Part 1: True/False/Multiple Choice

1. Subnetting is the process of extracting the network address from an IP address

   -False

2. TCP has the property of slow start to probe the congestion level in the network

   -True

3. The MTU is the maximum number of Bytes that the IP packet can encapsulate

   -True

4. Communications can be initiated either from the private network or from the public network, as long as the private network is using a NAT mechanism.

   -True

5. The following masks (in slash notation for simplicity) are only used as default masks: /8, /16 and /24

   -True

6. In link state routing, every router has exactly the same link state database but the routing tables are different in each router.

   -True

7. In distance vector routing, each router receives distance vectors from every router in the network.

   -False

8. In 802.11 CSMA/CA, when a station senses the medium to be idle it sends a frame immediately.

   -False

9. 802.11 and 802.3 have the same frame format but they differ in the sense that 802.11, acknowledgements are needed since a sending station can't detect a collision.

   -False

10. In 802.11, when two stations transmit RTS frames simultaneously, a collision will occur and no CTS frame is received. Each station will wait a random period of time and try again.

    -True

11. An ACK number of 500 in the TCP header, indicates that the receiver has received 499 Bytes, and the next byte it expects to receive is #500

    -False

12. The maximum window size in TCP is limited by the round-trip time RTT of the connection

    -False

13. If an IP fragment does not arrive at the destination, then only that fragment, not the entire packet, is retransmitted by the source host

    -False

14. The IP header changes each time a packet passes through an IP router

    -True

15. In 802.11, sending an ACK after SIFS prevents a collision with a potential data frame transmission, since other nodes will wait for DIFS time units before attempting a transmission

    -False

16. After fast retransmit is invoked, fast recovery cuts the slow start period in half

    -False

17. In 802.3 standard, if the maximum size (coverage) were increased, the minimum frame size would decrease.

    -False

18. In 802.3 standard, if the bandwidth were decreased, the minimum frame size would decrease as well.

    - False

19. In 802.3, if an ACK is not received within a specified time (timeout) the sender will retransmit the frame.

- False

20. In the case fragmentation is needed, the TCP/UDP headers always end up in the first fragment.

-True

21. Host A (The Client) initiates a TCP session with host B (The server). The connection setup 3-way handshaking include SYN, SYN-ACK and ACK respectively. Host A can start sending data immediately after sending the ACK segment where as Host B can send some data immediately after sending the SYN-ACK segment to the client.

-False

22. A smart phone can spread traffic to/from a single TCP connection over the WiFi and Cellular interfaces at the same time.

-False

……………………………………………………………………………………

23. Which statement describes remote access VPNs? Select all that applies

a. Client software is usually required to be able to access the network.

b. Remote access VPNs are used to connect entire networks, such as a branch office to headquarters.

c. Remote access VPNs support the needs of telecommuters and mobile users

d. A leased line is required to implement remote access VPNs.

e. End users are not aware that VPNs exists.

- A, C

24. If a TCP flow and a UDP flow share the same "bottleneck" in the network. Which of the following is "more likely" to be true?

a. UDP connection will get a greater percentage of the bandwidth than TCP

b. TCP connection will get a greater percentage of the bandwidth than UDP

c. Both TCP and UDP connections will be affected equally by the network congestion

d. TCP will continue because it is reliable but UDP will stop

e. Both connections will terminate

-B

25. A sender sends an unencrypted message and its encrypted digest over a network. Which of the following types of information assurance is provided in this scenario?

a. Confidentiality b. Authentication c. Integrity d. None of the above

- C

26. A sender sends a message encrypted by a public key of the recipient. Which of the following is NOT provided in this scenario?

a. Confidentiality b. Integrity c. Authentication d. None of the above

-C

27. A sender sends a message encrypted by his own private key. Which of the following is NOT provided in this scenario?

a. Confidentiality b. Integrity c. Authentication d. All of the above

-A

28. Replacing a Hub by a switch results in (Select all that applies)

a. It increases the number of collision domains.

b. It decreases the number of collision domains.

c. It increases the number of broadcast domains.

d. It decreases the number of broadcast domains.

e. It makes smaller collision domains.

f. It makes larger collision domains.

-A, E

29. An ISP advertises the CIDR network address 192.168.3.48/20 (and no other addresses). What network addresses could this ISP own? (Select all that applies)

a. 192.168.3.128 b. 192.168.3.49 c. 192.168.3.64 d. 192.168.3.1 e. 192.168.3.62

-B, E

30. A network administrator discovers that host A is having trouble with Internet connectivity, but the server farm has full connectivity. In addition, host A has full connectivity to the server farm. What is a possible cause of this problem?

a. NAT is required for the host A network.

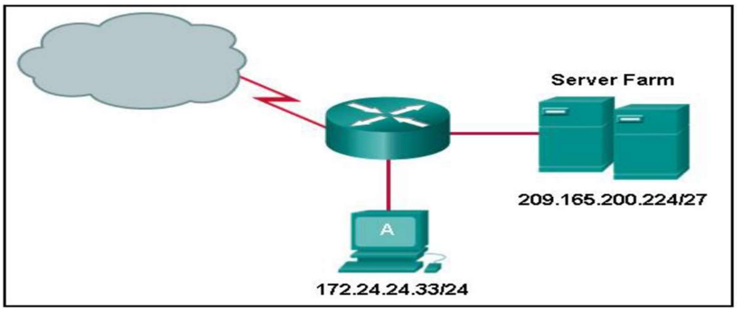
b. Host A has an incorrect subnet mask.

c. Host A has an incorrect default gateway configured.

d. The router has an incorrect gateway.

e. Host A has an overlapping network address.

-A



Part 2: Fill-in-the-Blank

1. Suppose a group of 10 stations are connected to a 10 Mbps Ethernet hub. The average bandwidth available to each station is __**1**__Mbps. Now suppose these 10 stations are connected to a 10 Mbps Ethernet Switch, the maximum bandwidth available to each station is _____**10**___Mbps. The aggregate capacity of the switch is ___ **100**_____ Mbps

2. A TCP sender is sending a full window of 216 Bytes over a 1 Gbps channel that has a 20msec round trip time.

a. The link utilization is _____**2.6**_____ %

b. The maximum throughput is ______**3276800**_______ Bytes/sec

3. The following classless network addresses: {200.47.96.0/24, 200.47.97.0/24 ……… 200.47.159.0/24}, are to be aggregated into two blocks of shorter prefixes. The network addresses (include the slash notation) are ______**200.47.96.0/19**_______ and _______**200.47.96.128/19**_________

4. Assume you have a 10 Mbps hub-based CSMA/CD network interconnection ten hosts. Each computer is connected to the hub with a cable of different length. Host H1 is connected via a 100 m cable, Host H2 is connected via a 200 m cable, and so on up to host H10 that is connected via a 1000 m cable (ignore the signal degradation problem). The speed of propagation is 2.5x108 m/sec. The minimum frame length used in this network so that CSMA/CD protocol will function correctly should be _________**152**_________ bits.

5. It is desired to aggregate the "entire" class B address space as a "single CIDR block" (i.e. the Block covers the entire class B address space). The block can be expressed as ____________**128.0.0.0/2**_____________ (must be written in the form a.b.c.d/n)

6. A router interconnects three subnets. All hosts in each of these subnets are required to have the prefix 223.1.17/24. Subnet #1 has 15 hosts, Subnet #2 has 12 hosts and Subnet #3 has 45 hosts. The three subnets have the following addresses (must be written in the form a.b.c.d/n)

Subnet #1: _____**223.1.17.64/27 ~ 233.1.17.95/27**____

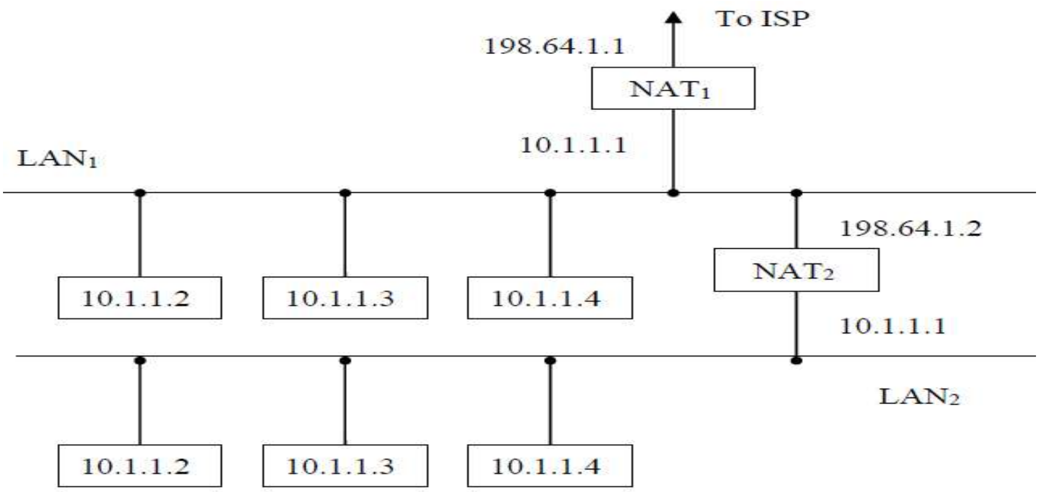
Subnet #2: ____**233.1.17.96/28 ~ 233.1.17.111/28**____

Subnet #3: ____**233.1.17.0/26 ~ 233.1.17.63/26**______

The aggregated address (of minimum prefix, in the form of a.b.c.d/n) that is advertised to the Internet is ____**223.1.17.0/25**_____

7. Two nodes "A" and "B" that are attached at the opposite ends of 1000 m Ethernet cable. They both have a 1000-bit frame to send to each other. Both nodes attempt to transmit at t = 0. Assume the transmission rate is 10 Mbps and that CSMA/CD is used. After the first collision, node "A" will retransmit immediately after it senses the medium is idle. Station "B" will retransmit 50 □seconds after it senses the medium is idle. Assume that the speed of propagation is 2x108 m/sec. Assume no jamming signal is used. Collision occur at t = ___**$2.5*10^{-6}$**____ sec. Station A will retransmit at t = ____**$1*10^{-5}$**_____ sec. The time it will take the frame from "A" to be completely delivered to "B" is ____**$1.15*10^{-4}$**___ sec. The throughput of node A is ___**8695652.2**____ bps.

8. Suppose an organization has installed "nested NATs". NAT1 with IP address 198.64.1.1 is connected directly to the ISP, while NAT2 is connected internally as shown below. Both private networks are numbered from 10.0.0.0/8 private IP address space.



▪ If host 10.1.1.2 on LAN_2 sends an IP packet with destination address 10.1.1.3, which host (or hosts) will receive it? Identify the LAN as well. Answer:
_______________**10.1.1.3 LAN_1**_________________________

▪ If host 10.1.1.2 on LAN_2 sends an IP packet with destination address 128.9.160.23, what source address will be on the packet when it arrives at the destination? Answer:
__________**198.64.1.1**___________

9. An organization was awarded a class B address. A host in that organization has an IP address of 145.104.182.100 and a subnet mask 255.255.224.0.

• The organization network address is _________**145.104.0.0**__________

• The subnet address on which the host is located is
________**145.104.160.0**________

• The host ID as viewed from routers outside the organization is
_________**0.0.182.100**____________

• The host ID as viewed from routers inside the organization is
_________**0.0.22.100**_____________

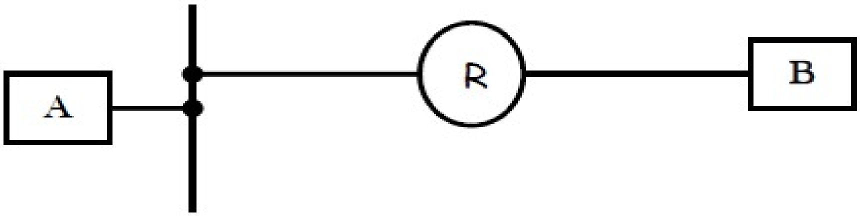
10. An e-mail client application on host A needs to send a 1536 Bytes image over TCP (TCP adds a header of 20 Bytes) which in turn runs over IP (IP adds a header of 20 Bytes) which runs over Ethernet which has an MTU of 1200 Bytes. A router connected to the Ethernet is connected to host B through a point-to-point connection with an MTU of 512 Bytes. Assume the TCP in host A knows that the MTU of the Ethernet is 1200Bytes. Answer the following questions

• The "minimum" number of segments created by TCP is ____**2**____.

• The payload size of each of these segments is (separate by comma if more than one segment) _________**1176, 380**__________ Bytes.

• The number of fragments delivered to B is ____**4**_____.

• Their offsets are (separate by comma) ______**0, 61, 122, 147**_______



11. The following is the forwarding table of a router X using CIDR

Destination Network	Subnet Mask	Outgoing Link Interface
223.92.32.0	/20	A
223.81.96.0	/19	B
223.112.0.0	/12	C
223.120.0.0	/14	D
128.0.0.0	/1	E
64.0.0.0	/2	F
32.0.0.0	/3	G

State, to what outgoing interfaces will these arriving packets, with the following destination IP addresses, be delivered?

a) Packet 195.145.34.2 delivered to ____**E**____

b) Packet 223.95.19.135 delivered to ____**E**____

c) Packet 63.67.145.18 delivered to ____**G**____

d) Packet 223.125.49.47 delivered to ____**C**____

12. Consider the wireless topology above, comprised of 6 nodes. Circles around each node illustrate their transmission range, e.g. A's range is shown by the dotted circle. Assume that the transmissions of two nodes will interfere at a location if and only if they transmit at the same time and their transmission areas overlap. When node A transmits to node B, list the potential hidden terminals from A (in either direction, i.e., those who might damage A's transmission or those who A's transmission might damage) and exposed terminals. Hidden terminals:

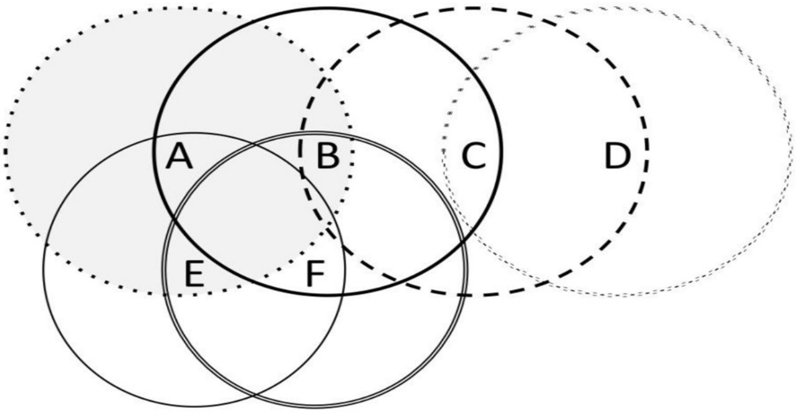
____________**C, F**_________________

Exposed terminals: _____________**E**_________________

What about when node B transmits to node C?

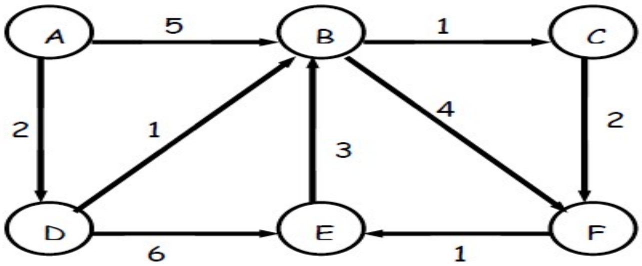
Hidden terminals: _____________**D**________________

Exposed terminals: _____________**A, F**_________________



Part 3 (Routing Algorithms)

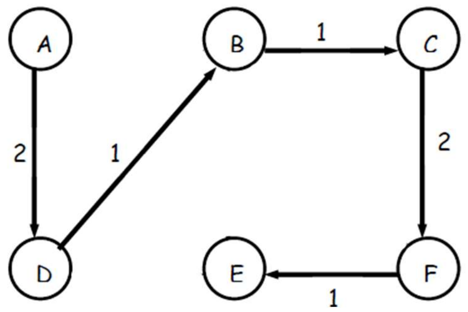
a. Consider the following computer network where each node represents a router and the edge label is the corresponding link cost. Note that the links are NOT bi-directional. Use Dijkstra algorithm to find the shortest path from router "A" to every other router in the network. Show your work step-by-step (i.e. I am not interested in the final answer. I am interested in algorithm steps). **After you finish, Sketch the spanning tree.**



Step by step algorithm:

STEP	N`	D(B), P(B)	D(C), P(C)	D(D), P(D)	D(E), P(E)	D(F), P(F)
0	A	5, A	∞	2, A	∞	∞
1	A, D	3, D	∞		8, D	∞
2	A, D, B		4, B		8, D	7, B
3	A, D, B, C				8, D	6, C
4	A, D, B, C, F				7, F	
5	A, D, B, C, F, E					

Spanning Tree:



b. This part is NOT related to part "a". Consider a Campus Network that runs RIP, where router R1 has the following routing Table

Destination	Distance	Next Hop Router
Net 1	0	Direct
Net 2	0	Direct
Net 4	8	R_2
Net 17	5	R_3
Net 24	6	R_4
Net 30	2	R_5
Net 42	2	R_4

Router R1 receives the following routing table from R4 from

Destination	Distance
Net 1	2
Net 4	3
Net 17	6
Net 21	4
Net 24	5
Net 30	10
Net 42	3

What will be R1 Routing Table (3 columns as shown above) be after it incorporates this update from Router R4?

R_1`s updated table:

Destination	Distance	Next Hop Router
Net 1	0	Direct
Net 2	0	Direct
Net 4	5	R_4
Net 17	5	R_3
Net 21	6	R_4

Net 24	7	R_4
Net 30	2	R_5
Net 42	5	R_4

Part 4: Subnetting/Addressing

An organization has the following block 192.168.1.0/24. The organization has three departments, namely the **Development department** (A) which requires 74 addressable devices, the **Production department** (B) which requires 52 addressable devices and the **Administration department** (C) which requires 28 addressable devices. All departments are connected with each other **via point-to-point links**. You are required to create **6** subnets (in the form of a.b.c.d/n), which will result in the "**minimum waste**" of the address space. How many addresses are reserved (i.e. available from the original block) for future use? Note: The all 0's and the all 1's can **NOT** be used in the host bits. A device means a Host or a Router. Your answer should be in a Table format listing the **Subnet address**, the **subnet mask** and the **direct broadcast** for **each of these subnets**.

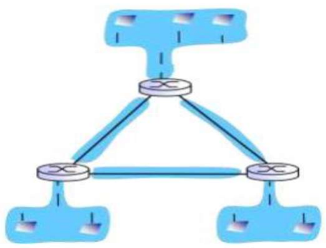


Table:

Id	Subnet Address	Subnet Mask	Direct Broadcast
A	192.168.1.0	/25	192.168.1.127
B	192.168.1.128	/26	192.168.1.191

C	192.168.1.192	/27	192.168.1.223
AB	192.168.1.224	/31	192.168.1.227
AC	192.168.1.228	/31	192.168.1.231
BC	192.168.1.232	/31	192.168.1.235

# of address for future use: 255 – 229 + 1 = 27

Hint: If departments are connected not through point-to-point links, then 3 intermediate subnet must be /30.

Part 5: TCP Congestion Control

Assume a TCP connection is established over a 1.2 Gbps link with an RTT of 4 msec. Assume that when a group of segments is sent, only a Single Acknowledgement is returned (i.e. cumulative). We desire to send a file of size 2MByte. The Maximum segment length is 1 Kbyte. Congestion **occurs** when the number of Bytes transmitted exceeds the Bandwidth x Delay product (expressed in Bytes). Two types of TCP congestion control mechanisms are considered. For each type sketch the congestion window vs. RTT diagram.

a. TCP implements **AIMD** (with **NO** slow start) starting at window size of 1 MSS. When congestion occurs, the window size is set to half its previous value. Will congestion occur? If Yes, when? If No, why not? **Find the throughput of the session and the link utilization in this case.**

b. TCP implements slow start procedure **ONLY** (i.e. **No** congestion avoidance phase). Again it starts with a window size of 1 MSS and doubles every RTT. When congestion occurs, the window size is reset to 1 MSS again. Will congestion occur? If Yes, when? If No why not? **Find the throughput of the session and the link utilization in this case.**

Useful Series:

$$\sum_{i=1}^{n} i = \frac{n(n+1)}{2}$$

Answer:

Congestion happen at: $1.2*10^{9}*4*10^{-3}$ bits = 600 MSS

a.

No, 63 < 600

Throughput: $(2*8) / (63*4*10^{-3})$ Mbps = 63.5Mbps

Link Utilization: $64.5 / (1.2*10^{3}) = 5.3\%$

b. Yes, at RTT = 11

Throughput: $(2*8) / (20*4*10^{-3})$ Mbps = 200Mbps

Link Utilization: $200 / (1.2*10^{3}) = 16.7\%$