National University of Computer & Emerging Sciences, Islamabad, Pakistan

Name: _____ Roll No: _____

EE-311 Data Communication & Networks

Summer 2007

Solution Final

Thursday, 2nd August 2007

Total Time: 3 Hours
Total Marks: 100

Course Instructor: Engr. Waleed Ejaz

You are advised to READ these notes:

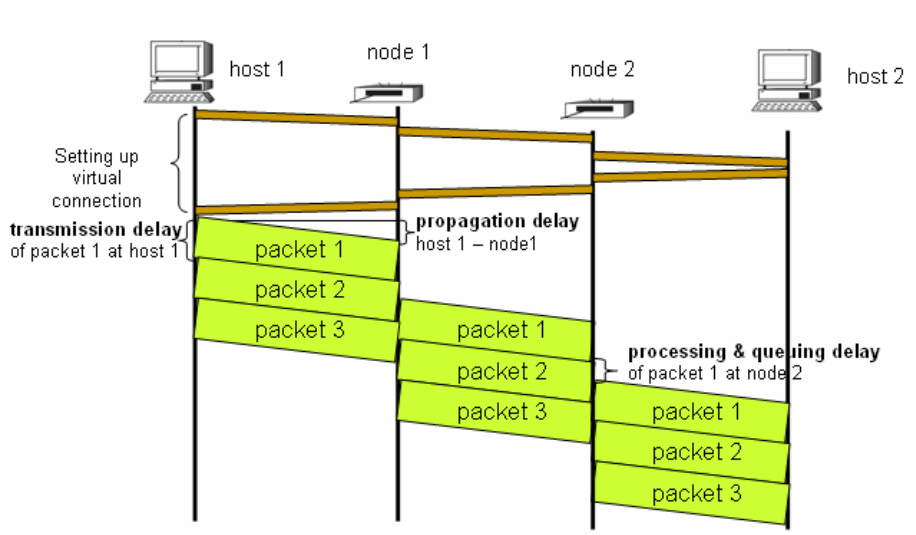
1. Make sure that you have 20 pages and 10 questions.
2. The marks for each sub part of question are written in brackets [ ]
3. Exam is closed books, closed notes. Please see that the area in your threshold is clean. You will be charged for any material which can be classified as 'helping in the paper' found near you.
4. Calculator sharing is strictly prohibited.
5. The invigilator present is not supposed to answer any questions. If you have any queries please wait for the appropriate person who may visit your exam room once in the initial half an hour or so.
6. If there is any missing parameter, write down your assumption and continue.
7. Write all the answers in the allocated space.

Question Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Marks	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**100**
Marks Obtained											

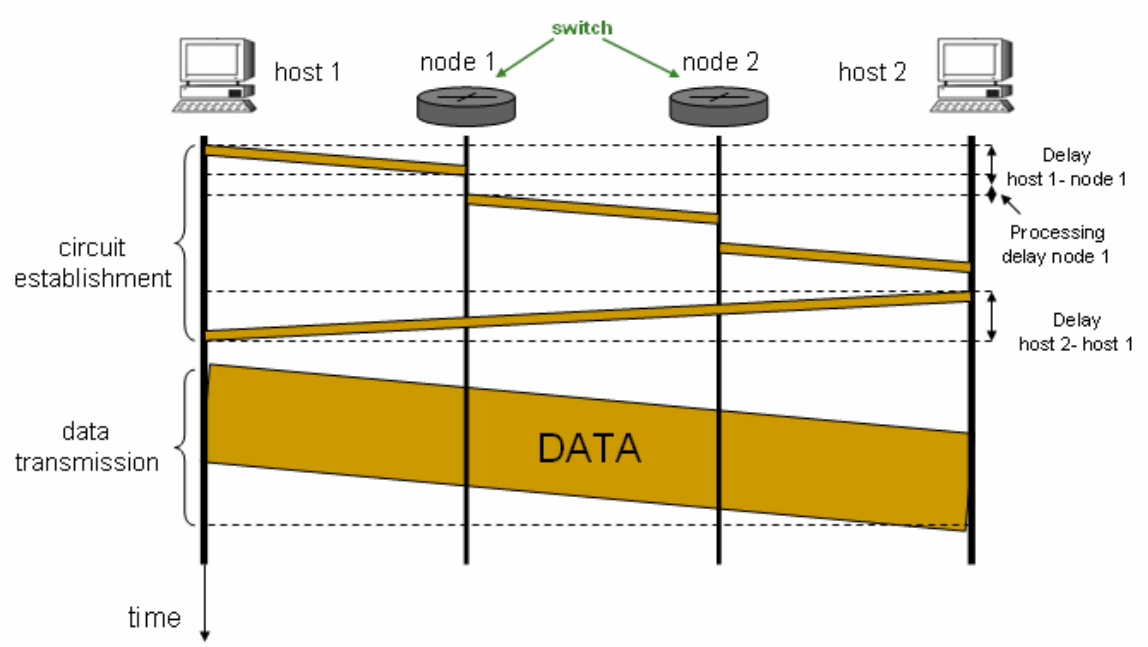
Question 1 [6+4]

Draw timing diagram for Virtual circuit switching, Circuit switching and Datagram Network (Connection less Packet Switching) for the following network. Assume three packets flow from source to destination and there are two intermediate nodes.

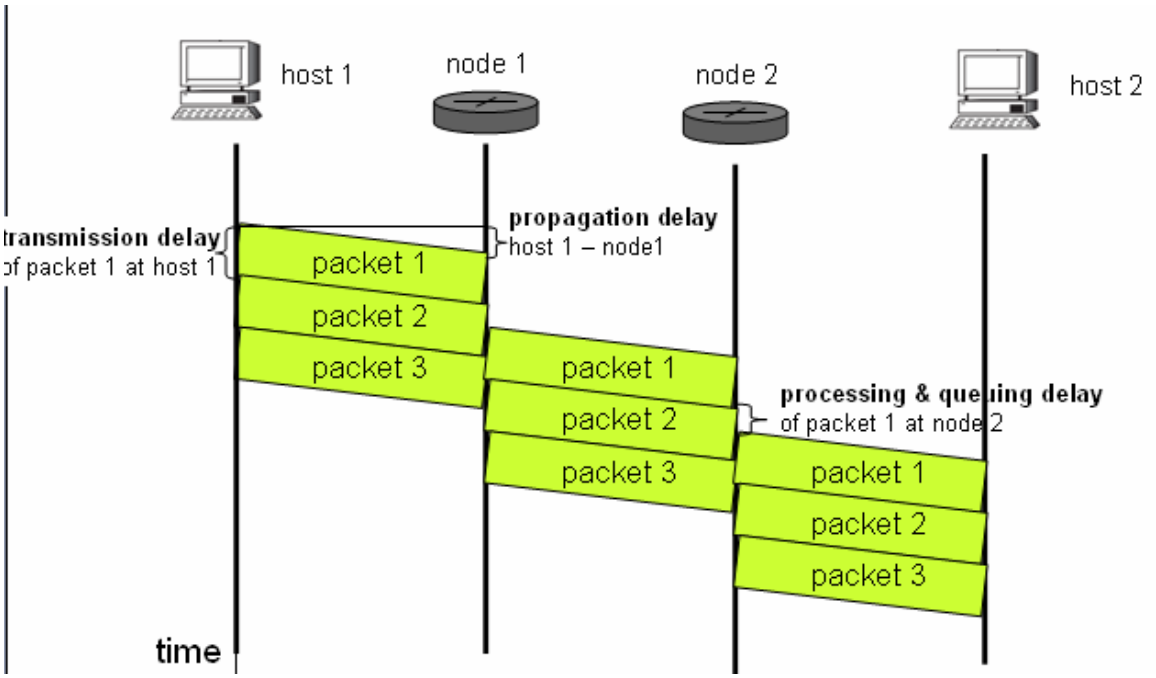
Virtual Circuit Switching:



Circuit Switching:

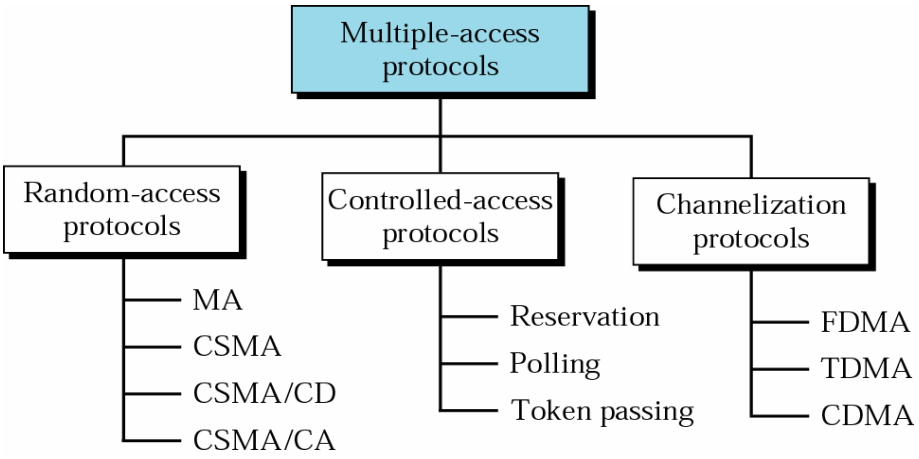


Datagram Network (Connectionless Packet Switching):



PART B

List three categories of multiple access protocols and also list at least three protocols in each category.



Question 2 [4+3+3]

PART A

A cable company uses one of the cable TV channels (with a bandwidth of 6MHz) to provide digital communication for each resident. What is the available data rate for each resident if company uses a 128-QAM technique?

Solution:

Bit Rate=2 X Bandwidth X $\log_2 L$

=2 X 6 X10^6X $\log_2$ 128

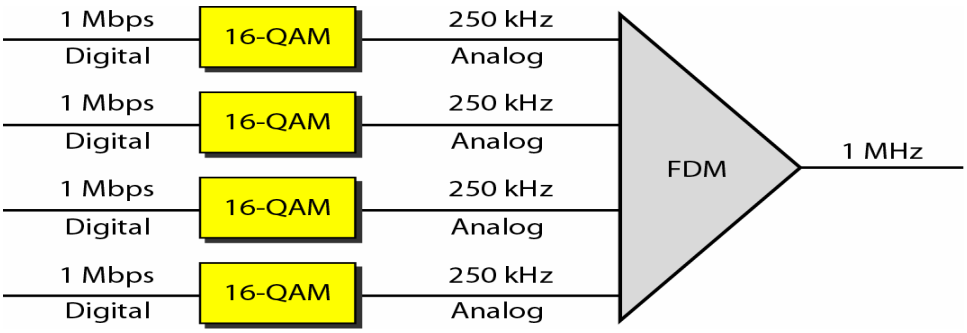
=84 X10^6 bps

PART B

Four data channels (digital), each transmitting at 1 Mbps, use a satellite channel of 1 MHz. Design an appropriate configuration, using FDM.

Solution:

The satellite channel is analog. We divide it into four channels, each channel having a 250-kHz bandwidth. Each digital channel of 1 Mbps is modulated such that each 4 bits is modulated to 1 Hz. One solution is 16-QAM modulation.



PART C

Given a 10 bit sequence 1010011110 and a divisor of 1011, find CRC. Check your answer.

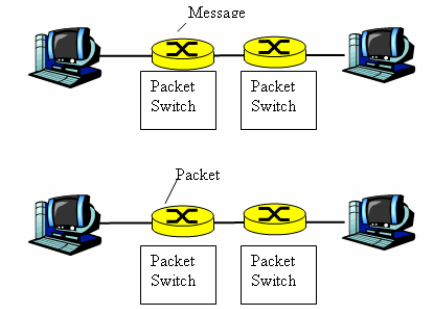
Solution:

001

Question 3 [7+3]

PART A

In modern packet-switched networks, the source host segment long, application layer messages (for example, an image or a music file) into smaller packets and sends the packet into the network. The receiver then reassembles the packets back into the original message. We refer to this process as message segmentation. Figure below illustrates the end-to-end transport of a message with and without message segmentation. Consider a message that is 7.5 $X10^6$ bits long that is to be sent from source to destination in figure below. Suppose each link in the figure is 1.5Mbps. Ignore propagation, queuing and processing delays?



a. Consider sending the message from source to destination without message segmentation. How long does it take to move the message from source host to first packet switch? Keeping in mind that each uses store-and-forward packet switching, what is the total time to move the message from source host to destination host?

b. Now suppose that the message segmented into 5,000 packets, with each packet being 1,500 bits long. How long does it take to move the first packet from source host to first switch? When the first packet is being sent from the first switch to the second switch, the second packet is being sent from the source host to the second switch. At what time will the second packet fully received at the first switch?

c. How long does it take to move the file from source host to destination host when message segmentation is used? Compare this result with your answer in part (a) and comment.

a) time taken to send message from source host to first packet switch = $\frac{7.5\times10^6}{1.5\times10^6}\text{sec} = 5\,\text{sec}$. With store-and-forward switching, the total time to move message from source host to destination host = $5\,\text{sec}\times 3\ hops = 15\,\text{sec}$

b) time taken to send 1st packet from source host to first packet switch = . $\frac{1.5\times10^3}{1.5\times10^6}\text{sec} = 1\ m\,\text{sec}$. Time at which 2nd packet is received at the first switch = time at which 1st packet is received at the second switch = $2\times1\ m\,\text{sec} = 2\ m\,\text{sec}$

c) time at which 1st packet is received at the destination host = . $1\ m\,\text{sec}\times 3\ hops = 3\ m\,\text{sec}$. After this, every 1msec one packet will be received, thus time at which last (5000th) packet is received = $3\ m\,\text{sec} + 4999 * 1m\,\text{sec} = 5.002\,\text{sec}$. It can be seen that delay in using message segmentation is significantly less (almost 1/3rd).

PART B

What is the capacity of a 4 KHz QAM-8 channel with SNR of 30dB?

Solution:

$C=B\ X\ \log_2 L$

Question 4 [3+1+2+4]

PART A

Suppose a router receives an IP packet containing 600 bytes and has to forward the packet to a network with maximum transmission unit of 200 bytes. Assume that the IP header is 20 byte long. Show the fragments that router creates and specify the values in fragment header. Use the pattern shown below.

Solution:

	Total length	**ID**	**MF**	**Fragment Offset**
Original Packet	600	X	0	0
Fragment 1	196	X	1	0
Fragment 2	196	X	1	22
Fragment 3	196	X	1	44
Fragment 4	92	x	0	66

PART B

How many fragments will constitute the packet when a router tries to transmit an IP packet with 20 bytes IP header and 512 bytes IP payload over a link having 256 MTU?

Solution:

3 Fragments

PART C

A host has an IP address of 150.32.64.34 and a subnet mask 255.255.240.0. What is the address of this subnet? What is the range of IP addresses that a host can have on this subnet?

Solution:

Subnet Address: 150.30.64.34
Range of IP addresses: 150.30.64.0 to 150.30.79.255

PART D

A university has 100 LANs with 200 hosts in each LAN. Suppose the university has one class B address.

(i) Design an appropriate subnet addressing scheme.
(ii) Design an appropriate CIDR addressing scheme.

Solution:

(i) Let we have class B address 128.29.0.0
Now as we require 200 hosts so we need 8 bits for HostID.
So Subnet mask is 255.255.255.0

(ii) we need a class less address like 128.29.0.0/17

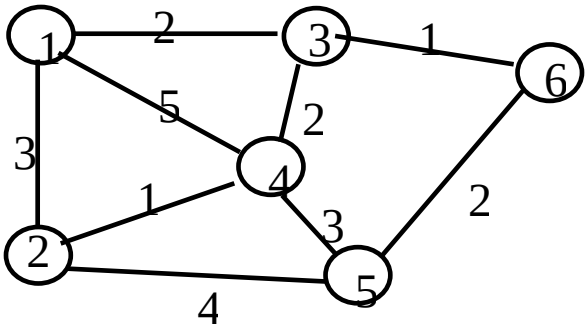
Question 5 [4+2+2+2]

PART A

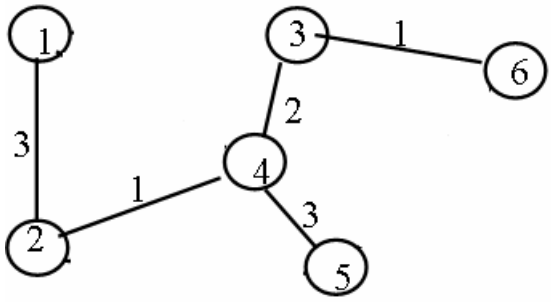
For a network shown in Figure below:

(i) Use the Dijkstra's algorithm to find the set of shortest path from node 2 to other nodes.

Iteration	**N**	D1	D3	D4	D5	D6
Initial	{2}	3	∝	1	4	∝
1	{2,4}	3	3	**1**	4	∝
2	{1,2,4}	**3**	3	**1**	4	∝
3	{1,2,3,4}	**3**	**3**	**1**	4	4
4	{1,2,3,4,5}	**3**	**3**	**1**	**4**	4
5	{1,2,3,4,5,6}	**3**	**3**	**1**	**4**	**4**



(ii) Draw the corresponding shortest path tree for node 2.



(iii) Find set of associated routing table entries at node 2.

Destination	Next Hop	Cost
1	1	3
3	4	3
4	4	1
5	4	4
6	4	4

PART B

Why is an ARP request broadcast? Why is an ARP reply Unicast?

Solution:

An ARP request is broadcast because sender does not know the physical address of the receiver.
An ARP reply is Unicast because sender does know the physical address of the receiver.

Question 6 [4+1+5]

PART A

Suppose a router has built up the routing table shown in the table below:

Subnet Number	Subnet Mask	Next Hop
128.96.39.0	255.255.255.128	Interface 0
128.96.39.128	255.255.255.128	Interface 1
128.96.40.0	255.255.255.128	R2
192.4.153.0	255.255.255.192	R3
Default		R4

The router can deliver packets directly over interfaces 0 and 1 or it can forward packets to routers R2, R3, R4. Describe what the router does with a packet address to each of the following destinations:

(i) 128.96.39.10
(ii) 128.96.40.12
(iii) 128.96.10.151
(iv) 192.4.153.17

PART B

When the time-to-live (TTL) field reaches zero, a time exceeds message notifies a source host about this. Which protocol is used to convey this message to the source host?

Solution:

ICMP

PART C

Consider the forwarding tables as shown below for nodes A and F in a network where all links have cost 1. Give a diagram of the smallest network consistent with these tables.

Node A				Node F		
Node	**Cost**	**Next Hop**		**Node**	**Cost**	**Next Hop**
B	1	B		A	3	E
C	2	B		B	2	C
D	1	D		C	1	C
E	2	B		D	2	E
F	3	D		E	1	E

Question 7 [2+5+2+1]

PART A

Following the OSI reference model (and the terminology used in the course), where would you place each of the following communication devices: Repeater, Bridge, Router, and Application Gateway?

Solution:

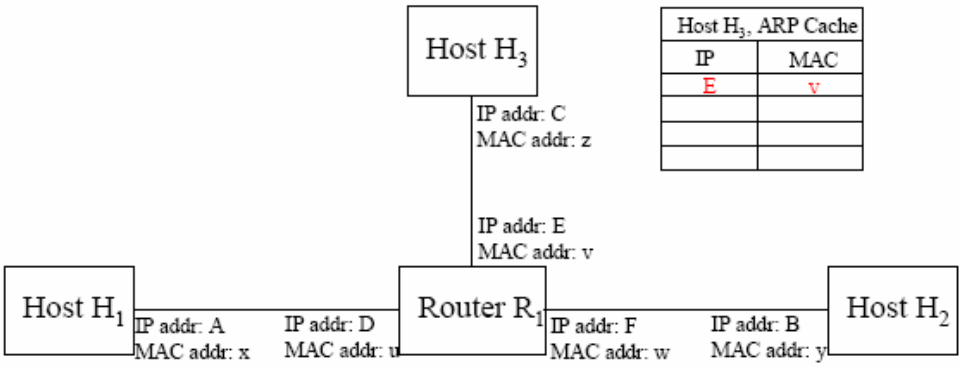
Repeater: L1, Bridge: L2, Router: L3, Application Gateway: L4-L7

PART B

The figure below illustrates three hosts H1, H2 and H3 running IPv4 over a routed network, connected by router R1. The IP and MAC addresses of the hosts and the router's interfaces are given in the figure. The ARP cache of each host and the router are shown. Assume the ARP caches are initially empty, and that no packets have been sent yet. Now, host H1 wants to send an IPv4 Unicast datagram to host H3.

Fill in the state of the four ARP caches as they will appear after the IPv4 Unicast datagram has been delivered to host H3, that is, after dynamic ARP resolution has been made.

Solution:



Host H_3, ARP Cache

IP	MAC
E	v

Host H_1, ARP Cache

IP	MAC
D	u

Router R_1, ARP Cache

IP	MAC
A	x
C	z

Host H_2, ARP Cache

IP	MAC

PART C

Which fields of the IP header change when a packet passes through a router? Assume that there are no IP options and that no fragmentation occurs.

Solution:

TTL (Time To Live) field: it is decremented by one.

Header Checksum field: it has to be recalculated when the TTL is decremented

PART D

Why is there need for a header length field in the IP header?

Solution:

The IP header may be of variable size since there may be options included in the header.

Question 8 [3+4+3]

PART A

Suppose client A initiates an HTTP session with the server S. At about the same time, client B initiates an HTTP session with the server S. Provide possible source and destination port numbers for:

(i) The Segments from A to S
(ii) The Segments from B to S
(iii) The Segments from S to A
(iv) The Segments from S to B
(v) If A and B are different hosts, is it possible that the source port number in the segments from A to S is the same as that from B to S?
(vi) How about if they are the same host?

Solution:

	source port numbers	destination port numbers
a) A→S	467	23
b) B→S	513	23
c) S→A	23	467
d) S→B	23	513

e) Yes.
f) No.

PART B

In a leaky bucket, what should be the capacity of the bucket if the output rate is 5 gal/min, and there is an input burst of 100 gal/min for 12 s and there is no input for 48 s?

Solution:

20 gallons

PART C

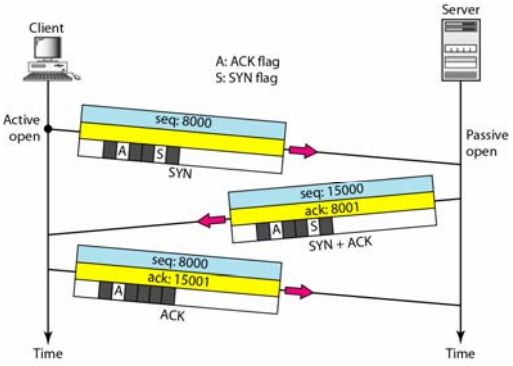
A TCP connection establishment phase involves exchange of messages between application processes on two hosts A and B. During this connection set up procedure, hosts negotiate to create and initialize several variables/parameters for managing the connection. These variables are stored in a record associated with the connection.

(i) What is the name of the procedure for connection establishment?

Solution:

Three way Handshaking

(ii) Sketch the sequence of message exchange for the connection establishment procedure between host A and B. Name the messages exchange along with corresponding SEQ and ACK numbers.

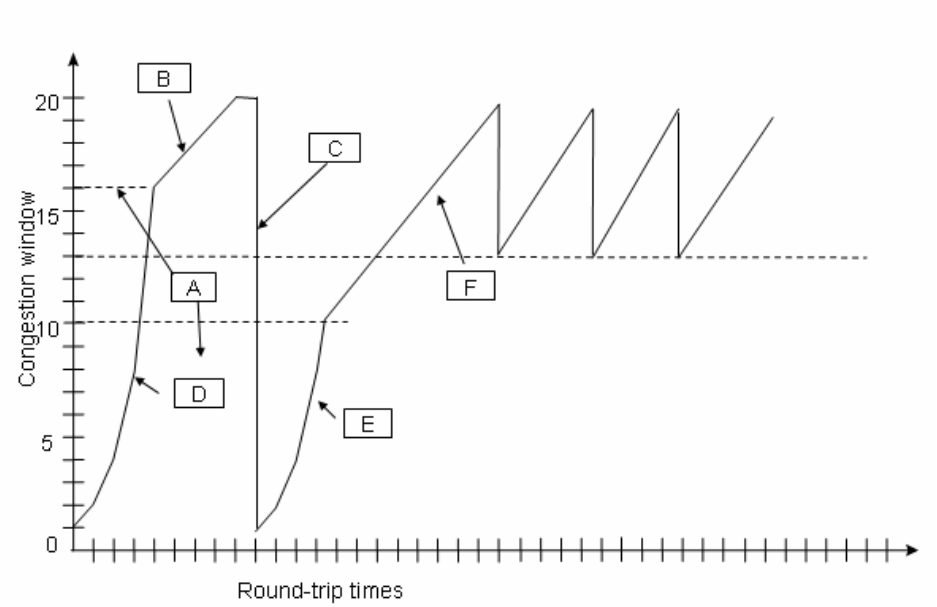


Question 9 **[3+3+4]**

PART A
Consider an email message being sent from a host to another host on the Internet. What transport and application protocols could be required in this message delivery?
Solution:

Application Layer Protocols: HTTP, SMTP, POP3
Transport Layer protocols: TCP

PART B
Consider the TCP trace shown in the Figure below which depicts the congestion control behavior.



Identify various congestion related situations and associated mechanism/parameters in the Figure as indicated by the labels A to F.
Solution:
A: Threshold
B: Additive Increase
C: Time out
D: Slow Start
E: Slow Start
F: Additive Increase

PART C
Suppose Bilal, with a Web-based e-mail account (such as Hotmail), sends a message to Afan, who accesses his mail from his mail server using POP3. Discuss how the message gets from Bilal's host to Afan's host. Be sure to list the series of application-layer protocols that are used to move the message between the hosts.
Solution:
Message is sent from Bilal's host to his mail server over HTTP. Bilal's mail server then sends the message to Afan's mail server over SMTP. Afan then transfers the message from his mail server to his host over POP3.

Question 10 [2+2+2+2+2]

PART A
What is difference between open-loop congestion control and closed-loop congestion control?
Solution:
Open loop congestion control policies try to prevent congestion.
Closed loop congestion control policies try to alleviate the effects of congestion.

PART B
Why do OSPF message propagate faster than RIP messages?
Solution:
OSPF messages are propagated immediately because a router using OSPF will immediately flood the network with news of any changes to its neighborhood. RIP messages are distributed slowly because a network using RIP relies on the periodic updates that occur every 30 seconds to carry any news from one router to the next and to the next.

PART C
List three transition strategies to move from IPv4 to IPv6.
Solution:
Dual Stack
Tunneling
Header Translation

PART D
What is NAT? How can NAT help in address depletion?
Solution:
Home users and small businesses may have created small networks with several hosts and need an IP address for each host. With the shortage of addresses, this is a serious problem. A quick solution to this problem is called network address translation (NAT). NAT enables a user to have a large set of addresses internally and one address, or a small set of addresses, externally. The traffic inside can use the large set; the traffic outside, the small set.

PART E
What is an autonomous system and which protocol is used for inter autonomous communication?
Solution:
Autonomous system (AS) or domain is a set of routers or networks administered by a single organization. BGP is used for inter autonomous communication.