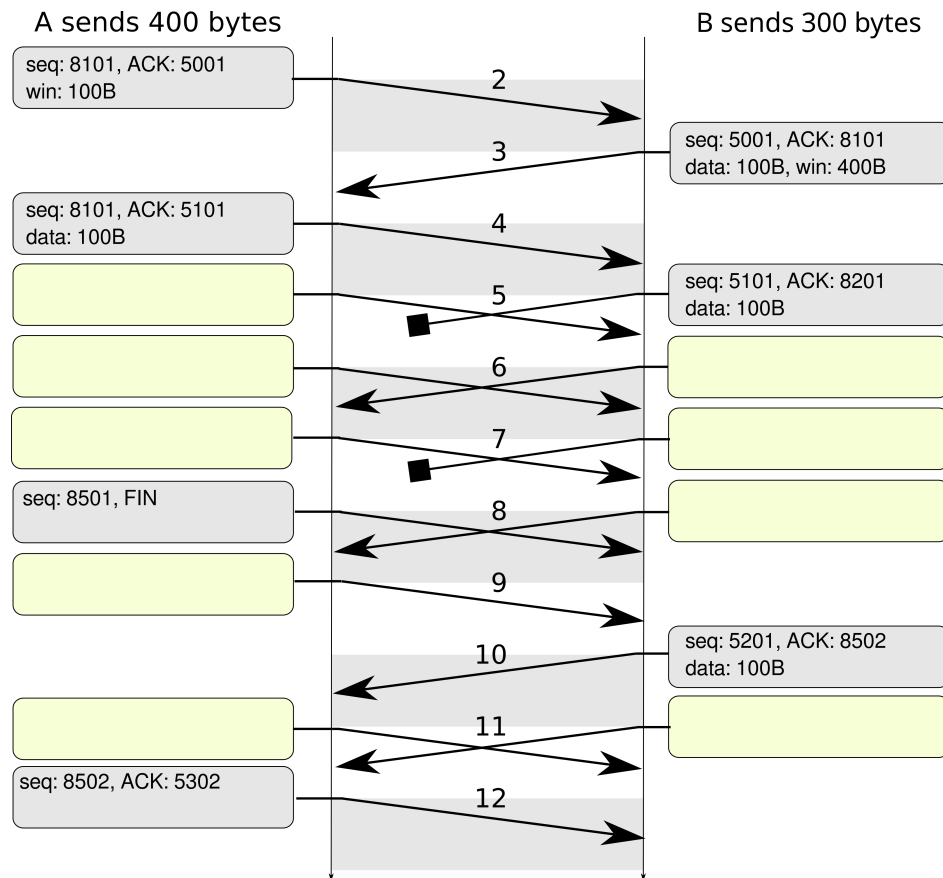


*This exam has a total of 20 points. For every 3 multiple-choice questions with 4 options or fewer answered incorrectly, 1 point will be deducted. Only one option is correct unless stated otherwise in the statement. When prompted, it's required to check all correct options. The use of a calculator is not allowed. The exam duration is 50 min. **Follow answer sheet instructions.***

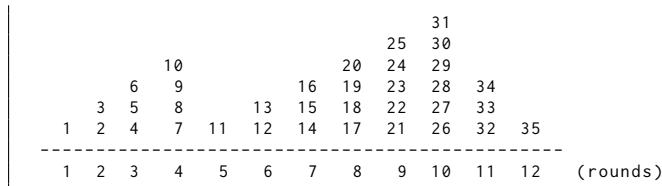
- 1** [1p] Can sockets be used as files in Python, using functions like write() instead of send()?
- ☐ a) No, because file are not sockets and vice versa.
 - ☐ b) No, because files are random access and sockets are not.
 - ☐ c) Yes. In fact, in Python socket and file are exactly the same.
 - ☐ d) Yes, even though there are some differences.
- 2** [1p] What are sockets raw used for?
- ☐ a) None, they are no longer used.
 - ☐ b) They are essential because TCP and UDP are based on them.
 - ☐ c) They are required for secure or encrypted transmissions.
 - ☐ d) They are necessary for lower OSI layers communications, protocol and utilities.
- 3** [1p] What for is SSL/TLS used?
- ☐ a) To enable a SSH connection to a server.
 - ☐ b) Is a protocol to secure a socket in the transport layer.
 - ☐ c) Is a deprecated protocol replaced by SSH.
 - ☐ d) Is a protocol used to provide mail services and remote access to networks.
- 4** [1p] Any TCP connection is identified by... (select the most accurate one)
- ☐ a) One socket.
 - ☐ b) Two sockets.
 - ☐ c) Four sockets.
 - ☐ d) Four sockets, two open from server (destination and source) and two from client.
- 5** [1p] Which of the following socket API functions turns an unconnected active TCP socket into a passive socket?
- ☐ a) connect ☐ b) recv ☐ c) listen ☐ d) accept
- 6** [1p] What is a port in computer networks?
- ☐ a) An interface to which a socket connects.
 - ☐ b) A number that identifies a service and cannot ever be changed.
 - ☐ c) A number associated with a process. Can be changed if needed.
 - ☐ d) A number associated with the IP address that helps to specify the destination host more precisely.

- A** [7p] Based on the TCP flow represented in the figure, answer the questions, considering: a) both will send data in sync with a clock tick, b) First two messages are not shown, c) RTO for both is 3 ticks, d) MSS=100 bytes for both peers.



- > **7** At which ticks does A send messages with data? Count both visible and hidden messages. Mark **all** that apply:
- ☐ a) 4 ☐ b) 5 ☐ c) 6 ☐ d) 7 ☐ e) 8 ☐ f) 9 ☐ g) 11
- > **8** At which ticks does B send messages with data? Count both visible and hidden messages. Mark **all** that apply:
- ☐ a) 3 ☐ b) 5 ☐ c) 6 ☐ d) 7 ☐ e) 8 ☐ f) 10 ☐ g) 11
- > **9** Mark **all** items that describe the message sent by B at tick 8:
- ☐ a) seq: 5101 ☐ c) seq: 5301 ☐ e) ACK: 8301 ☐ g) ACK: 8501 ☐ i) win: 200B
☐ b) seq: 5201 ☐ d) ACK: 8201 ☐ f) ACK: 8401 ☐ h) data: 100B ☐ j) FIN
- > **10** Mark **all** items that describe the message sent by B at tick 11:
- ☐ a) seq: 5201 ☐ c) seq: 5301 ☐ e) ACK: 8401 ☐ g) ACK: 8501 ☐ i) data: 100B
☐ b) seq: 5202 ☐ d) seq: 5302 ☐ f) ACK: 8402 ☐ h) ACK: 8502 ☐ j) FIN
- > **11** What are the ISNs of the client and the server? Mark one for A and one for B:
- ☐ a) A: 5000 ☐ c) A: 8000 ☐ e) A: 8100 ☐ g) B: 5000 ☐ i) B: 5100 ☐ k) B: 8000
☐ b) A: 5001 ☐ d) A: 8050 ☐ f) A: 8101 ☐ h) B: 5001 ☐ j) B: 5101 ☐ l) B: 8001
- > **12** Select **all** items that describe the message sent by A at tick 11:
- ☐ a) seq: 8500 ☐ c) seq: 8502 ☐ e) ACK: 5300 ☐ g) ACK: 5302
☐ b) seq: 8501 ☐ d) seq: 8503 ☐ f) ACK: 5301 ☐ h) FIN
- > **13** What is the value of *ssthresh* (in bytes) at tick 13 if the initial value was 64 KiB?
- ☐ a) 100 ☐ b) 200 ☐ c) 400 ☐ d) Does not apply

- B** [4p] Consider the following diagram representing the congestion window of a TCP connection. The numbers indicate the order in which the segments are sent, regardless its content. Assume that $rwnd > cwnd$ and that the initially $ssthresh = 2 \text{ MSS}$. Answer the following questions:



- > **14** (1p) Indicate the rounds during which the Slow Start algorithm is applied (check **all** that apply):
- ☐ a) 1 ☐ c) 3 ☐ e) 5 ☐ g) 7 ☐ i) 9 ☐ k) 11
- ☐ b) 2 ☐ d) 4 ☐ f) 6 ☐ h) 8 ☐ j) 10 ☐ l) 12
- > **15** (1p) Indicate in which round(s) the value of $ssthresh$ changes and what the new value that it takes (check **all** that apply):
- ☐ a) Round 2: 3 MSS ☐ c) Round 4: 2 MSS ☐ e) Round 11: 1.5 MSS
- ☐ b) Round 4: 1 MSS ☐ d) Round 10: 3 MSS ☐ f) Round 10: 4 MSS
- > **16** (1p) Indicate the round(s) in which 3 duplicate ACKs are received (check **all** that apply):
- ☐ a) 1 ☐ c) 3 ☐ e) 5 ☐ g) 7 ☐ i) 9 ☐ k) 11
- ☐ b) 2 ☐ d) 4 ☐ f) 6 ☐ h) 8 ☐ j) 10 ☐ l) 12
- > **17** (1p) If the value of $MSS=100$ bytes, how many effective bytes (excluding RTX) are received?
- ☐ a) 3100 ☐ b) 3200 ☐ c) 3300 ☐ d) 3400 ☐ e) 3500 ☐ f) 3600
- 18** [1p] Why does TCP set $cwnd = swnd/2$ after receiving 3 duplicate ACKs, instead of $cwnd = cwnd/2$?
- ☐ a) The sending rate is determined by $swnd$, not by $cwnd$. ☐ c) False. It is $cwnd = ssthresh/2$.
- ☐ b) Because $swnd$ is always greater than $cwnd$. ☐ d) False. It is $cwnd = rwnd/2$.
- 19** [1p] What is the main goal of the fast recovery algorithm?
- ☐ a) To reduce the sending rate to alleviate congestion. ☐ c) To avoid a too abrupt drop in the sending rate.
- ☐ b) To temporarily increase the retransmission timer. ☐ d) To recover lost segments.
- 20** [1p] What technique is commonly used in AQM (Advanced Queue Management)?
- ☐ a) Drop packets before the input queue becomes full. ☐ c) Forward excessive traffic to another router.
- ☐ b) Drop packets after the input queue becomes full. ☐ d) Send excessive traffic back to the sender.