SOLUTIONS TO CS 422 MIDTERM, SRPING 2026 (PARK)

P1(a) 20 pts

(8 * x) / (RTT / 1000) bps
8 pts

(S / x) * RTT msec
6 pts
// Completion time in unit of sec: divide by 1000.

Throughput is number of bits transferred per unit time. Since unit is bps,
x is multiplied by 8 (S in bytes) and RTT is divided by 1000 (RTT in msec).
// Note that this ignores the case where x does not divide S, hence the
// last packet has payload size less than x. For larger files this is a
// minor detail.
3 pts

Completion time depends on number of data packets (hence RTTs since one
data packet per RTT) which is multiplied by RTT (time to complete transport
of one data packet).
3 pts

P1(b) 20 pts

Since the hot spot is a wireless multi-access link where other APs in the
vicinity can hear a frame transmission, the specific hot spot's AP address
is needed to identify which AP should forward the frame.
7 pts

Source address to specify address of original sender.
Destination address to specify address of final destination.
Address of hot spot AP.
9 pts

Since Ethernet links are wired, there is no danger of another device that is
not part of the Ethernet LAN hearing a frame transmission.
4 pts

P2(a) 20 pts

1.1 GHz, 1.2 GHz, ..., 1.9 GHz, 2 GHz.
// Since bandwidth is 1 GHz / 10 = 0.1 GHz (i.e., 100 MHz).
8 pts

10 / 1 GHz = 10 nanoseconds.
// Symbol period is 10 divided by bandwidth. Inverse of 1 GHz is 1 nanosecond.
4 pts

2 bits per 10 nanoseconds = 0.2 Gbps (i.e., 200 Mbps).
// Since 4 levels, 2 bits are transmitted per symbol period; 1 bit per nanosecond
// means 1 Gbps.
4 pts

Yes. Since bandwidth increases two-fold.
2 pts

No. Since bandwidth (= 5 GHz - 4 GHz) remains 1 GHz.
2 pts

P2(b) 20 pts

1. AND destination address 128.10.5.9 with mask 255.255.255.0 which yields
128.10.5.0.
2. Find match in table which yields first entry.
3. Consult ARP to find MAC address (call it M) of 128.10.5.9.
4. Transmit Ethernet frame with destination address M on interface 0.
// Since third column specifies interface 0 which means final destination
// is on the same LAN as the router.
12 pts

1. AND destination address 128.10.6.7 with mask 255.255.255.0 which yields 128.10.6.0.
2. Find match which yields second entry.
3. Consult ARP to find MAC address (call it L) of 128.10.6.77.
4. Transmit Ethernet frame with destination address L.

8 pts

// Since third column contains IP address the final destination is not
// directly reachable through a LAN connected to the IP router. Instead,
// the packet needs to be forwarded to next hop IP router 128.10.6.77.
// To do so, its MAC address L is needed before Ethernet takes over.

P3 20 pts

Contention-free.
Pro:
Orderly, predictable performance.
// Since resources are allocated/reserved prior to data transmission.
3 pts

Con:
Overhead stemming from pre-allocation of resources.
// Single point of failure is also valid: 2 pts.
3 pts

Reverse (i.e., vice versa) for contention-based.
2 pts

Servicing dense metropolitan would result in excessive collision.
3 pts

Ethernet CD requires knowledge of maximum distance between Ethernet devices (i.e., diameter of network). For a building's electrical wiring this information varies is not available.
3 pts

In WLAN collision (or bit flips from noise) is assumed if an ACK frame does not arrive within a specified time window.
3 pts

Exponential backoff.
3 pts

Bonus 10 pts

(a) 10 pts
IPv4 packet is transmitted with one of the 3 bits (do not fragment bit) set to 1.
3 pts

When a router receives an IPv4 packet that requires fragmentation, it is discarded.
3 pts

A response (ICMP packet) sent to the original sender indicating that the packet was discarded for what reason.
2 pts

The sender reduces the size of the original IPv4 packet so that it would not be discarded by the router when retransmitted.
2 pts

(b) 10 pts
TTL prevented a packet from roaming the Internet without being delivered due to inaccuracies in routing tables.
4 pts

An IPv4 packet with TTL set to 1 is transmitted. The first IP router decrements TTL. Since the resultant value is 0, the router discards the packet and sends a response (ICMP packet) to the original sender. The original sender identifies the router that dropped the packet from the source address field. The sender then transmits an IPv4 packet with TTL set to 2 to find the IP address of the second hop IP router. And so forth.
6 pts