

# CS232 Final - 2025

- Use of books/notes is forbidden.
- Write the answers using only the predefined space using a black pen
- **Duration:** 2 hrs.

**Q1** Consider a  $M/M/1/K$  queueing system with arrival and service rate equal to  $\lambda$  and  $\mu$  pkt/s, respectively. If we decrease  $K$ , the probability that a packet is dropped in going to

- a) Increase. -> **correct answer**
- b) Decrease.
- c) Stay the same.

**Q2** Consider a  $M/M/1$  queueing system with arrival and service rate equal to  $\lambda$  and  $\mu$  pkt/s, respectively. Define  $\rho = \lambda/\mu$ , the expected total time spent by packets in the system ( $E[T]$ ) is equal to

- a)  $1/\mu$ .
- b)  $\frac{1/\mu}{(1-\rho)}$ . -> **correct answer**
- c)  $\frac{\rho}{(1-\rho)}$ .

**Q3** The application layer protocol used by web browsers (such as Chrome and Firefox) is:

- a) SMTP
- b) FTP
- c) HTTP -> **correct answer**
- d) IMAP

**Q4** TCP is implemented at:

- a) Switches
- b) Routers
- c) host devices -> **correct answer**
- d) all the above

**Q5** Little's Formula (no blocking) is

- a)  $E[N] = \sum_{n=0}^N p^n n$ .
- b)  $P[N(t) = 0] = 1 - \rho$ .
- c)  $E[N] = \lambda E[T]$ . -> **correct answer**

**Q6** IMAP (Internet Mail Access Protocol) is an e-mail protocol used between:

- a) the sender and the sender's mail server.
- b) the sender's mail server and the receiver's mail server.
- c) the recipient's mail server and the recipient. -> **correct answer**

**Q7** Consider a setting where only one node has traffic. Compared to TDMA, polling-based access control achieves

- a) a larger data rate.-> **correct answer**
- b) a smaller data rate.
- c) the same data rate.

**Q8** in  $M/M/1/\infty$  the probability of having an empty buffer is

- a)  $p_0 = 1 - \rho$ . -> **correct answer**
- b)  $p_0 = \rho$ .
- c)  $p_0 = 1/(1 - \rho)$ .

**Q9** in M/M/c/c the probability that a connection is rejected is

- a)  $\frac{\rho^c / c!}{\sum_{k=0}^c \rho^k / k!}$  -> correct answer
- b)  $\sum_{k=0}^c \rho^k / k!$
- c)  $\rho^c$ .

**Q10** A socket is implemented between:

- a) transport layer and network layer.
- b) application layer and transport layer. -> correct answer
- c) network layer and link layer.

**Q11** Mark the (one) correct statement

- a) UDP implements packet retransmissions and packet reordering
- b) UDP implements packet retransmissions, but does not implement packet reordering
- c) UDP does not implement packet retransmissions and packet reordering -> correct answer

**Q12** In TCP, if we increase the timeout time with respect to the RTT

- a) The number of retransmitted packets will increase
- b) The number of retransmitted packets will decrease -> correct answer
- c) The number of retransmitted packets will be the same

**Q13** In Distance Vector-based routing algorithms

- a) the routers send broadcast messages to all the routers in the autonomous system
- b) the routers send broadcast messages to all their directly connected routers -> correct answer
- c) the routers do not need to exchange messages.

**Q14** In broadcast routing based on reverse path forwarding, the router forwards the packet

- a) in any case
- b) if the packet comes from their shortest path link to the source -> correct answer
- c) If the packet comes from a link part of the spanning tree

**Q15** Briefly motivate and describe the delayed playout mechanism in multimedia streaming.

Delayed playout mechanism in multimedia streaming refers to the process of adding a delay at the start of the video playtime at the client side. In other words, when the video starts to arrive at the client, the client won't immediately begin the video playout/streaming. Instead, the client will build up a reserve of video frames in an application buffer. Once the client has built up a reserve of several seconds of buffered-but-not-yet-played video frames, the client can then begin the video playout.

The purpose of this self-induced delayed-playout by the client is to compensate for the varying end-to-end delays (i.e. jitter) that is caused by varying amounts of available bandwidth between server and client which in turn ensures that the played video won't freeze (i.e. running out of frames to play) during the streaming time.

**Q16** Describe the update rules of the transmission window  $W$  in slow start and congestion control states of TCP (Tahoe).

The congestion control of TCP-Tahoe starts with a transmission window  $W = 1$  (i.e. TCP will transmit a maximum of  $W$  un-ACKed packets simultaneously). Then for each ACKed packet, TCP will increase  $W$  size by one (i.e.  $W$  size will double after all packets in  $W$  are ACKed). This stage is known as "Slow Start" mode and  $W$  size will continue doubling for each successfully  $W$  ACKed packets until  $W$  reaches some pre-defined "slow start threshold" which then TCP will enter "Congestion Avoidance" mode where TCP will increase the size of  $W$  by 1 for each RTT (i.e. for each batch of successfully ACKed packets). TCP will continue this linear increase until a

timeout is detected (i.e. a packet is lost due to congestion). When this happens, TCP-Tahoe will set the “slow start threshold” to  $W/2$  and then sets  $W = 1$ .

**Q17** Describe the leaky bucket mechanism and discuss how the bucket parameters influence the characteristics of the output traffic.

The leaky bucket mechanism allows the bursty traffic to be constant. It is inspired by the idea of having a bucket in which we are pouring water in a random rate and we want to get water in a fixed rate. To accomplish that mission we will make a hole at the bottom of the bucket.

The parameters of the leaky bucket are: an input rate, a buffer or size of the bucket, the initial fullness of the bucket and the output rate.

The output rate determines the maximum rate at which the data is sent. The size of the bucket controls the maximum size of burst that it can receive.

With this mechanism we can have lost data, however there is a token leaky bucket algorithms which provides a limited amount tokens to the coming packets such that each packet can be transmitted only after getting a token.

**Q18** Describe the difference between unicast and broadcast. What are the dangers of broadcast and what mechanisms are implemented to avoid them?

broadcast is a packet intended to reach all the nodes, while unicast is a packet intended for a specific destination.

The main risk is connected to packet duplication due to loops, and the countermeasures include time to live, reverse packet forwarding and spanning tree.

Then they should describe what they are (and optionally what is good and bad about them)