NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF COMPUTER SCIENCE

QUALIFICATION: BACHELOR OF COMPUTER SCIENCE	
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COURSE: BROADBAND NETWORKS	**COURSE CODE**: BBN810S
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DURATION: 3 HOURS	**MARKS:** 75

SUPPLEMENTARY / SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
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MODERATOR:	**PROF VELEMPINI MTHULISI**

INSTRUCTIONS
1. Answer ALL the questions. 2. Write clearly and neatly. 3. Number the answers clearly.

THIS QUESTION PAPER CONSISTS OF 8 PAGES (Including this front page)

QUESTION I

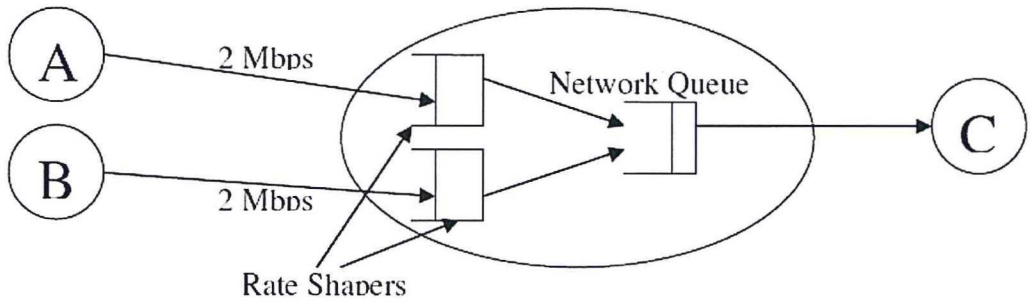
a) Name three advantages and one disadvantage of fixed size packets (cells) compared to variable length packets. [4 marks]

b) For ATM networks to operate as part of IP networks, ATM needs to provide a form of IP addresses resolution using ARP protocol. However, the ARP procedure as described in an IP network cannot work because it depends on the fact that packets can be broadcasted to all hosts in a single network. For this reason, there is a different procedure of ARP that is defined for ATMs network and known as the ATMARP protocol. Under ATMARP, explain how does the ARP server learn the physical MAC addresses of the hosts in its subnet? [2 marks]

c) Asynchronous Transfer Mode (ATM) is a virtual-circuit (VC) based technology in which data is transmitted in small and fixed packet size called cells. List and explain the three advantages of ATMs benefit in using cells instead of variable packet length. [3marks]

QUESTION II

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. Each of the data streams is first passed through a rate shaper queue, and then fed into the network queue. A rate shaper queue puts out the "shaped" traffic such that consecutive outgoing packets have a minimum separation of a specified duration. Assume that all the contributions to the end-to-end delay only come from the rate shaper and the network queues, and that there are no packet losses. Each rate shaper has an average occupancy of 12 packets, and the network queue has the [5 mark]

average occupancy of 1 packet. What's the average end-to-end delay experienced by each packet?

QUESTION III

Compare Go-Back-N (GBN), Selective Repeat, and TCP (no delayed ACK). Assume that the timeout values for all three protocols are sufficiently long such that 5 consecutive data segments and their corresponding ACKs can be received (if not lost in the channel) by the receiving host (Host B) and the sending host (Host A) respectively. Suppose Host A sends 5 data segments to Host B, and the 2nd segment (sent from A) is lost. At the end of the connection, all 5 data segments are correctly received by Host B.

a) *How many segments has Host A sent in total and how many ACKs has Host B sent in total? What are their sequence numbers? Answer this question for all three protocols* [5 marks]

b) *If the timeout values for all three protocols are much longer than 5 RTT, then which protocol successfully delivers all five data segments in the shortest time interval?* [2 marks]

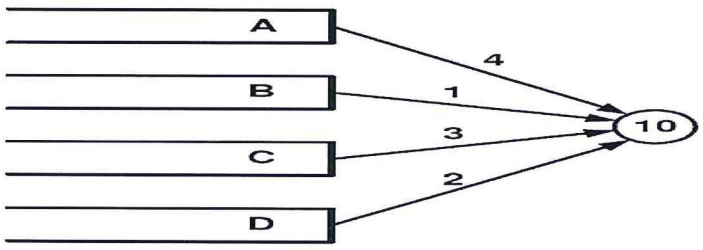
QUESTION IV

a) Why is round-trip time an appropriate time scale for the retransmission of frames? [2 marks]

b) Name two factors that can cause variance in the network's round-trip time? [3 marks]

QUESTION V

Suppose that a router has four input flows being serviced according to a Weighted Fair Queueing (WFQ) scheduling policy. The weights given to the four queues (A, B, C, D) are 4, 1, 3, and 2 respectively. They are being serviced by a router at the rate of 10 Mbps. [6 marks]



The table below gives a list of different input traffic rates (in Mbps) at the four input queues. Fill in the resultant output rates for each of these four queues. The first two rows have been filled, complete the rest. Each row [2 marks]

.

Table 1. Weighting Fair Queuing Router

Input Rates				Received Rates			
Link A	Link B	Link C	Link D	Link A	Link B	Link C	Link D
1	1	1	1	1	1	1	1
10	10	10	10	4	1	3	2
6	6	2	2				
8	0	0	8				
1	5	3	5				

QUESTION VI

a) What percentage of an ATM link's total bandwidth is consumed by all non-payload bits in AAL3/4 (ATM Adaptation Layer 3/4) when the user data is 512 bytes long? [5 mark]

QUESTION VII

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? [3 marks]

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

QUESTION VIII

Consider the figure 1 (which is similar to the packet audio playout figure discussed in class). A sender begins sending packetized audio periodically at t = 1. The first

packet arrives at the receiver at t = 8. Note that each vertical and horizontal line segment in the figure has a length of 1, 2, or 3 time units.

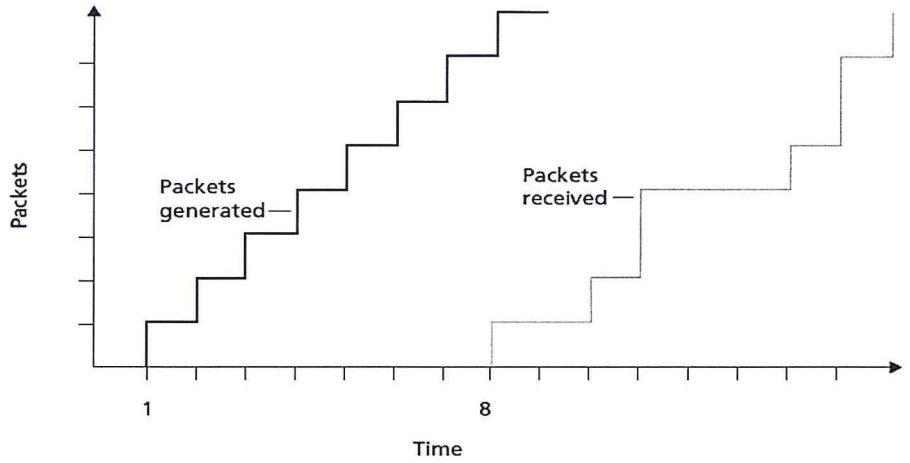


Figure 1. Packet Audio Playout

a) *What are the delays (from sender to receiver, ignoring any playout delays) of the second, third, fourth, and fifth packets sent?* [2 marks]

b) *If audio playout begins as soon as the first packet arrives at the receiver, which of the first 8 packets sent will not arrive in time for playout?* [2 marks]

c) *If audio playout begins at time t=8 which of the first 8 packets sent will not arrive in time for playout?* [2 marks]

d) *What is the minimum playout delay at the receiver that results in all of the first 8 packets arriving in time for playout?* [2 marks]

QUESTION IX

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 X

Consider a VC network with a 2-bit filed for the VC number. Suppose that the network wants to set up a virtual circuit over four links: link A, link B, link C and link D. Suppose that each of those links is currently carrying two other virtual circuits, and the VC numbers of these other VCs are as follows:

Link A	Link B	Link C	Link D
00	01	10	11
01	10	11	00

Assume that each of the existing VCs may only traverse one of the four links.

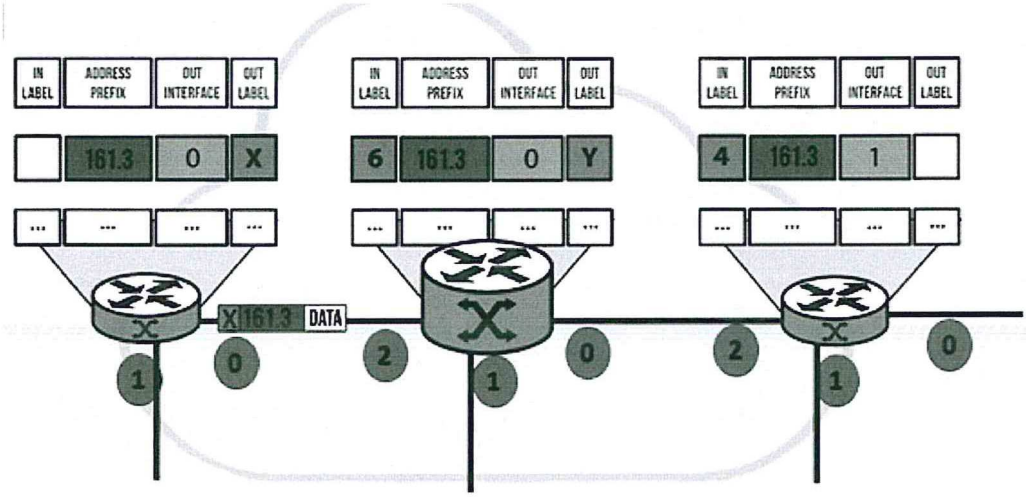
1) If each VC is required to use the same VC number on all the four links along its path, what VC number could be assigned to the new VC?) [3 marks]
2) If each VC is permitted to have a different VC number in the different links along its path, how many different combinations of four VC numbers (one for each of the four links) could be used? [3 marks]

QUESTION XI

The diagram below represents a MPLS network. A packet arrives and then through MPLS's routers, it is moved to the destination IP address. The diagram also shows router tables that contain mappings between labels and output interfaces. IN LABEL contains label values for arriving packets, ADDRESS PREFIX is for different reachable destinations, OUT INTERFACE is the output interface, OUT LABEL is label values added to outbound packets through this interface.

a) What are the X and Y values in the schema?

b) Name three benefits or features of this MPLS network



QUESTION XII

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 3 to answer the following questions (Note that the Figure 3 does not explicitly show timeouts, but you should be able to figure out when timeouts happened based on the events shown).

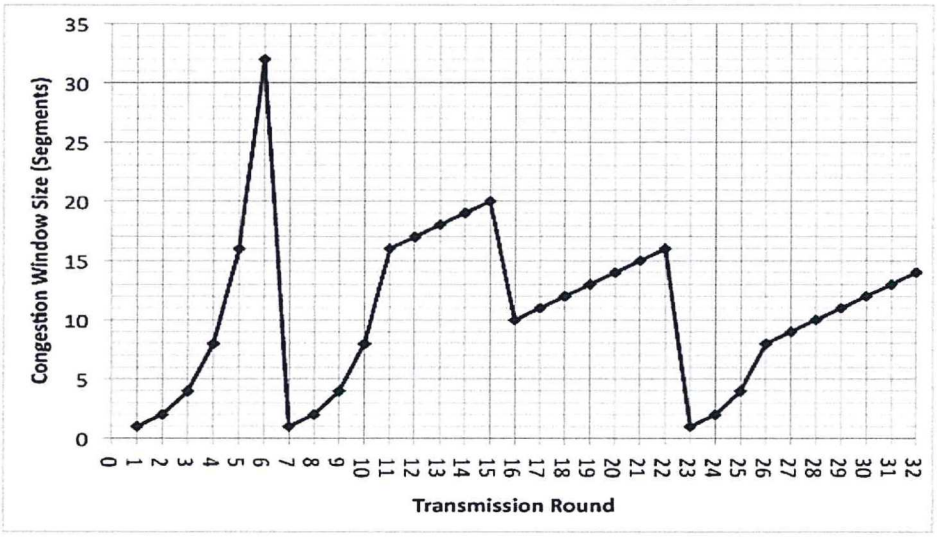


Figure 3. TCP Congestion Window Size

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

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

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

d) *Identify the intervals of time when TCP fast retransmission is used. Please explain what fast retransmission does and how it is triggered.* [2 marks]

e) *Identify the intervals of time when TCP fast recovery is operating. What does fast recovery do and explain why is it beneficial?* [2 marks]

f) *Identify the interval(s) of time when fast recovery could have happened, but did not. Identify one specific example of a circumstance that may prevent fast recovery from happening.* [2 marks]

g) *Which version of TCP is represented in this Figure?* [2 marks]

GOOD LUCK!