COMP3234B Computer and Communication Networks
ELEC3443B Computer Networks

Online Midterm Quiz

Date: March 29, 2022 **Time: 1:45 pm - 2:45 pm**

Instructions

- **Candidates are permitted to refer to the following printed/handwritten materials in the midterm quiz: textbook, lecture slides and notes made on the lecture slides, workshop and assignment handout and sample solutions. Internet searching and crowdsourcing from group messages, online forums or social media, etc. are strictly forbidden.**
- **Total of 60 points. This midterm quiz consists of 7 questions. Candidates are required to answer all questions.**
- **If you are not clear about what a question is asking, be sure to write down any assumptions you have made in answering the question.**
- **To answer the questions, you SHOULD write the answers on paper. Please DON'T type your answers. Scan all answers to a single PDF file before submission.**
    - **Please write your University Number and the Course Code on the top of the first page of your answer sheet.**
    - **Please write your answers clearly with black or blue pens. For drawings and calculations, you are allowed to write your answers in pencil; however, they must be clearly visible in your pdf file after scanning.**
- **Online invigilation will be implemented via Zoom.**
    - **The setting of the webcam: Set your webcam to capture your faces & body and the immediate environment while you are taking the midterm.**
    - **You should not use Zoom virtual background during the midterm.**
    - **You should not use headphones, earbuds, or any kind of listening equipment. You should not communicate with any other person by any means.**
    - **The Zoom meeting will be recorded.**
    - **Students shall not leave the Zoom session throughout the midterm unless they have finished and uploaded their answers.**
- **Before submitting the pdf file to Moodle, please make sure that**
    - **It includes all your answers, and the answers are arranged in the question order.**
    - **The quality of the images is acceptable and clear.**

Question 1 (6 points)
Which of the layers in 5-layer Internet Protocol Stack handling the following?

i. _____ Provides process-to-process delivery of the entire message.

ii. _____ Determines how packets are routed from source to destination.

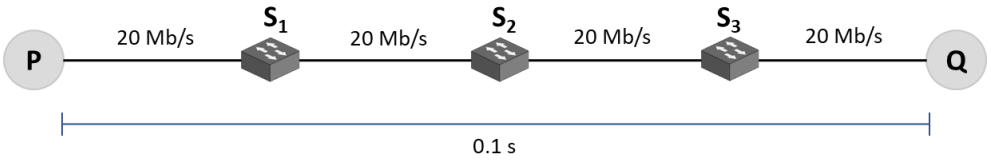
iii. _____ Provides control access to the shared communication channel.

iv. _____ Provides a mechanism to identify end-systems across a network of networks.

v. _____ Makes it possible for computers with different data representations to communicate.

vi. _____ Provides node-to-node communications with reliable service.

Question 2 (12 points)
A 5.6×10^5 bits message is to be sent from P to Q through the following path. Consider the transmission rate of the links between the host-switch and switch-switch is 20 Mb/s.



Assume the propagation delay between P and Q is 100 ms (milliseconds). You can safely assume some of the costs are negligible if no information is provided to you.

i. (6) The network is a circuit switch network. It can support at most 10 users using the network at the same time. A user wants to send a 5.6×10^5 bits message from P to Q. The setup time for setting a circuit for the user is 220 ms. Assume the circuit does not exist before the transfer, what is the total time to transfer the entire message from P to Q for that user? Show the calculation. You can ignore the circuit teardown time.

ii. (6) The network is a packet switch network. The maximum packet size is 1420 bytes, which includes 1400 bytes of payload and 20 bytes of header. What is the total time to transfer the entire 5.6×10^5 bits message from P to Q? Show the calculation.

Question 3 (10 points)
Are the following statements TRUE or FALSE? Briefly justify your answer in **no more than one sentence**. [Note: ***No marks will be given without explanation***.]

i. Both routers and link-layer switches do not implement all layers of the 5-layer Internet protocol stack; they only implement layers 1 through 3 (i.e., bottom three layers).

ii. For a client-server application running on top of UDP, the server process needs N+1 sockets for interacting with N independent clients at the same time.

iii. The longer the packets or the shorter the propagation time, the higher utilization can be achieved in Stop-and-Wait ARQ.

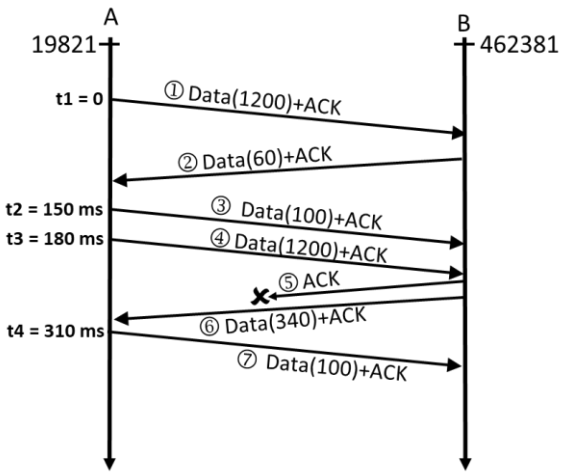
iv. GBN requires individual acknowledgements but does not require buffering of out-of-order packets.

v. Once both sides of a TCP connection have an agreement on the value of MSS, both of them limit the size of the segments to this value.

Question 4 (10 points)
Assume the system uses Selective Repeat ARQ as the reliable protocol. Currently, the sender window is at [3,4,5,6,7] and the sender has sent one window full of packets to the other end. The receiver has received all packets and has just transmitted all acknowledgements and moved the receive window to [8,9,10,11,12]. Unfortunately, ACK[4] and ACK[5] are lost.

i. (5) Describe what happens to the sender window after receiving the ACKs and give the sequence of events that leads to the advance of sender window to [8,9,10,11,12].
ii. (5) With Selective Repeat ARQ on a network that does not reorder packets, is it possible for the sender to receive an ACK for a packet that falls outside of its current window? Don't just say "Yes" or "No"; explain/justify your answer.

Question 5 (7 points)
Consider there is a TCP connection between hosts A and B. Assume all previous segments have been acknowledged and the next sequence numbers **to be used** by host A and host B are 19821 and 462381 respectively. Assume that all segments sent between A and B have a 20-byte TCP header, and the Retransmission Timeout duration for all segments is around 160 ms.



Now A and B are exchanging seven segments. A sends segment ① at t1 with a 1200-byte payload and an acknowledgment. B responds with segment ② with a 60-byte payload and an acknowledgment. A then sends segments ③ and ④ at t2 and t3, and the two piggybacked segments carry 100-byte and 1200-byte payloads respectively. B responds with an ACK segment ⑤. Unfortunately, segment ⑤ is lost. B also sends segment ⑥ with a 340-byte payload and an acknowledgement. Finally, A sends segment ⑦ at t4 with a 100-byte payload and acknowledgement.

Give the value of the sequence number and acknowledgment number fields for these seven segments.

Segment	Sequence Number	Acknowledgement Number
①		
②		
③		
④		
⑤		
⑥		
⑦		

Question 6 (8 points)
You are going to design a reliable **byte-stream protocol** similar to TCP. This protocol will run over a 200-Mb/s network. The RTT of the network is 160 milliseconds, and the maximum segment lifetime is 15 seconds (which means we want to have a sequence number space that should not be wrapped around within 15 seconds to avoid sequence number ambiguity). To allow your protocol to run in full speed, you want to have a receive buffer that is at least larger than the best window size for this network. When designing your segment structure, how many bits would you allocate to store the Receive Window and Sequence Number fields in your protocol header? Show the calculation.

Question 7 (7 points)

We learned from the lecture that HTTP/1.1 uses the persistent connection with pipelining.

i. (3) Briefly explain why the persistent connection with pipelining is better than without pipelining. (Note: don't just copy the statements in the lecture note as the answer; you need to explain the information with your sentences.)

ii. (4) With the persistent connection with pipelining, the server needs to differentiate individual HTTP requests in the same TCP connection. How can the server separate individual HTTP requests?

End-of-Paper