Exam Information Cover Sheet

COMP3331/9331— Computer Networks and Applications

Term 2, 2021

Practice Final Examination

Instructions:

1. TIME ALLOWED: **2 hours and 10 minutes (Reading Time)**.

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 29 QUESTIONS.

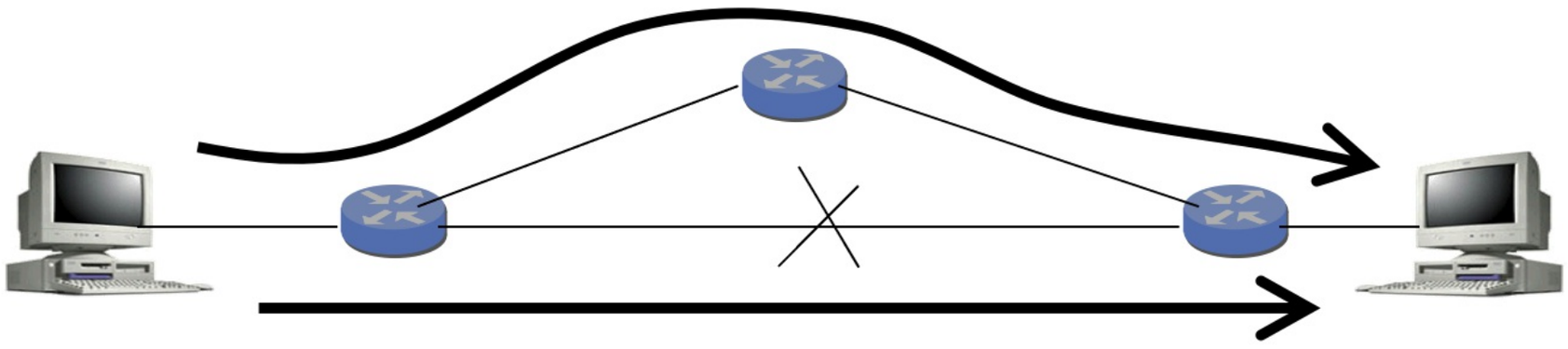
4. STUDENTS ARE ADVISED TO READ THE EXAMINATION QUESTION BEFORE ATTEMPTING TO ANSWER THE QUESTION.

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 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 TCP Path Change Q1

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 TCP Path Change Q2

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 TCP SYN

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 TCP 3 Way Handshake

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 TCP Sequence Q1

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

Maximum marks: 0.75

6 TCP Sequence Q2

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 # TCP Sequence Q3

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 TCP Sequence Q4

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

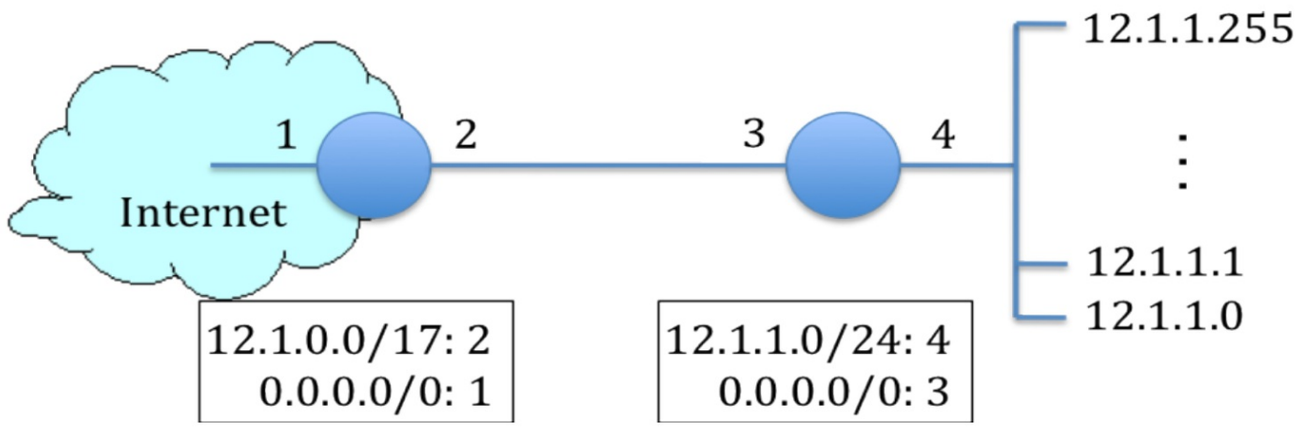
TCP Sequence Q5

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

A small university campus is assigned a large address block 12.1.0.0/17, but is only using a portion of these addresses (in 12.1.1.0/24) to number its computers. The campus uses a single Internet Service Provider (ISP) to reach the rest of the Internet. The picture below shows the forwarding tables on the ISP's router (on the left) and the campus edge router (on the right).



For example, the ISP forwards all packets with destination addresses in 12.1.0.0/17 to link #2 toward the campus edge router. Both routers include a default forwarding entry (i.e., 0.0.0.0/0) that can match any destination IP address.

Answer the following 4 questions.

10

IP Addressing Q1

How many IP addresses does the campus “own” in its 12.1.0.0/17 block? You can represent your answer as a power of two.

Fill in your answer here

Maximum marks: 0.5

11

IP Addressing Q2

What are the smallest and largest IP addresses that the campus “owns”? Do these addresses have special meaning and if so what do they signify?

Fill in your answer here

Maximum marks: 1

12

IP Addressing Q3

Suppose the ISP router receives a packet from the Internet with destination IP address 12.1.20.1? What path does this packet follow (indicate the path using link numbers from the above figure)? What is the ultimate outcome for this packet?

Fill in your answer here

Maximum marks: 1.5

13

IP Addressing Q4

Suppose the ISP router receives a packet from the Internet with destination IP address 12.1.1.1? What path does this packet follow (indicate the path using link numbers from the figure above)?

Fill in your answer here

Maximum marks: 1.5

14

NAT

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

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

Maximum marks: 1

15

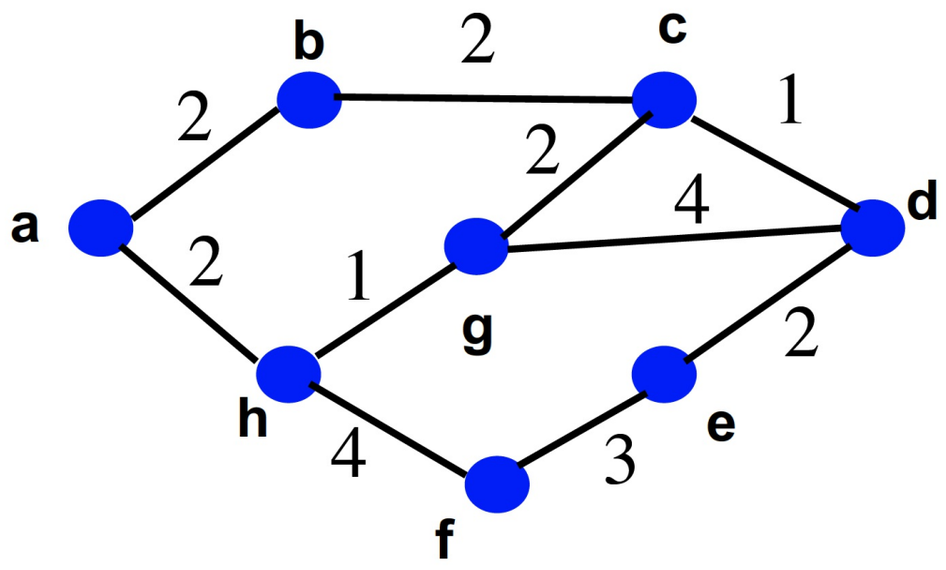
DV MCQ

Which of the following statements about distance vector routing are true? Multiple statements may be true.
Select one alternative:

- The distance vector sent by each router is propagated to all other routers in the network.
- None of the other choices are true.
- Poison reverse may not always resolve the count to infinity problem.
- 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.

16

Dijkstra

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

17

Forwarding Table

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

18

CRC Q1

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

19

CRC Q2

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.

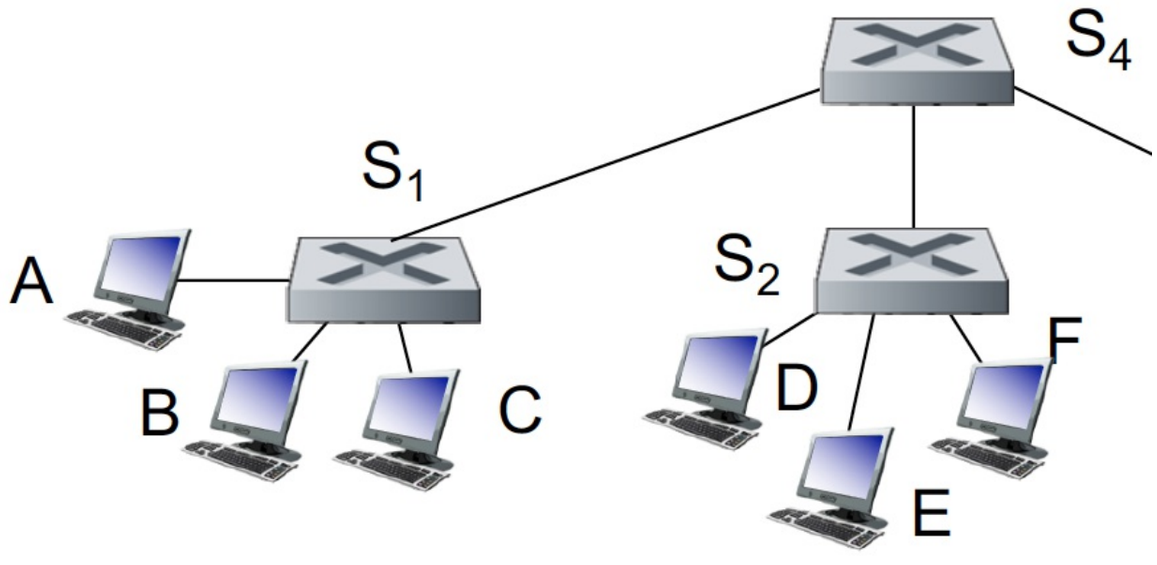
2) Continuing with the previous question. Assume that the sender transmits <D, R>. Neglect any other headers. Assume that 2nd, 3rd and 4th bits of this sequence are flipped as the frame is transmitted through the link. Will the receiver be able to detect the error?

Select an alternative

- True
- False

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).

20

Switch Q1

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

21

Switch Q2

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

22

ARP

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.

23

WiFi Q1

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

24

WiFi Q2

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

25

WiFi Q3

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

Fill in your answer here

Maximum marks: 1

26

Keys

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

27

CA

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

28

Email

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

29

Putting it together

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

Words: 0

Maximum marks: 3