April 13th 2010

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ID: [illegible]

Network Architecture I: Exam 2

-32.5

- Put your name and student id.
- The exam is closed book and closed note.
- You have 75 minutes to complete the exam.
- Answer all the questions directly on the exam papers (back page included). If you need additional sheets, let the instructor know.
- *Be brief, but do not omit necessary details.*
- If the problem appears to be ambiguous to you, write your assumptions along with your answer.
- Enjoy and Good luck!

42.5/75

1. (8 pt) Answer 'true' or 'false' to the following questions.

V a) TCP uses a network assisted congestion control. (True/False) False

-1 T b) ATM provides multiple class of network layer QoS services. (True/False) False. True

V c) The Internet provides only one class of network layer QoS service. (True/False) True. V

-1 F d) ATM uses an end-to-end congestion control. (True/False) True

V e) TCP provides a reliability on a hop-by-hop basis. (True/False) False

V f) TCP sender's window size is decided by the maximum from the congestion control and flow control. (True/False) False

V g) All the ATM services guarantee in-order delivery of packets. (True/False) True

F h) All the ATM services guarantee bandwidth per connection. (True/False) True. false

~~false~~ True

2. (3 pt) Which of the followings is not about network layer connection management?

c

(a) A network layer provides either connection or connection-less service, but not both in a same network.
(b) Network layer connection management is between two hosts rather than two processes.
(c) Routers do not involve in the connection setup.
(d) Resources reservation can be made during the connection setup.

3. (3 pt) Which function of TCP is *not* related to providing congestion control?

(a) Timeouts
(b) Multiple duplicate acknowledgement
(c) Port number
(d) Sender's buffer

Window Size

4. (3 pt) Which of the following is not a network layer functionality? (Ans:_____)

Cong = Cong + MSS

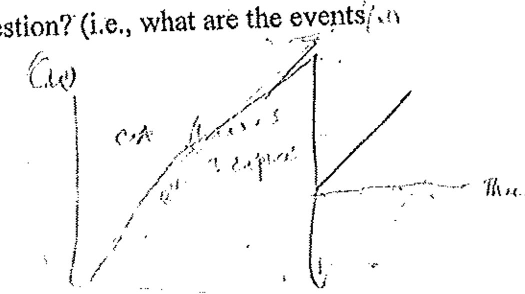
(a) Forwarding
(b) Routing
(c) Connection management
(d) Flow control

5. (3 pt) Which of the following is not about forwarding or routing? (Ans:_____)

(a) Forwarding moves packets from router's input to appropriate router output
(b) Routing determines route taken by packets from a source to a destination.
(c) Forwarding algorithm produces a routing table.
(d) Forwarding is based on a forwarding table.

6. (5 pt) How does TCP source perceive network congestion? (i.e., what are the events that trigger congestion control mechanism?)

(i) Repeated ACK
(ii) Timeouts



7. (20 pt) Fill out the blanks in the table below, on TCP congestion control.

-10

State (Slow start or congestion avoidance)	Event	TCP Sender Action	Commentary
		Increase Exponentially	
(a. SS)	ACK receipt for previously unacked data	CongWin = (c. MSS X 2), Cond+MSS RTT If (CongWin > Threshold) set state to "Congestion Avoidance" CongW + MSS x (MSS/CongW)	Resulting in a doubling of CongWin every RTT
(b. CA)	ACK receipt for previously unacked data	CongWin = (d. MSS + 1) For every RTT Increase Gradually.	Additive increase, resulting in increase of CongWin by 1 MSS every RTT

8. (15 pt) Consider TCP procedure for estimating RTT. Suppose that $\alpha = 0.1$. Let `sampleRTT`$_1$ be the most recent sampleRTT, let `sampleRTT`$_2$ be the next most recent sample RTT, and so on.
   (a) For a given TCP connection, suppose four acknowledgements have been returned with corresponding sample RTTs, `sampleRTT`$_4$ `sampleRTT`$_3$ `sampleRTT`$_2$, and `sampleRTT`$_1$. Expressed EstimatedRTT in terms of thr four sample RTTs.
   (b) Generalize the formula for n sample RTTs.
   (c) For the formula in part (b) let n approach infinity. Comment on why this averaging procedure is called an exponential moving average.

$EstRTT = (1-\alpha)\,SampleRTT + \alpha\,SampleRTT \Rightarrow$ General forma

$EstRTT_1 = (1-\alpha)\,SampleRTT_1 + \alpha\,SampleRTT_1$

$EstRTT_2 = (1-\alpha)\,SampleRTT_2 + \alpha\,SampleRTT_2 + EstRTT_1$

$EstRTT_3 = (1-\alpha)\,SampleRTT_3 + \alpha\,SampleRTT_3 + EstRTT_2$

$EstRTT_4 = (1-\alpha)\,SampleRTT_4 + \alpha\,SampleRTT_4 + EstRTT_3$

$\therefore EstRTT_4 = \sum_{i=1}^{4} (1-\alpha)^4\,SampleRTT_4 + \alpha\,SampleRTT_4$

-5

check the solution in homework 3.

(b) $n = \frac{1}{10} \sum_{i=0}^{n} 1/9\,(1-\alpha)^n\,SampleRTT_n + \alpha\,SampleRTT_n$

-5

(c) This is Called Exponential Moving Average, this we Can See from above that the Sample RTT is increasing in a geometric way as the acknowledgment increase the Estimated RTT is going Thus Signifies that the estimated is an exponential format.

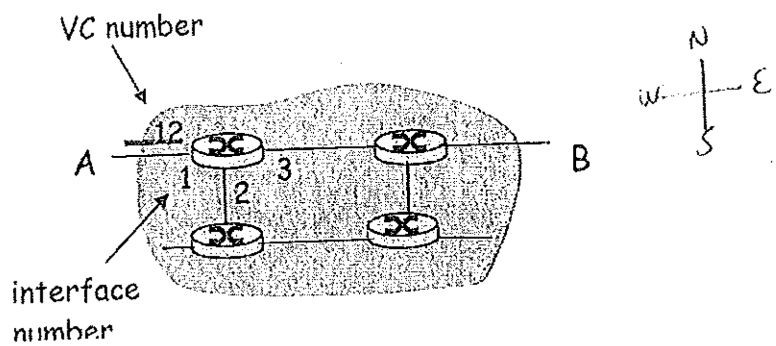
-5

The weight given to past samples decays exponentially.

9. (5 pt) Consider sending a large file from a host to another over a TCP connection that has no loss. Suppose TCP uses AIMD for its congestion control without slow start. Assuming cwnd increases by 1 MSS every time a batch of ACKs is received and assuming approximately constant RTTs, how long does it take for cwnd increase from 5 MSS to 10 MSS?

for every RTT the Cwnd increases (size) by 1MSS
there from 5MSS to 10MSS we have
5-6 = 1RTT and 9-10 = 1 RTT
6-7 = 1RTT Therefore the Total is 5RTT
7-8 = 1RTT
8-9 = 1RTT.

10. (5 pt) Consider the following virtual circuit network. A forwarding table of the northeast router is shown below. On the northwest router, what interface and outgoing VC# will be used for a packet from A?



Incoming interface	Incoming VC #	Outgoing interface	Outgoing VC #
1	12	2	22
2	12	2	18
3	7	2	17
1	97	3	87

Outgoing interface = 2
Outgoing VC# = 22

Name: ______________________
ID: ______________________

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A broadcast ARP

2. route the datagram.

The adaptor in A

End to End Propagation delay

= Cable length / Signal Speed

Cable length / Signal Spe...

Bit rate RTT = 2 x

frame size =

Worst Case x BW

1. (3 pt) Answer 'true' or 'false' to the following questions.

T or F

T a) BGP allows for policy routing by filtering routes at the inbound and outbound points.

T b) Ping program exploits 'TTL expired' ICMP message

F c) Virtual circuit forwarding table keeps only the current connection states whereas packet switching forwarding table keeps entries for all possible destination.

2. (3 pt) Which of the following is *not* about NAT?
(Ans:____)

(a) Translates IP address and port numbers from/to internal to/from external network
(b) The same ip addresses can be used in an internal network
(c) Mask the true internal IP addresses of the internal network
(d) Connections have to be initiated from internal network

3. (3 pt) Which of the following is not routing protocol?
(Ans:____)

(a) IP
(b) RIP
(c) IGRP
(d) ICMP

4. (3 pt) Which of the following is *not* about multicasting?
(Ans:____)

(a) Multicast routing uses in-network duplication rather than source duplication
(b) Reverse path forwarding (RPF) removes cycle and broadcast/multicast storm
(c) In PIM-SM multicast member router sends *join* message to a center node (rendezvous point)
(d) Flood-and-prune RPF is effective when small portions of routers are multicast members

5. (8 pt) Below is a list of requests for network address allocations to a service provider. The service provider allocates addresses in the order of organization 1, 2, 3 and 4, beginning at 234.195.0.0.

Organization 1: 350 hosts
Organization 2: 1500 hosts
Organization 3: 400 hosts
Organization 4: 4000 hosts

512

Show the resulting address allocations with CIDR notation.

Once these have been allocated, also show the gaps that exist of unallocated addresses in between those of the networks above.

	Notation of CIDR Address allocation	Range of Addresses Allocated
Organization 1		
Organization 2		
Organization 3		
Organization 4		

Org1: 234.195.0.0/23
Range:234.195.0.0~234.195.1.255
Bin:[234.195.00000000.00000000 ~ 234.195.00000001.11111111]
Org2: 234.195.8.0/21
Range: 234.195.8.0~234.195.15.255
Bin:[234.195.00001000.00000000 ~ 234.195.00001111.11111111]
Org3: 234.195.2.0/23
Range:234.195.2.0~234.195.3.255
Bin:[234.195.00000010.00000000 ~ 234.195.00000011.11111111]
Org4: 234.195.16.0/20
Range:234.195.16.0~234.195.31.255
Bin:[234.195.00010000.00000000 ~ 234.195.00011111.11111111]

32 9 23 2^8 = 256 32 64 2^9 512

6. (10 pt) The table below is a routing table using CIDR. Address bytes are denoted in hexadecimal. The notation '/12' in C4.60.0.0/12 denotes a netmask with 12 leading 1-bits, that is FF.F0.0.0.

NetMask/Length	NextHop
C4.5E.2.0/23	A
C4.5E.4.0/22	B
C4.5E.C0.0/19	C
C4.5E.40.0/18	D
C4.4C.0.0/14	E
C0.0.0.2/2	F
80.0.0.0/1	G

234.195.00001001

2^9 512 2^{10} 1024

1100 0000
1100 0100
1100 0000

0011

Robot Mobile Computin 490
Computing 5590

Select to what next hop the packets with the following destination address will be delivered, following the longest prefix matching.

a. (5 pt) C4.5E.13.87

$R = 1/2^n$

b. (5 pt) C4.5E.22.09

n = m

$1/2^5 = \frac{1}{32}$

Delay = $B * \frac{L}{B}$

C4 5E 0000 0010
C4 5E 0000 0100
C4 5E 1100 0000
C4 5E 0100 0000
C4 0100 1100 0000

1100 0000 0000

2^0 1
0001 0011
1 3

$2^1 2^0$
2 1
0001 0011

8 4
$2^3 2^2$
1100

A = 10
B = 11
C = 12

7. (12 pt) Consider multicast routing with presence of unicast routers

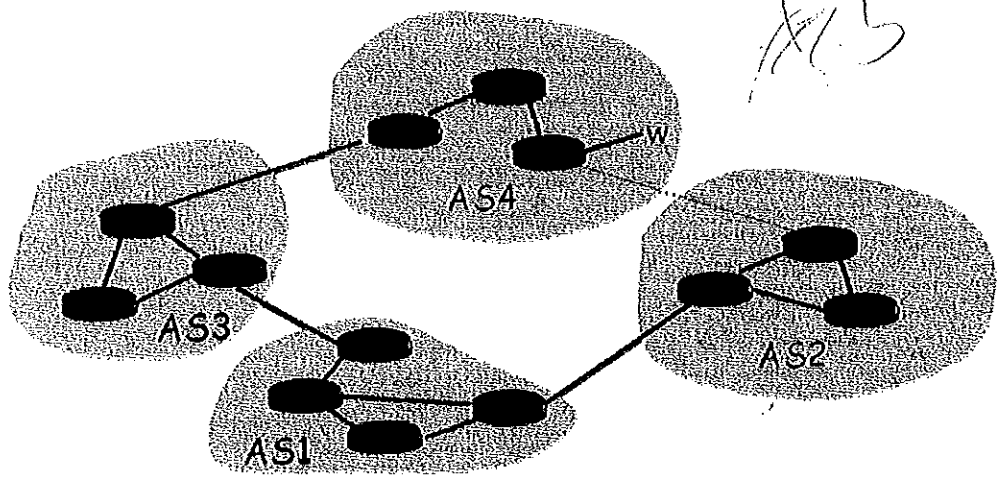
```
A--- B---C---D---E---F
                  \
                   G
```

A is a multicast source host, F and G are multicast destination hosts. B, E are multicast-capable routers and C, D are only unicast routers. Assume multicast group address is 'g'.
How tunneling can be done? Show IP packet source and destination addresses on the links between A---B, B---C, C---D, D---E, E---F, and E---G.

8. (12pt) 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. Initially suppose there is no physical link between AS2 and AS4.

?

AS 5



a. Once router 1d learns about w, what entry will be put in its forwarding table? i.e., (w,i_1) or (w,i_2) ? Explain why in one sentence.

(W, I_1) (w, ~~I6~~) This is b/cus the least to W is ~~3~~. This is discovered from the Intra-routing protocol.

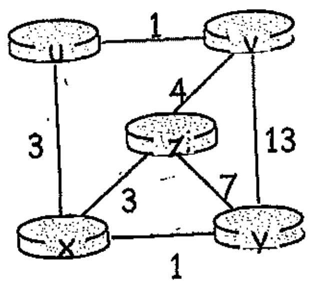
b. Now suppose that there is a physical link between AS2 and AS4 shown by the dotted line. Suppose router 1d learns that w is accessible via AS2 as well as via AS3. Then what will the forwarding table entry for w? i.e., (w,i_1) or (w,i_2) ? Explain why in one sentence.

Hot-potatoes routing Same as previous

c. Now suppose there is another AS called AS5, which lies on the path between AS2 and AS4 (not shown in diagram). Suppose router 1d learns that w is accessible via AS2 AS5 AS4 as well as via AS3 AS2. Then what will the forwarding table entry for w? i.e., (w,i_1) or (w,i_2) ? Explain why in one sentence.

It could be any depending Shortest AS-PATH

9. (8 pt) Consider the network shown below, and assume that each node initially knows the costs to each of its neighbors. Consider the distance vector algorithm and a) show the distance table entries at node x. Then b) construct its forwarding table.



from x

	x	u	y	z	v
x	0	3	1	3	∞
u	∞	∞	∞	∞	∞
y	∞	∞	∞	∞	∞
z	∞	∞	∞	∞	∞

from y

	x	u	y	z	v
x	∞	∞	∞	∞	∞
u	∞	∞	∞	∞	∞
y	1	∞	0	7	13
z	∞	∞	∞	∞	∞

from u

	x	u	y	z	v
x	∞	∞	∞	∞	∞
u	3	0	∞	∞	1
y	∞	∞	∞	∞	∞
z	∞	∞	∞	∞	∞

from z

10. (8 pt) Consider the same network shown above, and assume that each node initially knows the topology and costs of all links. Consider the link state algorithm and a) show the computation of Dijkstra algorithm at node x. Then b) construct its forwarding table from the shortest path tree constructed.

THE END

November 9th 2009

Name: RAHUL PAROPKARI
ID: 16056952

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66/93

1. (6 pt) Answer 'true' or 'false' to the following questions.

T or F	
V F	a) TTL field in IP header is incremented by one on each hop. F
F T	b) TCP uses Selective Repeat ARQ. (GBN).
-2 V T	c) Virtual circuit forwarding requires resource reservation prior to data forwarding. T
F T	d) An object can always be found in a Gnutella-like P2P system if existing. (hop limits so can't reach the end of the n/w) F
V F	e) TCP provides reliability on a hop-by-hop basis. F
V T	f) For TCP, AIMD relates to how a source responds to network congestion. T

V 2. (3 pt) Which type of application would *not* be difficult to use behind a NAT? (Ans: b)

(a) File sharing
(b) Web browsing
(c) IP Telephony c
(d) Peer-to-peer gaming

V 3. (3 pt) Which function of TCP is *not* related to providing reliable packet transmission? (Ans: d)

(a) Timeouts
(b) Sequence number
(c) Acknowledgements
(d) Sender's buffer size change

-3 4. (3 pt) Which of the following is *not* about saving IP address usage? (Ans: c)

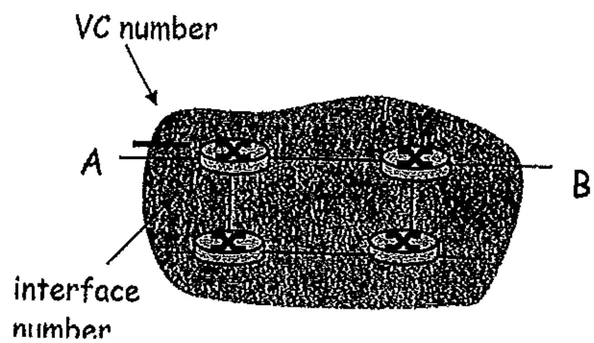
a

(a) IPv6 — not saving but a new pool.
(b) DHCP - temporary allocation.
(c) CIDR - bits than the bytes ... so saving.
(d) NAT - one outside and many pseudo inside.

5. (3 pt) Which function of TCP is *not* related to TCP sender's buffer? (Ans: b)

(a) Reliable data transfer
(b) Multiplexing/Demultiplexing (port #)
(c) Flow control
(d) Congestion control

6. (5 pt) Consider the following virtual circuit network. A forwarding table of the northeast router is shown below. On the northwest router, what interface and outgoing VC# will be used for a packet from A?



Incoming interface	Incoming VC #	Outgoing interface	Outgoing VC #
1	12	2	22
1	22	3	18
2	12	3	17
2	2	1	30
3	67	3	87

Outgoing Interface : 2.

Outgoing VC# : 22.

7. (10 pt) The table below is a routing table using CIDR. Address bytes are denoted in binary. The notation '/12' in 11000000.01100000.00000000.00000000/12 denotes a netmask with 12 leading 1-bits, that is 11111111.11110000. 00000000. 00000000.

NetMask/Length	NextHop
11000100.01011110.00000010.00000000/23	A
11000100.01011110.00000100.00000000 /22	B
11000100.01011110.10100000.00000000/19	C
11000100.01011110.01000000.00000000/18	D
11000100.01001100.00000000.00000000/14	E
11000000.00000000.00000000.00000000/2	F
10000000.00000000.00000000.00000000/1	G

not ? Qb

Select to what next hop the packets with the following destination address will be delivered, following the longest prefix matching.

a. (5 pt) 11000100. 01011110.01000011.11111100

→ D

b. (5 pt) 11000100.01011110.11101100.10001111

→ F

8. (9 pt) Write the answers to the following questions on reliable data transfer mechanisms.

(a) Selective repeat :
   i. Receiver window size: N
   ii. Number of timers: N
   iii. Minimum number of sequences: $\geq 2N$

(b) Go-Back-N
   i. Receiver window size: 1
   ii. Number of timers: 1
   iii. Minimum number of sequences: N n+1 (sender window size + receiver window size)

−1

(c) Stop-n-Wait
   i. Receiver window size: 1
   ii. Number of timers: 1
   iii. Minimum number of sequences: N (1) 2

−1

9. (6 pt) On IP fragmentation and reassembly:
   (a) Why is it necessary? Because the packet passes through network through many links. At some stage, the link capacity might be less and so the packet needs to be fragmented to many small size packets.
   (b) Where does it occur?
      fragmentation: In the network at some router.
      reassembly: At the destination host.

   (c) What fields of IP header are used for fragmentation and reassembly?
      Frag filed will be set or reset. offset / flags / IP id.

−1

10. (5 pt) What are the problems of a P2P system with a centralized directory (eg. Napster)? In case of a centralised directory, all the central database resides on a single central server. So, all the queries will go to this server to ask where this file is located and on which peer. So, the traffic is more. Also, this is a single point of failure. The information of the entire system will be lost if the server fails. However, the file sharing is peer to peer basis. Also, the server is not capable of handling so much traffic

11. (5 pt) What is 'controlled flooding' (or 'limited scope flooding') in Gnutella like P2P system? In case of a Gnutella like peer to peer system, the information of all the files of one peer stays with itself. Every peer also has the information about all of its neighbouring nodes. Here we have controlled or limited flooding means that the query will be flooded or forwarded only to its neighbours. If any of the neighbors still don't have the required file then each of this peer will forward again to only its neighbour. So, the entire n/w is gradually flooded and not like to all peers. So, it is limited or controlled flooding.

−5

12. (15 pt) The following requests for network address allocations are received in this chronological order. Each network receives an address allocation before the next network requests its addresses.

Requests: Network A – 2030 Hosts : 193.124.24.0 ~ 193.124.31.255 / 21 2^{11}
Network B – 510 Hosts . 193.124.18.0 ~ 193.124.19.255 / 23 2^{9}
Network C – 4096 Hosts · 193.124.32.0 ~ 193.124.47.255 / 20 2^{12}

−4

(a) (10 pt) Use CIDR address allocation for the requests above starting from address 193.134.17.0. Allocate addresses in the order they were requested with each allocation using the lowest range of addresses possible. Give the answer in standard CIDR notation. Once these have been allocated, gaps exist of unallocated addresses in between those of the networks above. Give the range of addresses for those gaps. The table below has space to list 5 gaps, but there may not actually be that many.

	CIDR Address Specification	Range of Addresses Allocated
Network A	193.134.00010111.00000000/18 21	193.134.17.0 ~ 193.134.24.255
Network B	193.134.00011001.00000000/18 23	193.134.25.0 ~ 193.134.26.255 ✓
Network C	193.134.00011011.00000000/12 20	193.134.27.0 ~ 193.134.42.255 ✓

	Range of Addresses Not Allocated
Gap 1	
Gap 2	
Gap 3	
Gap 4	
Gap 5	

Such allocation gives no gaps in between the nws.

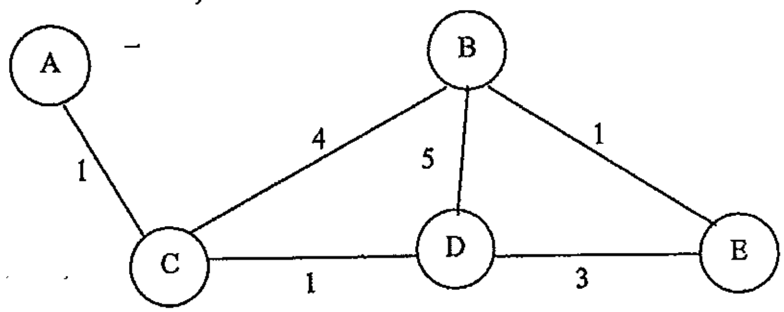
−5

(b) (5 pt) What is the lowest starting address larger than 193.134.17.0 where the allocation could have started and no gaps would have existed after the address allocations?

A → 193.134.00010111.00000000 ~ 193.134.00100000.11111111 — for 2030 users.
Similarly, for network B and network C as computed above.
Actually for 2030 users /21 is enough. But as we are starting from 193.134.17.0 we have to use the subnet mask /18.

Also for 510 hosts /23 is sufficient and for 4096 /20 is enough.
Since more than required bits are used and hence lot of [illegible] addresses are wasted.

13. (20 pt) Consider the network shown below (the labels are the delay on the links).



(a) (10pt) Show the operation of Dijkstra's (Link State) algorithm for computing the shortest path from C to all destinations.

→ In the above diagram C is directly connected to B, D and A. It is connected to E through D and through B. But the shortest cost path is through D. Here D(x) is the cost of the node x from source. i.e. D(x) is the path cost from source to x. Also; P(y) is the node precessor to y. Like in the above example : P(D) = C or B if going from C to D.

Dijkstra's (link state) :—

	D(A), P(A)	D(B), P(B)	D(D), P(D)	D(E), P(E)
C	1, C	4, C	1, C	∞
CD	1, C	4, C	1, C	4, D

Even if we keep solving this further, this will be unchanged. As these are the least cost paths from the source node C.

Table

N.I.	path from C
	1, C
B	4, C
D	1, C
E	4, D

(b) (10pt) Show the distance table that would be computed by the distance vector algorithm in C. You don't have to show all the steps of the distance vector algorithm.

−5 →

In distance vector algorithm; we compute as follows;

My dear you were supposed to do for all neighbors for C.

$$d_x(y) = \min \left(c(x,y) + d_y(y) \right)$$

where $c(x,y)$ = path cost from x to y.

$d_y(y)$ = current cost from the y to y (same in this case).

& $d_x(y)$ is the least cost from x to y.

In this figure;

$d_c(D) = \min \left(c(c,D) + d_D(D) \right) = (1+0) = 1.$

$d_c(E) = \min \left\{ c(E,B) + d_B(E) \,;\, c(C,D) + d_D(E) \right\}.$

$= \min \left\{ 4+1 \,;\, 1+3 \right\} = \min \left\{ 5, 4 \right\} = \underline{\underline{4}}.$

i.e. through D.

∴ Distance Vector:

	C → A	C → B	C → D	C → E
C	1	4	1	min (5, 4) = 4

Table: →

Node	Path Cost from C
A	1
B	4
D	1
E	4

	A	B	C	D	E
A	0	5	1	2	4
B	5	0	4	4	1
C	1	4	0	1	4
D	2	4	1	0	2