

Data Communication & Networks

Spring 2008 Semester

Roll Number _____

Name _____

Section _____ Signature: _____

FINAL

Tuesday, 20th May 2008

Total Time: 180 Minutes

Total Marks: 100

Signature of Invigilator

Course Instructors:

Engr. Shahid Qurashi, Engr. Waleed Ejaz

Q	1	2	3	4	5	6	7	8	9	10	11	Total	Bonus
Marks	Zero	13	13	10	6	13	12	16	10	7	Zero	100	5
Obtained Marks	Zero										Zero		
Suggested Time	20 min	23 min	17 min	14 min	10 min	16 min	20 min	18 min	15 min	7 min	20 min	180 min	

You are advised to READ these notes:

1. Attempt the paper on the question paper. **NO EXTRA SHEETS** will be provided. Use the back of the page if more space is required. However, no extra sheet will be checked.
2. After asked to commence the exam, please verify that you have **twenty two (22) different printed pages** including this title page.
3. There are **11 questions**. Attempt all of them. It is advisable to go through the paper once before starting with the first question.
4. All questions don't carry **equal marks**. Marks for subparts are indicated.
5. **Suggested time** for each question is also indicated but this is not hard and fast, it's just for your convenience.
6. If part of a problem depends on a previous part that you are unable to solve, explain the method for doing the current part, and, if possible, give the answer in terms of the quantities of the previous part that you are unable to obtain.
7. 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.
8. Calculator sharing is strictly prohibited.
9. Students who attempt the paper with **lead pencils** lose the right to get them rechecked.
10. The invigilator present is not supposed to answer any questions. No one may come to your room for corrections and you are not supposed to request to call anyone. Make assumptions wherever required and clearly mark them.

Question 1 [0] [Suggested Time: 20 min]

Take a look at whole paper.

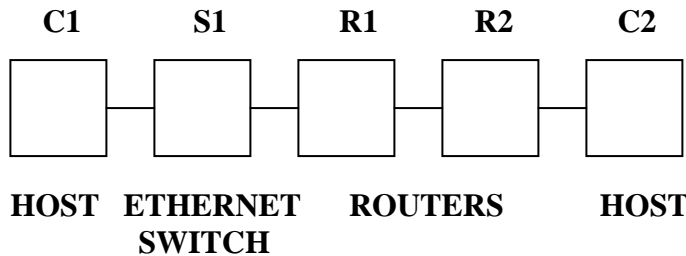
Question 2 [2+2.5+8.5] [Suggested Time: 23 min]

- a. Following are 10 functions. Identify which layer of the TCP/IP model each function is most likely to belong to. It is possible that one or more of the below cannot be mapped to a TCP/IP layer. If this is the case, explain why.

Write ‘A’ for Application Layer, ‘P’ , ‘T’ for transport Layer, ‘N’ for Network Layer, ‘D’ for Data Link Layer, ‘P’ for Physical layer and ‘NONE’ if not mapped on OSI layer model.

Functionality	Layer
i. Recovering lost packets between two directly connected nodes	
ii. Recovering lost packets between two nodes separated by multiple hops	
iii. Defining the pin-outs in a connector used to attach to a network cable	
iv. Providing an interface to a visual packet monitoring program	
v. Arbitrating between multiple nodes attached to a single medium	
vi. Finding the shortest path between two nodes separated by multiple hops	
vii. Defining frequency of operation for WLAN.	
viii. Defining the size of MTU.	

- b. Highlight the correct layers traversed by a packet from C1 to C2 in a connection in the following setting.



C1 ,C2 -> Hosts
S1 -> Ethernet switch
R1,R2 -> Routers

A	A	A	A	A
T	T	T	T	T
N	N	N	N	N
D	D	D	D	D
P	P	P	P	P

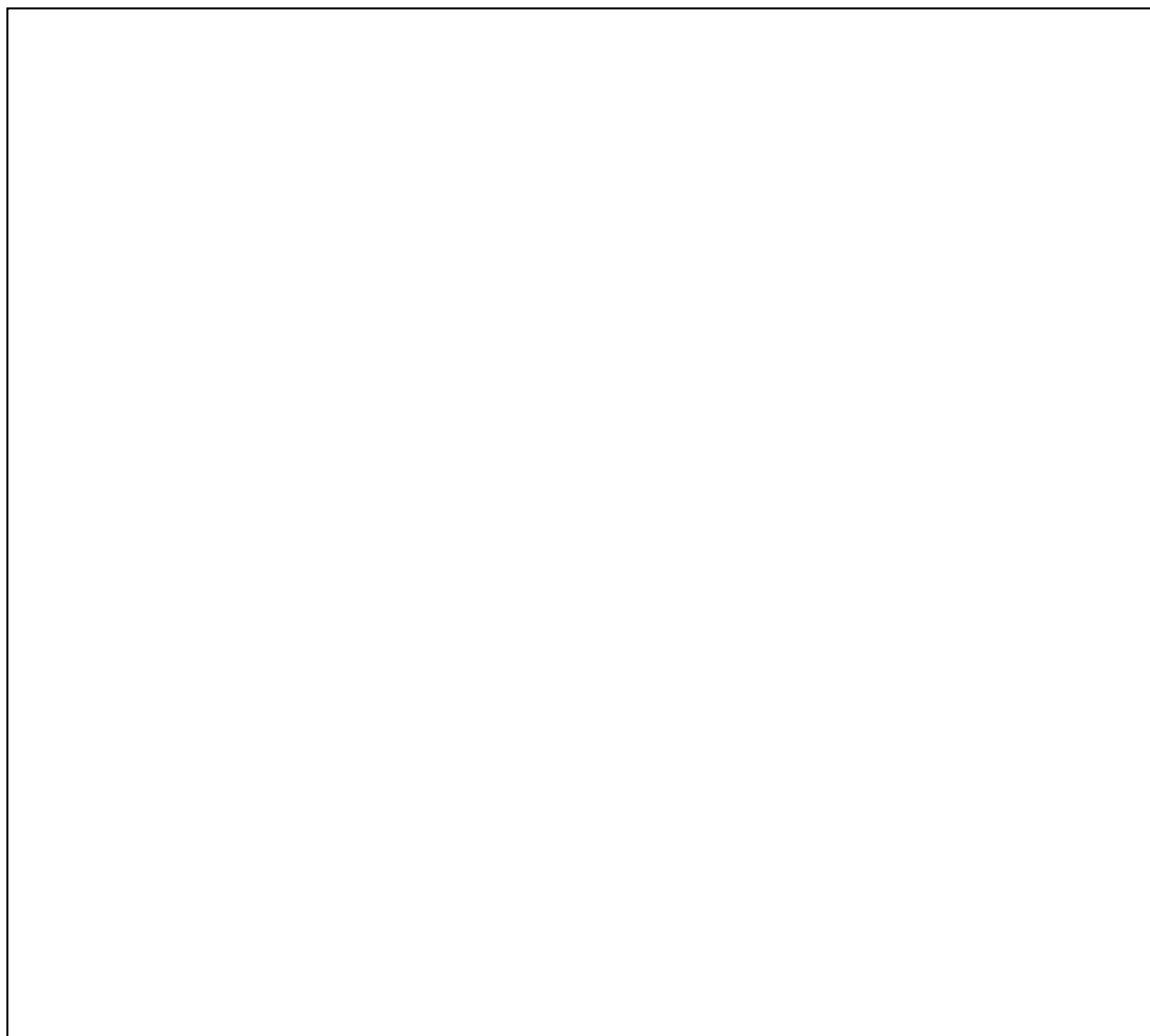
- c. We want to transfer a file of size d bytes. Each link has bandwidth b bits/sec and fixed propagation delay f sec. All routers on the path are store-and-forward. We use packets of total size P bytes, of which h bytes are occupied by headers. We always pad the last packet so that it is full. There is no set-up time for the transfer. Packets are sent continuously and are not lost. There is no queuing delay or processing overhead, and we ignore acknowledgments sent back by the receiver.

- i. How many data packets are sent?

- ii. What is the delay (from when the sender starts transmitting until when the receiver has received everything) to transfer the file across one link?

- iii. What is the delay for one packet to arrive at a destination that is n links away?

- iv. What is the delay to transfer the entire file across n links?

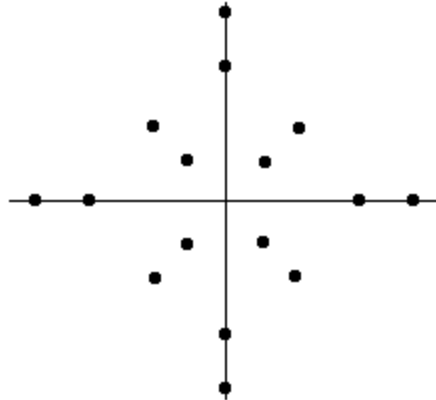


Question 3

[4+4.5+4.5]

[Suggested Time: 17min]

- a. Given the following constellation for a 9600 bps modem



- i. How many bits are encoded on every signal element?

- ii. What is the baud rate?

- iii. How many:

Phases are present

Amplitudes are present?

b. Given a channel that can pass signals with frequencies ranging between 5000 and 10000 Hz

- i. What is the maximum theoretical data rate for this channel if the signal transmitted over this channel has 32 levels?

- ii. What is the maximum data rate for this channel if the channel has a signal to noise ratio of 20 DB?

- iii. What is the actual data rate for this channel if a 2400 Baud signal with four states is sent?

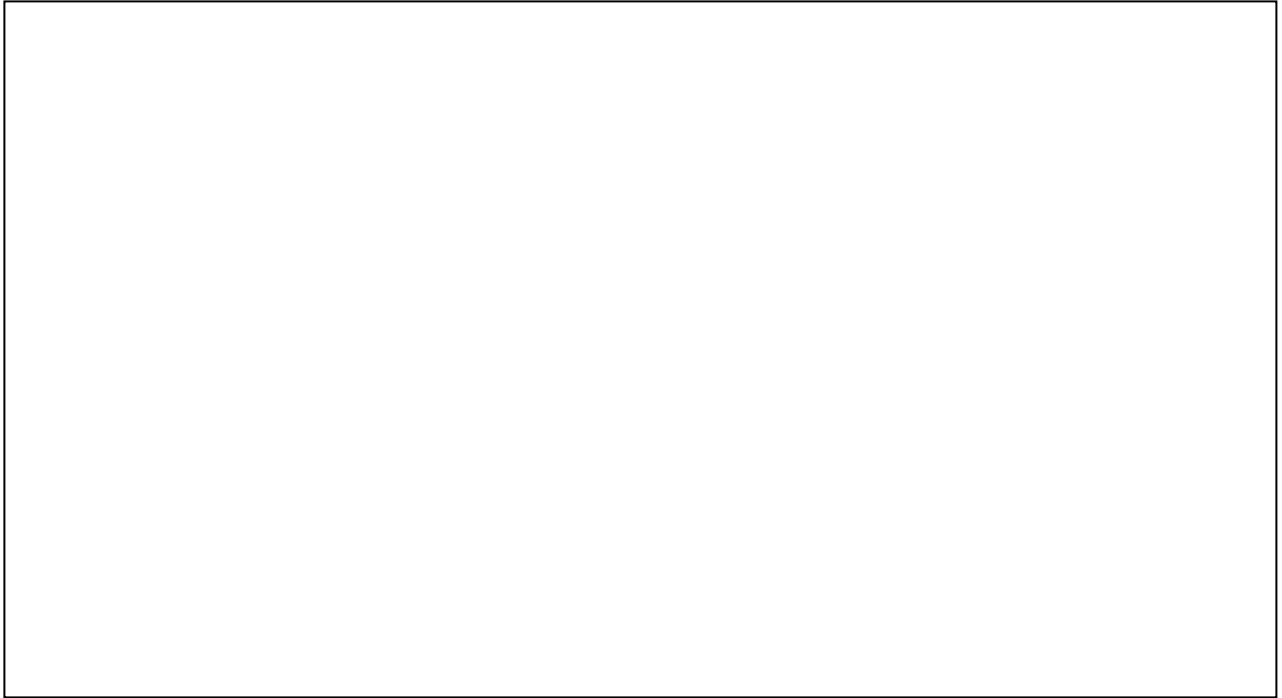
c. Assuming that the physical layer encodes 'low' as the absence of an electrical signal and 'high' as the presence of an electrical signal, for which of the following encodings:

- i. NRZ (Non-Return to Zero)
- ii. NRZI (Non-Return to Zero Inverted)
- iii. Manchester

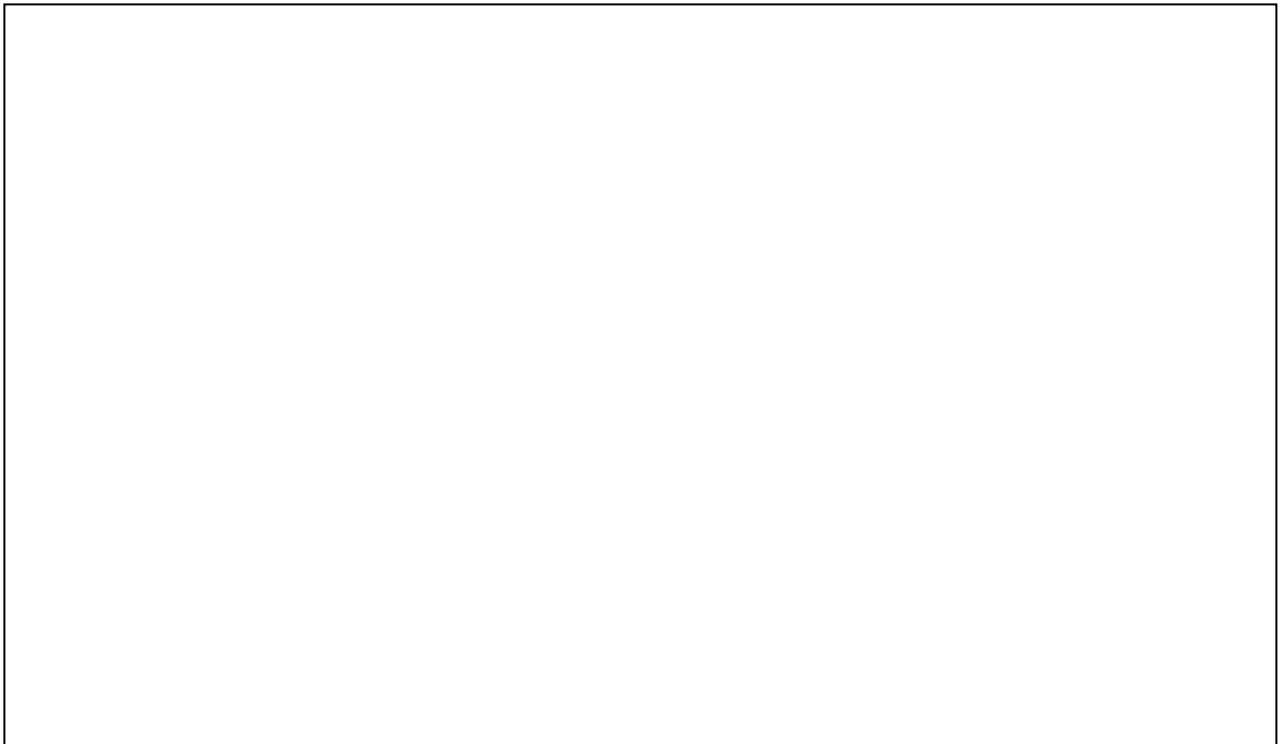
might the Ethernet controller have difficulty determining the end of the frame, and under what circumstances? Why not for the others? [You must give an example for each case]

Question 4**[2+2+3+3]****[Suggested Time: 14 min]**

- a. Compute the checksum for the following data bits:
11010100 11001001 11011001 00001001
Assume an 8 bit checksum is being used.



- b. If bits 6 and 14 (counting from the left) arrived in error, what would be the reaction at the receiver?

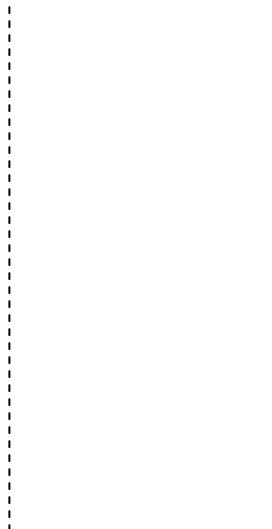


- c. Network protocols typically generate checksums or Cyclic Redundancy Checks (CRCs) for each packet sent, which are then used by the receiver to detect if the packet has been corrupted in transit. For example, if you download an audio to your laptop from a website, each packet will include an Ethernet CRC, an IP header checksum, and a TCP data checksum; and the entire content of the audio file will include an application-layer checksum. Instead of maintaining checks at each layer, suppose we build a network where data integrity is only validated at the lowest layer (e.g., Data Link layer) or only at the highest layer (e.g., Application layer).

- i. What problem arises if we can only do error-checking at the lowest layer?

- ii. What about if we can only do error-checking at the highest layer?

- d. The timer of a system using the Stop-and-Wait ARQ Protocol has a time-out of 2 ms. Draw the flow graph for four frames if the round trip delays is 4ms. Assume no data frame or control frame is lost or damaged.

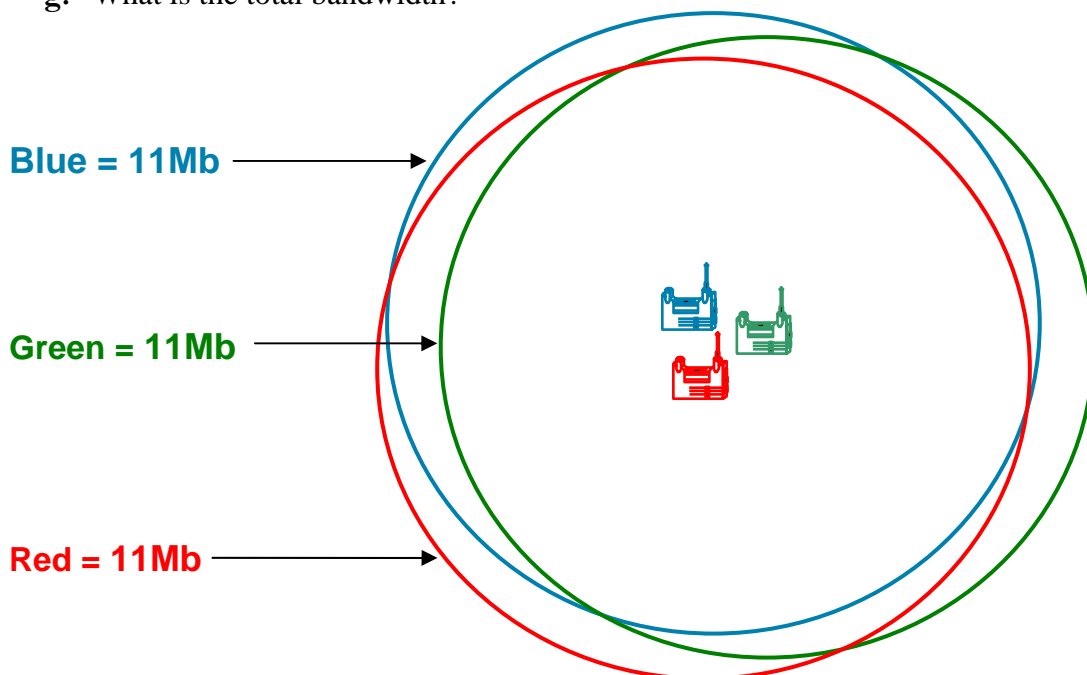


Question 5

[0.5+0.5+0.5+0.5+1+1+2]

[Suggested Time: 10min]

- a. Which RF frequency band used in WLANs?
- b. What is the IEEE standard for WLANs?
- c. What networking medium is used for WLAN technologies?
- d. What is maximum data rate standard for IEEE 802.11b WLANs?
- e. What is the most basic type of IEEE 802.11 LAN that can operate without AP?
- f. What is defined as two or more Basic Service Sets (BSSs) connected by a common distribution system?
- g. What is the total bandwidth?



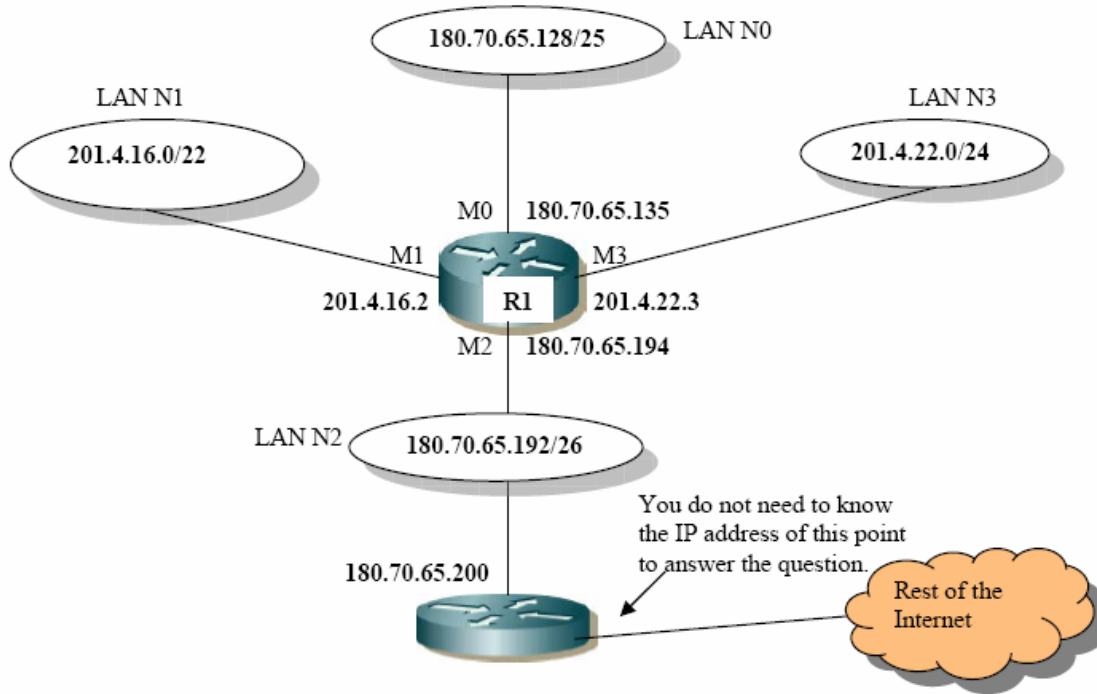
Question 6**[1+3+3+6]****[Suggested Time: 16 min]**

- a. A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts it can handle?

- b. A router has just received the following new IP addresses: 57.6.96.0/21, 57.6.104.0/21, 57.6.112.0/21, and 57.6.120.0/21. If all of them use the same outgoing line, can they be aggregated? If so, to what? If not, why not?

- c. The configuration of a network consisting of four LANs – N0 through N3 – and two routers has been shown in the following diagram. All the four networks have been represented in the *Address/Prefix-length* notation. The four end-points of router R1 have been denoted by M0 through M3. The IP addresses of the two routers can be found next to their interfaces.

Make a routing table for router R1.

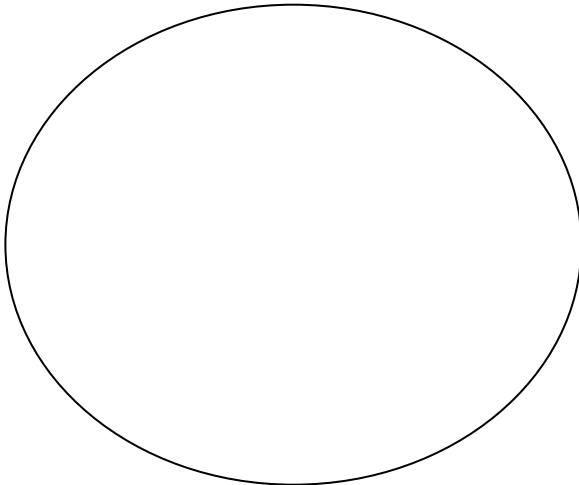


d. HEC (Higher Education Commission) has asked all universities of public and private sector to build their network infrastructure in such a way that may facilitates the students, faculty and researchers of one institute to gain benefit from other institutes. HEC has also decided to give online access to 5000 journals and has setup a digital library to facilitate the community. HEC has recruited few fresh students from NU-FAST Islamabad to design the infrastructure, plan for the fulfillment of connectivity for country wide intra network of public and private universities. Now you have to design the network for NU-FAST, NUST and UET-Taxila. The details are as follows

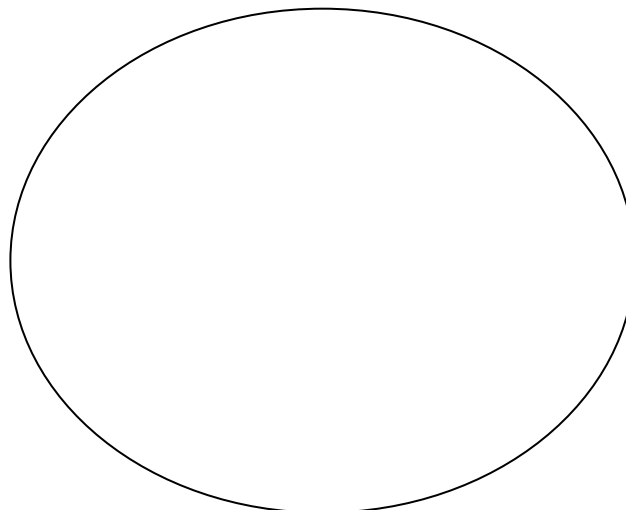
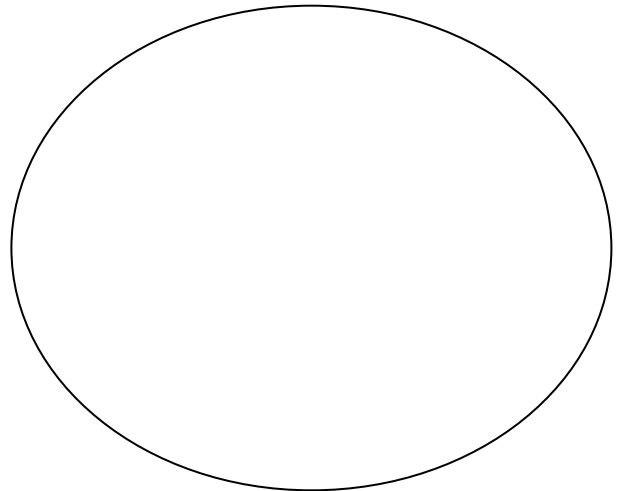
- NU-FAST network consists of 4 routers. The cost for each link is 1
- NUST network consists of 6 routers. Assign arbitrary cost to the links other than the 1
- UET-Taxila consists of 5 routers. The cost for each link is 1.

You should show the interconnections among the routers and the routing protocol running on each router.

NU-FAST



NUST



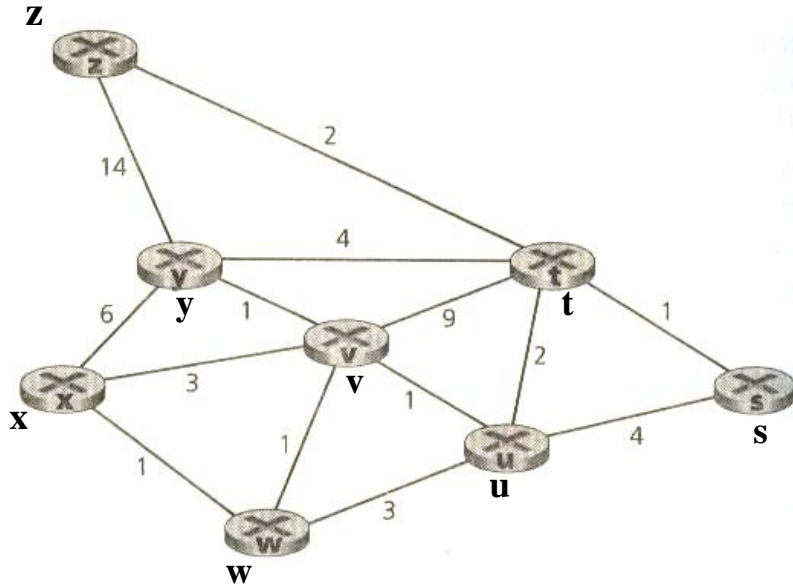
UET-Taxila

Question 7

[7+4+1]

[Suggested Time: 20 min]

- a. For the network given in the following diagram, show how the link-state algorithm builds the routing table for node **x**. Use the table given below



Iteration	s	t	u	v	w	y	z
Initial							
1							
2							
3							
4							
5							
6							
7							
8							

- b. Suppose the fragments shown below all pass through another router onto a link with an MTU of 380 bytes, not counting the link header. Show the fragments produced.

Start of header			
Ident = x		1	Offset = 0
Rest of header			
512 data bytes			

Start of header			
Ident = x		1	Offset = 64
Rest of header			
512 data bytes			

Start of header			
Ident = x		0	Offset = 128
Rest of header			
376 data bytes			

<i>more fragment bit</i>	Offset	Number of Data bytes carried

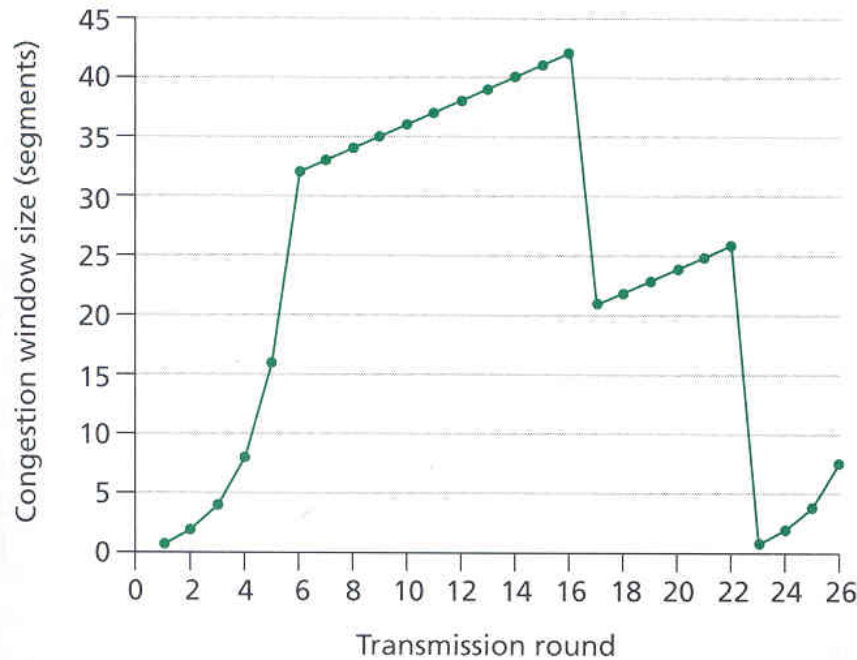
- c. If the packet were originally fragmented for this MTU (380 bytes), how many fragments would be produced?

Question 8

[9+1+1+2+1+2]

[Suggested Time: 18 min]

- a. Consider the following plot of TCP window size as a function of time. (reproduced below for you)



Assuming TCP Reno is the protocol experiencing the behavior shown above, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

- i. Identify the intervals of time when TCP slow start is operating.
- ii. Identify the intervals of time when TCP congestion avoidance is operating
- iii. After the 16th transmission round, is segment loss detected by a tripleduplicate ACK or by a timeout?

- iv. After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?

 - v. What is the initial value of Threshold at the first transmission round?

 - vi. What is the value of Threshold at the 18th transmission round?

 - vii. What is the value of Threshold at the 24th transmission round?

 - viii. During what transmission round is the 70th segment sent?
- b. A process on host 1 has been assigned port p, and a process on host 2 has been assigned port q. Is it possible for there to be two or more TCP connections between these two ports at the same time?

- c. Which protocol provides an appropriate transport service for an application that has tight timing constraints but can tolerate losses?
- d. TCP header contains a number of fields that include: source port number, destination port number, acknowledgment number, and sequence number, receive window, checksum, flags (SYN, FIN, RESET, PUSH, URG, ACK), etc. Identify the fields corresponding to the following TCP protocol mechanisms/functions;
- i. error detection
 - ii. application process identification
 - iii. reliable data transfer
 - iv. flow control
- e. Host A sends two segments back to back to host B over a TCP connection. The first segment has sequence number 50,000; the second segment has sequence number 50,512.
- i. How much data is in the first segment?
 - ii. If the first segment is lost but the second segment arrives at B. In the acknowledgement that host B sends to host A, what will be the acknowledgement number?
- f. Consider an HTTP client that wants to retrieve a Web document at a given URL. The IP address of the HTTP server is initially unknown. The Web document at the URL has one embedded JPEG image that resides at the same server as the original document. What transport and application protocols besides HTTP are needed in this scenario?

Question 9

[2+2+2+2+2]

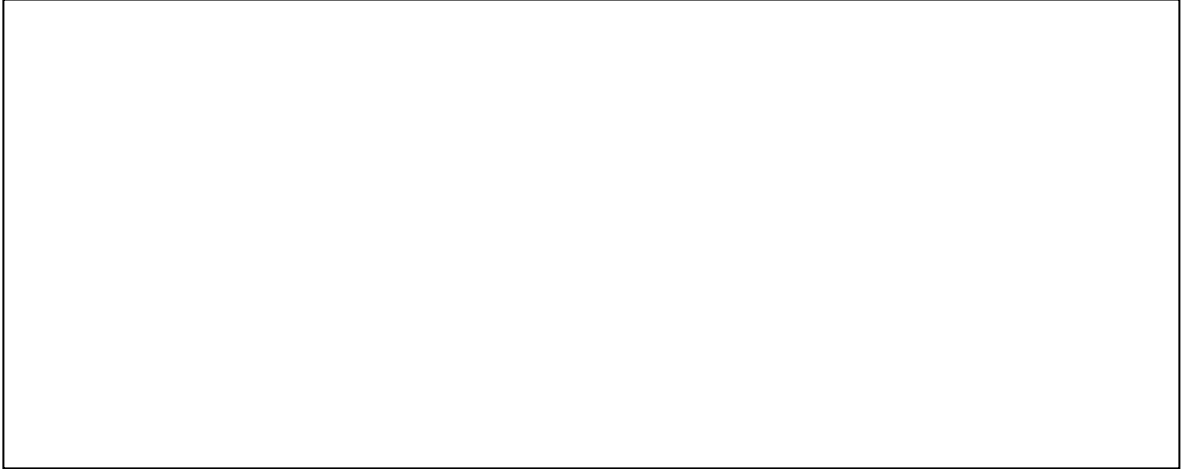
[Suggested Time: 15 min]

- a. Consider a web browsing session of a user. Within the Web browser, the user clicks on a link to obtain a Web page. The IP address for the associated URL is cached in the local host, so a DNS lookup is not necessary to obtain the IP address. Suppose that the Web page associated with the link contains exactly one object, containing HTML text of size 100 KBytes. The RTT between the local host and the server containing the object is 100 ms. A bandwidth of 100 Kbps is available for this transfer.
- i. What will be the total transfer time for the object containing HTML text, including the transmission time for the object?

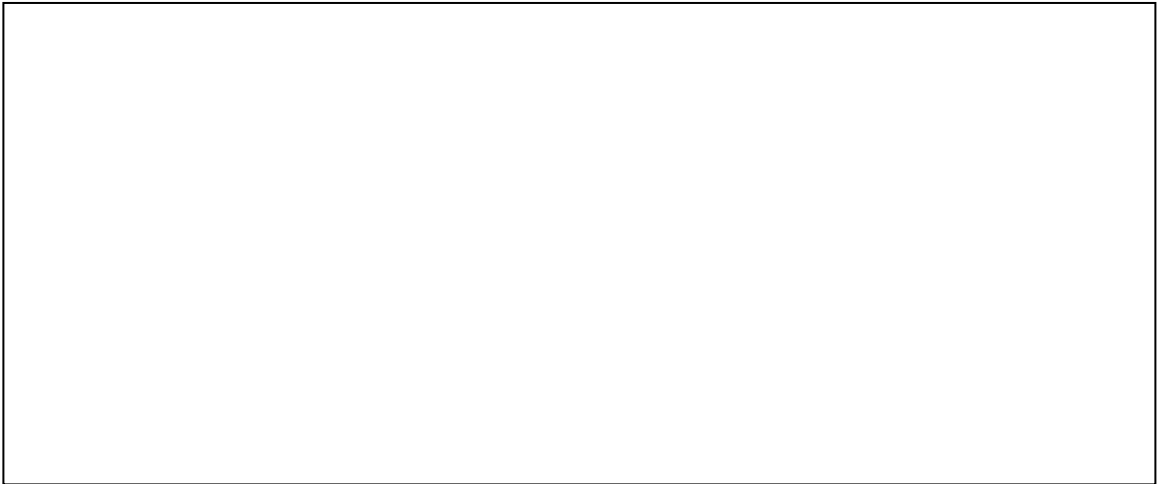
Suppose the HTML file retrieved in part (a) references four objects on the same server. If the sizes of the objects are **300 KBytes**, **600 KBytes**, **800 KBytes** and **1 MBytes** respectively, what will be the total transfer delay for the complete web page, including the transmission delays for all the objects, in each of the following cases:

- ii. Non-persistent HTTP without pipelining?

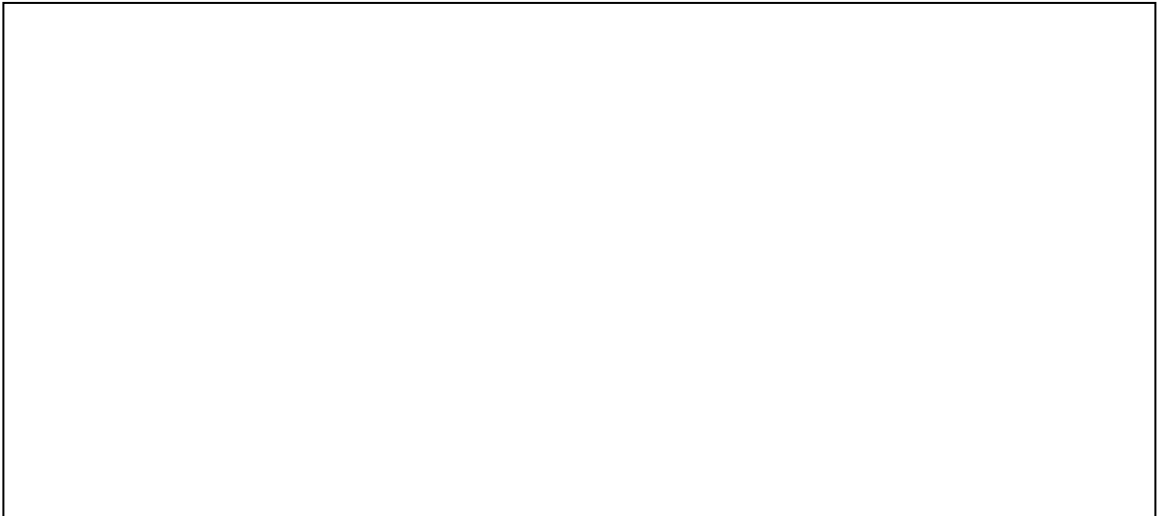
iii. Non-persistent HTTP with pipelining?



iv. Persistent HTTP without pipelining?



v. Persistent HTTP with pipelining?

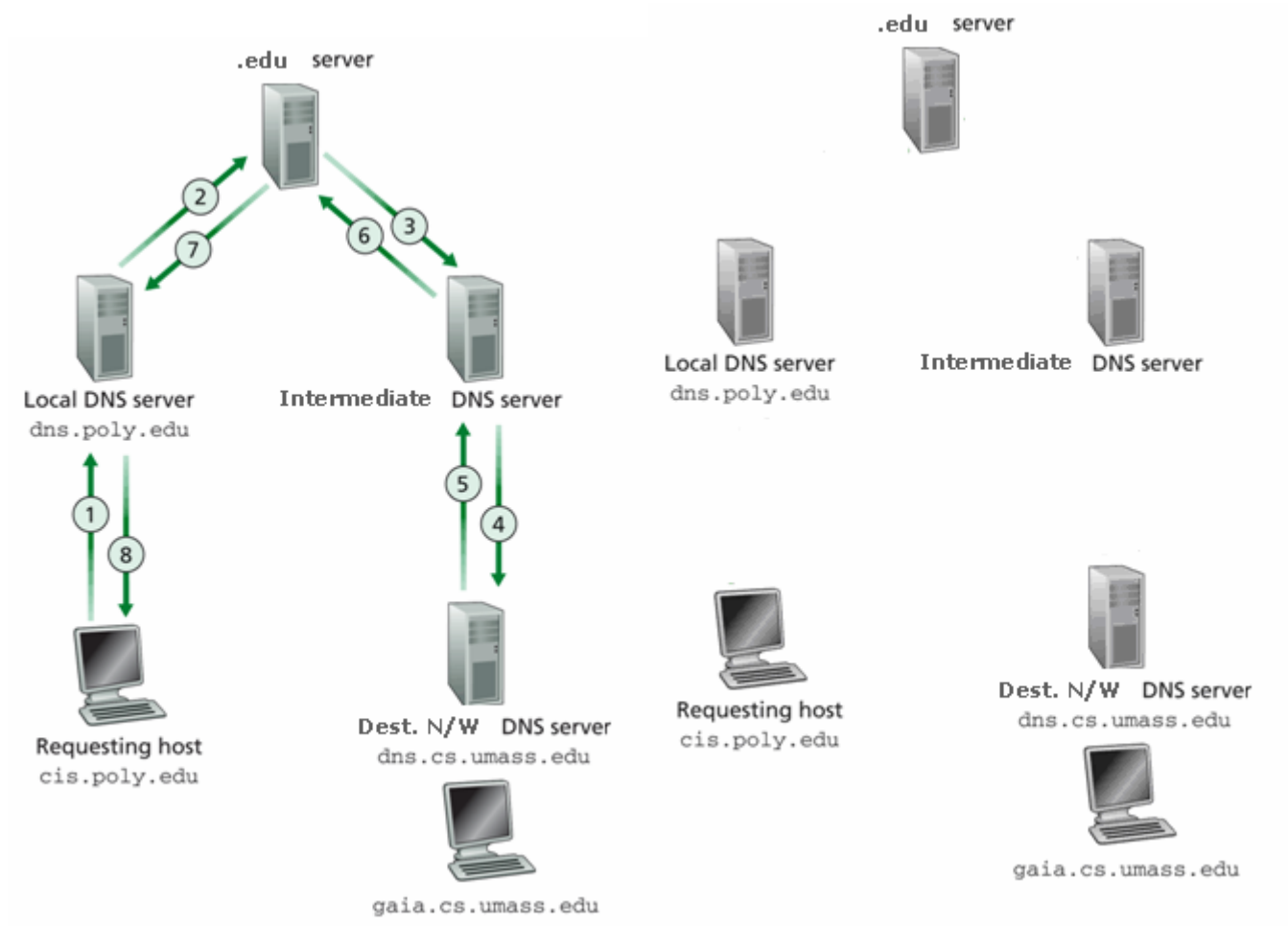


Question 10

[3+1+3]

[Suggested Time: 7 min]

- a. The following diagram presents a scenario of a DNS query when a host *cis.poly.edu* needs the IP address of *gaia.cs.umass.edu*. Redraw the arrows in the figure beside for the case in which all queries from the local name server are now iterative.



- b. How many TCP connections are required for a transfer of 1GB file using FTP?

- c. Suppose Kamran with a web based email account (such as gmail) sends a message to Ali, who accesses his email from his mail server using Microsoft Outlook Express (email client software). List the protocols which are used for the communication between

Question 11

[0]

[Suggested Time: 20 min]

Just recheck your answers.

Bonus Question

[5]

- a. Name three applications of Wireless Sensor Networks?
- b. Name two routing protocols for Wireless Sensor Networks?

c. Name two MAC layer protocols for Wireless Sensor Networks?

d. What is the major challenge for Sensors in Wireless Sensor Networks?

e. What are the major capabilities of Sensors in Wireless Sensor Networks?