1 Suppose a webpage contains 10 referenced objects. Identify a scenario in which an HTTP client would experience the same page download time, regardless of whether it implements *non-persistent* or *persistent with pipelining* HTTP (assume NO parallel connections).

Fill in your answer here Help

Format

2 Suppose the sender and receiver in a pipelined Selective Repeat reliable data transfer protocol, both have a window of size **N**. Suppose the sequence number of the segment at the base of the window at the receiver is **x**. What are the possible range of sequence numbers in the sender's window? Justify your answer.

Fill in your answer here Help

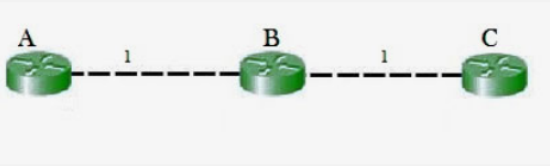
Format

3 In the context of IP fragmentation, what is the range of MTU values (in bytes) for which the length field of the first fragment can be 992? Explain your answer.

Fill in your answer here Help

Format

4 Consider the following network comprised of 3 routers. The link costs of both links are 1 as shown and do not change. Assume that the network uses Distance Vector routing protocol with Poisoned Reverse enabled. In the final distance vector update sent by router B to router C, (i.e. just before it achieves convergence), what is the cost to router A advertised by router B?



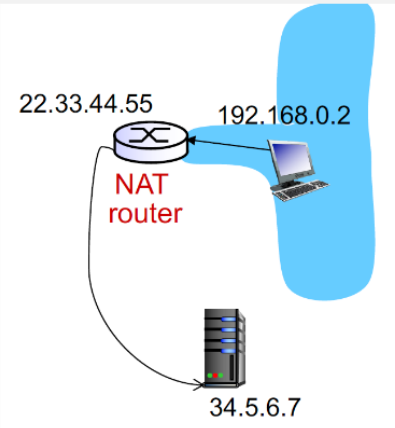
Select one alternative:

- ○ 1
- ○ infinity
- ○ 3
- ○ none of the provided choices
- ○ 2

Reset

Maximum marks: 3

5 Consider the network topology shown in the figure below. A host with a private IP address 192.168.0.2 opens a TCP socket on its local port 6700 and connects to a web server at 34.5.6.7. The NAT Router's public IP address is 22.33.44.55. Suppose the NAT router creates the following mapping (WAN -> LAN): [22.33.44.55, 4001] -> [192.168.0.2, 6700] for this connection.



In the IP datagram encapsulating the SYN-ACK response sent from the web server what is the destination IP address and the destination port number (in the TCP header)? Note down the answers in the spaces provided below. No explanation is required.

Destination IP Address:

Destination Port Number:

6 A conventional NAT translates both the IP address and the port number. Now, let's consider a special NAT software that translates only the IP addresses but **not** the port numbers. Answer the following questions in the space provided:

1. Under what scenarios will this NAT continue to work perfectly OK? [1 mark]
2. Under what scenarios will this NAT face problems, and how likely are those scenarios? [1 mark]

Fill in your answer here Help

7 Which of the following statements is true?

Select one alternative:

- ○ There are millions of IP addresses that cannot be routed through the public Internet
- ○ None of these
- ○ Two machines located in two different organisations cannot use the same IP address
- ○ Every combination of 32-bit IPv4 address is a valid IP address that can be routed through the public Internet

8 Consider a router with the following forwarding table:

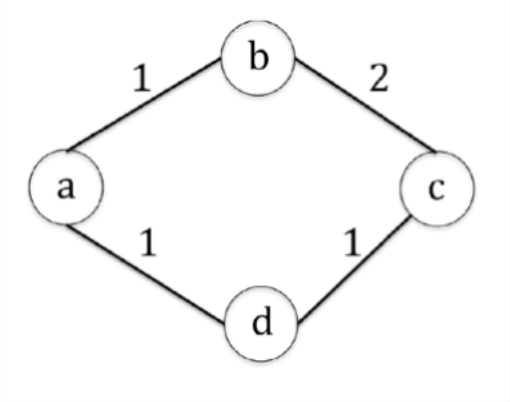
Network	Interface	Next-hop
10.1.1.0/24	e0	directly connected
10.1.2.0/24	e1	directly connected
10.1.3.0/25	s0	directly connected
10.1.4.0/24	s1	directly connected
10.1.5.0/24	e0	10.1.1.2
10.1.5.64/28	e1	10.1.2.2
10.1.5.64/29	s0	10.1.3.3
10.1.5.64/27	s1	10.1.4.4

Assume that an IP datagram with the destination address 10.1.5.65 arrives at this router. Which interface will this datagram be forwarded on? No explanation is required.

Select one alternative:

- ○ s1
- ○ s0
- ○ e1
- ○ e0

Consider the network in the figure below (for Q9 and Q10) that runs a link-state routing protocol that computes shortest paths as a sum of link weights. The number on each link is the weight of the link in each direction (e.g., links b-c and c-b both have weight 2).



Answer the following two questions (Q9 and Q10)

9 Suppose nodes *a*, *b*, and *d* send packets to destination node *c*. If link *d-c* (and *c-d*) *fails*, which of nodes *a*, *b*, and *d* could conceivably see their packets stuck in a temporary forwarding loop? Which nodes would not? Explain your answer.

Fill in your answer here Help

10 Now suppose the network operator wants to take link *d-c* (and *c-d*) down for planned maintenance. The network operator wants to temporarily set the weight of the link to a higher value, to coax nodes to move away from paths that use the link without creating any loops. What is the (minimum) weight that can be assigned to the link to ensure that no packets destined to node *c* experience a loop? Note that weights may be different in each direction, i.e. *d-c* and *c-d*. Indicate how the paths from nodes *a*, *b* and *d* to node *c* would change as a result of this. Explain your answer.

Fill in your answer here Help

11 Assume that a malicious host A connected to an Ethernet network has modified its implementation of the exponential back-off algorithm such that after each collision, the value of *K* will always be chosen from the set {0, 1} as opposed to the set {0, 1, … 2^n-1} used in Ethernet (*n* corresponds to the number of consecutive collisions). Now, another host B, which obeys the Ethernet back-off algorithm is trying to send a frame at the same time as host A. Assume that A and B have already collided four times consecutively. What is the probability that host B will succeed in transmitting a frame before host A in its next attempted transmission? Explain your answer.

Fill in your answer here Help

12 Consider a host H that is on a shared Ethernet network where CSMA/CD is enabled. Recall that, after the m-th successive collision, a host chooses **K** at random from {0,1,2, …, 2^m-1} as per the exponential backoff algorithm employed by the Ethernet CSMA/CD protocol. Assume that host H has a frame to transmit but encounters 3 successive (i.e. back-to-back) collisions. Which of the following is an **invalid** sequence of values of K that host H may have chosen during this sequence of 3 collisions.

Select one alternative:

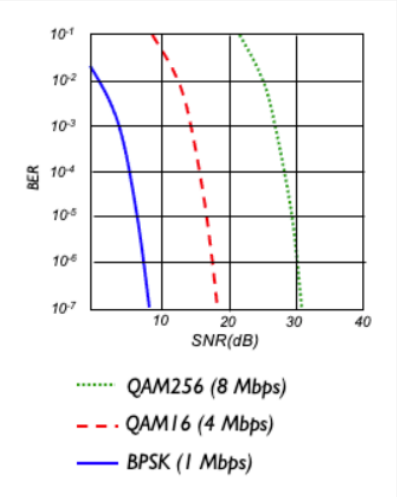
- ○ 1, 3, 7
- ○ 1, 2, 3
- ○ 2, 3, 5
- ○ 1, 1, 1
- ○ 0, 3, 1

13 A Local Area Network (LAN) utilizes Time Division Multiple Access (TDMA) for sharing a common channel among 100 connected nodes. The TDMA system operates with 1-ms slots, and it takes exactly 1 ms to transmit each packet over the LAN. Let's consider a scenario where a node has two packets awaiting transmission on the LAN. How much time does the second packet need to wait before it can access the channel, once the first packet has been transmitted?

Type your answer, in ms, in the space provided: [ ] .

Maximum marks: 2

14 The following figure shows the BER-SNR (Bit Error Rate - Signal-to-Noise Ratio) curves for three available data rates in a wireless network, where the BERs are shown as negative powers of 10. For example, a BER of 10^{-5} (10^-5) means only 1 bit in error out of 10,000 bits transmitted on average.



Now, let's consider a mobile user who experiences a SNR of 30 dB when outside a tunnel. However, upon entering the tunnel, the SNR drops by 20 dB. The wireless network is designed to automatically detect changes in SNR and adjust the data rate accordingly, ensuring that the error rate remains low, with no more than 1 bit out of 1 million being in error on average.

What reduction in throughput (data rate) can the mobile user expect upon entering the tunnel?

Select one alternative:

- ○ 12.5%
- ○ 75%
- ○ 87.5%
- ○ 50%
- ○ 20%

15 We are to protect an 8-bit message with a CRC checksum. If 1001 (binary) is used as a CRC generator, which of the following is a valid sequence of transmitted bits? Note that the transmitted bit sequence contains the original 8-bit message followed by its checksum

Select one alternative:

- ○ 1010111011
- ○ None of these
- ○ 111010101001
- ○ 10101010100