CS422 Mid1 Answer Sheet

P1(a) 10 pts

Point-to-point and multi-access links may cover long distances.
6 pts

Ex1: Fiber point-to-point link connecting two routers across an ocean.
2 pts

Ex2: Satellite wireless multi-access link that sends/receives data from thousands of miles up in the atmosphere.
2 pts

P1(b) 10 pts

Pro of concurrent server: Server process attends to next client request, parsing it, but delegates the actual processing of a requested task to a worker process. This prevents client requests from being queued up.
3 pts

Con of concurrent server: overhead incurred by using multiple processes (e.g., process forking and inter-process communication/coordination).
3 pts

The opposite holds for iterative network servers.
2 pts

Web servers follow concurrent server design since the transmission of user requested information (e.g., files) takes a while to complete due to disk I/O overhead.
2 pts

P1(c) 10 pts

24 channels (or users), 8 bits per channel, plus 1 frame bit which yields a frame of $24 * 8 + 1 = 193$ bits. Squeeze in 8000 frames per second which yields $8000 \times 193 = 1.544$ Mbps.
10 pts

P2(a) 12 pts

Completion time: $(8 * S / C) + L / 1000$ sec
6 pts

The first component, transmission time, measures how long it takes all the bits ($8 * S$) to hit the link at the sender side. The second component, latency, measures how long it takes the last bit, after hitting the link at the sender, to reach the receiver.
6 pts

P2(b) 12 pts

Half association: (protocol, src-IP, src-port, *, *)
3 pts

Full association: (protocol, src-IP, src-port, dst-IP, dst-port)
3 pts

Socket descriptor with half association is given as input to accept().
2 pts

The accept() system call returns a socket descriptor of full association.

2 pts

No, the original socket descriptor remains in half association state so that it can be reused for waiting on the next client connection request. The returned descriptor is a new socket descriptor that is a copy of the original but with the client IP address and port numbers filled in which forms a full association.
2 pts

P2(c) 12 pts

For sending a single bit per user, for N simultaneous users, arbitrary N different sinusoids will work. However, when each user sends a sequence of bits, the amplitude of the sinusoid used by a user must be changed (e.g., high for 1, low for 0) in time as the bits being streamed change. The resultant signal is not a sinusoid anymore, hence orthogonality may be violated which results in interference.

P3(a) 17 pts

When a receiver receives two consecutive packets, it cannot, in general tell whether the second packet contains new payload or is a retransmission of the earlier packet and its payload. For example, the receiver receives a packet and sends back an ACK. If the ACK is received by the sender, it will transmit a new packet. If not, or if the alarm timeout expires too soon because of RTT underestimation, then the second packet received is a retransmit. The receiver cannot know which is which unless a sequence number (single bit) is used to disambiguate.
5 pts

packet-size / RTT
3 pts

One packet is transmitted and acknowledged per RTT assuming nothing goes wrong (lost data packet or ACK). Hence throughput, which is defined as data (bits) per unit time (second), is as above.
3 pts

In broadband/high-speed networks where bandwidth is high and distances may be long, stop-and-wait wastes a lof of bandwidth since it sends one data packet and does nothing until an ACK arrives after RTT. Since packet sizes are capped by a maximum, stop-and-wait's throughput does not benefit from ever increasing network speeds.
3 pts

Since ever increasing packet sizes is not an option, sliding window emulates larger packet sizes by sending multiple packets.
3 pts

P3(b) 17 pts

The actual OFDM carrier frequencies are 0.1 GHz, 0.2 GHz, ..., 0.9 GHz, 1.0 GHz which are multiples of 0.1 GHz. These carrier frequencies are multiplied by the 1 GHz sinusoid so that they occuy the 1 GHz-2 GHz spectrum allowed (not the 100 MHz-1 GHz). Since the receiver can divide the received signal by the same 1 GHz sinusoid, the original OFDM carriers 0.1 GHz, 0.2 GHz, ..., 0.9 GHz, 1 GHz can be recovered. Hence it's an OFDM system.
8 pts

4 amplitude levels means 2 bits. Since the 1.1 GHz carrier is actually a 0.1 GHz OFDM carrier, the bandwidth is 2 * 0.1 Gbps = 200 Mbps.
5 pts

Although the other OFDM carrier frequencies oscillate faster, the symbol time is determined by the slowest carrier 0.1 GHz during whose

period (i.e., symbol time) the carrier frequencies are mutually orthogonal. Hence all of the other carriers also transmit at the same bit rate 200 Mbps. Therefore total bandwidth is 2 Gbps.
4 pts

Bonus 10 pts

"High-speed" may be viewed as a misnomer since individual bits do not travel faster (signals are capped by the speed-of-light).
4 pts

A more accurate term is "broadband" networks which points to a broad range of carrier frequencies that simultaneously carry bits.
3 pts

The term "high-speed" is still used, despite the inaccuracy, since for completing the transfer of a block of bits (e.g., file), the completion time of the block of bits is reduced which translates to a perception of higher speed to a user who cares about how long it takes to download files and other data objects.
3 pts