

over how many interfaces? How many forwarding tables will be indexed to move the datagram from the source to the destination?

Solution: 8 interfaces; 3 forwarding tables.

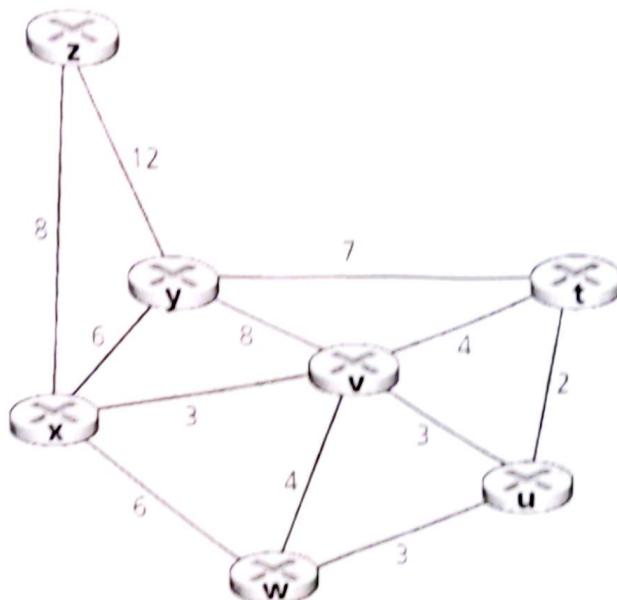
viii. Is it necessary that every autonomous system use the same intra-AS routing algorithm?
Why or why not?

Solution: No. Each AS has administrative autonomy for routing within an AS.

Question 3

10 + 4 = 14 Marks

- i. Consider the following network. With the indicated link costs, use Dijkstra's shortest-path algorithm to compute the shortest path from x to all network nodes. Show how the algorithm works by filling the values in the below given table.

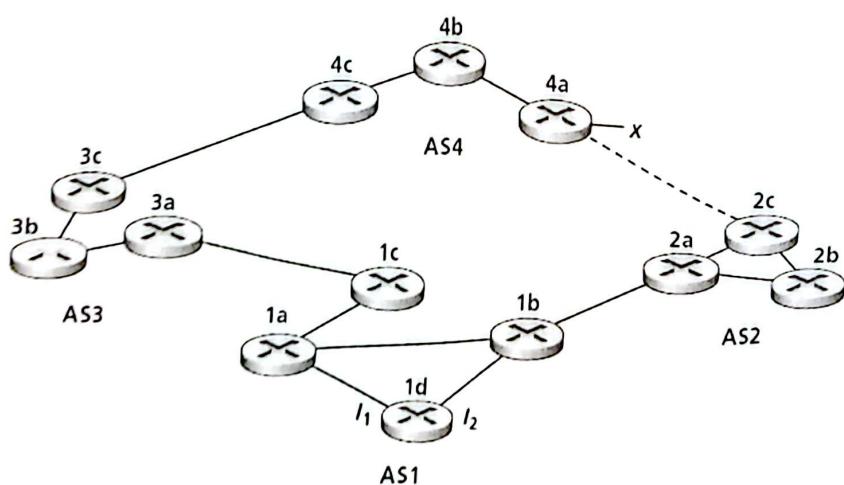


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Solution:

Step	N'	$D(l), p(l)$	$D(u), p(u)$	$D(v), p(v)$	$D(w), p(w)$	$D(y), p(y)$	$D(z), p(z)$
0	x	∞	∞	3,x	6,x	6,x	8,x
1	xv	7,v	6,v	3,x	6,x	6,x	8,x
2	xvu	7,v	6,v	3,x	6,x	6,x	8,x
3	xvuw	7,v	6,v	3,x	6,x	6,x	8,x
4	xvwy	7,v	6,v	3,x	6,x	6,x	8,x
5	xuwyt	7,v	6,v	3,x	6,x	6,x	8,x
6	xuwytz	7,v	6,v	3,x	6,x	6,x	8,x

- ii. Consider the network shown below. Suppose AS3 and AS2 are running OSPF for their intra-AS routing protocol. Suppose AS1 and AS4 are running RIP for their intra-AS routing protocol. Suppose eBGP and iBGP are used for the inter-AS routing protocol. Suppose there is no physical link between AS2 and AS4.



- i. Router 3c learns about prefix x from which routing protocol: OSPF, RIP, eBGP, or iBGP?
- ii. Router 3a learns about x from which routing protocol?
- iii. Router 1c learns about x from which routing protocol?

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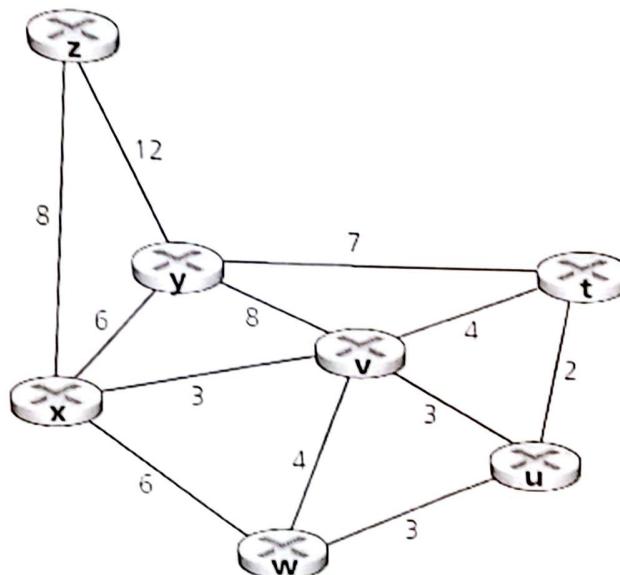
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iv. Router 1d learns about x from which routing protocol?

Solution

- i. eBGP
- ii. iBGP
- iii. eBGP
- iv. iBGP

Question 4

10 + 5 = 15 Marks

A. Consider sending a 2400-byte datagram into a link that has an MTU of 700 bytes. Suppose the original datagram is stamped with the identification number 422. How many fragments are generated? What are the values in the various fields in the IP datagram(s) generated related to fragmentation?

Solution:

The maximum size of data field in each fragment = 680 (because there are 20 bytes IP header). Thus the number of required fragments

$$= \left\lceil \frac{2400 - 20}{680} \right\rceil = 4$$

Each fragment will have Identification number 422. Each fragment except the last one will be of size 700 bytes (including IP header). The last datagram will be of size 360 bytes (including IP header). The offsets of the 4 fragments will be 0, 85, 170, 255. Each of the first 3 fragments will have flag=1; the last fragment will have flag=0.

- B. Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R1 = 500 kbps, R2 = 2 Mbps, and R3 = 1 Mbps.
- a. Assuming no other traffic in the network, what is the throughput for the file transfer?
 - b. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?

Solution: a) 500 kbps b) 64 seconds

Question 5

5 + 5 = 10 Marks

A. Suppose a segment that has been transmitted from Sender X to Sender Y with the following sequence numbers: 0 1 2 3 4 5 6 7 8 9. Draw the packet flow diagram while mentioning the sequence number and window size.

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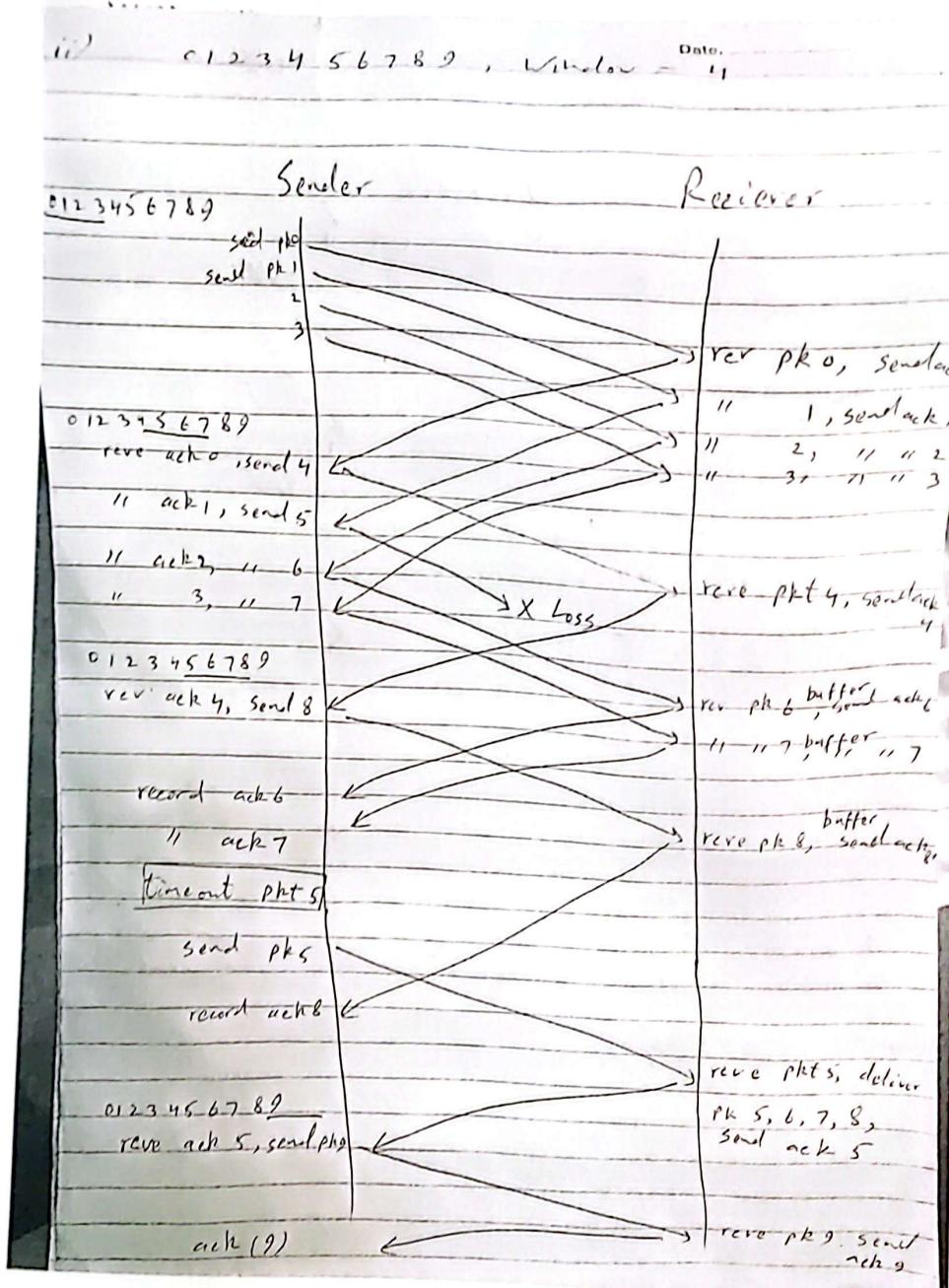
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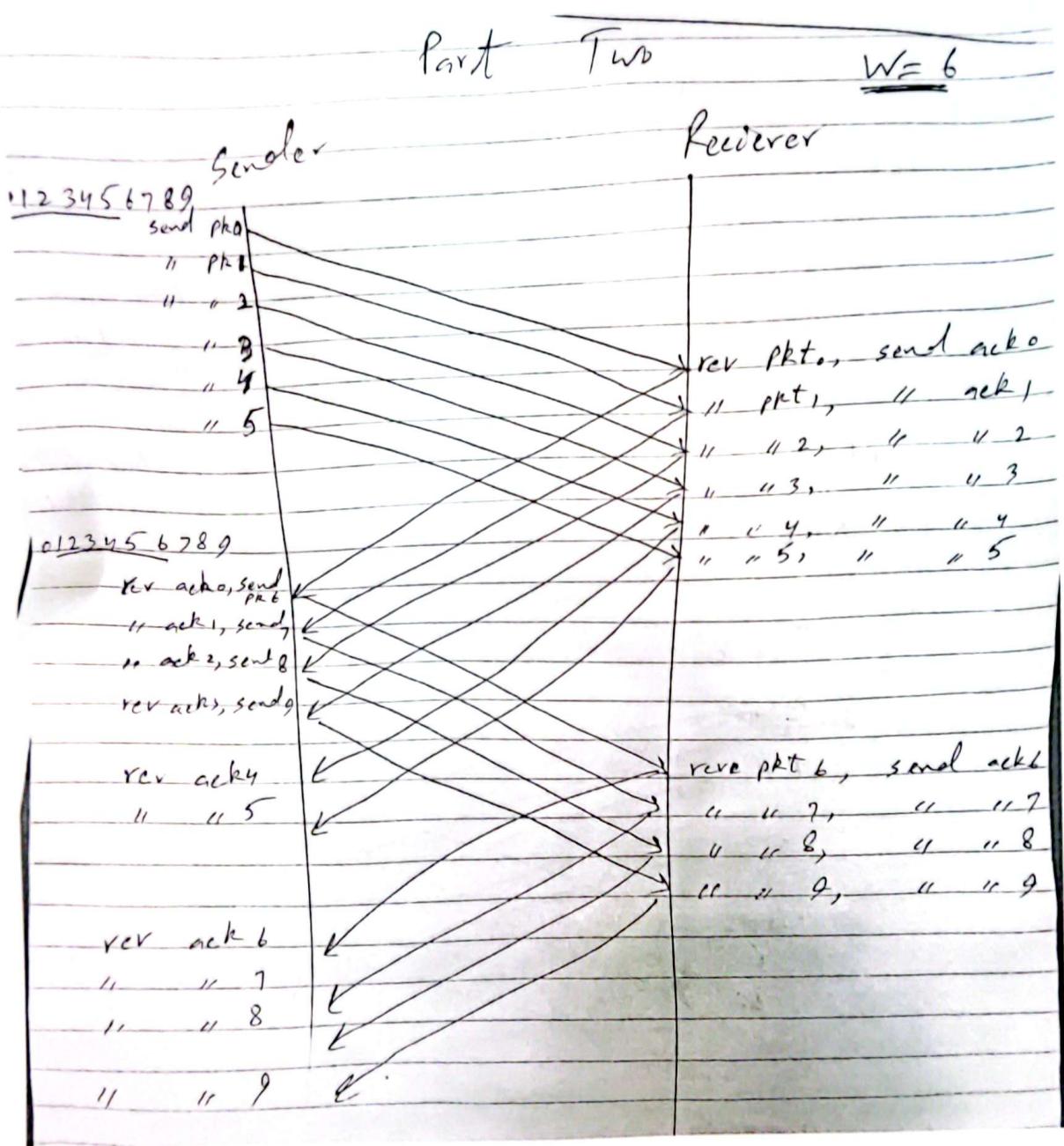
- i. Consider the window size is 4 and the packets transmitted by using Selective Repeat technique. During the transmission, 2nd packet was lost in the second iteration.
- ii. Repeat (i) by considering window size 6 and no lost of packets during the transmission.

Solution:

i:



ii:



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1. The _____ is the physical path over which a message travel.
 - a. Protocol
 - b. Medium
 - c. Signal
 - d. All of the above

2. The information to be communicated in a data communications system is the _____
 - a. Medium
 - b. Protocol
 - c. Transmission
 - d. Message

3. An unauthorized user is a network _____ issue.
 - a. Performance
 - b. Reliability
 - c. Security
 - d. All of the above

4. The _____ layer changes bits into electromagnetic signals.
 - a. Physical
 - b. Transport
 - c. None of the above
 - d. Data link

5. Mail services are available to network users through the _____ layer.
 - a. Data link
 - b. Physical
 - c. Application
 - d. Transport

6. As the data packet moves from the lower to the upper layers, headers are _____.
 - a. Added
 - b. Rearranged
 - c. Modified
 - d. Stripped

7. What is the main function of the transport layer?
 - a. Process-to-process delivery
 - b. Node-to-node delivery
 - c. Synchronization
 - d. Updating and maintenance of routing tables

8. Which of the following is an application layer service?
 - a. Remote log-in
 - b. File transfer and access
 - c. Mail service
 - d. All the above

9. The Internet model consists of _____ layers.
 - a. Three
 - b. Five
 - c. Seven
 - d. Four

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10. A telephone network is an example of a _____ network.
- Circuit-switched
 - Packet-switched
 - Message-switched
 - None of the above
11. Open Shortest Path First (OSPF) is also called as _____
- Link state protocol
 - Error-correction protocol
 - Routing information protocol
 - Border gateway protocol
12. The computation of the shortest path in OSPF is usually done by _____
- Bellman-ford algorithm
 - Routing information protocol
 - Dijkstra's algorithm
 - Distance vector routing
13. The header length of an IPv6 datagram is _____
- 10bytes
 - 25bytes
 - 30bytes
 - 40bytes
14. Suppose two IPv6 nodes want to interoperate using IPv6 datagrams, but they are connected to each other by intervening IPv4 routers. The best solution here is _____
- Use dual-stack approach
 - Tunneling
 - No solution
 - Replace the system
15. Flow control is needed to prevent _____.
- Overflow of the sender buffer
 - Overflow of the receiver buffer
 - Bit errors
 - Collision between sender and receiver
16. In Stop-and-Wait protocol, for n data packets sent, _____ acknowledgments are needed.
- $n - 1$
 - $n + 1$
 - n
 - $2n$
17. _____ is a client-server program that provides an IP address, subnet mask, IP address of a router, and IP address of a name server to a computer.
- NAT
 - DHCP
 - CIDR
 - ISP
18. In _____, each packet of a message need not follow the same path from sender to receiver.
- The virtual approach to packet switching
 - The datagram approach to packet switching

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- c. Message switching
 - d. None of the above
19. On a network that uses NAT, the router can use _____ global address(es).
- a. A pool of
 - b. One
 - c. Two
 - d. None of the above
20. Given the IP address 201.14.78.65 and the subnet mask 255.255.255.224, what is the subnet address?
- a. 201.14.78.64
 - b. 201.14.78.32
 - c. 201.14.78.65
 - d. 201.14.78.12
21. When the hop-count field reaches zero and the destination has not been reached, a _____ error message is sent.
- a. Destination-unreachable
 - b. Redirection
 - c. Time-exceeded
 - d. Parameter-problem
22. If the fragment offset has a value of 100, it means that _____.
- a. The first byte of the datagram is byte 800
 - b. The datagram has not been fragmented
 - c. The datagram is 100 bytes in size
 - d. The first byte of the datagram is byte 100
23. A router reads the _____ address on a packet to determine the next hop.
- a. MAC
 - b. Source
 - c. IP
 - d. ARP
24. Which of the following types of ICMP messages needs to be encapsulated into an IP datagram?
- a. Time-exceeded
 - b. Multicasting
 - c. Echo reply
 - d. All the above
25. A datagram is fragmented into three smaller datagrams. Which of the following is true?
- a. The do not fragment bit is set to 1 for all three datagrams.
 - b. The identification field is the same for all three datagrams.
 - c. The more fragment bit is set to 0 for all three datagrams.
 - d. The offset field is the same for all three datagrams.
26. A routing table contains _____.
- a. The destination network ID
 - b. The hop count to reach the network
 - c. The router ID of the next hop
 - d. All the above

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27. In distance vector routing each router receives information directly from _____.

- a. Its neighbors only
- b. Every router on the network
- c. Every router less than two units away
- d. A table stored by the network hosts

28. Which is a legal port address?

- a. 0
- b. 513
- c. 65,535
- d. All the above

29. Which of the following does UDP guarantee?

- a. Acknowledgments to the sender
- b. Flow control
- c. Sequence numbers on each user datagram
- d. None of the above

30. In TCP, an ACK number of 1000 always means that _____.

- a. 999 bytes has been successfully received
- b. 1000 bytes has been successfully received
- c. 1001 bytes has been successfully received
- d. None of the above

31. Which of the following is not a client program in WWW?

- a. FTP
- b. HTTP
- c. HTML
- d. TELNET

32. A user wants to replace a document with a newer version; the request line contains the _____ method.

- a. PUT
- b. GET
- c. POST
- d. COPY

33. Which one is a wireless network standard?

- a. IEEE 802.3
- b. IEEE 802.5
- c. IEEE 802.11
- d. IEEE 802.12e

34. TCP provides a reliable service which includes the use of sequence numbering. The sequence number shown in a TCP header indicates:

- a. the first byte being carried within a segment.
- b. the sequence number of the segment.
- c. the last byte being carried within a segment.
- d. None of the above

35. Tunneling may be described as whereby a _____ receives a datagram, or packet, on an incoming port and forwards it to an outgoing port _____.

- a. multiprotocol router; formatted with the same protocol
- b. multiprotocol router; formatted with a different protocol

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- c. router; using the same protocol
 - d. None of the above
36. Host A sends a TCP segment (Seq = 43, ACK = 103), to which host B replies with a TCP segment (Seq = 103, ACK = 57). The payload of the first TCP segment is
- a. 14 bytes long.
 - b. 43 bytes long.
 - c. 46 bytes long.
 - d. 57 bytes long.
37. The Distance-Vector algorithm is not:
- a. iterative.
 - b. distributed.
 - c. used in RIP.
 - d. None of the above.
38. Longest prefix matching is used:
- a. in routers to know on which link interface to forward packets.
 - b. in classless addressing to use the address space more efficiently than in classful addressing.
 - c. by NAT to increase the available address space in home networks.
 - d. None of the above.
39. A user requests a Web page that consists of some text and 3 images. The browser's cache is empty. For this page, the client's browser:
- a. sends 1 http request message and receives 1 http response messages.
 - b. sends 1 http request message and receives 3 http response messages.
 - c. sends 1 http request message and receives 4 http response messages.
 - d. sends 4 http request messages and receives 4 http response messages.
40. _____ provides a best-effort packet delivery service.
- a. TCP
 - b. UDP
 - c. IP
 - d. SMTP
41. The data link layer is responsible for _____.
a. flow control
b. error control
c. access control
d. all of the above
42. The _____ layer is responsible for the source-to-destination delivery of a packet, possibly across multiple networks.
- a. network
 - b. session
 - c. transport
 - d. data link
 - e. physical
43. Two hosts simultaneously send data through a link of capacity 1Mbps. Host A generates data with a rate of 1Mbps and uses TCP. Host B uses UDP and transmits a 100 bytes packet every 1ms. Which host will obtain higher throughput?

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- a. Host A.
 - b. Host B.
 - c. They obtain roughly the same throughput.
 - d. They experience congestion collapse and negligible throughput.
44. Wireless transmission is _____ prone to error than/as wired transmission.
- a. Less
 - b. More
 - c. Half as
 - d. None of the above
45. What is the name of the fixed route established at the time of initial connection setup in ATM networks?
- a. connection network
 - b. data route
 - c. virtual circuit
 - d. ring
 - e. VPN
46. The number of allowed hops for an IP packet is kept in the _____ field.
- a. AHF
 - b. IHL
 - c. Fragment offset
 - d. TTL
 - e. ToS
47. Problems encountered in IP networks are usually reported with this protocol.
- a. TCP
 - b. SNMP
 - c. SMTP
 - d. HTTP
 - e. ICMP
48. Which of the following is not one of the seven OSI layers?
- a. Network
 - b. Session
 - c. Routing
 - d. Transport
 - e. Presentation
49. Which of the following is not a part of the IP datagram?
- a. Fragment offset
 - b. Header length
 - c. Type of service
 - d. TTL
 - e. Destination Ethernet address
50. How does source host know if a destination host is on the same IP network?
- a. Looks up from a hosts list
 - b. DHCP server tells it
 - c. Via ARP
 - d. From network part of IP address
 - e. If it responds then it is local

Computer Networks (CS337) Final Exam (Objectives) Solution (Spring 2021)

Question 1

50

Answer an MCQ by encircling exactly one option. You must use the answer sheet given below. Only the answers in this answer sheet will be considered for grading. Each correct answer carries 1 mark. Cutting and overwriting will result in zero (0) marks.

S#	MCQs					S#	MCQs				
1	A	E	C	D	E	26	A	B	E	D	E
2	A	B	C	D	E	27	A	B	C	D	E
3	A	B	C	D	E	28	A	B	C	D	E
4	A	B	C	D	E	29	A	B	C	D	E
5	A	B	C	D	E	30	A	B	C	D	E
6	A	B	C	D	E	31	A	B	C	D	E
7	A	B	C	D	E	32	A	B	C	D	E
8	A	B	C	D	E	33	A	B	C	D	E
9	A	E	C	D	E	34	A	B	C	D	E
10	A	B	C	D	E	35	A	B	C	D	E
11	A	B	C	D	E	36	A	B	C	D	E
12	A	B	C	D	E	37	A	B	C	D	E
13	A	B	C	D	E	38	A	B	C	D	E
14	A	E	C	D	E	39	A	B	C	D	E
15	A	E	C	D	E	40	A	B	C	D	E
16	A	B	C	D	E	41	A	B	C	D	E
17	A	B	C	D	E	42	A	B	C	D	E
18	A	B	C	D	E	43	A	B	C	D	E
19	A	E	C	D	E	44	A	B	C	D	E
20	A	B	C	D	E	45	A	B	C	D	E
21	A	B	C	D	E	46	A	B	C	D	E
22	A	B	C	D	E	47	A	B	C	D	E
23	A	B	C	D	E	48	A	B	C	D	E
24	A	B	C	D	E	49	A	B	C	D	E
25	A	E	C	D	E	50	A	B	C	D	E

1. Mail services are available to network users through the _____ layer.
 - a. data link
 - b. physical
 - c. Application
 - d. Transport

2. As the data packet moves from the lower to the upper layers, headers are _____.
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 - b. Rearranged
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 - a. $n - 1$
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9. _____ is a client-server program that provides an IP address, subnet mask, IP address of a router, and IP address of a name server to a computer.
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19. Which of the following does UDP guarantee?
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 - Flow control
 - Sequence numbers on each user datagram
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26. The _____ layer is responsible for the source-to-destination delivery of a packet, possibly across multiple networks.
- network
 - session
 - transport
 - data link
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27. Two hosts simultaneously send data through a link of capacity 1Mbps. Host A generates data with a rate of 1Mbps and uses TCP. Host B uses UDP and transmits 100 bytes packet every 1ms. Which host will obtain higher throughput?

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 - b. More
 - c. Half as
 - d. None of the above
29. The number of allowed hops for an IP packet is kept in the _____ field.
- a. AHF
 - b. IHL
 - c. Fragment offset
 - d. TTL
 - e. ToS
30. In TCP, sending and receiving data is done as _____
- a) Stream of bytes
 - b) Sequence of characters
 - c) Lines of data
 - d) Packets
31. The outcome of Dijkstra's calculation is used to populate the _____
- a) Topology table
 - b) Routing table
 - c) Neighbor table
 - d) Adjacency table
32. ICMP is primarily used for _____
- a) error and diagnostic functions
 - b) addressing
 - c) forwarding
 - d) routing
33. A 4-byte IP address consists of _____
- a) only network address
 - b) only host address
 - c) network address & host address
 - d) network address & MAC address
34. An endpoint of an inter-process communication flow across a computer network is called _____
- a) socket
 - b) pipe
 - c) port
 - d) machine
15. DHCP uses _____ as a transport layer protocol.
- a. TCP
 - b. UDP
 - c. RTP
 - d. HTTP

36. The sharing of a medium and its link by two or more devices is called _____
a) Fully duplexing
b) Multiplexing
c) Duplexing
d) None of the above
37. TCP process may not write and read data at the same speed. So we need _____ for storage.
a) Packets
b) Buffers
c) Segments
d) Stacks
38. Transport layer protocols deals with _____
a) application to application communication
b) process to process communication
c) node to node communication
d) man to man communication
39. Which of the following routing algorithms can be used for network layer design?
a) shortest path algorithm
b) distance vector routing
c) link state routing
d) all the mentioned
40. In a network, If P is the only packet being transmitted and there was no earlier transmission, which of the following delays could be zero?
a) Propagation delay
b) Queuing delay
c) Transmission delay
d) Processing delay
41. The computation of the shortest path in OSPF is usually done by _____
a) Bellman-ford algorithm
b) Routing information protocol
c) Dijkstra's algorithm
d) Distance vector routing
42. Which multiplexing technique used to transmit digital signals?
a) FDM
b) TDM
c) WDM
d) FDM & WDM
43. Which of the following is not an application layer service?
a) Network virtual terminal
b) File transfer, access, and management
c) Mail service
d) Error control
44. DHCP allows a host to learn:
a. subnet mask
b. address of its first-hop router (often called the default gateway)
c. address of its local DNS server
d. All the above

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Question 1

2 + 2 = 4 Points

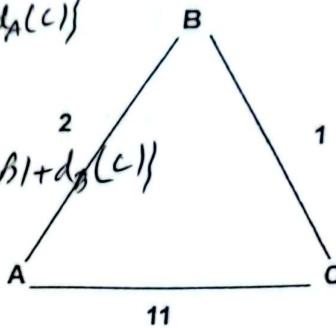
Consider the topology given below for this question. Assume the nodes A, B and C use the Distance-Vector Algorithm (i.e., Bellman Ford) to find minimum cost routing (distance) tables. Answer the following questions.

$$d_B(C) = \min\{c(B, C) + d_C(C), c(B, A) + d_A(C)\}$$

$$= \min\{1 + 0 + 12 + 11\} = 1$$

$$d_A(C) = \min\{c(A, C) + d_C(C), c(A, B) + d_B(C)\}$$

$$d_A(C) = \min\{11 + 0 + 12 + 1\} = 11$$



So, the optimal Node C table after change will be

	A	B	C
B	12	0	1

(a) Suppose the cost from A to B changes from 2 to 13. Give the Node B optimal routing table after the change (without considering poisoned reverse). [2]

For A		
A	B	C
1	0	2
2	0	0
3	0	0

For A _L		
A	B	C
1	0	2
2	0	1
3	1	0

Now, as ~~c(A, B)~~ changes to 13, we'll update table.

For A_L

~~c(A, B)~~

~~c(A, C)~~

~~c(A, A)~~

~~c(A, B)~~

~~c(A, C)~~

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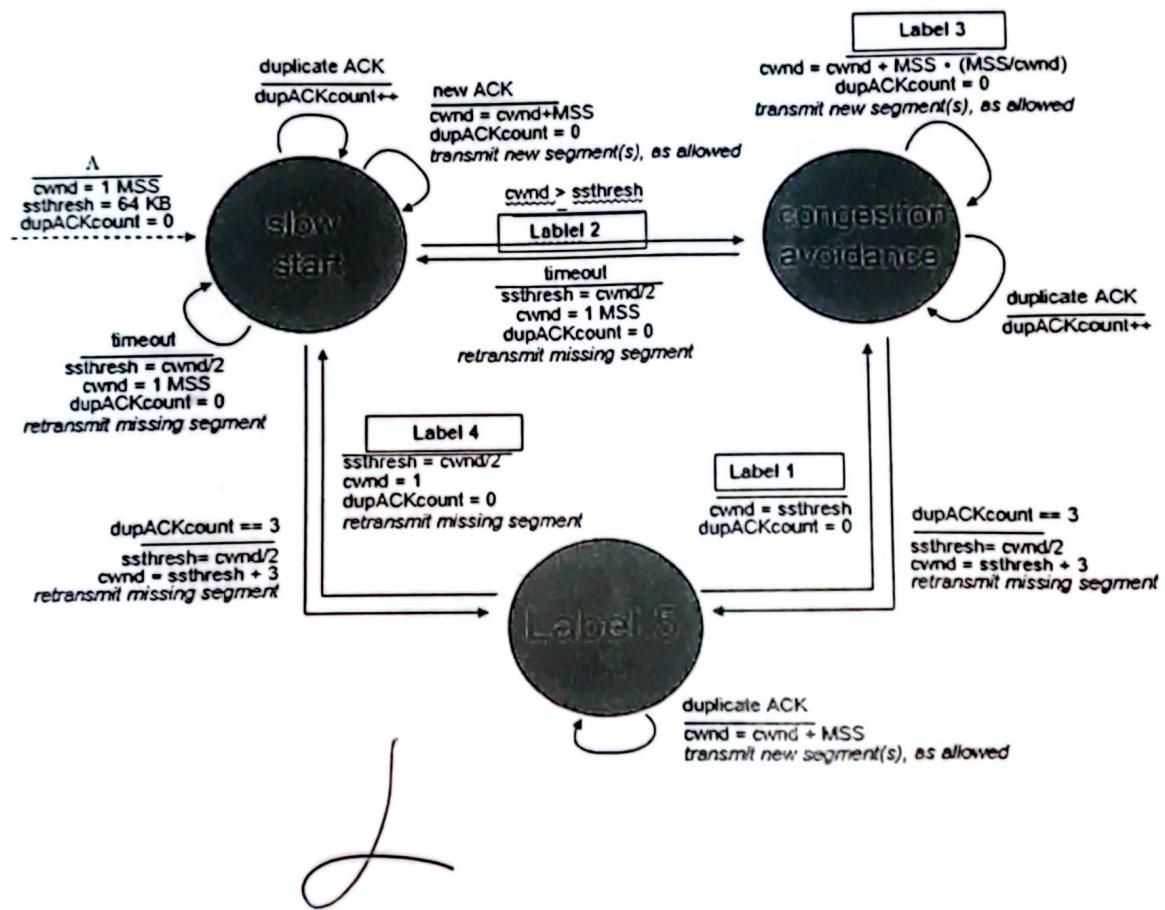
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Question 2

5 x 1 = 5 Points

Below diagram shows the state machine of the TCP (Transmission Control Protocol). TCP changes its state in response to an event. The state machine shown below is missing some events and responses. These are shown as numbered labels. You are required to fill those missing labels.



Question 3

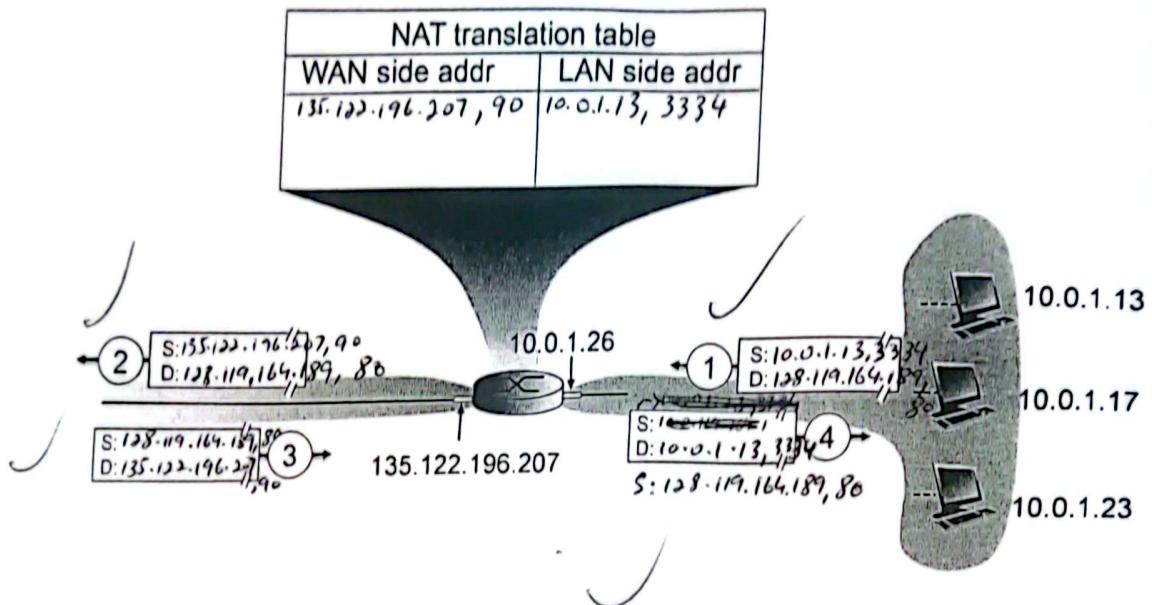
04*02=08 Points

Consider the scenario below in which three hosts, with private IP addresses 10.0.1.13, 10.0.1.17, 10.0.1.23 are in a local network behind a NATted router that sits between these three hosts and the larger Internet. IP datagrams being sent from, or destined to, these three hosts must pass through this NAT router. The router's interface on the LAN side has IP address 10.0.1.26, while the router's address on the Internet side has IP address 135.122.196.207.

Suppose that the host with IP address 10.0.1.13 sends an IP datagram destined to host 128.119.164.189. The source port is 3334, and the destination port is 80. The scenario below shows four boxes labeled with numbers 1 to 4. Each box contains S: and D: representing the source IP/Port numbers and destination IP/Port numbers.



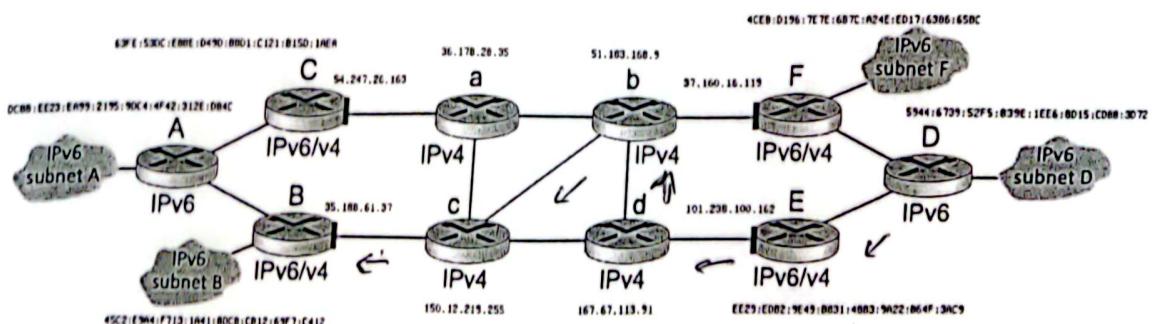
In this problem, you are asked to fill each box with appropriate source (and destination) IP and Port numbers.



Question 4

1 * 10 = 10 points

Consider the network shown below which contains four IPv6 subnets, connected by a mix of IPv6-only routers, IPv4-only routers and dual-capable IPv6/IPv4 routers.



Suppose that a host of subnet D wants to send an IPv6 datagram to a host on subnet B. Assume that the forwarding between these two hosts goes along the path:

D --> E --> d --> b --> c --> B

QUESTIONS

1. Is the datagram being forwarded from D to E an IPv4 or IPv6 datagram?

D to E datagram will be IPv6 ~~IPv4~~ datagram.

2. Is this D to E datagram encapsulating another datagram? Yes or No.

No. ✓

3. Is the datagram being forwarded from E to d an IPv4 or IPv6 datagram?

E to d ~~datagram~~ forwarding will have IPv4 datagram.

4. Is this E to d datagram encapsulating another datagram? Yes or No.

Yes. ✓

5. Is the datagram being forwarded from d to b an IPv4 or IPv6 datagram?

d to b datagram will be IPv4 datagram.

6. Is this d to b datagram encapsulating another datagram? Yes or No.

~~Yes~~ Yes, this datagram is already encapsulated at ~~d~~ and is encapsulated.

7. Is the datagram being forwarded from b to c an IPv4 or IPv6 datagram?

b to c forwarding will have IPv4 datagram-
which is carrying IPv6 datagram as payload.

8. What router is the 'tunnel entrance'? Give the router's letter

(E) is entering '(A)' point for tunnel.

9. What router is the 'tunnel exit'? Give the router's letter

(B) is the exit point for tunnel.

10. Which protocol encapsulates the other, IPv4 or IPv6?

IPv4 encapsulates IPv6.

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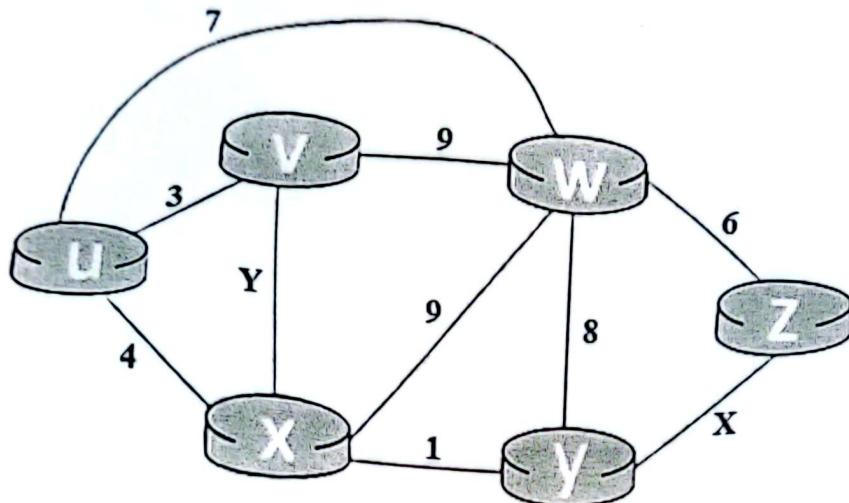
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Question 5

4+4=08 points

Consider the incomplete 6-node network shown below, with the given link costs.



Consider the completed table below, which calculates the shortest distance to all nodes from X:

Node	Shortest distance from X	Previous Node
X	0	n/a
Y	1	X
Z	3	Y
U	4	X
V	5	X
W	9	X

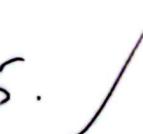
1. For link X, what is the cost associated with this link? If the answer can't be determined given the information, respond with 'n/a'.

The cost for X is 2.



2. For link Y, what is the cost associated with this link? If the answer can't be determined given the information, respond with 'n/a'

The cost for link Y is 5. /

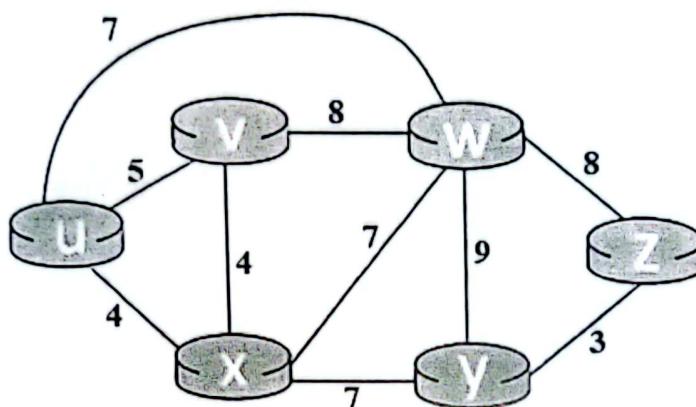


Question 6

4+4+4=12 Points

Consider the 6-node network shown below, with the given link costs.

Note: (n, p) = (n= Distance to node, p= predecessor)



Using Dijkstra's algorithm, find the least cost path from source node U to all other destinations and answer questions. Do not attempt the calculation directly, Solve the problem step by step and then answer the following questions.

	$n(v).p(v)$	$n(x).p(x)$	$n(w).p(w)$	$n(y).p(y)$	$n(z).p(z)$
u	5, u		7, u	∞	∞
ux	5, u	4, u	7, u	11, x	∞
uxv			7, u	11, x	∞
uxvw				11, x	15, w w
uxvwy					14, y y
uxvwyz					

1. What is the shortest distance to node V and what node is its predecessor (Next Hop)? Write your answer as (n, p).

(5, u) ✓

2. What is the shortest distance to node X and what node is its predecessor? Write your answer as (n, p).

(4, u) ✓

3. What is the shortest distance to node W and what node is its predecessor? Write your answer as (n, p).

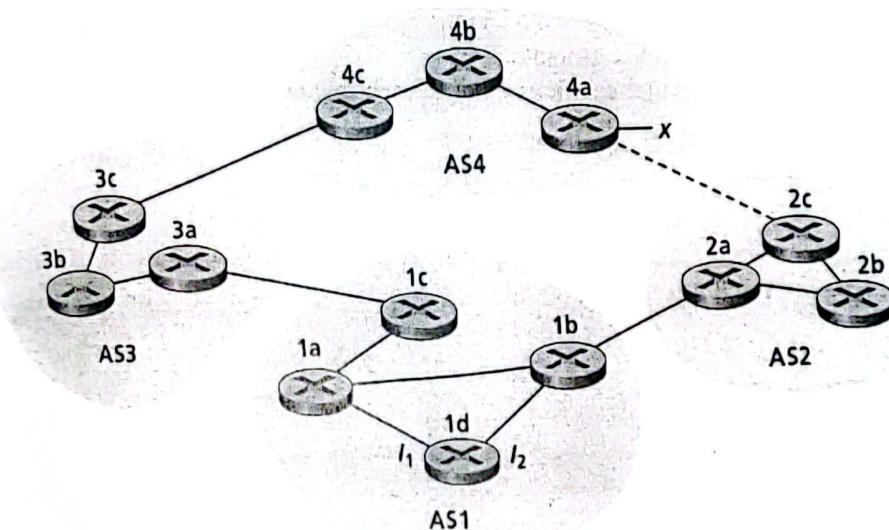
(7, u) ✓

Question 8

12

4+4+4+4=12 points

Consider the network shown below. Suppose AS3 and AS2 are running OSPF for their intra-AS routing protocol. Suppose AS1 and AS4 are running RIP for their intra-AS routing protocol. Suppose eBGP and iBGP are used for the inter-AS routing protocol. Suppose there is no physical link between AS2 and AS4.



- Router 3c learns about prefix x from which routing protocol: OSPF, RIP, eBGP, or iBGP?

eBGP

- Router 3a learns about x from which routing protocol?

iBGP

- Router 1c learns about x from which routing protocol?

eBGP

- Router 1d learns about x from which routing protocol?

iBGP

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Question 9

3.5+3.5=7 points

Consider sending a 3,000-byte datagram into a link which has an MTU of 500 bytes. Suppose the original datagram is stamped with the identification number 422.

a. How many fragments are generated?

b. What are the values in the various fields in each fragment? e.g., packet id, offset, etc.

(a) as ~~the~~ MTU is 500 byte so, we require

$\frac{3000}{500} = 6$ fragments of data. and 7th segment

b): for 1st fragment

rest of bytes as
length will be 500 bytes
Identification number will be 422
frag flag will be set to 1
and offset will be 0

for all fragment table is below:-

Frag No.	Length	Identification Number	frag flag	offset
1	500	422	1	0
2	500	422	1	60
3	500	422	1	120
4	500	422	1	180
5	500	422	1	240
6	500	422	1	300
7	120	422	0	360