NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF COMPUTER SCIENCE

QUALIFICATION: BACHELOR OF COMPUTER SCIENCE HONOURS: COMMUNICATION NETWORKS	
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COURSE: BROADBAND NETWORKS	COURSE CODE: BBN810S
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DURATION: 3 HOURS	MARKS: 70

FIRST OPPORTUNITY 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 8 PAGES (Including this front page)

QUESTION 1

a) Name one advantage and one disadvantage of fixed size packets (cells) compared to variable length packets. Justify. [4 mark]

b) In Ethernet, what is the difference between a hub and a switch? [2 marks]

c) Why does the TCP congestion control mechanism have a "slow-start" and a "congestion avoidance" phase? [2 marks]

QUESTION 2

We consider the following set of autonomous systems, LEVEL3, GTT, CLARANET, RENATER, INTEROUTE and IRISA as shown in figure 1. The relationships between these autonomous systems are of the peering or transit type (customer to provider). The letters U to Z represent any IP equipment on the networks of each of these autonomous systems. It is assumed that only the type of relationship between autonomous systems governs routing in this exercise: no other decision criteria are taken into account in the routing selection.
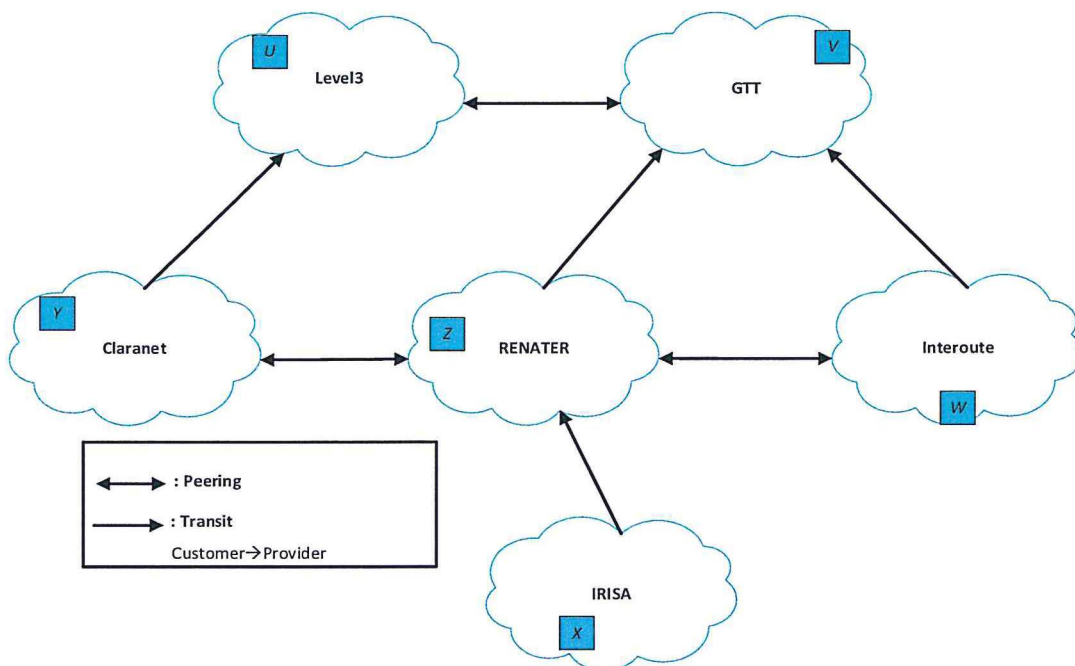

Figure 1: Autonomous Systems Relationship

Question 2.1: Looking at the topology above, the agreement between Claranet and Level3 implies that (select all correct answers): [2 marks]

Claranet is billed for the volume of traffic sent and received from Level3.	
Level3 is billed for the volume of traffic sent and received from Claranet.	
Traffic exchanged between Claranet and Level3 is not billed.	
Level3 routes traffic from Claranet to the rest of the Internet.	

Question 2.2: According to the proposed topology, the agreement between Claranet and RENATER implies that (select all correct answers): [2 marks]

Claranet is billed for the volume of traffic exchanged with RENATER.	
RENATER routes traffic from Claranet to the rest of the Internet.	
RENATER routes traffic from Claranet to IRISA.	
The exchange of traffic between Claranet and RENATER is not invoiced.	

Question 2.3: For a communication from Y to V, what are the paths that respect the agreements between the autonomous systems? (select all correct answers) [2 marks]

Claranet -> RENATER -> Interoute -> GTT	
Claranet -> RENATER -> GTT	
Claranet -> Level3 -> GTT	
Claranet -> RENATER -> Interoute -> RENATER -> GTT	

Question 2.4: For a communication from X to W, what are the paths which respect the agreements between the autonomous systems? (select all correct answers) [2 marks]

IRISA -> RENATER -> Interoute	
IRISA -> RENATER -> Claranet -> Level3 -> GTT -> Interoute	

| IRISA -> RENATER -> GTT -> Interoute | |
| IRISA -> RENATER -> Claranet -> Level3 -> GTT -> RENATER -> Interoute | |

Question 2.5: For a communication from Y to W, what are the paths that respect the agreements between the autonomous systems? (select all correct answers)

Claranet -> RENATER -> Interoute	
Claranet -> Level3 -> GTT -> RENATER -> Interoute	
Claranet -> RENATER -> GTT -> Interoute	
Claranet -> Level3 -> GTT -> Interoute	

QUESTION 3

Suppose every link in the network carries two classes of traffic – telephone calls and e-mail messages, with a separate queue for each class. When deciding which packet to send next, the router first selects the head of the queue containing the voice traffic, and only sends an e-mail packet if the voice queue is empty. Does the e-mail traffic have *any* effect on the performance experienced by the telephone calls? If so, what can be done to minimize the effects?

[4 marks]

QUESTION 4

Suppose that a router has three input flows and one output port. It receives packets continuously as per table below, with all flows beginning at the same time and queues being empty before the arrival of the first packet. Packet order in each separate flow is listed in the table (packets 1, 5 and 7 are the first to arrive). Length represents the number of clock ticks it takes to transmit a packet.

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:

(i)   Fair queuing is used.   [3 marks]

(ii)   Weighted fair queuing is used, with flow 2 having weight 2, and the
        other two with weight 1.   [3 marks]

QUESTION 5

In an ATM Adaptation, what percentage of the total bandwidth do all non-payload   [5 marks]
bits consume when a user transmits a cell?

QUESTION 6

Consider the IP network shown in Figure 1. Routers R1 to R6 belong to a network
using MPLS (R1 to R6 are LSRs). These routers connect networks A, B, C and D.
The topology links, whether internal to the MPLS network or external, have a
capacity of 1 Gb/s.

We are interested in communications to C and D.

We have the following information:
R1 has announced to R2 and R3 that it can route packets but only to network D;
R2 has announced to R4 that it can route packets to C and D;
R3 has announced to R4 that it can route packets to network D;
R4 has announced to R5 and R6 that it can route packets to C and D.

We know the routing tables of routers R1 to R6.

R1 Routing Table		
Dest.	NH	Cost
R1	-	-
R2	R2	10
R3	R3	10
R4	R2	10
R5	R2	10
R6	R2	10
A	R2	10
B	R2	10
C	R2	10
D	D	10
Default	R2	10

R2 Routing Table		
Dest.	NH	Cost
R1	R1	10
R2	-	-
R3	R4	20
R4	R4	10
R5	R4	20
R6	R4	20
A	R4	30
B	R4	30
C	C	10
D	R1	20
Default	R4	10

R3 Routing Table		
Dest.	NH	Cost
R1	R1	10
R2	R4	20
R3	-	-
R4	R4	10
R5	R4	20
R6	R4	20
A	R1	30
B	R4	30
C	R4	30
D	R1	20
Default	R4	10

R4 Routing Table			R5 Routing Table			R6 Routing Table		
Dest.	NH	Cost	Dest.	NH	Cost	Dest.	NH	Cost
R1	R3	20	R1	R4	30	R1	R4	30
R2	R2	10	R2	R4	20	R2	R4	20
R3	R3	10	R3	R4	20	R3	R4	20
R4	-	-	R4	R4	10	R4	R4	10
R5	R5	10	R5	-	-	R5	R4	20
R6	R6	10	R6	R4	20	R6	-	-
A	R6	20	A	R4	20	A	A	10
B	R5	20	B	B	10	B	R4	30
C	R2	20	C	R4	30	C	R4	30
D	R3	20	D	R4	40	D	R4	40
Default	R2	10	Default	R4	10	Default	R4	10

We have several information on the labels used:

R4 switching table:

(FEC)	Label IN	Label OUT	Next Hop
(FEC A)	6	1	R6
(FEC B)	2	5	R5
(FEC C)	7	8	R2
(FEC D)	3	10	R3

Hypotheses : It is sought to minimize the number of labels used and to group streams having the same FEC as much as possible by assigning them the same label when possible.
    The edge LSRs do the POPs.
    The packets destined for A received by R2 carry a label equal to 12.
    The packets destined for B received by R2 carry a label equal to 5.
    The packets destined for C received by R2 carry a label equal to 8.
   The packets destined for D received by R2 carry a label equal to 10.
    When R1 receives a packet with an MPLS label equal to 6, it is bound for D.

Complete the commutation table of R6.   [12 marks]

QUESTION 7

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 the graph shown below to answer the following questions. Note that the graph does not explicitly show timeouts, but you should be able to figure out when timeouts happened based on the events shown.
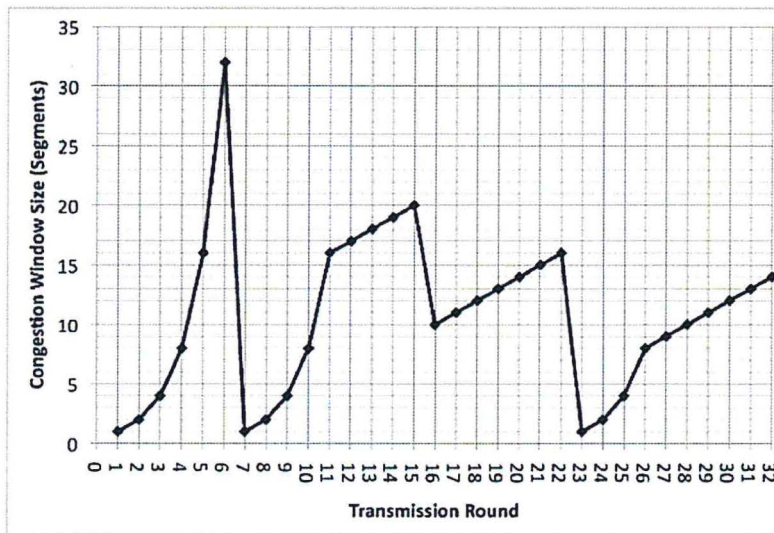
a) *Give two reasons why slow start is used, and explain why it does a better job than congestion avoidance for that function.* [2 marks]

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]

[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.*

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]

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f) *Identify the interval(s) of time when fast recovery could have happened,* [2 marks]
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?*

QUESTION 8

Suppose you are designing a sliding window protocol for a 1 Mbps p-to-p link to
the moon, which has a one-way latency of 1.25 seconds. Assuming that each frame [2 marks]
carries 1 KB of data.

a) *Find the window size of the protocol based on the bandwidth-delay* [2 marks]
product.

b) *What is the minimum number of bits you need for the sequence*
number field?

QUESTION 9

Explain the main difference between an ADSL and VDSL used for broadband [4 marks]
communication. Which of these two technologies give better performance in terms
of speed?

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