COMP3331/9331— Computer Networks and Applications

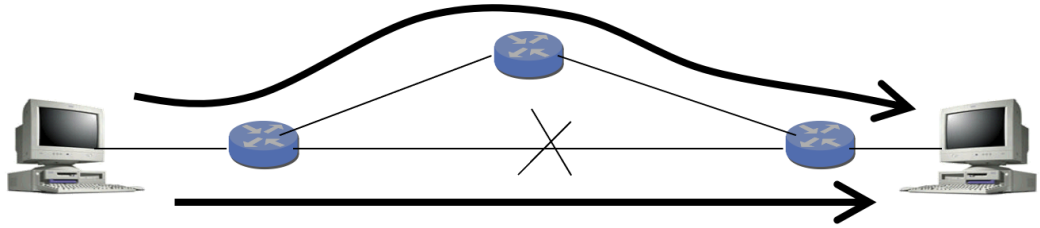
Term 2 2022

Practice Final Examination

Instructions:

1. TIME ALLOWED: **2 hours, plus 15 minutes.**
2. TOTAL MARKS AVAILABLE: **40 marks worth 40% of the total marks for the course**. **You must score at least 16 marks on the exam to pass the course.**
3. MARKS AVAILABLE FOR EACH QUESTION ARE SHOWN IN THE EXAM. YOU MUST ANSWER ALL QUESTIONS. THERE ARE A TOTAL OF **28 QUESTIONS**.
4. STUDENTS ARE ADVISED TO READ THE EXAMINATION QUESTION BEFORE ATTEMPTING TO ANSWER THE QUESTION.
5. THIS EXAM CANNOT BE COPIED, FORWARDED, OR SHARED IN ANY WAY.
6. STUDENTS ARE REMINDED OF THE UNSW RULES REGARDING ACADEMIC INTEGRITY AND PLAGIARISM.
7. YOUR WORK WILL BE SAVED PERIODICALLY THROUGHOUT THE EXAM AND WILL BE AUTOMATICALLY SUBMITTED PROVIDED YOU ARE CONNECTED TO THE INTERNET.

Suppose two hosts have a long-lived TCP Reno session over a path with a 100 msec round-trip time (RTT). Then, a link fails, causing the traffic to flow over a longer path with a 500 msec RTT. This scenario is depicted in the figure below. The original path is the straight path at the bottom. The new path is at the top.



Answer the following two questions.

1 Suppose the router on the left recognises the failure immediately and starts forwarding data packets over the new path, without losing any packets. (Assume also that the router on the right recognises the failure immediately and starts directing ACKs over the new path, without losing any ACK packets.) Why might the TCP sender retransmit some of the data packets anyway?

Fill in your answer here

Maximum marks: 1.5

2 Suppose instead that the routers do not switch to the new paths all that quickly, and the data packets (and ACK packets) in flight are all lost. What new congestion window size does the TCP sender use? Explain your answer.

Fill in your answer here

Maximum marks: 1.5

3 Why does a TCP sender use a very large retransmission timeout (e.g., several seconds) for the SYN segment? Answer in 2 sentences at most.

Fill in your answer here

Maximum marks: 1

4 Why is it necessary to have a 3 way handshake for connection establishment in TCP? Why is a 2 way handshake not sufficient?

Fill in your answer here

Maximum marks: 2

Assume that the SendBase for a TCP Reno sender is currently 4000. The TCP sender has sent four TCP segments with sequence numbers 4000, 4500, 5500 and 7000. The sender then receives a segment with an acknowledgement number 7500 and a receive window 6000. The congestion window, CongWin, is set to 10000 bytes after this ACK is processed. Answer the first three questions assuming that this ACK is processed and no further ACKs are received.

5 What is the value of SendBase? Only enter the numeric value in the space provided: .

Maximum marks: 0.75

6 How many bytes in total are sent in the four TCP segments? Only enter the numeric value in the space provided: [ ].

Maximum marks: 0.75

7 What is the last byte (number) that the TCP sender can send with certainty that the receiver's buffer will not overflow? Assume that the sender always has data to send. Explain your answer in 1-2 sentence.

Fill in your answer here

Maximum marks: 1

8 Now assume that the sender receives three more TCP segments, such that all three segments have TCP acknowledgement number 7500.

Answer the this question and the next question assuming that all three ACKs are processed and no further ACKs are received.

What is the value of CongWin and why?

Fill in your answer here

Maximum marks: 1

9 What is the sequence number of the next segment that will be transmitted by the sender? Explain your answer in 1 sentence.

Fill in your answer here

Maximum marks: 1

10 Consider an IP datagram of size 4520 bytes (including the IP header) is to be forward by a router on an outgoing link which has an MTU of 2500 bytes. Assume that the second fragment of the original datagram (created by the first router) arrives at a second router and is to be forwarded on an outgoing link which has an MTU of 1500 bytes. What are the MF flag and offset values in the IP headers of the resulting fragments and the total size of these fragments as created by the second router.

Fill in your answer here

Maximum marks: 1

11 Assume that an organisation has been assigned a Class C address block. Assume that the network administrator has divided this address block into a number of equally sized subnets and that the subnet mask of 255.255.255.248 is used.

1) How many subnet blocks were created? How many hosts can be assigned IP addresses in each subnet? (1 mark)

2) If a host within this organisation has an IP address is 192.168.10.17, then what is the network address and broadcast address of the subnet to which this host belongs to? (1 mark)

Fill in your answer here

Maximum marks: 2

12 Assume that the forwarding table at a router is as follows:

Destination Address	Interface
192.168.32.0/26	1
192.168.32.0/24	2
192.168.32.0/19	3
0.0.0.0/0	4

Note that the last entry is the default entry which matches all destination addresses.

1) Assume that an IP datagram with destination IP address 192.168.32.100 arrives at this router. Which interface will this datagram be forwarded on?

Select one alternative:

- Interface 3
- Interface 4
- Interface 1
- Interface 2

2) Assume that an IP datagram with destination IP address 192.168.31.200 arrives at this router. Which interface will this datagram be forwarded on?

Select one alternative

- Interface 1
- Interface 2
- Interface 4
- Interface 3

Maximum marks: 1.5

13 When an IP datagram containing a transport segment is going from a private network onto the public Internet through a Network Address Translation (NAT) router, which of the following network and transport layer header fields might the router change? You can select multiple options.

Select one or more alternatives

- [ ] IP checksum
- [ ] Destination IP address
- [ ] Destination port number
- [ ] None of the provided choices
- [ ] Source port number
- [ ] Source IP address
- [ ] Transport checksum
- [ ] Protocol field in IP header

Maximum marks: 1

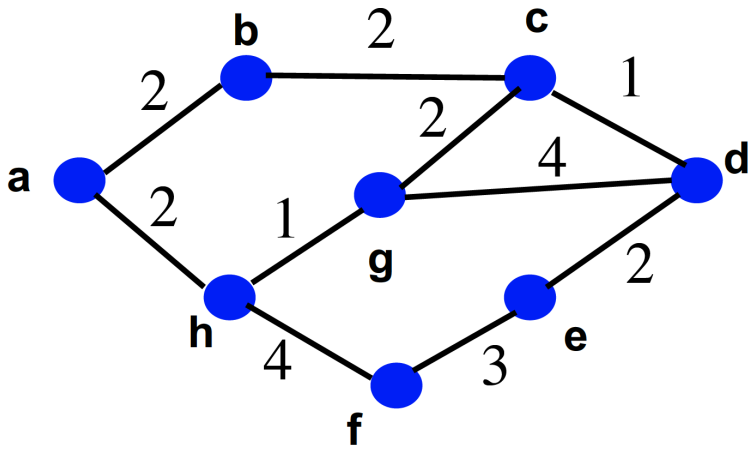
14 Which of the following statements about distance vector routing are true? Multiple statements may be true.

Select one alternative:

- None of the other choices are true.
- Poison reverse may not always resolve the count to infinity problem.
- The distance vector sent by each router is propagated to all other routers in the network.
- Every router in the network knows the entire network topology.
- A reduction in the cost of a link connected to a router will always trigger a distance vector update to be sent from this router.

Maximum marks: 1

Consider the 8-node network shown in the figure below with link costs as shown. Note that each link shown in this network is bidirectional and has the same cost in either direction.



Answer the following two questions.

15 Execute Dijkstra's algorithm at Node **a** to determine the shortest path from Node **a** to every other node in the network. You will have to draw an appropriately sized table using the table option in the menu at the top of the text area below (similar to the one shown in the lecture notes on Dijkstra's algorithm) You are required to show all steps.

Fill in your answer here

Format

Words: 0

Maximum marks: 4

16 Based on the execution of the Dijkstra's algorithm in the above question, draw the forwarding table for node **a**, which contains the outgoing link for reaching every other node in the network. A link between two nodes x and y should be denoted as (x, y).

Fill in your answer here

Maximum marks: 1.5

17 Assume that the data bits D being transmitted over a link are 100010 and that CRC is being used to provide error detection. Suppose that a generator, G = 111 is being used and known to both the sender and receiver.

1) What are the CRC bits (R) as computed (and included with the message) by the sender? You are not required to show your calculations. Simply note down R in the space provided.

2) Continuing with the previous question. Assume that the sender transmits <D, R>. Neglect any other headers. Assume that 2nd, 3rd and 4th bits of this sequence are flipped as the frame is transmitted through the link. Will the receiver be able to detect the error?

Select an alternative

- True
- False

Maximum marks: 1.5

18 Now assume that the data bits D are the same as the previous two questions (100010) but that a generator G = 1111 is used.

1) What will be the CRC bits (R) as computed (and included with the message) by the sender? You are not required to show your calculations. Simply note down R in the space provided.

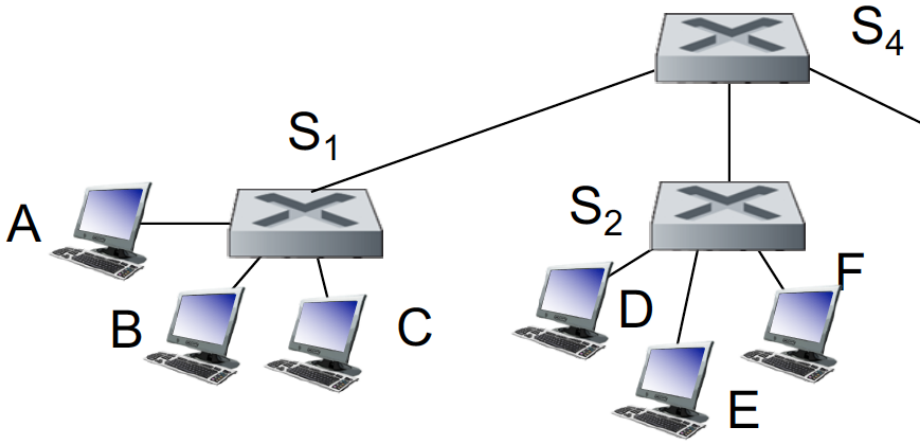
2) Continuing with the previous question. Assume that the sender transmits <D, R>. Neglect any other headers. Assume that 2nd, 3rd and 4th bits of this sequence are flipped as the frame is transmitted through the link. Will the receiver be able to detect the error?

Select an alternative

- False
- True

Maximum marks: 1.5

Consider the network shown in the figure below. You may assume that all switch tables are empty at the start.



Answer the following three questions. To represent links you can use notations such as A-S1 (the link connecting A to S1) and S1-S4 (the link connecting S1 to S4).

19 Assume that host A sends a frame to Host F. Indicated all links in the network that this frame is transmitted on and explain why.

Fill in your answer here

Maximum marks: 1.5

20 Assume that host F now sends a frame to Host A. Indicated all links in the network that this frame is transmitted on and explain why.

Fill in your answer here

Maximum marks: 1.5

21 Suppose Host C wants to send an IP datagram to Host F. Assume that Host C only knows the IP address of Host F but does not know its MAC address. Describe how Host C proceeds to send the IP datagram (i.e., outline the sequence of events leading to transmission of this datagram).

Fill in your answer here

Maximum marks: 1.5

Consider the wireless network composed of four nodes in the figure below, which has a linear topology deployed along a highway. The distance between neighbouring nodes is equal. Assume all nodes are using 802.11 MAC with RTS/CTS enabled. The radio range for each node is fixed, and this radio range is slightly longer than the inter-node distance, i.e., each node can reach only its left and right neighbours. Assume that if there are two simultaneous transmissions within the radio range of the receiver, both transmissions will be unsuccessful.

Answer the following three questions.

22 Assume that node A is currently sending a data frame (not an ACK, an RTS, or a CTS) to node B. Node C wants to send a packet to node D. Assume that node C (and only C) ignores the 802.11 MAC and sends the packet. Would C's packet arrive successfully at D? Would A's packet arrive successfully at B? Explain your reasoning.

Fill in your answer here

Maximum marks: 1

23 Consider the same situation as in the previous questions except that all nodes are using the 802.11 MAC. Will C start transmission while A is sending the data packet? Why or why not? If not, how does C know that A is transmitting a data frame?

Fill in your answer here

Maximum marks: 1

24 Is there any way for C to know when A's transmission will end? Explain.

Fill in your answer here

Maximum marks: 1

25 Suppose N people want to communicate with each of $N - 1$ other people using symmetric key encryption. All communication between any two people, i and j, is visible to all other people in this group of N, and no other person in this group should be able to decode their communication. How many keys are required in the system as a whole?

Now suppose that public key encryption is used. How many keys are required in this case?

Provide a short explanation for your answers in the space below.

Fill in your answer here

Maximum marks: 2

26 What is the role of a Certification Authority (CA) in Public Key Infrastructure (PKI)?
Select one alternative:

- Guarantee that the public key of the registered user is authenticated by issuing a digital certificate
- Maintain private keys of all authenticated users
- CA's are not used in PKI
- Issues a session key to both end parties for communication

Maximum marks: 1

27 SuperMail wants every email to be authenticated and protected from modification or tampering while it is transit from the sender to the receiver. Suppose Alice is sending an email *M* to Bob. Assume that a SuperMail employee proposes the following solution: Alice's software should encrypt M using Bob's public key. In other words, Alice's software should send E_{KB+} (M) to Bob. Can you comment on whether the employee's solution meets the requirement stated above. Justify your answer.

Fill in your answer here

Maximum marks: 1

28 You walk into a room, connect your laptop to an Ethernet outlet, and type in your web browser a URL of a web page. List all the messages/packets that you expect your laptop to send or receive until you download the web page. Assume that your laptop is configured with the IP address of a local DNS server, as well as the IP address of a default gateway (a router through which traffic from your laptop will exit the local IP subnet).

Fill in your answer here

Format | B I U x_2 x^2 | I_x | | Ω | Σ |

Words: 0

Maximum marks: 3