

Dept. of Computer Science and Engineering, National Sun Yat-sen Univ.
Spring 2025 PhD Qualifying Exam

Subject: Computer Networks

Each question 10 pts. Select 10 questions to answer. Exam max 100 pts.

1. What are the similarity and differences between Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM)? What are the similarity and differences between packet switching and circuit switching? (Be sure to indicate when each would be used and why)
2. Draw pictures to explain and differentiate between TDMA, FDMA, and slotted ALOHA.
3. For the Internet Protocol (IP) Stack, how many layers are there? For the Open Systems Interconnection (OSI) model, how many layers are there? Please draw the IP stack and explain the function of each layer, respectively. Also, indicate which layer(s) of the OSI model correspond to the IP stack.
4. Encapsulation is a method adopted repeatedly in computer networking. What are the advantages of encapsulation? Please draw pictures to explain the operations of encapsulation. Please describe four computer networking examples in which encapsulation is used.
5. Please draw a graph to show the operations of Transmission Control Protocol (TCP) and User Datagram Protocol (UDP). The *slow start phase*, *congestion avoidance phase*, and experiencing a *time out or three repeated ACKs* must be included in your picture with explanations. How can we achieve a reliable data transfer under unreliable channel conditions? What is the role of a window? If we can mimic TCP behavior with UDP, how would we?
6. What is a Domain Name System (DNS)? There are four types of Resource Records (RRs). Please explain each type in detail.
7. There are four main causes of a packet delay. Please draw a picture to explain them in order. Please also explicitly demonstrate the differences between transmission delay and propagation delay. When the traffic load is larger than a threshold (0.9 as an example), the queuing delay increases exponentially. Why?
8. Please write TCP socket programming pseudo-code for simple client-server interactions. Please also comment your code for easier reading. (You may use POSIX APIs, if necessary)
9. What is demultiplexing in TCP and UDP, respectively? Please draw pictures to show the differences between TCP and UDP demultiplexing.
10. Please write the pseudo-code for Dijkstra's algorithm and provide some remarks about your code, i.e. provide useful comments explaining the logic behind your code.
11. What is Carrier Sense Multiple Access with Collision Detection (CSMA/CD) and Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)? Which one is used in IEEE 802.3 wired Ethernet? Which one is used in 802.11 wireless networks? How does each medium access mechanism work?
12. What is Multi-Protocol Label Switching (MPLS)? What is Software-Defined Networking (SDN)? Please explain them in your words.
13. Please draw pictures to explain weighted fair queueing (WFQ), FIFO scheduling, round-robin scheduling, max-min fair, and priority scheduling, respectively.
14. What is Address Resolution Protocol (ARP)? Please describe the ARP protocol by giving an example. Please draw signals between a client and a DHCP server to explain how and what an arriving client obtains via the DHCP protocol.
15. If a host A receives two SYN packets from the same port of remote host B, the second may be either a retransmission of the original or, if B has crashed and rebooted, an entirely new connection request. (a) Describe the difference as seen by host A between both cases. (b) Give an algorithmic description of what the TCP layer needs to do upon receiving a SYN packet. Consider the duplicate/new packet cases above, and the possibility that nothing is listening to the destination port.