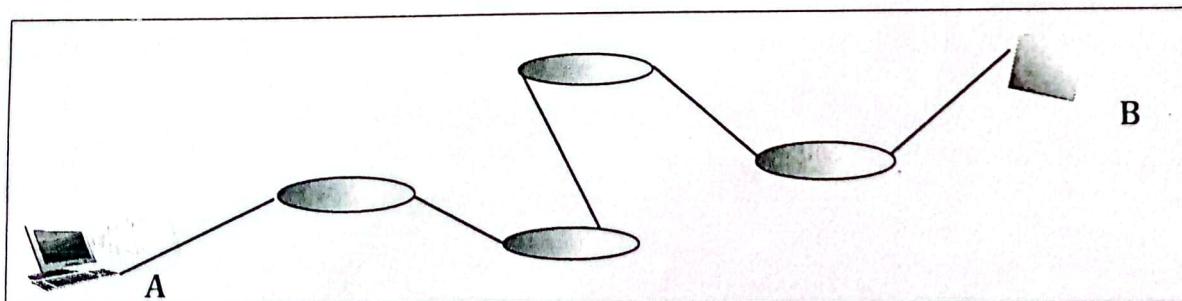


Attempt ALL questions

Time allowed: 1 hour

1.
 - a. Define the following terms as used in Computer Networks:
(4 mark)
 - i. Protocol
 - ii. Network edge
 - iii. Network core
 - iv. Encapsulation
 - b. Differentiate between:
(6 mark)
 - i. Enterprise access networks and wireless access networks
 - ii. Time Division Multiplexing and Frequency Division Multiplexing
 - iii. Packet switching and circuit switching
2. Suppose there are four routers between source host (A) and destination host (B). Assume the network is lightly congested with a queuing delay of 1 ms. The processing delay at all nodes is 0.5 ms. The transmission rate out of each router and the source host is 100 Mbps.



- a. Calculate the transmission delay at each node assuming packet length of 1500 bytes
(2 marks)
- b. Calculate the propagation delay if the length of each physical link is 10km and the medium propagation speed is 2×10^8 m/sec.
(2 marks)
- c. Calculate the total nodal delay at one of the routers
(3 marks)
- d. Calculate the end to end delay between A and B
(3 marks)

3. For each of the following statements, state whether they are True or False?
[10 marks]

- A. The TCP/IP model has these layers Application, Transport, Network, Data link and Session layers
- B. Host A is sending Host B a large file over a TCP connection. Assume Host B has no data to send Host A. Host B will not send acknowledgments to Host A because Host B cannot piggyback the acknowledgments on data.
- C. Suppose Host A is sending Host B a large file over a TCP connection. The number of unacknowledged bytes that A sends cannot exceed the size of the receive buffer.
- D. Suppose Host A is sending a large file to Host B over a TCP connection. If the sequence number for a segment of this connection is m , then the sequence number for the subsequent segment will necessarily be $m + 1$.
- E. During the process of encapsulation, the encapsulated information reaches the transport layer in form of packets.
- F. Tracking the individual communication between applications on the source and destination hosts is one of the primary responsibilities of the transport layer protocols.
- G. The standards agency of the OSI model is the Internet Engineering Task Force
- H. Internet standards are defined in RFC documents
- I. In guided media signals propagate freely
- J. A DOS attack makes resources (server, bandwidth) unavailable to legitimate traffic by overwhelming resource with bogus traffic.
4. Describe why an application developer might choose to run an application over TCP rather than UDP. (4 marks)
5. Suppose that a Web server runs in Host C on port 80. Suppose this Web server uses persistent connections, and is currently receiving requests from two different Hosts, A and B. Are all of the requests being sent through the same socket at Host C? If they are being passed through different sockets, do both of the sockets have port 80? Discuss and explain. (6 marks)

bits
frames
packets
segments
data

MAKERERE UNIVERSITY
COLLEGE OF COMPUTING & INFORMATION SCIENCES
SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY

END OF SEMESTER I EXAMINATION 2022/2023 FOR BSSE & BSC. CS

YEAR OF STUDY: II

COURSE NAME: COMPUTER NETWORKS

COURSE CODE: BSE 2106

DATE: 25TH January 2023

TIME: 12:00PM - 3:00PM

EXAMINATION INSTRUCTIONS

- a) ATTEMPT ALL QUESTIONS IN SEC A (40 MARKS)
- b) ATTEMPT ONLY THREE QUESTIONS IN SECTION B (60 MARKS).
- c) DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
- d) ATTEMPT EACH QUESTION ON A NEW PAGE OF THE ANSWER BOOKLET
- e) ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

SECTION A - ATTEMPT ALL QUESTIONS

1. What are some of the possible services that a data link-layer protocol can offer to the network layer? [2 marks]
2. Why would the token-ring protocol be inefficient if a LAN had a very large perimeter? [3 marks]
3. Explain why an ARP query is sent within a broadcast frame and an ARP response is sent within a frame with a specific destination MAC address? [4 marks]
4. Given the macroscopic description of TCP throughput, in the period of time from when the connection's rate varies from $\frac{W}{(2 \cdot RTT)}$ to $\frac{W}{RTT}$, only one packet is lost (at the very end of the period), where W is the window size and RTT is the Round trip time. Show that the loss rate (fraction of packets lost) is equal to

$$L = \text{loss rate} = \frac{1}{\frac{3}{8} W^2 - \frac{3}{4} W} \quad [5 \text{ marks}]$$

5. List three nonproprietary Internet applications and the application-layer protocols that they use. [6 marks]
6. Give any two applications of terrestrial microwave. [2 marks]
7. In developing any network, the designer must take into account a number of considerations when selecting the type of medium to use. Give any three of these considerations. [3 marks]
8. What is the 32-bit binary equivalent of the IP address 223.1.3.27? [4 marks]
9. Compare and contrast the IPv4 and the IPv6 header fields. Do they have any fields in common? [3 marks]
10. It has been said that when IPv6 tunnels through IPv4 routers, IPv6 treats the IPv4 tunnels as link-layer protocols. Do you agree with this statement? Why or why not? [2 marks]
11. Compare and contrast link-state and distance-vector routing algorithms. [3 marks]
12. Discuss how a hierarchical organization of the Internet has made it possible to scale to millions of users. [3 marks]

SECTION B - ATTEMPT ANY THREE QUESTIONS

Question One

- a. List down any three common types of firewalls. [3 marks]
- b. As a network administrator for your company, give two reasons why you would consider it preferable to invest company resources in a firewall. [2 marks]
- c. Using RSA, choose $p = 3$ and $q = 11$, and encode the word "dog" by encrypting each letter separately. Apply the decryption algorithm to the encrypted version to recover the original plaintext message. [6 marks]
- d. Considering RSA with $p = 5$ and $q = 11$.
 - i. Compute the values of n and z you would obtain. [2 marks]
 - ii. Let e be 3. Why is this an acceptable choice for e ? [1 mark]
 - iii. Find d such that $de \equiv 1 \pmod{z}$ and $d < 160$. [2 marks]
 - iv. If c denotes the corresponding cipher-text, by showing the steps necessary, encrypt the message $m = 8$ using the key (n, e) . [4 marks]

Question Two

Consider Figure 1 below showing TCP window size as a function of time. Assuming TCP Reno is the protocol experiencing the behavior shown in Figure 1, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

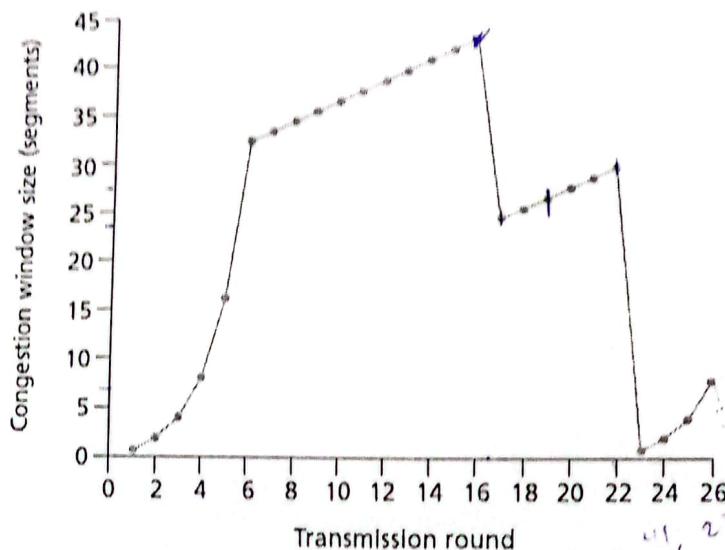


Figure 1: TCP window size as a function of time

- Identify the intervals of time when TCP slow start is operating. [2 marks]
- Identify the intervals of time when TCP congestion avoidance is operating. [2 marks]
- After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? [2 marks]
- What is the initial value of ssthresh at the first transmission round? [2 marks]
- During what transmission round is the 70th segment sent? [2 marks]
- Assuming a packet loss is detected after the 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of ssthresh? [3 marks]
- Suppose TCP Tahoe is used (instead of TCP Reno), and assume that triple duplicate ACKs are received at the 16th round. What are the ssthresh and the congestion window size at the 19th round? [4 marks]
- Again, suppose TCP Tahoe is used, and there is a timeout event at 22nd round. How many packets have been sent out from 17th round till 22nd round, inclusive? [3 marks]

Question Three

- Discuss the four main services offered by the data link layer. [4 marks]
- Considering Voice-over-IP applications, one of the drawbacks of a small packet size is that a large fraction of link bandwidth is consumed by overhead bytes. To this end, suppose that the packet consists of P bytes and 5 bytes of header.
 - Consider sending a digitally encoded voice source directly. Suppose the source is encoded at a constant rate of 128 kbps. Assume each packet is entirely filled before the source sends the packet into the network. The time required to fill a packet is the **packetization delay**. In terms of L , determine the packetization delay in milliseconds. [5 marks]

- ii. Packetization delays greater than 20 msec can cause a noticeable and unpleasant echo. Determine the packetization delay for $L = 1,500$ bytes (roughly corresponding to a maximum-sized Ethernet packet) and for $L = 50$ (corresponding to an ATM packet). [4 marks]
- iii. Calculate the store-and-forward delay at a single switch for a link rate of $R = 622$ Mbps for $L = 1,500$ bytes, and for $L = 50$ bytes. [4 marks]
- iv. Give the advantages of using a small packet size. [3 marks]

[3 Marks]

Question Four

a) What is FTP and the role of ports 20 and 21 in its operation?

- b)
- i. HTTP is defined as a *stateless* protocol but in some applications, state is important. How do HTTP-based applications maintain state between communication entities? [2 Marks]
 - ii. Describe the basic working of HTTP in a client-server setup. [4 Marks]
- c) The Domain Name System (DNS) is a distributed and hierarchical database system for domain name resolution. Using an example (*mak.ac.ug*), discuss and state the relevance of such a structure. [5 Marks]
- d) Compare and contrast top-level and authoritative DNS servers. [4 Marks]
- e) ARP and DNS both depend on caches; ARP cache entry lifetimes are typically 10 minutes, while DNS cache is on the order of days. What undesirable consequences might there be in having too long a DNS cache entry lifetime? [2 Marks]

Question Five

[2 Marks]

- a) Give two important functions of the network layer.

- b) The Makerere University Library is in the process of redesigning its network to accommodate more users and also to achieve traffic segmentation for the different offices and users. The user projections below are for the next 3 years:

- ✓ Students – 250
- ✓ Staff – 50
- ✓ Wireless - 500

The University ICT Services, mandated with provision of University ICT needs, has assigned the CIDR address space 10.10.0.0/22 for use with a prefix of /24 as the least for subnets to be created in the new design. The Library has also been tasked with address space utilization with minimum wastage possible.

- i. What is CIDR as applied to the use case above?

[2 Marks]

- ii. Advise the University Library on the segmentation of the network above for the different users clearly showing the following: [10 Marks]

- Address space
- Start and end usable IP addresses
- Maximum number of users supported

iii. State the relevance of NAT in such a setup.

[1 Mark]

iv. Describe the two configuration types that may be required by the Library router to ensure communication between the networks above and the University core network. [4 Marks]

c) List two routing protocols that support equal load balancing.

[1 Mark]

Question Six

Consider the scenario shown in Figure 2, in which there are four wireless nodes, A, B, C, and D. The radio coverage of the four nodes is shown via the shaded ovals; all nodes share the same frequency. When A transmits, it can only be heard/received by B; when B transmits, both A and C can hear/receive from B; when C transmits, both B and D can hear/receive from C; when D transmits, only C can hear/receive from D. Suppose now that each node has an infinite supply of messages that it wants to send to each of the other nodes. If a message's destination is not an immediate neighbor, then the message must be relayed. For example, if A wants to send to D, a message from A must first be sent to B, which then sends the message to C, which then sends the message to D. Time is slotted, with a message transmission time taking exactly one-time slot, e.g., as in slotted Aloha. During a slot, a node can do one of the following: (i) send a message; (ii) receive a message (if exactly one message is being sent to it), (iii) remain silent. As always, if a node hears two or more simultaneous transmissions, a collision occurs and none of the transmitted messages are received successfully. You can assume here that there are no bit-level errors, and thus if exactly one message is sent, it will be received correctly by those within the transmission radius of the sender.

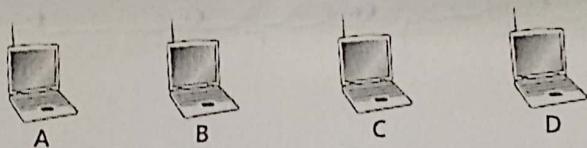


Figure 2. Network scenario for question 6

- a. Suppose an omniscient controller (i.e., a controller that knows the state of every node in the network) can command each node to do whatever it (the omniscient controller) wishes, i.e., to send a message, to receive a message, or to remain silent. Given this omniscient controller, what is the maximum rate at which a data message can be transferred from C to A, given that there are no other messages between any other source/destination pairs? [5 marks]
- b. Assume now A sends messages to B, and D sends messages to C. What is the combined maximum rate at which data messages can flow from A to B and from D to C? [5 marks]
- c. If instead A sends messages to B, and C sends messages to D. What is the combined maximum rate at which data messages can flow from A to B and from C to D? [5 marks]
- d. Suppose now that the wireless links are replaced by wired links, what is the maximum rate at which a data message can be transferred from C to A in this wired scenario. [5 marks]

HAPPY NEW YEAR TO YOU

SECTION A - ATTEMPT ALL QUESTIONS

1. What are some of the possible services that a data link-layer protocol can offer to the network layer? [2 marks]
2. Why would the token-ring protocol be inefficient if a LAN had a very large perimeter? [3 marks]
3. Explain why an ARP query is sent within a broadcast frame and an ARP response is sent within a frame with a specific destination MAC address? [4 marks]
4. Given the macroscopic description of TCP throughput, in the period of time from when the connection's rate varies from $\frac{W}{(2 \cdot RTT)}$ to $\frac{W}{RTT}$, only one packet is lost (at the very end of the period), where W is the window size and RTT is the Round trip time. Show that the loss rate (fraction of packets lost) is equal to
$$L = \text{loss rate} = \frac{1}{\frac{3}{8} W^2 + \frac{3}{4} W}$$
[5 marks]
5. List three nonproprietary Internet applications and the application-layer protocols that they use. [6 marks]
6. Give any two applications of terrestrial microwave. [2 marks]
7. In developing any network, the designer must take into account a number of considerations when selecting the type of medium to use. Give any three of these considerations. [3 marks]
8. What is the 32-bit binary equivalent of the IP address 223.1.3.27? [4 marks]
9. Compare and contrast the IPv4 and the IPv6 header fields. Do they have any fields in common? [3 marks]
10. It has been said that when IPv6 tunnels through IPv4 routers, IPv6 treats the IPv4 tunnels as link-layer protocols. Do you agree with this statement? Why or why not? [2 marks]
11. Compare and contrast link-state and distance-vector routing algorithms. [3 marks]
12. Discuss how a hierarchical organization of the Internet has made it possible to scale to millions of users. [3 marks]

SECTION B - ATTEMPT ANY THREE QUESTIONS

Question One

- a. List down any three common types of firewalls. [3 marks]
- b. As a network administrator for your company, give two reasons why you would consider it preferable to invest company resources in a firewall. [2 marks]
- c. Using RSA, choose $p = 3$ and $q = 11$, and encode the word "dog" by encrypting each letter separately. Apply the decryption algorithm to the encrypted version to recover the original plaintext message. [6 marks]
- d. Considering RSA with $p = 5$ and $q = 11$.
 - i. Compute the values of n and z you would obtain. [2 marks]
 - ii. Let e be 3. Why is this an acceptable choice for e ? [1 mark]
 - iii. Find d such that $de = 1 \pmod{z}$ and $d < 160$. [2 marks]
 - iv. If c denotes the corresponding cipher-text, by showing the steps necessary, encrypt the message $m = 8$ using the key (n, e) . [4 marks]

$$\begin{aligned} \frac{cd-1}{40} &= 8 \text{ remain } \\ 2, 3, 5, 7, 11, & \quad \frac{ed-1}{ed} = 80 \\ \rightarrow abdefghijklmnoqrstuvwxyz & \quad \frac{ed}{d} = 80 \\ & \quad d = 2 \end{aligned}$$

Question Two

Consider Figure 1 below showing TCP window size as a function of time. Assuming TCP Reno is the protocol experiencing the behavior shown in Figure 1, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

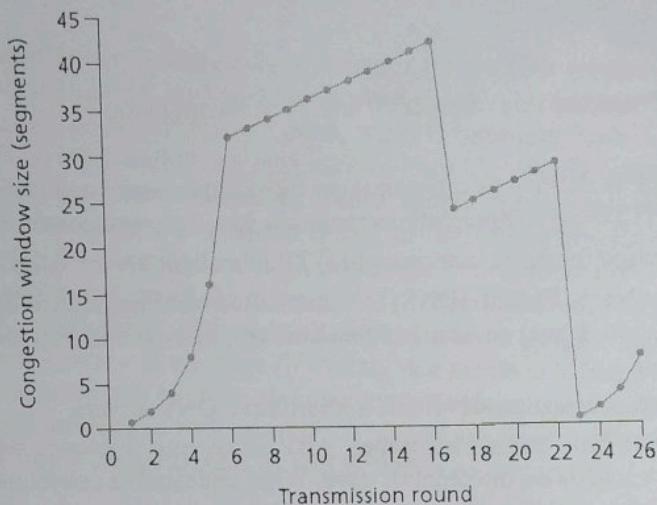


Figure 1: TCP window size as a function of time

- Identify the intervals of time when TCP slow start is operating. [2 marks]
- Identify the intervals of time when TCP congestion avoidance is operating. [2 marks]
- After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? [2 marks]
- What is the initial value of ssthresh at the first transmission round? [2 marks]
- During what transmission round is the 70th segment sent? [2 marks]
- Assuming a packet loss is detected after the 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of ssthresh? [3 marks]
- Suppose TCP Tahoe is used (instead of TCP Reno), and assume that triple duplicate ACKs are received at the 16th round. What are the ssthresh and the congestion window size at the 19th round? [4 marks]
- Again, suppose TCP Tahoe is used, and there is a timeout event at 22nd round. How many packets have been sent out from 17th round till 22nd round, inclusive? [3 marks]

Question Three

- Discuss the four main services offered by the data link layer. [4 marks]
- Considering Voice-over-IP applications, one of the drawbacks of a small packet size is that a large fraction of link bandwidth is consumed by overhead bytes. To this end, suppose that the packet consists of P bytes and 5 bytes of header.
 - Consider sending a digitally encoded voice source directly. Suppose the source is encoded at a constant rate of 128 kbps. Assume each packet is entirely filled before the source sends the packet into the network. The time required to fill a packet is the **packetization delay**. In terms of L , determine the packetization delay in milliseconds. [5 marks]

- ii. Packetization delays greater than 20 msec can cause a noticeable and unpleasant echo. Determine the packetization delay for $L = 1,500$ bytes (roughly corresponding to maximum-sized Ethernet packet) and for $L = 50$ (corresponding to an ATM packet). [4 marks]
- iii. Calculate the store-and-forward delay at a single switch for a link rate of $R = 622$ Mbps for $L = 1,500$ bytes, and for $L = 50$ bytes. [4 marks]
- iv. Give the advantages of using a small packet size. [3 marks]

Question Four

- a) What is FTP and the role of ports 20 and 21 in its operation? [3 Marks]
- b)
- i. HTTP is defined as a *stateless* protocol but in some applications, state is important. How do HTTP-based applications maintain state between communication entities? [2 Marks]
 - ii. Describe the basic working of HTTP in a client-server setup. [4 Marks]
- c) The Domain Name System (DNS) is a distributed and hierarchical database system for domain name resolution. Using an example (***mak.ac.ug***), discuss and state the relevance of such a structure. [5 Marks]
- d) Compare and contrast top-level and authoritative DNS servers. [4 Marks]
- e) ARP and DNS both depend on caches; ARP cache entry lifetimes are typically 10 minutes, while DNS cache is on the order of days. What undesirable consequences might there be in having too long a DNS cache entry lifetime? [2 Marks]

Question Five

- a) Give two important functions of the network layer. [2 Marks]
- b) The Makerere University Library is in the process of redesigning its network to accommodate more users and also to achieve traffic segmentation for the different offices and users. The user projections below are for the next 3 years:
- ✓ Students – 250
 - ✓ Staff – 50
 - ✓ Wireless - 500

The University ICT Services, mandated with provision of University ICT needs, has assigned the CIDR address space 10.10.0.0/22 for use with a prefix of /24 as the least for subnets to be created in the new design. The Library has also been tasked with address space utilization with minimum wastage possible.

- i. What is CIDR as applied to the use case above? [2 Marks]
- ii. Advise the University Library on the segmentation of the network above for the different users clearly showing the following: [10 Marks]
- Address space
 - Start and end usable IP addresses
 - Maximum number of users supported

- iii. State the relevance of NAT in such a setup. [1 Mark]
- iv. Describe the two configuration types that may be required by the Library router to ensure communication between the networks above and the University core network. [4 Marks]
- c) List two routing protocols that support equal load balancing. [1 Mark]

Question Six

Consider the scenario shown in Figure 2, in which there are four wireless nodes, A, B, C, and D. The radio coverage of the four nodes is shown via the shaded ovals; all nodes share the same frequency. When A transmits, it can only be heard/received by B; when B transmits, both A and C can hear/receive from B; when C transmits, both B and D can hear/receive from C; when D transmits, only C can hear/receive from D. Suppose now that each node has an infinite supply of messages that it wants to send to each of the other nodes. If a message's destination is not an immediate neighbor, then the message must be relayed. For example, if A wants to send to D, a message from A must first be sent to B, which then sends the message to C, which then sends the message to D. Time is slotted, with a message transmission time taking exactly one-time slot, e.g., as in slotted Aloha. During a slot, a node can do one of the following: (i) send a message; (ii) receive a message (if exactly one message is being sent to it), (iii) remain silent. As always, if a node hears two or more simultaneous transmissions, a collision occurs and none of the transmitted messages are received successfully. You can assume here that there are no bit-level errors, and thus if exactly one message is sent, it will be received correctly by those within the transmission radius of the sender.

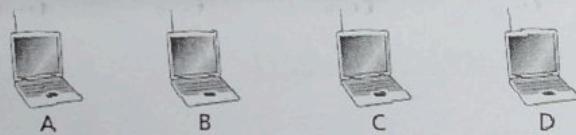


Figure 2. Network scenario for question 6

- a. Suppose an omniscient controller (i.e., a controller that knows the state of every node in the network) can command each node to do whatever it (the omniscient controller) wishes, i.e., to send a message, to receive a message, or to remain silent. Given this omniscient controller, what is the maximum rate at which a data message can be transferred from C to A, given that there are no other messages between any other source/destination pairs? [5 marks]
- b. Assume now A sends messages to B, and D sends messages to C. What is the combined maximum rate at which data messages can flow from A to B and from D to C? [5 marks]
- c. If instead A sends messages to B, and C sends messages to D. What is the combined maximum rate at which data messages can flow from A to B and from C to D? [5 marks]
- d. Suppose now that the wireless links are replaced by wired links, what is the maximum rate at which a data message can be transferred from C to A in this wired scenario. [5 marks]

HAPPY NEW YEAR TO YOU

MAKERERE UNIVERSITY

COLLEGE OF COMPUTING & INFORMATION SCIENCES

SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY

END OF SEMESTER I EXAMINATION 2020/2021

YEAR OF STUDY: II

COURSE NAME: COMPUTER NETWORKS

COURSE CODE: BSE 2106

DATE: 22nd September 2021 **TIME:** 9AM - 6PM

EXAMINATION INSTRUCTIONS

- a) ATTEMPT ONLY FOUR QUESTIONS (25 MARKS EACH).**

b) ANY PROOF OF PLAGIARISM (COPYING AND PASTING) FROM ANY SOURCE MAY LEAD TO CANCELLATION OF YOUR EXAM

Question One

Suppose the network layer provides the following service. The network layer in the source host accepts a segment of maximum size 1,200 bytes and a destination host address from the transport layer. The network layer then guarantees to deliver the segment to the transport layer at the destination host. Suppose many network application processes can be running at the destination host.

- a) Design the simplest possible transport-layer protocol that will get application data to the desired process at the destination host. Assume the operating system in the destination host has assigned a 4-byte port number to each running application process. **[10 marks]**
- b) Modify this protocol so that it provides a “return address” to the destination process. **[5 marks]**
- c) In your protocols, does the transport layer “have to do anything” in the core of the computer network? Explain your answer. **[4 marks]**
- d) The Transmission Control Protocol (TCP) has got six flag fields. List these six fields and discuss the purpose of each of these fields. **[6 marks]**

Question Two

- a) Explain the ARP protocol to a friend. In that explanation, mention what layer it operates at and the kind of service it provides to the layer above it. **[6 Marks]**
- b) Having ARP table entries time out after 10 to 15 minutes is an attempt at a reasonable compromise. Describe the problems that can occur if the timeout value is too small or too large. **[4 marks]**
- c) IEEE defines two sublayers at Layer 2, discuss the purpose of each. **[4 Marks]**
- d) How does a computer attached to a shared LAN decide whether to accept a packet? **[3 Marks]**
- e) Expand the acronym CSMA/CD, explaining each part **and** why CSMA/CD uses a random delay? **[4 Marks]**
- f) Explain why collision is an issue in a random-access protocol but not in reservation or channel partitioning protocols. **[4 Marks]**

Question Three

- a) Differentiate between:
- Routing and Forwarding. **[3 Marks]**
 - Manual IP address allocation and dynamic IP address allocation. **[3 Marks]**
- b) Using an illustration, give the difference between packet switching and circuit switching. **[4 Marks]**
- c) Discuss the following as they relate to IP networks:
- Network Address Translation. **[3 marks]**
 - Datagram Networks. **[3 marks]**
 - IP Fragmentation and Reassembly. **[3 marks]**
 - ICMP. **[3 marks]**
 - ICANN. **[3 marks]**

Question Four

- a) Discuss any two characteristics of IP Protocol. **[4 Marks]**
- b) With explanation of the rules applied, provide the short form of the IPv6 address, 2041:0000:140F:079F:0000:0000:131B? **[4.5 Marks]**
- c) Suppose a router has built up the routing table shown in Table below:

SubnetNumber	SubnetMask	NextHop
128.96.170.0	255.255.254.0	Interface 0
128.96.168.0	255.255.254.0	Interface 1
128.96.166.0	255.255.254.0	R2
128.96.164.0	255.255.252.0	R3
(default)		R4

The router can deliver packets directly over interfaces 0 and 1, or it can forward packets to routers R2, R3, or R4. Assume the router does the longest prefix match. Describe what the router does with a packet addressed to each of the following destinations: **[5 marks]**

- 128.96.167.151.
- 128.96.163.151
- 128.96.169.192.

- iv. 128.96.165.121.
 - v. 171.1.2.3
- d) Consider the network shown on the link below, with the indicated link costs. Use Dijkstra's shortest path algorithm to compute the graph of the shortest path from A to all network nodes i.e. B, C, D, E, and F. **[7.5 Marks]**
-
- ```

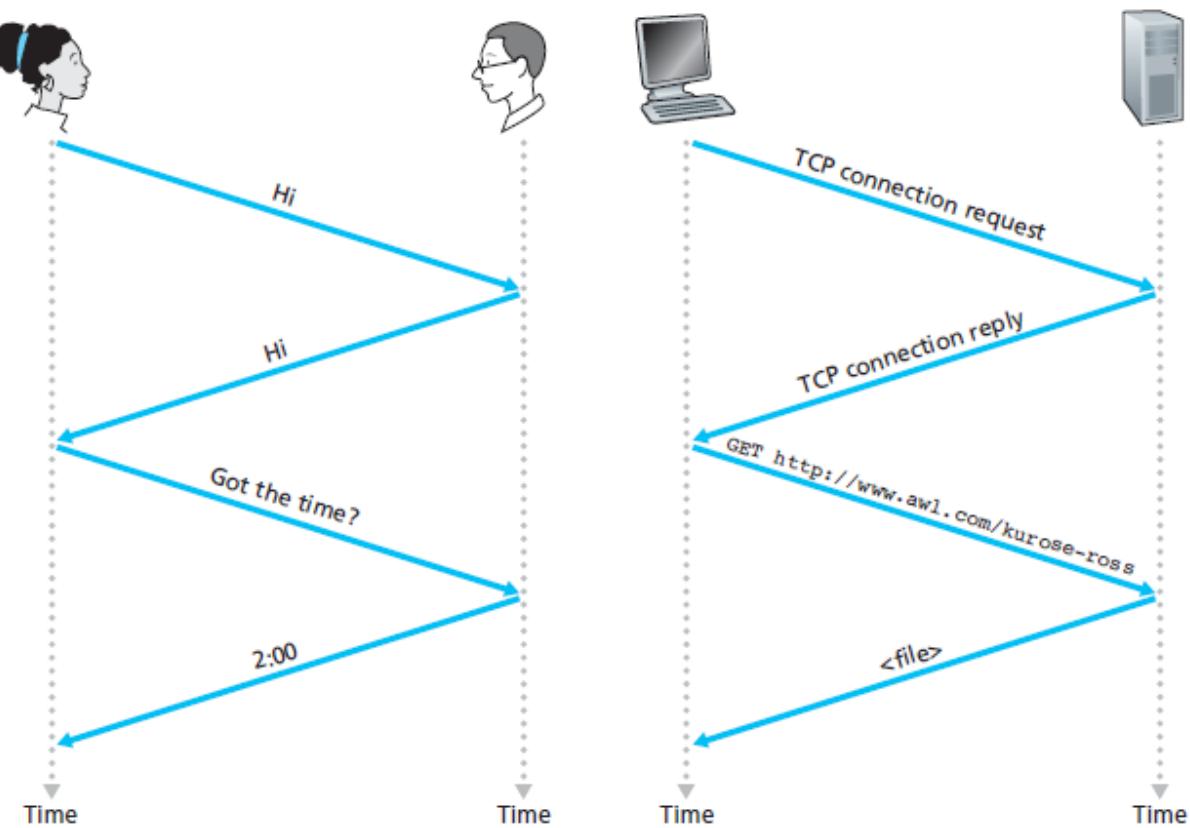
graph LR
 A((A)) --- B((B))
 A --- C((C))
 A --- E((E))
 B --- C
 B --- E
 C --- D((D))
 C --- F((F))
 E --- F
 D --- F

```
- e) Suppose that instead of using 16 bits for the network part of a class B address originally, 20 bits had been used. How many class B networks would there have been? **[2 Marks]**
- f) A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts it can handle? **[2 Marks]**

### Question Five

Design and describe an application-level protocol to be used between an automatic teller machine (ATM) and a bank's centralized computer.

- a) Your protocol should allow a user's card and password to be verified, the account balance (maintained at the centralized computer) to be queried, and an account withdrawal to be made. Your protocol entities should be able to handle the all-too-common case in which there is INSUFFICIENT BALANCE on the account to cover the withdrawal. Specify your protocol by listing the messages exchanged and the action taken by the ATM or the bank's centralized computer on transmission and receipt of messages. **[12 marks]**
- b) Sketch the operation of your protocol for the case of a simple withdrawal with no errors, using a diagram similar to that in **Figure 1 below**. **[7 marks]**
- c) Explicitly state the assumptions made by your protocol about the underlying end-to-end transport service. **[6 marks]**



*Figure 1: A human protocol and a computer network protocol*

**THE END**

**MAKERERE UNIVERSITY**  
**COLLEGE OF COMPUTING & INFORMATION SCIENCES**  
**SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY**

**END OF SEMESTER I EXAMINATION 2016/17**

**PROGRAMME: CSC, BIT & BSSE**

**YEAR OF STUDY: II**

**COURSE NAME: Computer Networks**

**COURSE CODE: BSE 2106**

**DATE: 30<sup>TH</sup> JAN 2017**

**TIME: 12:00 – 3:00 PM**

**EXAMINATION INSTRUCTIONS**

1. ATTEMPT ALL QUESTIONS IN SECTION A (40 MARKS)
2. ATTEMPT THREE (03) QUESTIONS IN SECTIONS B (60 MARKS)
3. DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
4. ATTEMPT EACH QUESTION IN SECTION B ON A NEW PAGE
5. ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

## SECTION A (40 marks)

- 1) What is encapsulation and how is it carried out at the network layer. [2marks]
- 2)
  - a) Name four services offered by the link layer to the network layer [2marks]
  - b) Which of the link-layer services (named in 2(a) above) have corresponding services in IP? [1 mark]
  - c) Which of the link-layer services (named in 2(a) above) have corresponding services in TCP? [1 mark]
- 3) What is a cookie in computer networks and what is it used for? [3marks]
- 4) Give two reasons for using layered protocols? [2 marks]
- 5) List two advantages and two disadvantages of having international standards for network protocols. [4 marks]
- 7) Differentiate between connection oriented and connectionless protocols. Give an example of each. [4 marks]
- 8) 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.
  - a) What transport and application-layer protocols besides HTTP are needed in this scenario? [2 marks]
  - b) What role will each protocol given in (a) above play? [2 marks]
- 9)
  - a) What is ARP in full and what is it for? [ 2marks]
  - b) Why is an ARP query sent within a broadcast frame? [ 2marks]
  - c) Why is an ARP response sent within a frame with a specific destination MAC address? [ 2marks]
- 10)
  - a) What is CSMA/CD in full? [1 marks]
  - b) Briefly explain how it works. [4 marks]
- 11) Explain the importance of the following numbers in regards to TCP. [6 marks]
  - a) Sequence number
  - b) Acknowledgement number
  - c) Port number

## **SECTION B (60 marks)**

### **Question 1**

- a) Using diagrams, explain how SMTP and POP work together to ensure emails are delivered from a sender's computer to the recipient's computer. [4 marks]
- b) From an ISP's point of view, POP3 and IMAP differ in an important way. POP3 users generally empty their mailboxes every day. IMAP users keep their mail on the server indefinitely. Imagine that you were called in to advise an ISP on which protocol it should support. What considerations would you bring up? [4 marks]
- c) For each of the following statements, state whether the statement is "true" or "false" and provide an explanation for your choice.  
  - i. Two distinct Web pages (for example, [www.mit.edu/research.html](http://www.mit.edu/research.html) and [www.mit.edu/students.html](http://www.mit.edu/students.html)) can be sent over the same persistent connection.
  - ii. With nonpersistent connections between browser and origin server, it is possible for a single TCP segment to carry two distinct HTTP request messages.
  - iii. HTTP response messages never have an empty message body.[ 6 marks]
- d) Name any three servers in the DNS hierarchy, briefly stating their role.[6marks]

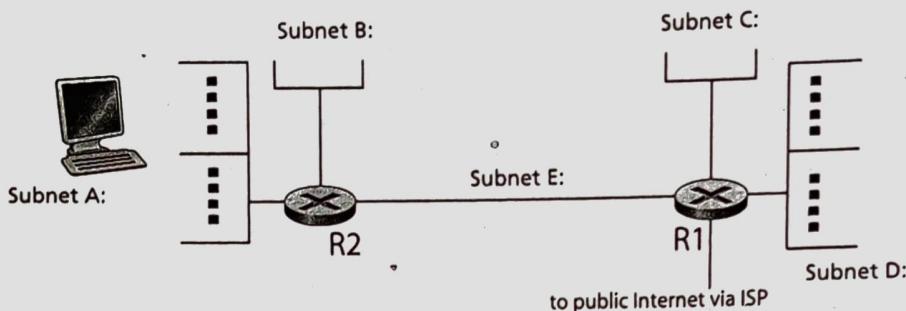
### **Question 2**

- a) During any communication, usually nodes on each side of a link have a limited amount of packet buffering capacity. Name and explain the service used to avoid buffer overflow at the receiving node? [4 Marks]
- b) With the help of a diagram explain how TCP achieves the service in (a) above. [4 Marks]
- c) TCP Provides reliable delivery of segments to ensure that all the data arrives at the destination. Explain how this reliability is achieved. [4 marks]
- d) Why does UDP exist? Would it not have been enough to just let user processes send raw IP packets? [4 Marks]
- e) An application may choose UDP for a transport protocol because UDP offers finer application control (than TCP) of what data is sent in a segment and when.
  - i. Why does an application have more control of what data is sent in a segment? [2 marks]
  - ii. Why does an application have more control on when the segment is sent? [2 marks]

### **Question 3**

- a) What is subnetting and why is it done? [2 marks]

- b) Consider the network shown below. Each of the subnets A-D contains at most 30 hosts; subnet E connects routers R1 and R2.



Assign network addresses to the five subnets shown above, with the following constraints: (i) All addresses must be allocated from 214.97.254.0/24; (ii) Subnet A should have enough addresses to support 60 interfaces; (iii) Subnet B should have enough addresses to support 30 interfaces; (iv) Subnet C should have enough addresses to support 30 interfaces. (v) Subnets E should each be able to support two interfaces.

- For each subnet, the assignment should take the form a.b.c.d/x or a.b.c.d/x - e.f.g.h/y.
- [10 marks]

- c) Suppose you purchase a wireless router from an ISP. Your ISP dynamically assigns your wireless router an (one) IP address. Suppose you have five PCs at home that wirelessly connect to your wireless router
- How are IP addresses assigned to the five PCs? [3 marks]
  - Does the wireless router use NAT? Why or why not? [2 marks]
  - Explain three benefits of NAT. [3 marks]

#### Question 4

- a) Give two reasons why networks might use an error-correcting code instead of error detection and retransmission. [2 Marks]
- b) Suppose a frame has the bit pattern 1110 0110 1001 1101. Assuming an even parity scheme is being used.
- What would the value of the field containing the parity bits be for the case of a two-dimensional parity scheme? [3 marks]
  - If there was an error on the first bit of the first word (1110), Show how it is detected. [3 marks]
- c) Suppose nodes A, B, and C each attach to the same broadcast LAN (through their adapters).

- i. If Node A sends thousands of IP datagrams to Node B with each encapsulating frame addressed to the MAC address of Node B, will Node C's adapter process these frames? **[2 marks]**
  - ii. How would your answer change if A sends frames with the MAC broadcast address? **[2 marks]**
  - iii. Give a precise statement of conditions under which a Switch will forward a packet. **[2 Marks]**
- d) Briefly explain three approaches to link access on a shared medium. **[6 marks]**

**MAKERERE UNIVERSITY**

**COLLEGE OF COMPUTING & INFORMATION SCIENCES**

**SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY**

**END OF SEMESTER I EXAMINATION 2017/2018**

**YEAR OF STUDY: II**

**COURSE NAME: COMPUTER NETWORKS**

**COURSE CODE: BSE 2106**

**DATE: 27<sup>th</sup> November 2017**

**TIME: 12PM - 3PM**

**EXAMINATION INSTRUCTIONS**

- a) ATTEMPT ONLY FIVE QUESTIONS (20 MARKS EACH).
- b) DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
- c) ATTEMPT EACH QUESTION ON A NEW PAGE OF THE ANSWER BOOKLET
- d) ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

### **Question One**

MarkQ is a South African based company, which was founded in 1996 by a group of IT professionals in business solutions of Computer Equipment, Network Infrastructure, Network Security, Web Site Design and Software Development in South Africa. It has sales and technical support offices in Botswana, Zimbabwe and Mozambique devoted to providing the highest quality professionals in the IT industry. With the openness of the global information technology market and expansion on a daily basis, MarkQ is planning to set up their offices in Kampala, Uganda and key to their operations will be the design of a network.

- a) Using examples, advise MarkQ on the five key factors they have to consider in selection of the transmission media to be used in the network design **(5 Marks)**
- b) The Botswana and Zimbabwe offices are inter-connected via a cross-border optical fiber connection;
  - i. Using a clearly labelled diagram, describe the components of an optical fiber cable **(6 Marks)**
  - ii. Explain four benefits of this optical fiber connection between the two offices of MarkQ **(4 Marks)**
  - iii. State two fiber transmission modes **(2 Marks)**
- c) MarkQ has future plans of implementing a line of sight transmission between the main Uganda office (Kampala) and its countrywide branches to be set up. Examine the defects likely to be associated with this type of wireless transmission. **(3 Marks)**

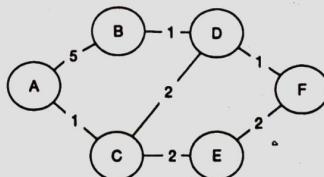
### **Question Two**

- a) What are the characteristics of IP Protocol? **(3 Marks)**
- b) What is the short form of 2041:0000:140F:079F:0000:0000:131B? **(3 Marks)**
- c) Suppose a router has built up a routing table shown in the Table below.

| <b>SubnetNumber</b> | <b>SubnetMask</b> | <b>NextHop</b> |
|---------------------|-------------------|----------------|
| 128.96.170.0        | 255.255.254.0     | Interface 0    |
| 128.96.168.0        | 255.255.254.0     | Interface 1    |
| 128.96.166.0        | 255.255.254.0     | R2             |
| 128.96.164.0        | 255.255.252.0     | R3             |
| {default}           |                   | R4             |

The router can deliver packets directly over interfaces 0 and 1, or it can forward packets to routers R2, R3, or R4. Assume the router does the longest prefix match. Describe what the router does with a packet addressed to each of the following destinations: **(4 marks)**

- i. 128.96.167.151.
  - ii. 128.96.163.151
  - iii. 128.96.169.192.
  - iv. 128.96.165.121.
- d) Consider the network shown in the figure below, with the indicated link costs. Use Dijkstra's shortest path algorithm to compute the graph of the shortest path from A to all network nodes (please show your working) **(6 Marks)**



- e) Suppose that instead of using 16 bits for the network part of a class B address originally, 20 bits had been used. How many class B networks would there have been? **(2 Marks)**
- f) A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts it can handle? **(2 Marks)**

### Question Three

- a) HTTP is the Web's application-layer protocol that operates in a client-server mode. Alice, a prospective student of Makerere University, is trying to access a web page on <https://www.mak.ac.ug/admissions/academic-programmes>;
  - i. Illustrate the client-server communication process involved in accessing the above web page using:
    - a) Persistent HTTP **(3 Marks)**

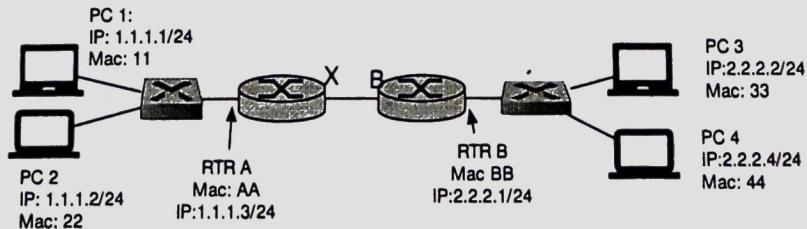
b) Non-persistent HTTP

(3 Marks)

- b) Two students one from Makerere University and the other from Nairobi University have emails dalice@cis.mak.ac.ug and kbob@uon.ac.ke respectively. The students are conducting a joint research project. Given the geographical distance between these two institutions, the main mode of communication will be electronic mail.
- Describe the three main components of electronic mail using examples and the text above. (4 Marks)
  - List two mail access protocols likely to be used in the communication (2 Marks)
- c) What are the roles of the following servers in relation Domain Name Services (DNS)
- Root DNS server (2 Marks)
  - Authoritative DNS server (2 Marks)
  - Recursive DNS server (2 Marks)
- d) ARP and DNS both depend on caches; ARP cache entry lifetimes are typically 10 minutes, while DNS cache is on the order of days. What undesirable consequences might there be in having too long a DNS cache entry lifetime? (2 Marks)

#### Question Four

- Name the two sublayers of Layer 2 protocols defined by IEEE, and give the purpose of each. (4 Marks)
- Having ARP table entries time out after 10 to 15 minutes is an attempt at a reasonable compromise. Describe the problems that can occur if the timeout value is too small or too large. (3 marks)
- How does a computer attached to a shared LAN decide whether to accept a packet? (3 Marks)
- Expand the acronym CSMA/CD, and explain each part and why does CSMA/CD use a random delay? (4 Marks)
- Explain why collision is an issue in a random-access protocol but not in controlled access or channelizing protocols. (3 Marks)
- If PC1 issues an ARP request for IP: 2.2.2.2, which MAC address will PC1 receive? Explain your answer. (3 Marks)



### **Question Five**

- a) Considering UDP's unreliable service, give two reasons for its continued use (2 Marks)
- b) Name any two applications that use UDP (1 mark)
- c) Illustrate with a diagram the TCP segment structure briefly explaining the purpose of six of the segment fields (5 Marks)
- d) Discuss how TCP achieves the following Transport services
  - i. Reliable Data Transfer (3 marks)
  - ii. Flow Control (3 marks)
  - iii. Connection Management (3 marks)
  - iv. Congestion Control (3 marks)

### **Question Six**

- a) Using an illustration, give the difference between packet switching and circuit switching (3 Marks)
- b) Discuss the following as they relate to IP networks
  - i. Network Address Translation (2 marks)
  - ii. Datagram Networks (2 marks)
  - iii. IP Fragmentation and Reassembly (2 marks)
  - iv. ICMP (2 marks)
- c) Data link protocols almost always put the CRC in a trailer rather than in a header. Why? (3 Marks)
- d) Give two reasons why networks might use an error-correcting code instead of error detection and retransmission. (3 Marks)
- e) Store-and-forward switches have an advantage over cut-through switches with respect to damaged frames. Explain what it is. (3 Marks)

- END -

# MAKERERE UNIVERSITY

## COLLEGE OF COMPUTING & INFORMATION SCIENCES SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY TEST I

### BSE 2106: Computer Networks

DATE: 22<sup>nd</sup> October 2017

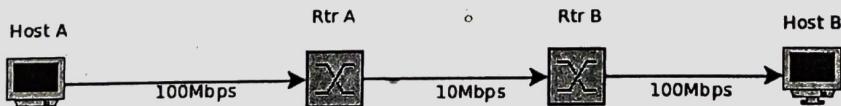
Time Allowed: 1 hour

#### Instructions:

- i. Attempt **ALL** the questions.
- ii. Answer to every question should be started on a fresh page.

#### Question One

- a) Define the Internet from:
  - i. an infrastructure view (2 Marks)
  - ii. a service view (2 Marks)
- b)
  - i. Using illustrations, give the differences between packet switching and circuit switching (4 Marks)
  - ii. Given the network segment below, calculate the total transmission delay given Host A is sending a 0.12GB e-mail file to Host B (6 Marks)



- c) Define the following concepts in the structure of the Internet and state their relevance,
  - i. Peering (2 Marks)
  - ii. Content provider network (2 Marks)
  - iii. IXP (2 Marks)

*[Handwritten signature]*

## **Question two**

- a) Briefly compare TCP and UDP transport layer protocols (2 Marks)
- b) Describe the UDP segment structure explaining the purpose of each of the fields (4 Marks)
- c) Discuss the purpose of each of the following in relation to Reliable Data Transfer (2 Marks each)
  - a. Checksum
  - b. Acknowledgements
  - c. Negative Acknowledgements
  - d. Sequence numbers
  - e. Countdown timer

## **Question three**

- a) A communication channel provided by an Internet Service Provider (ISP) is used to transmit e-mails and real-time video. Describe the transport services required by each of these two applications (4 Marks)
- b) A student from the University of Nairobi (uon.ac.ke) is accessing a web application server arims.mak.ac.ug hosted at Makerere University. Using appropriate DNS architecture illustrations, explain the following types of queries:
  - i. Iterated query (2 Marks)
  - ii. Recursive Query (2 Marks)
- c) Describe three mail access protocols indicating the standard secure application ports used by each (6 Marks)

**~ END ~**



MAKERERE UNIVERSITY  
COLLEGE OF COMPUTING & INFORMATION SCIENCES  
SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY

END OF SEMESTER I EXAMINATION 2017/2018

YEAR OF STUDY: II

COURSE NAME: COMPUTER NETWORKS

COURSE CODE: BSE 2106

DATE: 27<sup>th</sup> November 2017

TIME: 12PM - 3PM

EXAMINATION INSTRUCTIONS

- a) ATTEMPT ONLY FIVE QUESTIONS (20 MARKS EACH).
- b) DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
- c) ATTEMPT EACH QUESTION ON A NEW PAGE OF THE ANSWER BOOKLET
- d) ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

### Question One

MarkQ is a South African based company, which was founded in 1996 by a group of IT professionals in business solutions of Computer Equipment, Network Infrastructure, Network Security, Web Site Design and Software Development in South Africa. It has sales and technical support offices in Botswana, Zimbabwe and Mozambique devoted to providing the highest quality professionals in the IT industry. With the openness of the global information technology market and expansion on a daily basis, MarkQ is planning to set up their offices in Kampala, Uganda and key to their operations will be the design of a network.

- a) Using examples, advise MarkQ on the five key factors they have to consider in selection of the transmission media to be used in the network design (*5 Marks*)
- b) The Botswana and Zimbabwe offices are inter-connected via a cross-border optical fiber connection;
  - i. Using a clearly labelled diagram, describe the components of an optical fiber cable (*6 Marks*)
  - ii. Explain four benefits of this optical fiber connection between the two offices of MarkQ (*4 Marks*)
  - iii. State two fiber transmission modes (*2 Marks*)
- c) MarkQ has future plans of implementing a line of sight transmission between the main Uganda office (Kampala) and its countrywide branches to be set up. Examine the defects likely to be associated with this type of wireless transmission. (*3 Marks*)

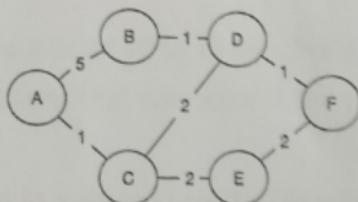
### Question Two

- a) What are the characteristics of IP Protocol? (*3 Marks*)
- b) What is the short form of 2041:0000:140F:079F:0000:0000:131B? (*3 Marks*)
- c) Suppose a router has built up a routing table shown in the Table below.

| SubnetNumber | SubnetMask    | NextHop     |
|--------------|---------------|-------------|
| 128.96.170.0 | 255.255.254.0 | Interface 0 |
| 128.96.168.0 | 255.255.254.0 | Interface 1 |
| 128.96.166.0 | 255.255.254.0 | R2          |
| 128.96.164.0 | 255.255.252.0 | R3          |
| (default)    |               | R4          |

The router can deliver packets directly over interfaces 0 and 1, or it can forward packets to routers R2, R3, or R4. Assume the router does the longest prefix match. Describe what the router does with a packet addressed to each of the following destinations: (4 marks)

- i. 128.96.167.151.
  - ii. 128.96.163.151
  - iii. 128.96.169.192.
  - iv. 128.96.165.121.
- d) Consider the network shown in the figure below, with the indicated link costs. Use Dijkstra's shortest path algorithm to compute the graph of the shortest path from A to all network nodes (please show your working) (6 Marks)



- e) Suppose that instead of using 16 bits for the network part of a class B address originally, 20 bits had been used. How many class B networks would there have been? (2 Marks)
- f) A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts it can handle? (2 Marks)

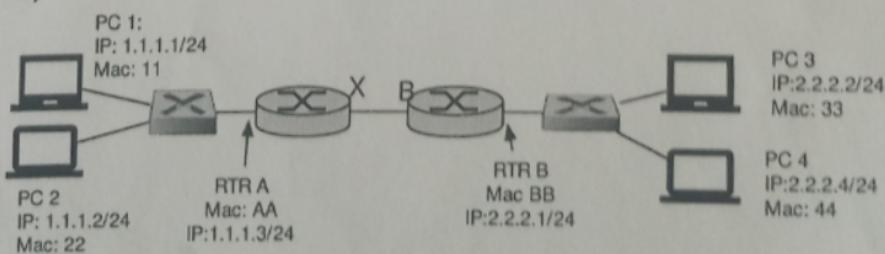
### Question Three

- a) HTTP is the Web's application-layer protocol that operates in a client-server mode. Alice, a prospective student of Makerere University, is trying to access a web page on <https://www.mak.ac.ug/admissions/academic-programmes>;
  - i. Illustrate the client-server communication process involved in accessing the above web page using:
    - a) Persistent HTTP (3 Marks)

- b) Non-persistent HTTP (3 Marks)
- b) Two students one from Makerere University and the other from Nairobi University have emails dalice@cis.mak.ac.ug and kbob@uon.ac.ke respectively. The students are conducting a joint research project. Given the geographical distance between these two institutions, the main mode of communication will be electronic mail.
- Describe the three main components of electronic mail using examples and the text above. (4 Marks)
  - List two mail access protocols likely to be used in the communication (2 Marks)
- c) What are the roles of the following servers in relation Domain Name Services (DNS)
- Root DNS server (2 Marks)
  - Authoritative DNS server (2 Marks)
  - Recursive DNS server (2 Marks)
- d) ARP and DNS both depend on caches; ARP cache entry lifetimes are typically 10 minutes, while DNS cache is on the order of days. What undesirable consequences might there be in having too long a DNS cache entry lifetime? (2 Marks)

#### Question Four

- a) Name the two sublayers of Layer 2 protocols defined by IEEE, and give the purpose of each. (4 Marks)
- b) Having ARP table entries time out after 10 to 15 minutes is an attempt at a reasonable compromise. Describe the problems that can occur if the timeout value is too small or too large. (3 marks)
- c) How does a computer attached to a shared LAN decide whether to accept a packet? (3 Marks)
- d) Expand the acronym CSMA/CD, and explain each part and why does CSMA/CD use a random delay? (4 Marks)
- e) Explain why collision is an issue in a random-access protocol but not in controlled access or channelizing protocols. (3 Marks)
- f) If PC1 issues an ARP request for IP: 2.2.2.2, which MAC address will PC1 receive? Explain your answer. (3 Marks)



### Question Five

- a) Considering UDP's unreliable service, give two reasons for its continued use (2 Marks)
- b) Name any two applications that use UDP (1 mark)
- c) Illustrate with a diagram the TCP segment structure briefly explaining the purpose of six of the segment fields (5 Marks)
- d) Discuss how TCP achieves the following Transport services
  - i. Reliable Data Transfer (3 marks)
  - ii. Flow Control (3 marks)
  - iii. Connection Management (3 marks)
  - iv. Congestion Control (3 marks)

### Question Six

- a) Using an illustration, give the difference between packet switching and circuit switching (3 Marks)
- b) Discuss the following as they relate to IP networks
  - i. Network Address Translation (2 marks)
  - ii. Datagram Networks (2 marks)
  - iii. IP Fragmentation and Reassembly (2 marks)
  - iv. ICMP (2 marks)
- c) Data link protocols almost always put the CRC in a trailer rather than in a header. Why? (3 Marks)
- d) Give two reasons why networks might use an error-correcting code instead of error detection and retransmission. (3 Marks)
- e) Store-and-forward switches have an advantage over cut-through switches with respect to damaged frames. Explain what it is. (3 Marks)

- END -

MAKERERE UNIVERSITY  
COLLEGE OF COMPUTING & INFORMATION SCIENCES  
SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY

END OF SEMESTER I EXAMINATION 2016/17

PROGRAMME: CSC, BIT & BSSE

YEAR OF STUDY: II

COURSE NAME: Computer Networks

COURSE CODE: BSE 2106

DATE: 30<sup>TH</sup> JAN 2017

TIME: 12:00 – 3:00 PM

EXAMINATION INSTRUCTIONS

1. ATTEMPT ALL QUESTIONS IN SECTION A (40 MARKS)
2. ATTEMPT THREE (03) QUESTIONS IN SECTIONS B (60 MARKS)
3. DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
4. ATTEMPT EACH QUESTION IN SECTION B ON A NEW PAGE
5. ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

## SECTION A (40 marks)

- 1) What is encapsulation and how is it carried out at the network layer. [2marks]
- 2)
  - a) Name four services offered by the link layer to the network layer [2marks]
  - b) Which of the link-layer services (named in 2(a) above) have corresponding services in IP? [1 mark]
  - c) Which of the link-layer services (named in 2(a) above) have corresponding services in TCP? [1 mark]
- 3) What is a cookie in computer networks and what is it used for? [3marks]
- 4) Give two reasons for using layered protocols? [2 marks]
- 6) List two advantages and two disadvantages of having international standards for network protocols. [4 marks]
- 7) Differentiate between connection oriented and connectionless protocols. Give an example of each. [4 marks]
- 8) 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.
  - a) What transport and application-layer protocols besides HTTP are needed in this scenario? [2 marks]
  - b) What role will each protocol given in (a) above play? [2 marks]
- 9)
  - a) What is ARP in full and what is it for? [ 2marks]
  - b) Why is an ARP query sent within a broadcast frame? [ 2marks]
  - c) Why is an ARP response sent within a frame with a specific destination MAC address? [ 2marks]
- 10)
  - a) What is CSMA/CD in full? [1 marks]
  - b) Briefly explain how it works. [4 marks]
- 11) Explain the importance of the following numbers in regards to TCP. [6 marks]
  - a) Sequence number
  - b) Acknowledgement number
  - c) Port number

## SECTION B (60 marks)

### Question 1

- a) Using diagrams, explain how SMTP and POP work together to ensure emails are delivered from a sender's computer to the recipient's computer. [4 marks]
- b) From an ISP's point of view, POP3 and IMAP differ in an important way. POP3 users generally empty their mailboxes every day. IMAP users keep their mail on the server indefinitely. Imagine that you were called in to advise an ISP on which protocol it should support. What considerations would you bring up? [4 marks]
- c) For each of the following statements, state whether the statement is "true" or "false" and provide an explanation for your choice.
  - i. Two distinct Web pages (for example, [www.mit.edu/research.html](http://www.mit.edu/research.html) and [www.mit.edu/students.html](http://www.mit.edu/students.html)) can be sent over the same persistent connection.
  - ii. With nonpersistent connections between browser and origin server, it is possible for a single TCP segment to carry two distinct HTTP request messages.
  - iii. HTTP response messages never have an empty message body.[ 6 marks]
- d) Name any three servers in the DNS hierarchy, briefly stating their role.[6marks]

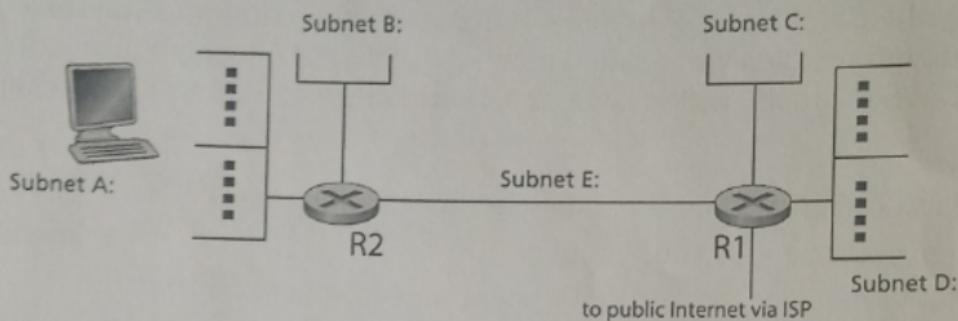
### Question 2

- a) During any communication, usually nodes on each side of a link have a limited amount of packet buffering capacity. Name and explain the service used to avoid buffer overflow at the receiving node? [4 Marks]
- b) With the help of a diagram explain how TCP achieves the service in (a) above. [4 Marks]
- c) TCP Provides reliable delivery of segments to ensure that all the data arrives at the destination. Explain how this reliability is achieved. [4 marks]
- d) Why does UDP exist? Would it not have been enough to just let user processes send raw IP packets? [4 Marks]
- e) An application may choose UDP for a transport protocol because UDP offers finer application control (than TCP) of what data is sent in a segment and when.
  - i. Why does an application have more control of what data is sent in a segment? [2 marks]
  - ii. Why does an application have more control on when the segment is sent? [2 marks]

### Question 3

- a) What is subnetting and why is it done? [2 marks]

- b) Consider the network shown below. Each of the subnets A-D contains at most 30 hosts; subnet E connects routers R1 and R2.



Assign network addresses to the five subnets shown above, with the following constraints: (i) All addresses must be allocated from 214.97.254.0/24; (ii) Subnet A should have enough addresses to support 60 interfaces; (iii) Subnet B should have enough addresses to support 30 interfaces; (iv) Subnet C should have enough addresses to support 30 interfaces. (v) Subnets E should each be able to support two interfaces. For each subnet, the assignment should take the form a.b.c.d/x or a.b.c.d/x - e.f.g.h/y.

[10 marks]

- c) Suppose you purchase a wireless router from an ISP. Your ISP dynamically assigns your wireless router an (one) IP address. Suppose you have five PCs at home that wirelessly connect to your wireless router
- How are IP addresses assigned to the five PCs? [3 marks]
  - Does the wireless router use NAT? Why or why not? [2 marks]
  - Explain three benefits of NAT. [3 marks]

#### Question 4

- a) Give two reasons why networks might use an error-correcting code instead of error detection and retransmission. [2 Marks]
- b) Suppose a frame has the bit pattern 1110 0110 1001 1101. Assuming an even parity scheme is being used.
- What would the value of the field containing the parity bits be for the case of a two-dimensional parity scheme? [3 marks]
  - If there was an error on the first bit of the first word (1110), Show how it is detected. [3 marks]
- c) Suppose nodes A, B, and C each attach to the same broadcast LAN (through their adapters).

- i. If Node A sends thousands of IP datagrams to Node B with each encapsulating frame addressed to the MAC address of Node B, will Node C's adapter process these frames? [2 marks]
  - ii. How would your answer change if A sends frames with the MAC broadcast address? [2 marks]
  - iii. Give a precise statement of conditions under which a Switch will forward a packet. [2 Marks]
- d) Briefly explain three approaches to link access on a shared medium. [6 marks]

MAKERERE UNIVERSITY

SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY

END OF SEMESTER II EXAMINATION 2015/2016

cookies, web proxies

PROGRAMME: BSE, BIT, CS

YEAR OF STUDY: II

COURSE NAME: COMPUTER NETWORKS

COURSE CODE: BSE2106

DATE: 09 December 2015

TIME: 12:00 – 3:00 pm

EXAMINATION INSTRUCTIONS

ATTEMPT ALL QUESTIONS IN SECTION A (40 MARKS)

ATTEMPT THREE (03) QUESTIONS IN SECTION B (60 MARKS)

DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO

ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

SECTION A [40 Marks]

Dm

- a) Define the term computer networks (2marks)
- b) State any two reasons why it's important to change your password frequently (2marks)
- c) Challenge-response authentication can be divided into four categories: State the four categories (2marks)
  - Symmetric cipher
  - Keyed hash function
  - Digital Signature
  - Asymmetric keyed cipher (4marks)
- d) Define a hash function and briefly explain three hash function criteria (2marks)
- e) Classification of computer networks depend on three characteristics. Briefly explain them (3marks)
  - Wired, Wired, Point-to-point
- f) Explain any three factors you would consider when selecting a network topology (3marks)
- g) State the OSI layers that don't appear in the TCP/IP model and describe one service each layer provides to the upper layers (4marks)
- h) With aid of a diagram explain the components of a communication system (5marks)
  - i. Write brief notes about the following network categories (1mark@)
    - i. MAN
    - ii. WAN
- j) With aid of a diagram explain the three transmission modes (3marks)
  - Simplex, Half duplex, Full duplex
- k) With aid of a diagram explain the four basic topologies and state any one advantage of each (6marks)
  - bus-star, mesh-ring
- l) A hash function guarantees the integrity of a message and does not authenticate the sender of the message. To provide message authentication, we need to change a modification detection code to a message authentication code. If Alice was sending a message to Bob, explain how Alice uses a keyed hash function to authenticate her message and how Bob can verify the authenticity of the message. (4marks)

→ One-way  
msg.

## SECTION B [60 Marks]

### Question 1

- a. State any two differences and two similarities between OSI and TCP/IP models (4marks)
- b. State the four fundamental characteristics that determine the effectiveness of a data communications system - ~~Integrity~~ Confidentiality, ~~Delivery~~ Authentication, ~~Authenticity~~ ~~Access~~ ~~Control~~ (4marks)
- c. With aid of a diagram explain the difference between hop-to-hop delivery and source-to-destination delivery (4marks)
- d. State all the TCP/IP layers and describe any one protocol found on each of the layers - ~~Application - HTTP, FTP, DNS~~ Internet IP  
- ~~Transport - UDP, TCP~~ Network Layer (6marks)
- e. Explain the difference between UDP and TCP - ~~confidentiality~~ ~~integrity~~ ~~authentication~~ ~~Delivery~~ ~~non-repudiation~~ ~~docs~~ create connection between peer and peer by sending the msg and accessible to user (2marks)

Application

HTTP  
FTP  
DNS

Transport Layer  
TCP  
UDP

Internet Layer  
IP

Network Layer

### Question 2

- a) Cryptography can provide five security services. Explain the five services (5marks)
- b) Explain the difference between asymmetric and a symmetric key cryptographies (2marks)
- c) In entity authentication, a claimant proves her identity to the verifier by using one of the three kinds of witnesses: Briefly explain them. - Some may know secret key or have access to shared public key or prove identity (3marks)
- d) Briefly explain any four ways to distribute public keys - Public key announcement, Trusted third parties (4marks) certificate authority
- e) With aid of diagrams explain how confidentiality with Symmetric-Key Cryptography is different from confidentiality with Asymmetric-Key Cryptography (6marks)

### Question 3

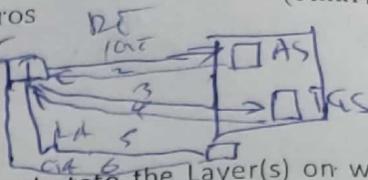
- a) A signature can either be Conventional or Digital. Discuss the differences between two types of signatures - Conventional - one to many - Signature - doc, letter  
Digital - one to one - Signature - msg (4marks)
- b) Digital signature can be achieved in two ways: signing the document or signing a digest of the document. Explain how they differ - Signing - sender applies his private key to the document  
- msg digest - apply the function to get fixed size (2marks)
- c) A digital signature can provide three out of the five security services. State and explain how these services can be achieved - Confidentiality  
- Integrity  
- Authentication (3marks)
- d) Symmetric-key cryptography is more efficient than Asymmetric key cryptography when we need to encrypt and decrypt large messages but needs a shared secret key between two parties. The problem with Symmetric-key cryptography is the number of keys and how to distribute them especially when dealing with a large group. Explain how Key

Ans

Distribution Center maintain and distribute secret keys.

- e) Kerberos is an authentication protocol and at the same time a Key Distribution Center that has become very popular. Explain the operation of Kerberos (5marks)

- AS (Authentication Server)
- TGS (Ticket Granting Server)
- KDC (Key Distribution Center)



#### Question 4

- a) Write brief notes about the following network devices and state the Layer(s) on which they operate (2marks@)

- I. Three-Layer Switch - used at network layer, kind of integrated in Bridge
- II. Bridge - carries frame & operates in the physical & data link layers
- III. Transparent Bridge - can forward & filter frames & automatically build MAC table
- IV. Gateway - takes an application message, reads it & interprets it.

- b) State any four characteristics that can be used by vendors to group stations in a VLAN?

Port numbers, MAC addresses, IP addresses, (2marks)

- c) State any three advantages of using VLANs. - Cost & time reduction. (3marks) ~~convenience of broadcast domain~~

- d) In a multi-switched backbone, each switch must know not only which station belongs to which VLAN, but also the membership of stations connected to other switches. State the three methods that have been devised for this purpose: - ~~TDM~~

- (3marks)
  - Table maintenance
  - frame tags

- e) Write brief notes about the following architectures as used in backbone networks

- I. The bus (2marks)

- II. The star (2marks)

#### Question 5

- a. Define the following terms as far as Cellular telephone and Satellite Networks are concerned

- i. Roaming (1mark)
- ii. Footprint (1mark)
- iii. Reuse factor (1mark)
- iv. Period of a satellite (1mark)

- b. Explain the three categories of satellites (1mark)

- c. Explain the two types of handoff (3marks)  
(2marks)

- d. Define the term Orbit and explain the three types of satellite orbits (4marks)
- e. According to Kepler's law, what is the period of a satellite in hours that is located at an orbit approximately 35,786 km above the Earth? Assume the diameter of the earth is 9813miles  
(1mile=1.3km) (5marks)
- What is the relationship between the Van Allen Belts and satellites? (2marks)

**GOOD LUCK**

MAKERERE UNIVERSITY  
COLLEGE OF COMPUTING AND INFORMATION SCIENCES

ROUND TWO TEST  
PROGRAMME:  
YEAR OF STUDY:  
COURSE NAME:  
COURSE CODE:  
DATE:

BIT, BCSC, BSE  
II  
COMPUTER NETWORKS  
BSE 2106  
21/11/2015

- a. Briefly explain any 3 ways to distribute public keys (3marks)
- b. Define the following terms as far as Cellular telephone and satellite networks are concerned (1mark)
- i. Roaming (1mark)
  - ii. Footprint (1mark)
  - iii. Reuse factor (1mark)
  - iv. Period of a satellite (1mark)
- c. Explain the three categories of satellites (3marks)
- d. Explain the two types of handoff (2marks)
- e. Define the term Orbit and explain the three types of satellite orbits (4marks)
- f. According to Kepler's law, what is the period of a satellite in hours that is located at an orbit approximately 35,786 km above the Earth? Assume the diameter of the earth is 9813 miles (1mile=1.3km) (4marks)
- g. What is the relationship between the Van Allen Belts and satellites? (2marks)
- h. Write brief notes about the following network devices (4marks)
- I. Repeater - It regenerates signals on the media
  - II. Bridge
  - III. Passive hub - It passes signals thru it and doesn't add any
  - V. Transparent Bridges

State any 4 characteristics that can be used by vendors to group stations in a VLAN? (4marks)

Thermal noise, induced noise,  
Crosstalk, impulse noise

- Distorted signal changes to form a shape.

passive hub - connector.

active hub - multiplex repeater.

### SECTION A (40 MARKS)

1. Why are standards needed in data communication? [2 marks]
2. State the three steps involved in Pulse Code Modulation. [3 marks]
3. Match the following to one or more layers of the OSI model. [4 marks]
  - i. Route determination
  - ii. Flow control
  - iii. Interface to transmission media
  - iv. Providing access for the end user
4. a) What is attenuation? [2 marks]  
b) Apart from attenuation, name the other types of transmission impairment. [2 marks]  
c) A signal travels from point A to point B. At point A, the signal power is 100 W. At point B, the power is 90 W. What is the attenuation in decibels? [3 marks]
5. Explain the following terms in regard to network security. [8 marks]
  - i. Message authentication
  - ii. Message integrity
  - iii. Message confidentiality
  - iv. Non-repudiation.
6. Five channels, each with a 100 kHz bandwidth, are to be multiplexed together.
  - i. What is the minimum bandwidth of the link if there is a need for a guard band of 10 kHz between the channels to prevent interference?
  - ii. Show the configuration using the frequency domain. [4 marks]
7. Explain the role of each of the following network devices and state the layer of the OSI model that the device operates on.
  - i. Hub [2 marks]
  - ii. Bridge [2 marks]
  - iii. Router - Network layer [2 marks]
8. What do you understand by the following terms as used in cellular telephony?
  - i. Hard hand-off? [2 marks]
  - ii. Soft hand-off? [2 marks]
  - iii. Roaming? [2 marks]

Internet Connection for Assignments  
ICAN → IP address

SECTION B (60 Marks)

~~60 Marks~~ → 28 marks

**Question One**

- Define the term Multiplexing [1 mark]
- Which of the three multiplexing techniques is commonly used for
  - Fibre optic links? [2 marks]
  - Digital data? [2 marks]
- Ten sources, six with a bit rate of 200 kbps and four with a bit rate of 400 kbps are to be combined using multilevel TDM with no synchronizing bits. Calculate:
  - The size of a frame in bits? [2 marks]
  - The frame rate? [2 marks]
  - The duration of a frame? [2 marks]
  - The data rate? [2 marks]
- Give any four applications of Frequency Division Multiplexing. [4 marks]
- Define Spread Spectrum and cite any three of its advantages. [5 marks]

**Question Two**

- State Shannon's law as applied in communication networks. [2 marks]
- Give any THREE types of noise in transmission of signals in data communication.
- UBC has a channel with 4 MHz band width. If the company needs to send data at a rate of 100 Mbps, calculate
  - The SNR? [3 marks]
  - The SNR in decibels? [2 marks]
  - The theoretical number of signal levels. [3 marks]
- A non-periodic composite signal has a bandwidth of 300 MHz, with a middle frequency of 150 MHz and peak amplitude of 55 V. The two extreme frequencies have an amplitude of 25 V.
  - Calculate the values of the extreme frequencies. [4 marks]
  - Draw the frequency spectrum of the signal. [2 marks]

**Question Three**

- Define the following terms as applied to encoding.
  - Signal element [2 marks]
  - Data element [2 marks]
  - bit rate [2 marks]
  - pulse rate / [2 marks]

Find an 8-bit data stream for each of the cases below if the first bit was 1.

# MAKERERE UNIVERSITY

WDM  
WA  
+22+23

Engg & Infrastruc  
Security request  
B, M, 15 321  
TR, 19

COLLEGE OF COMPUTING AND INFORMATION SCIENCES  
DEPARTMENT OF NETWORKS

19/12/14  
Engineering  
Dept

END OF SEMESTER I EXAMINATION FOR 2014/2015

COURSE NAME: COMPUTER NETWORK

COURSE CODE: BSE 2106

YEAR OF STUDY: II



DURATION: 3 HOURS

Date: 9<sup>th</sup> December 2014 Time: 12.00PM-3.00PM

## INSTRUCTIONS:

1. All answers must be written in the answer sheet provided.
2. Attempt ALL questions in section A and ANY FOUR questions in B
3. Clearly indicate the question Number that you are attempting
4. Begin Each question in section B on a new Page

Each page has to  
may not need same  
page.

Identity provided by the party  
same as

Attenuation  $\Rightarrow$  Reduction in amplitude  
is produced by reflection

of signal during data transmission  
in communication line

## SECTION A [ 40 Marks ]

a) Layering is a key design principle in computer networks.

- (i) Use no more than three sentences to describe two advantages of layering.  
Modularity  $\Rightarrow$  protocols are easier to manage and maintain.  
Abstraction clarity  $\Rightarrow$  lower level layers can be changed without affecting the upper layers. (2 marks)
- (ii) Use no more than three sentences to describe one disadvantage of layering.

(2 marks)

b) Carrier error in data mostly transmitted over telephone wire. (Causes of errors)  
Noise, Thermal noise, induced, cross talk may corrupt the signal. (3 marks)

c) Distortion  $\Rightarrow$  Any undesired change in wave form of an electric signal. (including causes of distortion)

d) Explain why the Internet DNS uses caching.  
DNS cache containing entries (Data) that facilitate Internet domain name to IP address conversion. (2 marks)

Three cache providers are efficient way for DNS to efficiently keep the Internet synchronized.

e) Differentiate between Twisted pair Cable, Co-axial, and Fiber optic cable.

Twisted pair cable  $\Rightarrow$  finds a suitable path for Pkt from source to destination / forwarder to proceed to next hop. (3 marks)

each of them  $\Rightarrow$  tells where to send data while forwarder is way to send data across the network. (3 marks)

forwarder determines the next hop IP address where it will send Pkt based on destination IP. (3 marks)

f) Compare CSMA/CA with CSMA/CD.  
CSMA/CA - allows multiple access with collision avoidance. (2 marks)

CSMA/CD - tells the station what to do when collision detected. (2 marks)

g) Why does IEEE 802.11 use CSMA/CA instead of CSMA/CD? (2 marks)

ii) What is throughput measure of how fast we can send data through a link. (2 marks)

It's a measure of how fast we can send data through a network. (2 marks)

FDM  $\Rightarrow$  frequency division multiplexing  $\Rightarrow$  analog technique that can be applied over analog TDM  $\Rightarrow$  time division multiplexing  $\Rightarrow$  digital multiplexing technique for combining several low rate signals into one high rate signal.

k) Briefly explain the difference between a network and internet? (2 marks)

l) Briefly explain the difference between circuit switching and packet switching. (2 marks)

m) Name 2 well known data protocols provided by the Internet Transport layer and briefly describe service of each. (4 marks)

(4 marks)

n) What is Instantaneous rate in throughput? (1 Mark)

o) What is average rate in throughput? (1 Mark)

need to consider multiple users holding

CFC in data  
(imported in  
desired unit)

#### Question 4

- Question 4

  - Describe how congestion occurs in computer networks and name the indicators of network congestion? (3 Marks)
  - What is the logical difference between transport layer and network layer? (2 Marks)
  - Explain the error detection method that operates at the transport layer? (5 Marks)  
*(Checksum.)*
  - What command can we use in windows networked computers to see the "real" Internet delay & loss in computer networks? (1 Mark)
  - Explain four sources of packet loss in a computer network. (4 Marks)  
*(noise, attenuator, def. twisted pair, interference, signal, capacity, delay, link circuit, agent.)*

Question 5

relay (receiver place to send)  
agents (sender place to send)  
error (3 Marks)

## Question 5

- a. Name the 3 components of a virtual circuit  
→ hub/switch (bridge) (1 Marks)

b. What is IP fragmentation? → division of datagram to smaller  
possible to pass through the different network (2 Marks)

c. Where do ISPs get IP address blocks?  
→ from local internet registry (2 Marks)

d. Describe how a host can get an IP address?  
→ static  
→ dynamic (5 Marks)

e. Describe the changes made to move from IPv4 to IPv6 (name 5)  
→ 128-bit address  
→ more efficient  
→ better security (2 Marks)

Q. Briefly, explain the work of NAT in computer network.  
→ It enables us to have a large set of addresses internally on one address of small set of addresses externally.

What nature of addressing is used to identify source and destination at the data link layer? (1 Marks) (4 Marks)

State four (4) Data Link layer services.

State your [4] Ques. No. \_\_\_\_\_

Ques. No. \_\_\_\_\_

Describe the function of ARP in computer networks. (10 Marks)

- How does physical address help us access the connection? (1 Mark)

Why is Ethernet referred to as connectionless? (None) (1 Mark)

→ Is a connectionless service with extremely slow neighbours, any mechanism acknowledged? (6 Marks)

What are the differences and similarities between a switch and a router? (12 Marks)

Q. State two characteristics of a wireless network in ad hoc mode. (2 Marks)

→ Shorter distances → Both use CSMA  
→ Direct delivery → Both are full  
→ No central controller → Both use PC  
→ Self-organizing

Rexher

4 of 4  
parents of unknown origin

Duckabush

- Trans. Linn (12)  
- also known as the Purple Sweet

Section B (60 Marks)

Question 1

- Which devices are included in the network edge? - Computer, switch, router. (2 Marks)
- Name 2 infrastructure involved in the network core? (2 Marks)
- Describe internet as a service (2 Marks)
- Describe how DSL can be used to transmit data from the user to the service provider. (5 Marks)
- Give two examples of a human protocol. (2 Marks)
- ~~Give two examples of a human protocol, and mention when are they speaking.~~ Which two important aspects do you need to keep in mind when planning to connect end systems to edge routers? (2 Marks)

Question 2

- Which application software runs on network-core devices? (2 Marks)
- Name four characteristics of a client in client/server architecture. (4 Marks)
- Name four characteristics of a network in P2P architecture? (4 Marks)
- Explain the work of a socket in computer networks. (4 Marks)
- A process must have identifier as an address. What is the identifier made up of? (2 Marks)

Question 3

*host name*      *path name*

a. www.myuniversity.edu/myclass/pic.gif

Identify the host and the path of the URL above

(2 Marks)

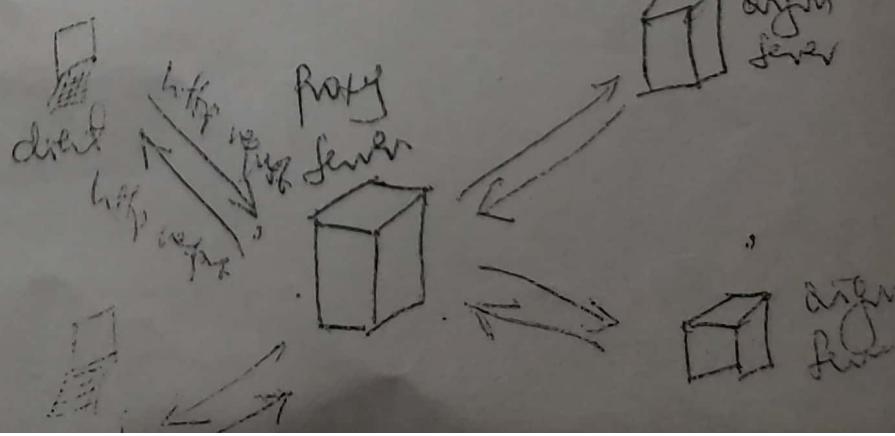
- With a diagram, explain how cache acts as both server and client. (2 Marks)
- What are the three major components of electronic mail? (3 Marks)
- With the aid of a diagram, explain recursive query in DNS resolution. (4 Marks)
- Explain 3 characteristics of fiber optic cable. (3 Marks)
- What is store-and-forward in computer networks? (1 Mark)

Page 3 of 4

User sets browser, web accesses via web cache.

Client sends all http requests to web cache.

Object exits, reaches cache memory



### Section B (60 Marks)

#### Question 1

- a. Which devices are included in the network edge? *smart phones, PC* (2 Marks)
- b. Name 2 infrastructure involved in the network core? (2 Marks)
- c. Describe internet as a service (2 Marks)
- d. Describe how DSL can be used to transmit data from the user to the service provider. (2 Marks)
- e. Give two examples of a human protocol. (5 Marks)  
(2 Marks)
- f. Which two important aspects do you need to keep in mind when planning to connect end systems to edge routers? (2 Marks)

#### Question 2

- a. Which application software runs on network-core devices? (2 Marks)
- b. Name four characteristics of a client in client/server architecture. (4 Marks)
- c. Name four characteristics of a network in P2P architecture? (4 Marks)
- d. Explain the work of a socket in computer networks. (4 Marks)
- e. A process must have identifier as an address. What is the identifier made up of? (2 Marks)

#### Question 3

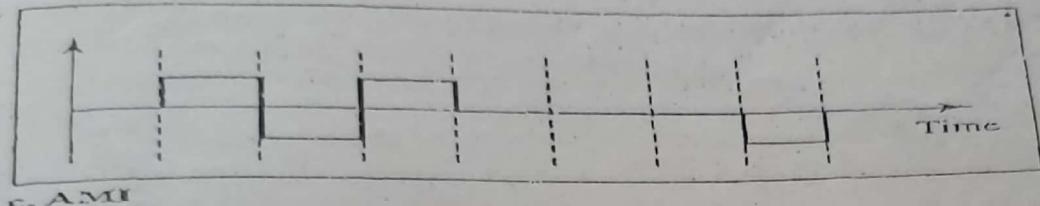
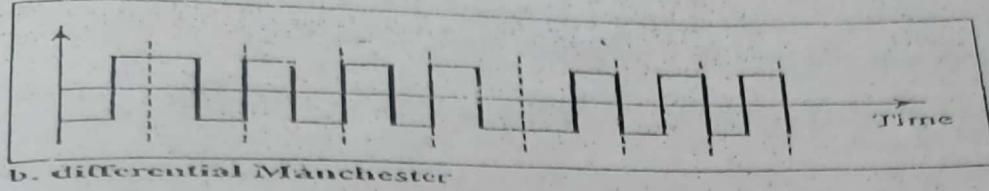
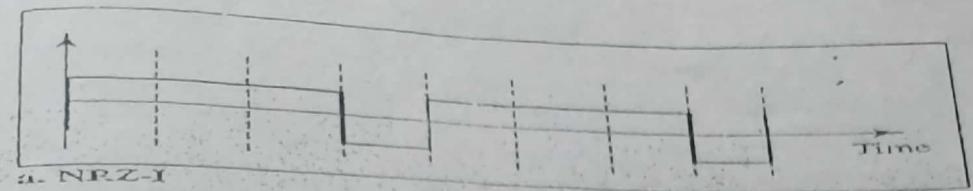
- a. [www.myuniversity.edu/myclass/pic.gif](http://www.myuniversity.edu/myclass/pic.gif) Identify the host and the path of the URL above (2 Marks)
- b. With a diagram, explain how cache acts as both server and client. (2 Marks)
- c. What are the three major components of electronic mail? (3 Marks)
- d. With the aid of a diagram, explain recursive query in DNS resolution. (4 Marks)
- e. Explain 3 characteristics of fiber optic cable. (3 Marks)
- What is end-to-end in computer networks? (1 Mark)

- VC network  
Connection is implemented in the work layer  
- bus  
- cross bar.
- Question 4**
- Describe how congestion occurs in computer networks and name the indicators of network congestion? (3 Marks)
  - What is the logical difference between transport layer and network layer? (2 Marks)
  - Explain the error detection method that operates at the transport layer? (5 Marks)
  - What command can we use in windows networked computers to see the "real" Internet delay & loss in computer networks? (1 Mark)
  - Explain four sources of packet loss in a computer network. (large 1 Marks)  
 # Are datagram been several smaller data
- Question 5**
- Name the 3 components of a virtual circuit? (3 Marks)
  - VC - Connection oriented. Highly protocols. (1 Marks)
  - Where do ISPs get IP address blocks? (2 Marks)
  - Internet Corporation for Assigned Names & Numbers, allocates addresses. (12 Marks)
    - Dynamic, plug & play.
    - domain names.
  - Describe the changes made to move from IPv4 to IPv6 (name 5)? (5 Marks)
  - Briefly, explain the work of NAT in computer network. (2 Marks)
- Question 6**
- What nature of addressing is used to identify source and destination at the data link layer? (1 Marks)
  - State four (4) Data Link layer services. (4 Marks)
  - Describe the function of ARP in computer networks. (1 Mark)
  - Why is Ethernet referred to as connectionless? (1 Mark)
  - What are the differences and similarities between a switch and a router? (6 Marks)
  - State two characteristics of a wireless network in ad hoc mode. (2 Marks)

ge 4 of 4

\* Examples services for:  
Individual datagrams.

Network  
- no C  
- host  
- Imp



[6 marks]

- c) Using the 8-bit stream in (b) and (c) of the diagram above, encode the following schemes respectively;

(i) Pseudoternary

[3 marks]

(ii) Manchester

[3 marks]

#### Question Four:

- a) State one important consideration according to Nyquist for an analog signal to be reproduced at the receiver during analog to digital conversion. [2 marks]
- b) We want to digitize the human voice, calculate the bit rate assuming 8 bits per sample. [Hint the frequency of a digitized voice is between 0 – 4000 Hz] [4 marks]
- c) Define analog modulation and give one application? [2 marks]
- d) Describe the different techniques used during analog to analog conversion and state the formulae used to calculate the available bandwidth for each technique. [6 marks]
- e) Calculate the bandwidth for the following cases if we need to modulate a 15-MHz voice;
- (i) AM [2 marks]
  - (ii) FM ( $\beta = 5$ ) [2 marks]
  - (iii) PM ( $\beta = 2$ ) [2 marks]

**Question Five**

- a) In cellular telephony frequencies are reused. Which is better, A low reuse or a high reuse? Explain your answer. [3 marks]
- b) What are the functions of the following in a cellular telephony? [2 marks]
- Mobile Switching Center [2 marks]
  - Base Station
- c) MTN Company is planning for cellular coverage of FOUR areas within Kawempe division. Due to the constraints in frequencies, it is contemplating on reusing frequencies. Suggestions of a frequency reuse patterns of 4 and 7 are proposed.
- Draw a cell pattern with a frequency reuse factor of 4. [3 marks]
  - If the frequency reuse factor of 7 is used. Give the pros and cons? [2 marks]
- d) Incorporating satellite into terrestrial networks is often hindered by three main characteristics possessed by satellite communication. What are they? [3 marks]
- e) According to Kepler's law, the period of the moon, is given by  $\text{Period} = C \times (\text{Distance})^{\frac{3}{2}}$ . C is the constant approximated to  $1/100$ , the period being in seconds and distance in kilometers from the centre of the earth. A communication satellite is located at an orbit approximately 35786 Km above the earth.
- What is the period (in hrs) of the satellite? [3 marks]
  - What conclusion about the satellite orbit can we draw from the answer above? [2 marks]

MAKERERE UNIVERSITY  
COLLEGE OF COMPUTING AND INFORMATION SCIENCES

ROUND ONE TEST

PROGRAMME:

BIT, BCSC, BSE

YEAR OF STUDY:

II

COURSE NAME:

COMPUTER NETWORKS

COURSE CODE:

BSE 2106

DATE:

24/10/2015

- a. With aid of a diagram explain the three transmission modes (3marks)
- b. With aid of a diagram explain the four basic topologies and state any one advantage of each (8marks)
- c. State any two differences and similarities between OSI and TCP/IP models (4marks)
- d. Define a hash function and briefly explain three hash function criteria (4marks)
- e. Cryptography can provide five security services. Explain the five services (5marks)
- f. Write brief notes about the following network categories (1mark@)
- i. LAN
  - ii. MAN
  - iii. WAN
- g. State the seven OSI layers and describe one service each layer provides to the upper layers (10marks)
- h. With aid of a diagram explain the difference between hop-to-hop delivery and source-to-destination delivery (4marks)
- i. Explain the difference between asymmetric and a symmetric key cryptographies (2marks)
- j. Challenge-response-authentication can be divided into four categories: State the four categories (4marks)
- k. In entity authentication, a claimant proves her identity to the verifier by using one of the three kinds of witnesses: Briefly explain them. (3marks)

*A hash function is any function that can be used to map data of any size to data of a fixed size.*

*END*

*By*

MAKERERE UNIVERSITY  
COLLEGE OF COMPUTING & INFORMATION SCIENCES  
SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY  
END OF SEMESTER 1 EXAMINATION 2019/2020

PROGRAMME: SE & CS

YEAR OF STUDY: II

COURSE NAME: COMPUTER NETWORKS

COURSE CODE: BSE 2106

DATE: 5<sup>TH</sup> DECEMBER 2019 TIME: 4PM - 7PM

EXAMINATION INSTRUCTIONS

1. ATTEMPT ALL QUESTIONS IN SECTION A (40 MARKS)
2. ATTEMPT THREE QUESTIONS IN SECTION B (20 MARKS EACH)
3. DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
4. ATTEMPT EACH QUESTION IN SECTION B ON A NEW PAGE OF THE ANSWER BOOKLET
5. ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

**SECTION A [40 Marks]- COMPULSORY**

- a. What is the name of the protocol data unit at each of the following layers. (3 Marks)  
Applic. message

- i. Transport layer
  - ii. Network layer
  - iii. Data link layer

|               |         |
|---------------|---------|
| Apparatus     | message |
| Trans. & Sel. | signals |
| Memory        | Data    |
| Processor     | Frame   |
| Data          | b/s     |

- b. Mention any four considerations the network designer takes into account while selecting media **(4 Marks)**

- c. Define the following terms as used in Computer Networks: (4 Marks)

  - i. Protocol
  - ii. Network edge
  - iii. Network core
  - iv. Encapsulation

- d. Give three properties of a transmission medium that should be taken into consideration in designing a network. (3 Marks)

- e. Name the two sublayers of Layer 2 protocols defined by IEEE, and give the purpose of each. (4 Marks)

- f. Discuss the three functions of the data link layer (6 Marks)

- g. Differentiate between:

- i. Enterprise access networks and wireless access networks

- ## ii. Routing and forwarding

- ### iii. Packet switching and circuit switching

- #### iv. IP Address and MAC address

- ## v. IPv4 and IPv6 address

- #### **vi. Transmission Control Protocol (TCP) and Internet Protocol (IP)**

ose of  
rks) •  $4t^2 = 6$   
 $3t$

$$\begin{array}{r} 3 \\ \times 40 \\ \hline -11 \\ 29 \end{array}$$

29

21

vii. TDMA and FDMA

viii. Round robin MAC protocols and contention-based MAC protocols

ix. Transmission Control Protocol (TCP) and Internet Protocol (IP)

**SECTION B [60 Marks] - ATTEMPT THREE QUESTIONS**

Question 1

- a) Describe the following properties of guided media, discussing the relative performance of each of these properties by Twisted pair, coaxial cable and optical fiber media  
**(12 Marks)**

- Attenuation
- Delay
- Repeater spacing

- b) Highlight the ~~XH2S~~ properties of unshielded twisted pair (UTP), shielded twisted pair (STP) and foiled twisted pair (FTP)  
**(4 Marks)**

- c) Briefly Discuss the benefits of the Optical Fiber media  
**(4 marks)**

Question 2

- a) List four examples of network applications  
**(2 Marks)**

- b) HTTP is a request-response protocol. What are the semantics of the following HTTP response status codes:  
400 - Bad req  
**(1 Mark)**

- i. 404 Not found  
**(1 Mark)**
- ii. 200 OK  
**(1 Mark)**
- iii. 500  
**(1 Mark)**
- iv. 301 Moved permanent  
**(1 Mark)**

- ) Given a base HTML file with 50 objects (images) all small enough to fit in one TCP segment. How many RTTs are required for retrieval of the base file and objects under the following conditions (Clearly show your working):

- i. Non-Persistent HTTP connection without parallel connection  
**(2 Marks)**

Total time =

$$= 2RTT + (parallel)$$

$$2 \times (5\%)$$

$$2RTT + DRT$$

- ii. Non-persistent HTTP connection with 10 parallel connection  
iii. Persistent connection  $2RTT + 50ms$

(2 Marks)

(2 Marks)

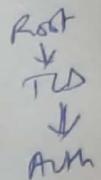
- d) Briefly explain the differences between the following terms as used in Domain Name Services (DNS)

(2 Marks)

(2 Marks)

(2 Marks)

- i. Recursive query and Iterated query  
ii. Local DNS server and an authoritative DNS server  
iii. Root DNS server and top level DNS server



- e) A caching DNS server normally stores DNS records locally for a period specified by the Time-to-Live (TTL) value. Describe the problems that can occur if the TTL value is too small or too large.

(2 Marks)

### ✓ Question 3

in hosts

(2 Marks)

- a) What are the primary roles of the network layer in an end-to-end web communication proceeding?

- b) State the new names in IPv6 for the following IPv4 fields if kept in the new IPv6 datagram structure:

(1 Mark)

- i. Type of Service ~~priority~~

(1 Mark)

- ii. Version ~~1~~ 128 64 32 8 4 2 1

- iii. Time to Live ~~256~~ 128 64 16 8 4 2

(1 Mark)

- iv. Header Checksum ~~No checksum~~

(1 Mark)

- c) Write the short forms for the following IPv6 addresses:

2001:0db8:3c4d:0015:0000:0000:1a2f:1a2b  
2041:0000:140f:079f:0000:0000:0000:131b

- i. 2001:0db8:3c4d:0015:0000:0000:1a2f:1a2b

(2 Marks)

hierarchy

- ii. 2041:0000:140f:079f:0000:0000:0000:131b

(2 Marks)

- d) Given the network 10.0.0.0/19, find:

128 64 32 8 4 2 1  
125 - 255, 255, 255, 128

- i. Total number of usable addresses

124 - 255, 255, 255, 0

(2 Marks)

- ii. The lowest and highest usable address

126 - 192

(2 Marks)

126

- iii. The subnet mask for the above network

127 - 224

(2 Marks)

125

4

128 - 240

5

129 - 248

6

130 - 252

7

131 - 252

8

132 - 252

9

133 - 252

10

134 - 252

11

135 - 252

12

136 - 252

13

137 - 252

14

138 - 252

15

139 - 252

16

140 - 252

17

141 - 252

18

142 - 252

19

143 - 252

20

144 - 252

21

145 - 252

22

146 - 252

23

147 - 252

24

148 - 252

25

149 - 252

26

150 - 252

27

151 - 252

28

152 - 252

29

153 - 252

30

154 - 252

31

155 - 252

32

156 - 252

33

157 - 252

34

158 - 252

35

159 - 252

36

160 - 252

37

161 - 252

38

162 - 252

39

163 - 252

40

164 - 252

41

165 - 252

42

166 - 252

43

167 - 252

44

168 - 252

45

169 - 252

46

170 - 252

47

171 - 252

48

172 - 252

49

173 - 252

50

174 - 252

51

175 - 252

52

176 - 252

53

177 - 252

54

178 - 252

55

179 - 252

56

180 - 252

57

181 - 252

58

182 - 252

59

183 - 252

60

184 - 252

61

185 - 252

62

186 - 252

63

187 - 252

64

188 - 252

65

189 - 252

66

190 - 252

67

191 - 252

68

192 - 252

69

193 - 252

70

194 - 252

71

195 - 252

72

196 - 252

73

197 - 252

74

198 - 252

75

199 - 252

76

200 - 252

77

201 - 252

78

202 - 252

79

203 - 252

80

204 - 252

81

205 - 252

82

206 - 252

83

207 - 252

84

208 - 252

85

209 - 252

86

210 - 252

87

211 - 252

88

212 - 252

89

213 - 252

90

214 - 252

91

215 - 252

92

216 - 252

93

217 - 252

94

218 - 252

95

219 - 252

96

220 - 252

97

221 - 252

98

222 - 252

99

223 - 252

100

224 - 252

101

225 - 252

102

226 - 252

103

227 - 252

104

228 - 252

105

229 - 252

106

230 - 252

107

231 - 252

108

232 - 252

109

233 - 252

110

234 - 252

111

235 - 252

112

236 - 252

113

237 - 252

114

238 - 252

115

239 -

- e) Suppose we have the forwarding tables shown in the following table for nodes A and F, in a network where all links have cost 1. Draw a diagram (network topology) of the smallest network consistent with these tables. **(4 Marks)**

**A**

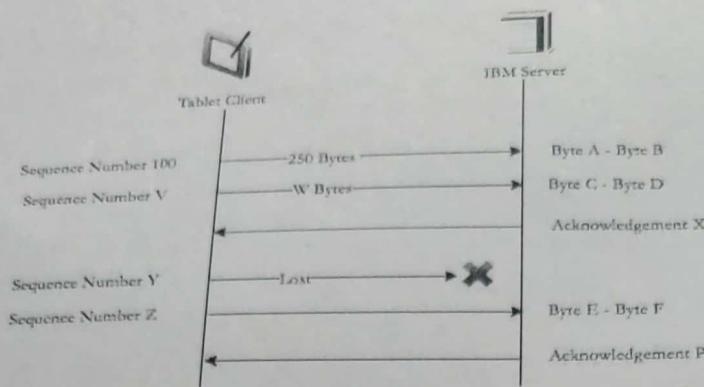
| Node | Cost | Next Hop |
|------|------|----------|
| B    | 1    | B        |
| C    | 1    | C        |
| D    | 2    | B        |
| E    | 3    | C        |
| F    | 2    | C        |

**F**

| Node | Cost | Next Hop |
|------|------|----------|
| A    | 2    | C        |
| B    | 3    | C        |
| C    | 1    | C        |
| D    | 2    | C        |
| E    | 1    | E        |

#### Question 4

- a) Outline the three primary functions of the transport layer. **(3 Marks)**
- b) Using a clearly labelled drawing, describe the structure of a UDP packet and state the roles of the different fields. **(6 Marks)**
- c) State the TCP ports used by the following applications:
- SSH **(1 Mark)**
  - SMTP **(1 Mark)**
  - POP3 **(1 Mark)**
  - HTTPS **(1 Mark)**
- d) Given the following FTP transaction between the Tablet client and the IBM server with a window size of 500 bytes:



- i. State the relevance of the window size in TCP (1 Mark)
- ii. Clearly showing your working, determine the values of A, B, C, D, E, F and V, W, X, Y, Z, P (0.5 Marks @)

### Question 5

- a) Define the following terms in relation to network security:
  - i. Integrity (1 Mark)
  - ii. Availability (1 Mark)
  - iii. Authentication (1 Mark)
  - iv. Confidentiality (1 Mark)
- b) Briefly describe the operation of a digital signature (2 Marks)
- c) Compare and contrast the Data Encryption Standard (DES) and Advanced Encryption Standard (AES) as block cipher encryption algorithms. (4 Marks)
- d) Write an access control lists for the following firewall rules at Organization X:
  - i. Allow all external users to access the web server with the IP address 10.10.2.5. (2 Marks)
  - ii. Block internal users on the network 10.10.0.0/16 from accessing telnet services outside the organization. (2 Marks)
  - iii. Implicit deny rule for all other kinds of traffic (2 Marks)
- e) Describe the two categories of Intrusion Detection Systems (4 Marks)

END