Name ….....ID …..... Section ….....Seat No.....

Sirindhorn International Institute of Technology
Thammasat University

Final Examination: Semester 1/2009

Course Title : ITS323 Introduction to Data Communications

Instructor : Dr Steven Gordon

Date/Time : Tuesday 6 October 2009; 9:00 – 12:00

Instructions:

- This examination paper has 13 pages (including this page).
- Condition of Examination
  Closed book (No dictionary; Non-programmable calculator is allowed)
- Students are not allowed to be out of the exam room during examination. Going to the restroom may result in score deduction.
- Turn off all communication devices (mobile phone etc.) and leave them under your seat.
- Write your name, student ID, section, and seat number clearly on the answer sheet.
- The space on the back of each page can be used if necessary.

Part A – Multiple Choice Questions [30 marks]

Select the most accurate answer (only select one answer). Each correct answer is worth 2 marks. Incorrect answer is 0 marks. No answer is 0 marks.

1. The User Datagram Protocol (UDP) is an example transport layer protocol. Normally it would be implemented as:
   a) Part of a user application, such as web browser, email client or audio/video streaming application.
   b) Device drivers that control the LAN/WAN interface cards
   c) Software in the operating system
   d) Hardware on the LAN/WAN interface cards
   e) An application installed by users that want to use UDP

2. TCP has a basic retransmission scheme, as well as a Fast Retransmit feature. TCP Fast Retransmit:
   a) Provides flow control so that the sender does not overflow the receiver.
   b) Guarantees that all segments will be delivered to the destination.
   c) Allows the sender to retransmit segments without a timeout occuring.
   d) Involves the sender sending 2 copies of a segment, in case 1 segment is lost.
   e) Allows the sender to send a retransmitted TCP segment at a faster data rate than the original TCP segment.
   f) None of the above.

3. In TCP connection establishment procedure, if a client chooses Initial Sequence Number of 395, and server chooses 260, then:
   a) The 1st segment sent will contain sequence number of 396
   b) The 2nd segment sent will contain acknowledgement number of 261
   c) The 3rd segment sent will contain sequence number of 261
   d) The 2nd segment sent will contain acknowledgement number of 396
   e) The 2nd segment sent will contain sequence number of 395
   f) The 3rd segment sent will contain acknowledgement number of 396

4. Consider IP addresses, port numbers and protocol numbers. Which is true?
   a) A protocol number is used to indicate the version of IP being used
   b) Every application must use a well-known port number
   c) Each host and router in the Internet has only a single IP address
   d) Client applications may dynamically select port numbers
   e) The protocol number commonly used by web server applications is 80
   f) None of the above

5. What technology uses dynamic, on-demand assignment of time slots to allow data from multiple users to be transmitted over a single link?
   a) Synchronous TDM
   b) Statistical TDM
   c) FDM
   d) WDM
   e) PSTN
   f) PDH

6. Consider Medium Access Control protocols. Which statement is true?
   a) A round-robin MAC protocol cannot be implemented in a distributed manner.
   b) A round-robin MAC protocol is efficient when only some of the stations in the LAN have data to transmit.
   c) Using a random access contention-based MAC protocol there will never be a collision.
   d) A random access contention-based MAC protocol is complex because a central station must inform all other stations of the upcoming transmissions.
   e) A reservation-based MAC protocol involves the assignment of transmission opportunities to stations.
   f) Reservation-based MAC protocols are the most common type of MAC protocol in Ethernet standards.

7. What is the difference between an Ethernet hub and an Ethernet switch?
   a) A switch can be used in a star topology; a hub cannot be used in a star topology.
   b) A switch forwards frames to other stations; a hub does not forward frames.
   c) A switch is used to send IP datagrams; a hub does not send IP datagrams.
   d) A hub always sends a frame to all stations; a switch may send a frame to a specific station.
   e) A hub can deliver higher network throughput than a switch.
   f) A hub requires more interfaces than a switch (to connect the same number of stations).
   g) None of the above

8. Compare circuit switching versus datagram packet switching. An advantage of circuit switching is it:
   a) Can guarantee the performance delivered to end hosts.
   b) Allows end hosts to use different line rates.
   c) Is efficient when the amount of traffic to be sent by end hosts varies over time.
   d) Is non-blocking.
   e) Sends packets instead of signals.
   f) Establishes a connection before sending data.

9. Consider datagram packet switching. A has 3 packets to send to B, via 2 switches. The transmission time of a packet is 10ms and the link propagation delay is 2ms. All links are identical. Assuming no queuing or processing delay, if A starts transmitting at time 0, at what time is the data fully received by B?
   a) 12ms
   b) 30ms
   c) 32ms
   d) 36ms
   e) 48ms
   f) 56ms
   g) 66ms

10. Which of the following statements about internetworking is true?
   a) A host can have only one network interface
   b) A router always has two network interfaces
   c) A subnet has only one router attached
   d) A router cannot be a source of IP datagrams
   e) A host may forward IP datagrams
   f) None of the above

11. Select the correct set of features provided by the Internet Protocol (IP):
    a) Connection-less, addressing, multiplexing
    b) Flow control, addressing, multiplexing
    c) Addressing, error control, security
    d) Addressing, error control, connection-less
    e) Connection-oriented, multiplexing, flow control
    f) Addressing, flow control, quality of service

12. Consider a Stop-and-Wait ARQ protocol. The transmission time of DATA frame is 20ms, and of ACK frame 2ms. The one-way link propagation delay is 5ms. If a retransmit timer starts after transmitting a DATA frame, of the following values which is the minimum timeout value (in ms) that should be used?
    a) 5
    b) 10
    c) 15
    d) 20
    e) 25
    f) 30
    g) 35

13. Consider Stop-and-Wait, Go-Back-N and Selective-Reject ARQ protocols. Which statement is true?
    a) Go-Back-N will always be more efficient than Stop-and-Wait and Selective-Reject.
    b) Selective-Reject requires the receiver to buffer out-of-order frames
    c) In Go-Back-N the sender may send multiple frames before waiting for an ACK; in Selective-Reject the sender must wait for an ACK after sending a single frame.
    d) Selective-Reject uses sequences numbers, whereas Go-Back-N and Stop-and-Wait do not.
    e) In Stop-and-Wait, ACK frames are never lost.
    f) Stop-and-Wait does not require timers to be used.

14. A source IP host sends an IP datagram across an internet to a destination IP host. Router X in the internet has received that IP datagram. Consider the IP datagram sent by router X: which statement is true?
    a) The destination address in the IP header is the IP address of the next router in the path.
    b) The destination address in the IP header is the MAC address of the next router in the path.
    c) The source address in the IP header is the IP address of router X.
    d) The source address in the IP header is the IP address of the source host.
    e) The Time To Live in the IP header will be same value as when router X received the datagram.
    f) The Time To Live in the IP header will be larger than the Time To Live value in the datagram received by Router X.
    g) None of the above

15. IP Fragmentation and Re-assembly can best be described as:
    a) Fragment at the source host; re-assemble at the destination host
    b) Fragment at the source host and routers; re-assemble at the destination host
    c) Fragment at the source host and routers; re-assemble at the routers and destination host
    d) Fragment at the source host; re-assemble at the routers and destination host
    e) IP does not support Fragmentation and Re-assembly.

Part B – General Questions [70 marks]

Question 1 [10 marks]

a) Draw the Internet protocol stack (or Internet protocol architecture), naming each of the *layers*. [3 marks]

b) Consider two computers connected via a single router to form an IP internet. One router interface uses IEEE 802.3 Ethernet and the other uses IEEE 802.11 wireless LAN. Each computer is running an application layer protocol called "ABCP". ABCP requires a reliable transport protocol. Draw the protocol stack for each of the devices in the network. In each layer you must write the name of the *protocol* used. You may use acronyms instead of the full name. [7 marks]

Question 2 [9 marks]

In this question assume classful IP addressing is used. Write your answers in the space given. Each part of (a), (b) and (c) is worth 1.5 marks.

a) For a host with IP address 203.93.16.100:

   i. What is the class? _____

   ii. What is the network address? _____

b) For a router with IP address 112.103.6.4:

   i. What is the directed broadcast address? _____

   ii. How many other hosts can attach to the network? _____

c) If a host does not currently have an IP address, then:

   i. If the host is running a web browser and web server, what IP address could it send an IP datagram to in order to communicate the web server?

   _____

   ii. What IP address could it send an IP datagram to in an attempt to discover an IP address from other devices in the network?

   _____

Question 3 [7 marks]

In this question assume classless IP addressing is used. Write your answers in the space given. Each part of (a) is worth 1.5 marks. Question (b) is worth 2.5 marks.

a) For a host with IP address 108.220.17.43 and subnet mask 255.255.224.0:

   i. What is the network address? _____

   ii. What is the directed broadcast address? _____

   iii. How many other hosts can attach to the network? _____

b) For a router with IP address 78.105.40.12 and network address 78.104.0.0:

   i. What is a possible subnet mask? _____

Question 4 [12 marks]

Consider a LAN with 5 computers (stations).

a) For each of the following topologies, draw a diagram illustrating the LAN. [6 marks]

   i. Bus

   ii. Ring

   iii. Mesh

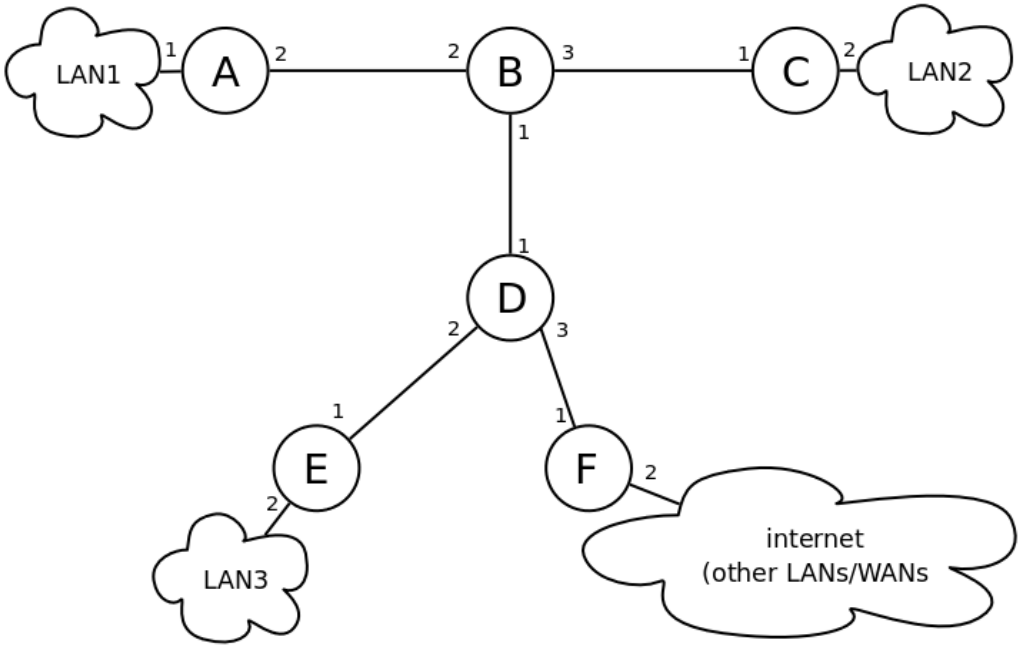
   iv. Hub (or star)

b) Considering the number of cables and number of interfaces of devices, compare the four topologies and discuss which topology (or topologies) is the best. [3 marks]

c) Considering the impact on the network when a link fails (e.g. a cable is cut), compare the four topologies and discuss which topology (or topologies) is the best. [3 marks]

Question 5 [12 marks]

Consider the network in the figure below. Each router has multiple numbered interfaces (e.g. Router A has interface A1 and A2). There are three LANs shown, with each LAN containing multiple hosts. Router F connects, via interface F2, to another router which then may connect to many more routers and LANs (in other words, assume more LANs can be reached via router F).



Assuming the destinations may be in any of the three LANs or in any LANs beyond router F, complete the following routing tables. You may use as many rows as necessary. Use * to indicate a wild card (any value). Use 'direct' to indicate direct delivery to the destination. Use the LAN name to refer to a network (e.g. LAN1). Use the router name and interface to refer to a next router (e.g. A1). Remember, rows in the routing table are processed in order (from top to bottom).

Router A	
Dest.	**Next**

Router B	
Dest.	**Next**

Router C	
Dest.	**Next**

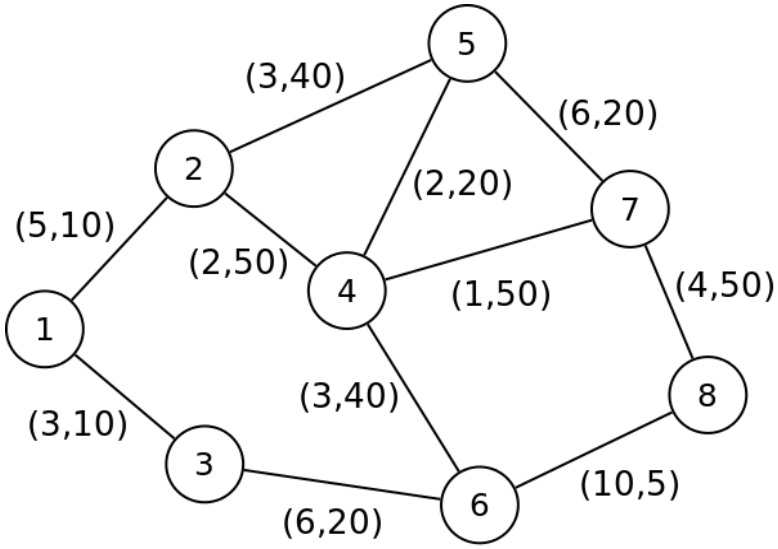
Router D	
Dest.	**Next**

Router E	
Dest.	**Next**

Host in LAN1	
Dest.	**Next**

Question 6 [8 marks]

Consider the network shown in the figure below. For each link, the delay (measured in milliseconds) and data rate (measured in Mb/s) are shown in the format (delay, data rate).



a) Assuming least-cost routing is used to find a path from 1 to 8, indicate the path and the total cost of that path if the cost metric is: [4 marks]

i. Number of hops Path: _____ Cost: _____

ii. Delay Path: _____ Cost: _____

b) Adaptive, link-state routing protocols often use flooding to distribute link-state packets on a regular basis.

i. What information should be included in link state packets? [2 marks]

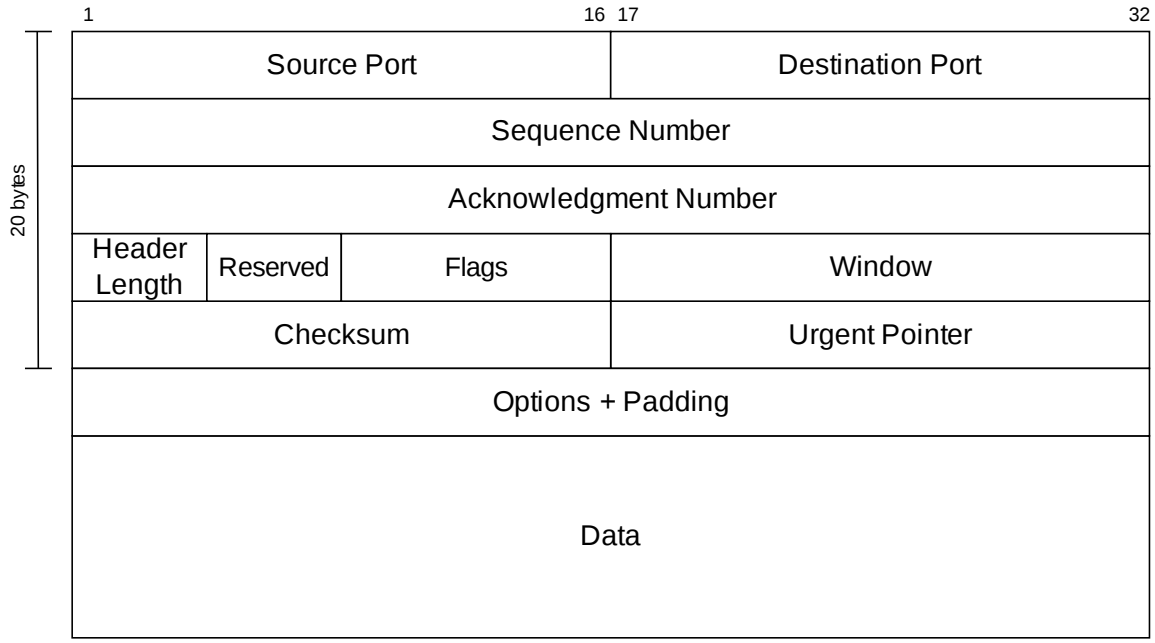
ii. What is an advantage of increasing the frequency at which link-state packets are distributed? [1 mark]

iii. What is a disadvantage of increasing the frequency at which link-state packets are distributed? [1 mark]

Question 7 [12 marks]

Consider the TCP communications between a client and server. Assume the following about the network and applications:

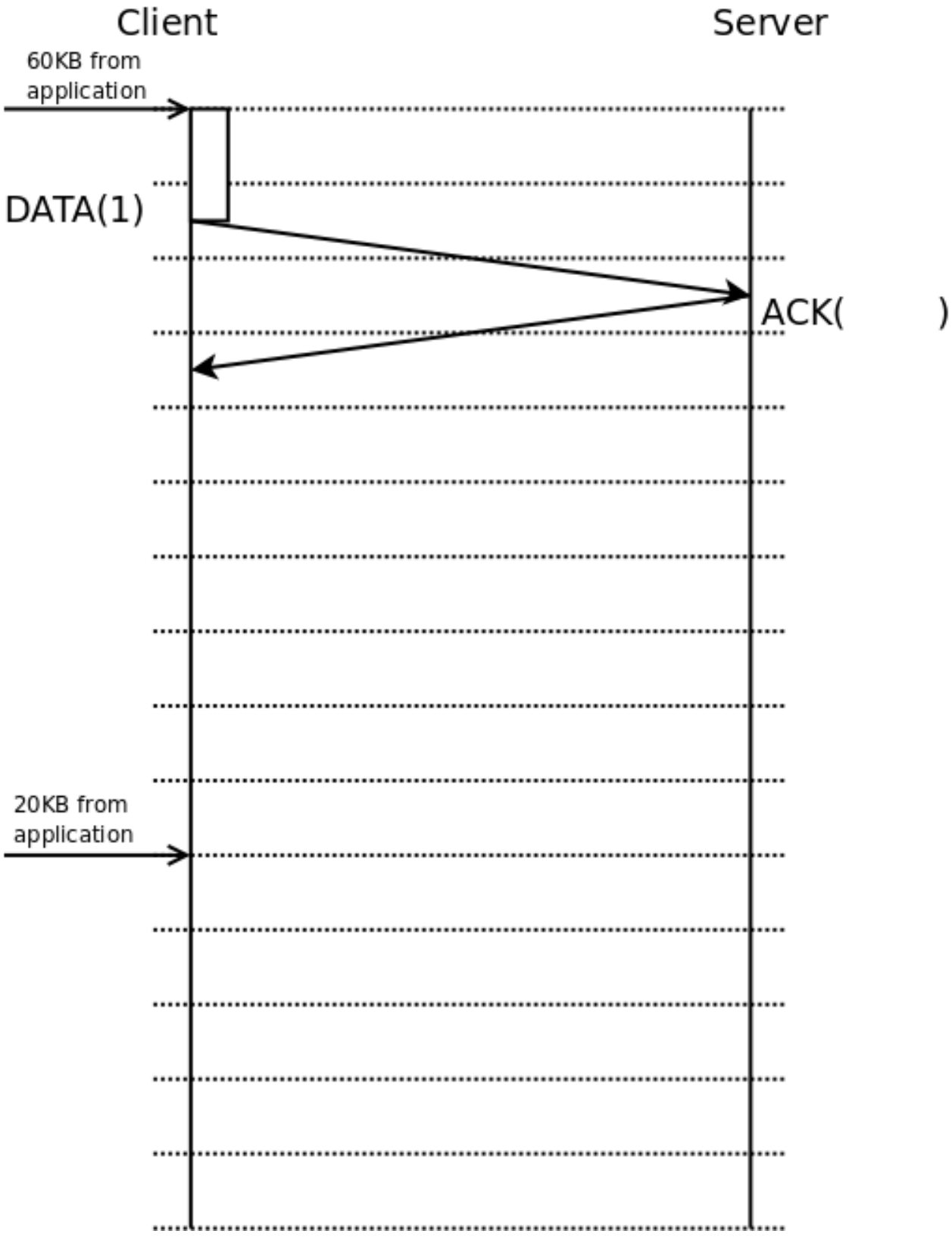
- TCP receiver sends an acknowledgement for every segment received.
- TCP receiver will send segments as fast as possible, without waiting for acknowledgements (ignore flow control or congestion control)
- The processing time at both hosts is 0. There are no queuing delays.
- The propagation time between Host A and Host B is 10ms.
- The average data rate over the internet is 1,000,000 Bytes/sec.
- There are no errors in transmission.
- TCP connection setup has been completed: both A and B chose an Initial Sequence Number of 0.



The application at the client host has 60,000B to send at time 0ms. The TCP client divides the data into four 15,000B pieces to send as four segments. Later, at time 100ms, the application at the client host has an additional 20,000B to send. The TCP client divides the data into two 10,000B pieces to send as two segments.

As the TCP header is very small compared to the data, you may ignore the size of the header in calculations of transmission time. For example, to transmit 10,000 Bytes of data in a TCP segment, when calculating transmission time, assume the header is 0. This also applies for acknowledgements, that is, you may assume an acknowledgement containing no data has a transmission time of 0.

a) Complete the diagram on the next page, showing the transfer of TCP segments. The diagram shows the first TCP segment containing DATA (and its sequence number), as well as the first acknowledgement (the acknowledgement number is not shown – you must give it). Repeat for all segments. For each TCP segment you must indicate the sequence number or acknowledgement number. [6 marks]


Client
Server
60KB from application
DATA(1)
ACK( )
20KB from application

b) At what time is the first ACK received by the client? [1 mark]

c) At what time does the client know that all 80,000 B have been successfully received? [1 mark]

d) If the TCP receiver sends an ACK after every 2nd segment received (instead of after every segment received), what would the acknowledgement number be in the 1st ACK segment sent? [2 marks]

In the following parts, consider only the 1st four segments sent (you can ignore the two segments sent when the application generates data at 100ms). Assume ACKs are sent after every segment received. The retransmit timeout interval is 200ms.

e) If the 2nd segment sent by the client is lost, what would the acknowledgement number be in the:

   i. 2nd ACK segment sent by the server? [1 mark]

   ii. 3rd ACK segment sent by the server? [1 mark]