Computer Science Department
1998 Examinations

B228, C329, D15 - Computer Communications

Answer THREE questions

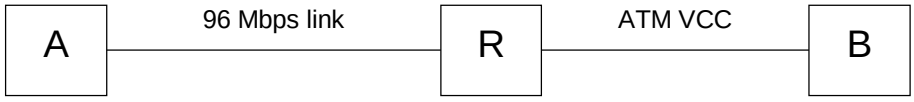
(The use of electronic calculators is not permitted in this examination)

1. *You may find the following formulae useful in this question:*

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

   The average number of customers in the system is $\frac{\lambda}{\mu - \lambda}$ *whilst the average delay per customer is* $\frac{1}{\mu - \lambda}$.

   A TCP source (*A*) transmits packets to a host (*B*) via a dedicated 96Mbps (96×10^6 bits/sec) link, a router (*R*) and an ATM virtual channel connection (VCC) (see diagram). Each packet carries an average of 920 bytes of data and is itself carried in an IP datagram. IP and TCP headers are 20 bytes each.



   a) Show that the maximum average transmission rate between *A* and *R* is 1.25×10^4 packets/sec and calculate what this represents in **<u>data</u>** bytes/sec? (You may assume an error-free channel and may ignore framing overheads).

   [4 marks]

   b) Router *R* fragments the IP datagrams and forwards them along the ATM VCC. The ATM cells are each 53 bytes, 48 of which carry data. Assuming there is no fragmentation overhead, at what average rate must ATM cells be transmitted from *R* to *B* in order to accommodate the maximum rate TCP stream?

   [2 marks]

   c) Outline the requirements on the TCP stream for *R* to be modelled as an M/M/1 queuing system.

   [4 marks]

[Question 1 continued on next page]

[Question 1 continued]

d) Assume that *R* may be modelled as an M/M/1 queuing system with arrival rate λ packets/sec and service rate μ packets/sec. Show that a capacity of at least 5 x 10^5 cells/sec is needed between *R* and *B* if the average queuing delay in *R* is to be no more than 80μsec (80×10^{-6} sec).

[12 marks]

e) Assuming the capacity of the ATM VCC is as indicated in d), what is the average number of **<u>data</u>** bytes buffered in *R*?

[4 marks]

f) The total distance from *A* to *B* is 100 Km. Assuming a propagation speed of 2 x 10^8 m/sec on both sections of the route and ignoring transmission and processing times, estimate the round-trip delay observed from *A* and hence suggest a suitable transmit window size for *A*. State any assumptions you make.

[7 marks]

2. a) i) A code designed to correct all single bit errors uses code words having *m* message bits and *r* check bits. Show that *m* and *r* must satisfy the inequality:

$$m + r + 1 \leq 2^r$$

[8 marks]

ii) Given the result of i) how many check bits would need to be added to 1000 bit messages if all single bit errors are to be corrected?

[3 marks]

iii) The code-word below is a *Hamming Code* for 7-bit ASCII calculated with even parity and having one bit in error. Explain how the check bits are calculated in this code and identify the bit which is in error.

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

[10 marks]

b) Illustrate by means of a time-sequence diagram how duplicates can occur and are detected by a simple stop-and-wait ARQ (Automatic Repeat Request) protocol.

[12 marks]

[CONTINUED]

3. a) A system is designed which allows students access to a remote database containing personal records of students. Each student is allowed access only to his or her own information. Students identify themselves to the system by typing a username followed by a password. The remote system encrypts the password and compares the result with an encrypted copy stored in a database table. For ease of maintenance, the encrypted passwords are globally readable.

   i) Criticise the security of the above scheme.

   [8 marks]

   ii) An alternative scheme requires students to authenticate themselves by sending messages encrypted with the *private key* of a *public/secret key pair*. Explain how the remote system would perform the authentication check under this scheme. Your answer should refer to the rôle played by *certificates* and *message digests* in this sort of scheme.

   [15 marks]

   b) A record used in a remote database access system consists of a "*personal information*" part followed by a "*comment*" part. The *personal information* contains a "*personal name*" section, followed by one of two integer fields; "*identity number*" or "*security code*". A *personal name* consists of three ASCII strings; "*title*", "*first name*", "*last name*". The *content* part is an arbitrary collection of bytes. Illustrate how the syntax of such a record might be specified using the ISO Abstract Syntax Notation 1 (ASN.1).

   [Marks will not be deducted for minor syntax errors]

   [10 marks]

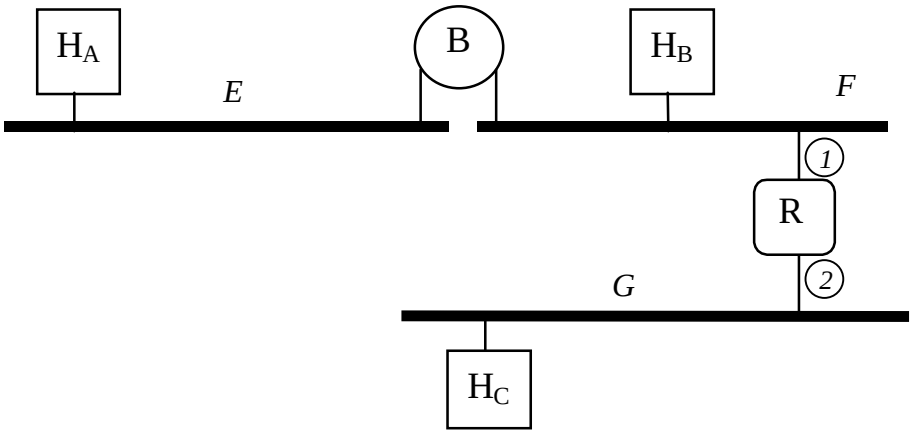
4. a) In the Internet world servers are said to reside on “well-known ports”. What does this mean? Outline how ports are used (both in the initial and in subsequent packets) as a document is retrieved from a WWW server.

[8 marks]

b) Internet hosts frequently make use of a “*generic server*” (sometimes called *a “server server*”). The *inetd* process used on Unix is an example. Explain how such servers operate.

[5 marks]

c) In the diagram below: B is a transparent MAC bridge between two Ethernets *E* and *F,* R is an Internet router between Ethernets *F* and *G*, H_A, H_B and H_C are hosts each of which employs the Internet Protocol (IP).



i) H_A, H_B and B have just been switched on so that H_A and H_B have empty address resolution tables and B has an empty forwarding table. Describe the exchanges between H_A, H_B and B as H_A sends an IP datagram to H_B. Your answer should cover the operation of the Internet *Address Resolution Protocol* (*ARP*) for Ethernet.

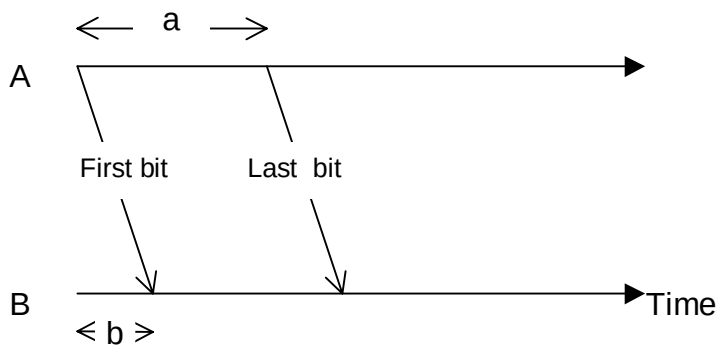
[10 marks]

ii) Outline the address resolution and routing steps which occur as H_B transmits its first IP datagram to H_C.

[10 marks]

[CONTINUED]

5. a) The time-sequence diagram below shows transmission of a frame on a CSMA-CD network from A to B at extreme ends of the network.



i) Two delays *a* and *b* are shown on the diagram. Which is the transmission delay and which the propagation delay?

[1 mark]

ii) Draw a diagram similar to the one above which shows two transmissions, one from *A* and one from *B* and which illustrates that transmission delay must be at least twice the propagation delay if collisions are to be detected successfully.

[8 marks]

iii) "*Twisted-pair Ethernet*" is a CSMA-CD network based on a device called a "*hub*". Outline the general configuration and operation of such a network explaining the rôle of the hub.

[8 marks]

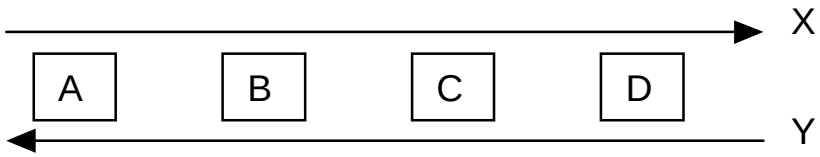
iv) What is an "*Ethernet Switch*"? How does such a switch differ from the hub of iii) above and what advantages does it confer?

[8 marks]

[Question 5 continued on next page]

[Question 5 continued]

b) IEEE Committee 802.6 has developed a Metropolitan Area Network standard called Distributed Queue Dual Bus (DQDB) (formerly QSPX). The diagram shows packet mode operation on a DQDB network with four stations. Each station has two counters; a `queue counter' Q which counts downstream requests and a `down counter' D which records the station's position in the queue. The counters relate to requests made on bus X for transmission slots on bus Y, currently only C has a request outstanding.



Q	D	Q	D	Q	D	Q	D
0	0	0	0	0	0	0	0
0	0	0	0	0	1	1	0

Show how the values of the counters will change as B, A, and D make requests (in that order) on bus X, followed by the passage of four free slots on bus Y.

[8 marks]

[END OF PAPER]