) i) It is common today to configure an Ethernet LAN using *twisted-pair* cabling and a *hub*. Briefly describe this sort of configuration, explaining the role of the hub and the part it plays in collision detection.

[6 marks]

ii) An alternative configuration employs an *Ethernet switch* rather than a *hub*. Briefly explain how a switch differs from a hub and the impact its adoption has on network performance.

[7 marks]

3. a) You may find the following formulae useful in this part:

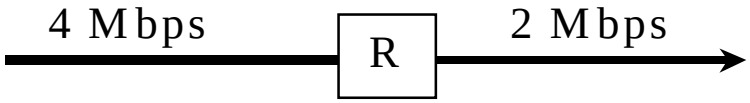
Given an M/M/1 queuing system with an infinite queue and customers arriving at mean rate λ with service rate μ:

The probability that there are n customers in the system is $\rho^n(1-\rho)$, *where* $\rho = \lambda/\mu$.

The mean number of customers in the system = $\frac{\rho}{1-\rho}$.

The mean time in the system per customer = $\frac{1}{\mu-\lambda}$.

The diagram below shows a router (*R*) with a 4 Mbps (4×10^6 bps) input link and a 2 Mbps (2×10^6 bps) output link. Packets have a mean size of 625 bytes (20-byte headers and 605 bytes of data). They arrive at *R* at a mean rate of 300 packets/sec. and the conditions for a M/M/1 queuing system are met.



i) Write down four important characteristics of a queuing system which allow it to be treated as an M/M/1 queuing system.

[2 marks]

ii) By treating the router as an M/M/1 queuing system, calculate the mean time for which packets remain at *R*.

[3 marks]

iii) What capacity would be needed on the output link to halve the time that packets remain at R?

[6 marks]

iv) The finance director refuses to pay for increased capacity on the output link but it is still essential to halve the delay calculated in ii) whilst maintaining the data rate. The network manager proposes to achieve this by reducing the mean size of the packets to 270 bytes (20-byte headers and 250 bytes of data). Will this work?

[9 marks]

[Question 3 is continued on the next page]

[Question 3 continued]

b) i) Define the *Hamming Distance* between two codewords.

[2 marks]

ii) Demonstrate, with the aid of a diagram, that a code capable of correcting all 1-bit errors must have a minimum Hamming Distance of at least 3.

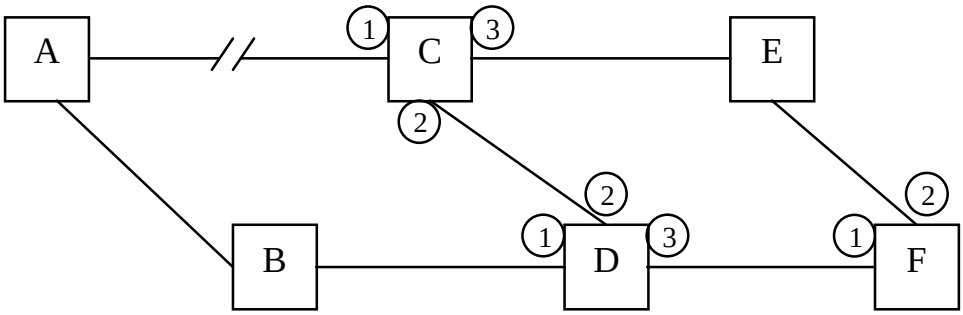
[5 marks]

iii) An 11-bit *Hamming Code* has 7 message bits and 4 check bits. The check bits are in the "power of two" positions and are calculated to give even parity. The codeword below, calculated according to the scheme above, has been subject to a 1-bit error. Which bit is in error (show your working)?

11	10	9	8	7	6	5	4	3	2	1
1	0	0	0	0	0	1	1	1	1	1

[6 marks]

4. a) The diagram below shows a configuration of Internet routers (*A*-*F*) which achieve dynamic routing through the use of a *Distance Vector* routing algorithm. The metric used is a simple hop-count (if two equal-length routes are available then the one via the lower numbered interface is chosen).



The link between *A* and *C* has been broken for some time and routing has stabilised to accommodate the situation. Each router maintains a routing table like the one below:

[Question 4 is continued on the next page]

[Question 4 continued]

Routing table for Router F

Destination	Hop count	Interface	Next router
A	3	1	*D*
B	2	1	*D*
C	2	1	*D*
D	1	1	*D*
E	1	2	*E*
F	0	-	*F*

i) Give the current routing table for router *C*.

[4 marks]

ii) Router *D* now discovers that the link between *B* and *D* has broken. Immediately after this (i.e. before *D* has reported the fact to any other routers), *D* receives distance vectors from *C* and *F* based on their *current* routing tables. Illustrate these two distance vectors.

[5 marks]

iii) Clearly outline the reasoning that *D* would use in calculating its new routing table entry for node *A* following receipt of the distance vectors from *C* and *F*.

[4 marks]

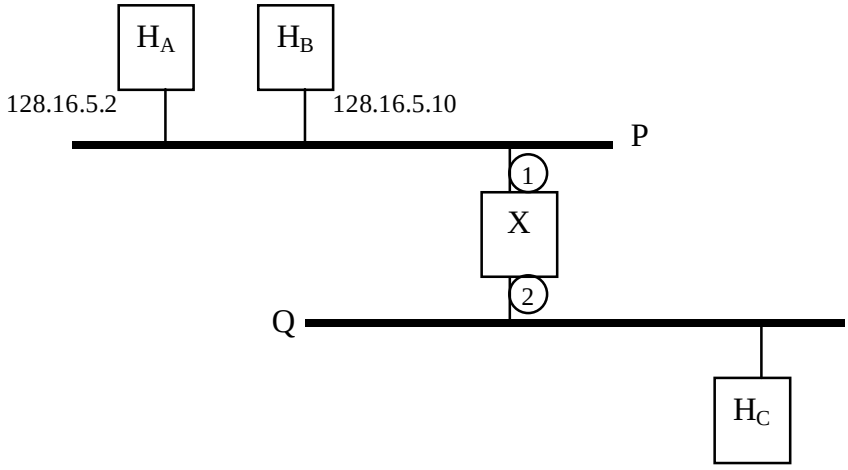
iv) How will *C*'s routing table be amended next time it receives a distance vector from *D*? What problem of distance vector algorithms does this illustrate?

[5 marks]

[Question 4 is continued on the next page]

[Question 4 continued]

b) The diagram below shows two Ethernets connected by a device *X*. H_A and H_B are hosts connected to Ethernet *P*. H_C is a host connected to Ethernet *Q*.



i) Explain the purpose of the *Address Resolution Protocol* (ARP) as applied to the Ethernet. Describe the operation of ARP as H_A sends to H_B for the first time.

[4 marks]

ii) H_C is allocated the IP address 129.16.42.2. Assuming H_C can communicate with the other hosts using IP, what can one say about device *X* and the addresses of its two interfaces?

[5 marks]

iii) Suppose that *X* is a transparent MAC bridge. Suggest an IP address that would be appropriate for H_C and give a reason for your choice.

[4 marks]

iv) Again supposing that *X* is a transparent MAC bridge, what part would *X* play in address resolution as H_A sends to H_C for the first time?

[2 marks]

5. a) Bob wishes to send a message (*M*) to Alice. Bob applies the following algorithm to his message:

- Apply a *hash function H* to *M, i.e.*: $M \rightarrow H(M)$
- Apply the *decryption* part of a *public key encryption algorithm* using Bob's secret key, i.e.: $H(M) \rightarrow D_S(H(M))$
- Send *M* and $D_S(H(M))$ to Alice.

i) Explain why $D_S(H(M))$ can be considered to be a digital signature for *M* and describe how Alice can verify the signature. (Assume that Alice is already confident of Bob's public key). State what is the purpose of the hash function *H*.

[5 marks]

ii) What special property must the public key encryption algorithm possess in order for the digital signing to work?

[2 marks]

iii) Bob now denies having sent the message to Alice; he claims that his public key is different from what Alice believes it to be. However, Alice produces a *certificate* to prove that Bob really did send the message.

Explain what a certificate is and how Alice might use one to prove her case.

[6 marks]

iv) Charles finds a weakness in Bob's hash algorithm which enables him to forge a message from Bob. Explain how this can be done.

[4 marks]

[Question 5 is continued on the next page]

[Question 5 continued]

b) An application is to be designed which will allow the retrieval of students' public examination results across a network. An "*examination result*" includes the following information: *subject*, *examination board* (both text strings) and *mark obtained* (an integer). Records to be sent across the network consist of the student's *first* and *last names*, *year of birth* and *registration number* followed by an arbitrarily long list of *examination results*. Design a suitable syntax for these records using the *ISO Abstract Syntax Notation no.1* (ASN.1).

[7 marks]

c) In the context of the ITU X.500 Directory Service:

i) Briefly explain the terms *Directory System Agent* (DSA), *Directory User Agent* (DUA) and *Lightweight Directory Access Protocol* (LDAP).

[4 marks]

ii) When the local DSA is unable to answer a query, it may invoke the services of other DSAs. Illustrate the two principal modes of operation in which this collaboration between DSAs may occur.

[5 marks]

[END OF PAPER]