namibia university
OF SCIENCE AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF COMPUTER SCIENCE

QUALIFICATION: BACHELOR OF COMPUTER SCIENCE HONOURS : COMMUNICATION NETWORKS	
QUALIFICATION CODE: 08BCCH	LEVEL: 8
COURSE: BROADBAND NETWORKS	COURSE CODE: BBN810S
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DURATION: 3 HOURS	MARKS: 80

SECOND OPPORTUNITY / SUPPLEMENTARY EXAMINATION QUESTION PAPER	
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| INSTRUCTIONS |
|---|
| 1. Answer ALL the questions. |
| 2. Write clearly and neatly. |
| 3. Number the answers clearly. |

THIS QUESTION PAPER CONSISTS OF 11 PAGES (Including this front page)

QUESTION 1

a) Give an example of an application-level requirement that might take [2 marks] advantage of the drop priority field in an ATM cell? List three reasons explaining your answer.

b) Why will two ISPs at the same level of the hierarchy often peer with each [4 marks] other? How does an IXP earn money?

QUESTION 2

Consider the logical representation in the figure below. The sources A and B are transmitting data at the average rate of 2 Mbps each to the destination C across a network. The data consists of 1000 bit packets. Assume that all the contribution to the end-to-end delay comes from the store-and-forward network queue shown in the figure, and that there are no packet losses. This queue has an average occupancy of 12 packets.
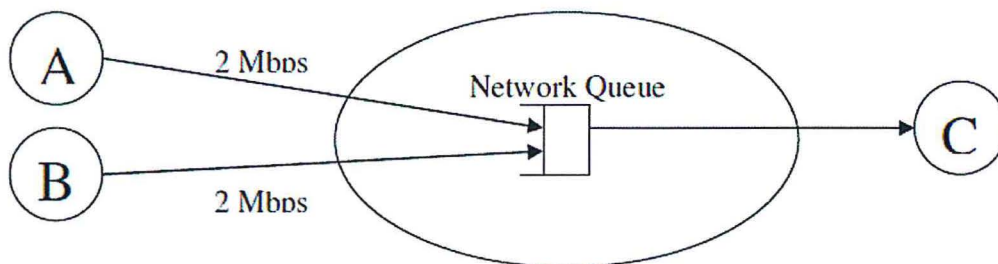
1) What's the average end-to-end delay experienced by each packet? [3 mark]

2) In light of your answer for the part (1), what advances have made 56 Kbps modems [2 marks] possible

QUESTION 3

The measurements available on the CAIDA AS Rank ranking site reveal the properties of autonomous systems (Ass) studied. Take for example the information concerning Level3, Renater and Irisa, which has the autonomous system number 3356, 2200 and 1938 respectively. On the CAIDA web page corresponding to three ASs (see Table 1) accessible through this link (https://asrank.caida.org/), we can identify the number of neighbours under the heading "AS degree" and the term "global". These neighbours can be suppliers (rated provider), AS with a peering agreement (rated peer), or customers (rated customer).

AS number	3356
AS name	LEVEL3
organization	Level 3 Parent, LLC
country	United States
AS rank	1

AS number	2200
AS name	FR-RENATER
organization	Renater
country	European Union
AS rank	683

AS number	1938
AS name	FR-RENATER-IRISA
organization	Renater
country	European Union
AS rank	13236

a) By observing the number of neighbours of Level3 and their types, how will you categorize Level3? [2 marks]

b) By observing the number of RENATER neighbors and their types on the next page, how will you categorise RENATER? [2marks]

c) By observing the number of neighbors of IRISA and their types on the next page, how will you categorise IRISA? [2 marks]

QUESTION 4

Consider the figure below. Suppose that the video is encoded at a fixed bit rate, and thus each video block contains video frames that are to be played out over the same fixed amount of time of 1 second. The server transmits the first video block at t0=0sec, the second block at t=1 sec, the third block at t=2 sec and so on. Once the client begins playout, each block should be played out 1second after the previous block.
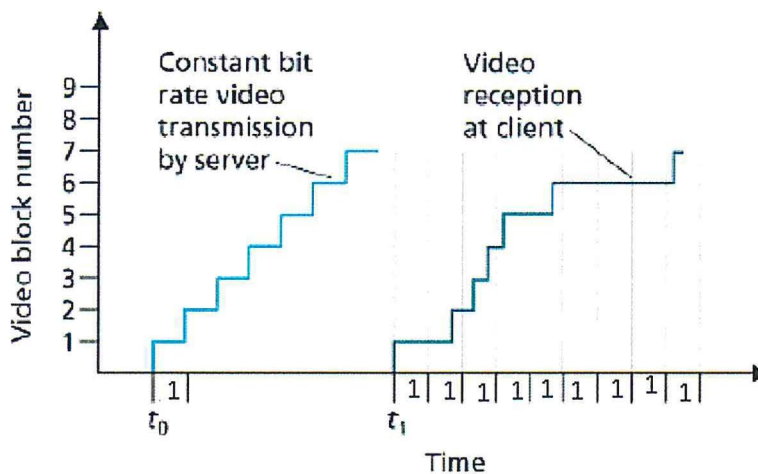

Figure 1. Video streaming transmission

a) Suppose that the client begins playout as soon as the first block arrives at t1. In the figure below, how many blocks of video (including the first block) will have arrived at the client in time for their playout? Explain how you arrived at your answer.   [2 marks]

b) Suppose that the client begins playout now at t1+1. How many blocks of video (including the first block) will have arrived at the client in time for their playout? Explain how you arrived at your answer.   [2 marks]

c) In the same scenario at (b) above, what is the largest number of blocks that is ever stored in the client buffer, awaiting playout? Explain how you arrived at your answer.   [2 marks]

d) What is the smallest playout delay at the client, such that every video block has arrived in time for its playout? Explain how you arrived at your answer.   [2 marks]

QUESTION 5

Suppose that a router has three input flows and one output port. It receives packets continuously as per table 1, with all flows beginning at the same time and queues being empty before the arrival of the first packet. Packets in each separate flow are listed in the order they are received at the router. For example, packets 1, 3 and 6 are the first to arrive. Length represents the number of clock ticks it takes to transmit a packet.

Table 1. Queuing Router

Packet id	Length	Flow
1	200	1
2	200	1
3	160	2
4	120	2
5	160	2
6	210	3
7	150	3
8	90	3

Determine the order in which packets are transmitted by the router if Weighted fair queuing is used, with flow 2 having weight 2, and the other two with weight 1: [5marks]

QUESTION 6

a) What percentage of an ATM link's total bandwidth is consumed by the payload bits in ATM? [4 mark]

QUESTION 7

You are hired to design a reliable byte-stream protocol that uses a sliding window (like TCP). This protocol will run over a 100-Mbps network. The RTT of the network is 100 ms, and the maximum segment lifetime is 60 seconds.

- (a) How many bits would you include in the AdvertisedWindow of your protocol header? [2 marks]
- (b) How many bits would you include in SequenceNum fields, assuming a minimum packet size of 40 bytes? [2 marks]

QUESTION 8

The Delta operator implements an IP / MPLS / Ethernet network whose topology is given in figure. 1. Networks A, B, C, D and E are IP's networks.
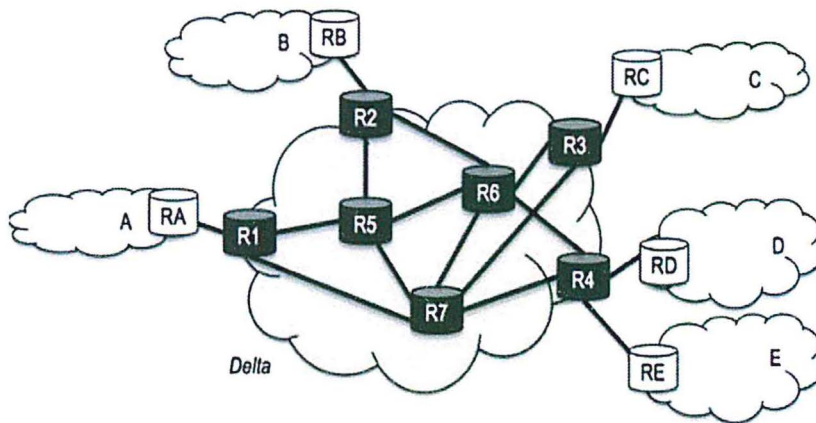

Figure 2. MPLS Network

The routing tables of the routers R1 to R7 are given in the Table 2.

Table 2. Routing Table

R1 Routing Table

Dest.	NH	Cost
R2	R5	1
R3	R7	2
R4	R7	2
R5	R5	1
R6	R5	2
R7	R7	1
Network A	RA	1
Network B	R5	3
Network C	R7	4
Network D	R7	3
Network E	R7	3

R2 Routing Table

Dest.	NH	Cost
R1	R5	2
R3	R6	2
R4	R6	2
R5	R5	1
R6	R6	1
R7	R5	2
Network A	R5	3
Network B	RB	1
Network C	R6	4
Network D	R6	3
Network E	R6	3

R3 Routing Table

Dest.	NH	Cost
R1	R7	2
R2	R6	2
R4	R6	2
R5	R6	2
R6	R6	1
R7	R7	1
Network A	R1	3
Network B	R4	3
Network C	R4	1
Network D	R1	3
Network E	R4	3

R4 Routing Table

Dest.	NH	Cost
R1	R7	20
R2	R6	10
R3	R6	10
R4	R7	-
R5	R6	10
R6	R7	10
Network A	R7	20
Network B	R6	20
Network C	R6	20
Network D	RD	20
Network E	RE	10

R5 Routing Table

Dest.	NH	Cost
R1	R1	30
R2	R2	20
R3	R6	20
R4	R6	10
R6	R6	-
R7	R7	20
Network A	R1	20
Network B	R2	10
Network C	R6	30
Network D	R6	40
Network E	R6	10

R6 Routing Table

Dest.	NH	Cost
R1	R5	30
R2	R2	20
R3	R3	20
R4	R4	10
R5	R5	20
R6	R7	-
Network A	R1	10
Network B	R2	30
Network C	R3	30
Network D	R4	40
Network E	R4	10

R7 Routing Table

Dest.	NH	Cost
R1	R1	1
R2	R5	2
R3	R3	1
R4	R4	1
R5	R5	1
R6	R6	1
Network A	R1	2
Network B	R5	3
Network C	R3	2
Network D	R4	2
Network E	R4	2

It is assumed that the Delta network administrator has enabled MPLS on his network. Equipment R1 to R7 are Label Switch Routers (LSP). (They switch packets using label. LSPs are built on demand; that is, we wait until the path is necessary to build it. The Delta network does not implement quality of service.

An IP packet is sent from a computer in Network A to another computer in Network D. The packet is forwarded by router RA via the Delta Network Router R1 with a TTL of 40. Router R1 is the Border Router receiving the packet. It will trigger the creation of the LSP that will route the packets to network D. It is assumed that this LSP is the first created in the network.

a) Which router will choose the label to use on the LSP link at the exit of R1 (LSP R1 to R7) towards Network D?   [2 marks]

b) The switching table in R1 contains the following line: [2 marks]

   In case the IP packet is to leave the Delta network, which router pops the MPLS header?   [2 marks]

c) Which LSR sent the packets to router R4 for the communication from R1 to D?   [2 marks]

d) Which next hop is associated with these packets in the switching table of R4?

e) If packets leaving router R7 are labelled 9, draw the switching table of router R7.   [3 marks]

QUESTION 9

a) Consider 10 flows passing through a Fair Queue (FQ) router with an outgoing (4) link running at 100Mbps. Five of the flows are part of a file backup service and can each fill the link if they are allowed to. The other five are video streams running at 2Mbps. Given that the router is the bottleneck for all the flows, how fast do the flows operate?   [3 marks]

b) Assume a link of capacity 10 Mbps that is traversed by four flows with arrival rates of 6, 4, 2, and 1 Mbps, respectively. How much bandwidth will each flow get? (Show all your calculations.)   [2 marks]

QUESTION 10

Using the network in Figure 2, give the virtual circuit tables for all the switches after each of the following connections is established. Assume that the sequence of connections is cumulative; that is the first connection is still up when the second connection is being established and so on. Also assume that the VCI assignment always picks the lowest unused VCI on each link, starting with 0.
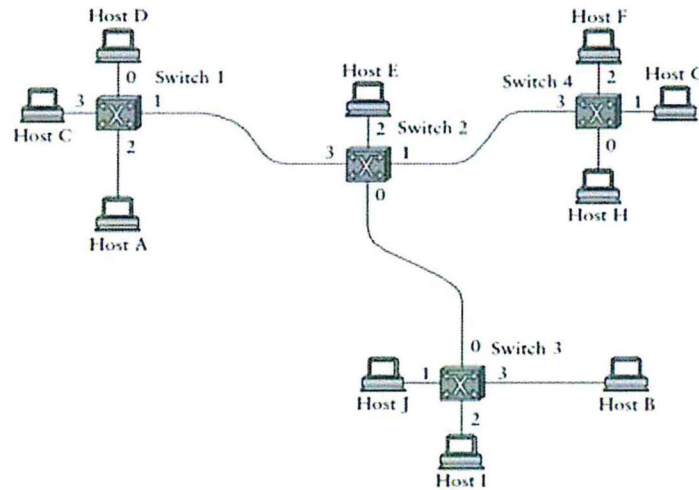
[12 marks]

Figure 2. Virtual Circuit Network

1) Host D connects to host H (1 mark)
2) Host B connects to host G (1 mark)
3) Host F connects to host A (1 mark)
4) Host H connects to host C (1 mark)
5) Host I connects to host E (1 mark)
6) Host H connects to host J (1 mark)

QUESTION 11

The Transmission Control Protocol uses a method called congestion control to regulate the traffic entering the network. The behavior of TCP congestion control can be represented as a graph in which the x-axis indicates the time, and the y-axis indicates congestion window size. Please use Figure 4 shown below to answer the following questions (Note that the Figure 4 does not explicitly show timeouts, but you should be able to figure out when timeouts happened based on the events shown).
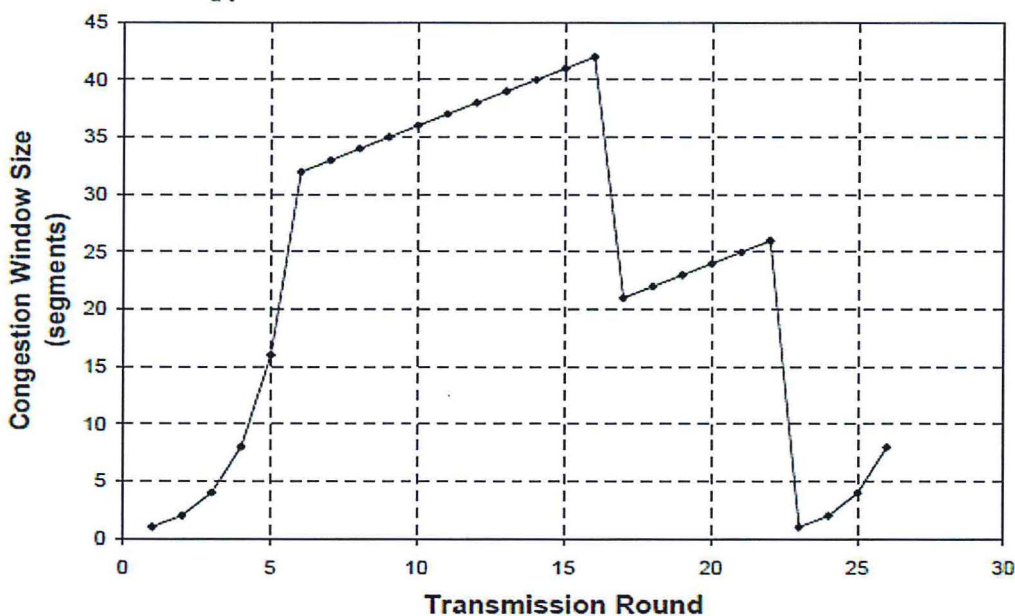

Figure 4. TCP Congestion Window Size

a) Give two reasons why slow start is used, and explain why it does a better job than congestion avoidance. [2 marks]

b) Identify the time intervals when the TCP slow start is operating. For each interval time, identify which reasons apply and do not apply and explain why. [2 marks]

c) Identify the time intervals when the TCP congestion avoidance is operating. Why congestion avoidance should be used instead of the slow start during these intervals. Please clearly identify one specific reason [2 marks]

d) After the 16th transmission round, a loss of segment 3 is detected by a triple duplicate ACK or by a timeout? Explain your answer. [2 marks]

e) What is the value of ssthreshold (slow start threshold) at the 18th [2 marks] transmission round?

f) Assuming a packet loss is detected after the 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of ssthresh? [2 marks]

=====================End of Examination=======================