Instructions:

- You have 2 hours and 30 minutes to complete this exam.
- The exam is closed book/notes.
- The exam has 10 questions, and each question is worth 10 points.
- Justify all your answers.

Questions:

1. Let’s assume we want to transfer the same file over a circuit-switched network and over a packet-switched network. Which one will result in lower end-to-end delay? What is the main drawback of packet-switched networks if the packet size is too small (e.g., a few bytes)?

2. Would TCP still need to provide end-to-end reliable communication if all data link layer protocols would provide reliable communication? Since TCP provides end-to-end reliable communication in the Internet, why do many data link layer protocols provide their own reliable communication mechanisms?

3. How many types of sockets does a TCP server create in response to 3 requests from 3 different clients? How many sockets does a UDP server create in the same scenario? What happens if both the server and the client attempt to read a message from their respective sockets immediately after the TCP connection has been established?

4. What are the reasons for sending duplicate acknowledgments in TCP? How do fast retransmit and fast recovery improve the TCP performance?

5. A computer receives the following IP packets:
   - Packet1 has length=1620, identifier=22, offset=200, and MF=1.
   - Packet2 has length=1620, identifier=33, offset=0, and MF=0.
   - Packet3 has length=1620, identifier=22, offset=400, and MF=0.
   All packets have the same source IP address. Assume that the packet headers do not include any options. Explain the processing done by the IP layer for each packet. When is the data carried by these packets passed to the higher layer?

6. (a) Assume an organization has the following network address: 134.56.0.0. The organization wants to divide its network into 24 subnets. What is the appropriate subnet mask? What is the maximum number of hosts on each subnet? What is the subnet address for 134.56.64.3?

(b) A router receives an IP packet for a destination identified by 196.7.234.88. Should this packet be forwarded on the interface associated with the following forwarding table entry: 196.7.192.0/18?
7. How does OSPF improve routing scalability compared with traditional link state routing? From a routing perspective, what changes in autonomous systems get propagated in the Internet and what changes don’t get propagated?

8. Compare multicast routing using center-based trees with multicast routing using source-based shortest path trees. What are the advantages and disadvantages of each approach? How are IP multicast packets forwarded through routers that are not equipped for multicasting?

9. (a) If WiFi and Bluetooth would have the same bandwidth, which one would finish faster a file transfer between two nodes? Assume that the communication is done in ad hoc mode for both, and no other nodes are in the communication range.

   (b) Why and how is IP tunneling used in Mobile IP?

10. (a) Explain step by step how public keys are authenticated.

    (b) What are the advantages and disadvantages of stateful firewalls compared to stateless firewalls? Give an example when stateful firewalls are better and an example when stateless firewalls are better.