

Department of Computer Science and Engineering  
National Sun Yat-sen University  
Second Semester of 2025 PhD Qualifying Exam

Subject : COMPUTER NETWORK

Answer all 10 questions. Each question is worth 10 points. The total score is 100 points.

1. Packets can encounter multiple types of delay while traversing a network from source to destination.
  - (a) (8 points) Name and describe the four types of packet delay in detail.
  - (b) (2 points) Which type of delay increases rapidly as the traffic intensity approaches 1, and why does this occur?
2. The Domain Name System (DNS) is a fundamental Internet service used by nearly all applications.
  - (a) (3 points) What is the primary purpose of DNS, and why is it necessary for Internet communication?
  - (b) (4 points) Explain the roles of the following types of DNS servers in the name resolution process:
    - Root DNS server
    - Top-Level Domain (TLD) server
    - Authoritative DNS server
  - (c) (3 points) Name and describe two common types of DNS Resource Records (RRs) that are fundamental for web communication.
3. Consider the TCP congestion control algorithm.
  - (a) (8 points) Explain the operation of TCP Reno's congestion control algorithm, including the phases of slow start, congestion avoidance, and fast recovery, as well as the fast retransmit mechanism. Be sure to explain how the congestion window (cwnd) evolves within each phase and across phase transitions, and how packet loss is detected and handled.
  - (b) (2 points) Identify one key improvement that TCP Cubic introduces over TCP Reno.
4. (10 points) What is QUIC and why was it developed? How is it different from using TCP with TLS? Mention two advantages of QUIC for improving web performance.
5. Routers are key components in the network layer responsible for forwarding packets across networks.
  - (a) (8 points) Describe the main components of a router's architecture. For each component, explain its role in the packet forwarding process.
  - (b) (2 points) Explain how a router uses its forwarding table to make forwarding decisions. What is the role of the longest prefix match rule?
6. (10 points) Routing algorithms are fundamental to how packets find their way across the

Internet. Compare and contrast link state and distance vector routing algorithms in terms of the following criteria:

- message complexity
  - speed of convergence
  - robustness to incorrect routing information
7. BGP is the de facto routing protocol used between Autonomous Systems (ASes) on the Internet.
    - (a) (6 points) Explain the fundamental difference between eBGP and iBGP.
    - (b) (4 points) Explain how the AS-PATH and local preference attributes are used in BGP route selection. Describe the purpose of each attribute and how they influence the selection among multiple available routes.
  8. (10 points) What is Software-Defined Networking (SDN)? How does the OpenFlow protocol operate within this context? Provide one use case enabled by SDN.
  9. (10 points) Describe how the traceroute utility uses ICMP and TTL to discover the sequence of hops (routers) along a path. What ICMP message types are involved?
  10. Consider the MAC protocols.
    - (a) (6 points) Explain the principles and operation of the following:
      - Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
      - Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)
    - (b) (4 points) Explain why CSMA/CD is unsuitable for wireless channels, while CSMA/CA is more appropriate.