CS 422 (Park) **Midterm** **Mar. 12 (Thu.), 2026**

Remarks: Please keep the answers compact, yet precise and to-the-point. Long-winded answers that do not address the key points are of limited value. Binary answers that give little indication of understanding are not good either. Time is not meant to be plentiful. Make sure not to get bogged down on a single problem.

PROBLEM 1 (40 pts)

(a) Suppose stop-and-wait is used to transport a large file of size S bytes over a point-to-point link from A to B. A packet has maximum payload size x bytes, and link RTT is d (msec) which includes transmission time of data packets and ACK packets. Under the assumption of no packet loss, what is the throughput of the protocol (in unit of bps) when transporting the file? What is the completion time for transporting the file? Explain your reasoning.

(b) Suppose two laptops K and L are connected to an IEEE 802.11 WLAN running in infrastructure mode ("hot spot"). K transmits a frame whose final destination is L. Why must the frame have 3 addresses in its header? What are the roles of the three addresses? Why are only two addresses needed if the WLAN is replaced by Ethernet?

PROBLEM 2 (40 pts)

(a) Suppose an ISP utilizes frequency range 1 GHz to 2 GHz using AM (amplitude modulation) with 4 levels to support 10 users using OFDMA. What are the 10 orthogonal carrier frequencies of the network system? What is the symbol period? What is the bandwidth (in bps) delivered to each user? Does increasing the frequency range from 1 GHz–2 GHz to 1 GHz–3 GHz increase the bandwidth (in bps) provided to each user? What about shifting the frequency range from 1 GHz–2 GHz to 4 GHz–5 GHz? Explain your reasoning.

(b) Suppose an IPv4 router has a forwarding table containing two entries (i.e., rows) comprised of triples that implement subnetting: ⟨128.10.5.0, 255.255.255.0, interface 0⟩ and ⟨128.10.6.0, 255.255.255.0, 128.10.6,77⟩. Assume the IP router is also an Ethernet switch. Suppose the router receives an IPv4 packet with destination address 128.10.5.9. Describe what steps are carried out at the router to forward the packet. What happens if the router receives a packet containing destination address 128.10.6.7? The steps should include actions carried out at both the network and LAN layers.

PROBLEM 3 (20 pts)

What are the pros/cons of contention-free vs. contention-based MAC? Why does satellite Internet service that covers dense metropolitan areas utilize the former instead of the latter? Why does broadband over powerline where existing electrical copper wires in buildings is utilized to transmit data packets use CSMA but without CD? Given that WLAN uses CSMA without CD, how does a WLAN device determine that a collision has occurred? What actions are undertaken when collisions occur?

BONUS PROBLEM (10 pts)

You may pick one of the two bonus problems (a) or (b)—but not both—to earn 10 bonus points. Note that bonus problems are optional and serve to reach full credit (100 points) more easily.

(a) IPv4 permits fragmentation whereas IPv6 does not. Since fragmentation is considered undesirable in today's Internet environment, operating systems such as Linux, Windows, MacOS that implement IPv4 utilize one of the bits in the 3-bit fragmentation field of the IPv4 header to prevent IP packet fragmentation. Describe how this method works.

(b) What was the original purpose of the TTL field in the IPv4 header? How is the TTL field used today by the traceroute app to discover the likely path of data packets?