CS164 Final Exam

Name: Last 4 digits of SSN:

Problem 1. State whether each of the following statements is **true** or **false**.
(**Two points for each correct answer, −1 point for each incorrect answer.**)

1. The maximum rate (in bits per second) at which data can be transmitted over a link is often called its *bandwidth*.

2. *Bit stuffing* is a copy protection technique that was developed by the entertainment industry to prevent unauthorized distribution of digital music over the Internet.

3. *Jitter* represents the variability in the delivery times for consecutive packets. Excessively large jitter can interfere with the transmission of real-time voice or video streams over the Internet.

4. A token ring network does not support broadcast delivery at the hardware level, so a node must transmit a *separate copy* of each broadcast packet to each node in the ring.

5. UDP stands for the "Ultra-reliable Delivery Protocol".

6. A *transparent bridge* is a packet switch that selects the correct output port for each packet based on Layer 2 information (i.e., 48-bit Ethernet addresses), and can operate without requiring any manual configuration.

7. A *router*, or Layer 3 packet switch, generally requires some manual configuration so that the switch can determine the network number associated with each 32-bit IP address, and hence to select the correct output port for each packet.

8. In the POP3 email protocol includes an *update* command, which allows the client to change his password and other user information on the POP3 server. This command can only be used after the client has successfully completed the login sequence in AUTHORIZATION state.

9. In the POP3 email protocol, after the client sends a request to the POP3 server, the server responds with a message that begins "+OK".

10. In socket programming, the application program calls the "sendto()" function whenever it wants to send a UDP datagram.

11. The "start bits" and "stop bits" are added to each character sent over a serial line as a simple form of flow control.

12. In socket programming, conversion functions such as "htons()", "htonl()", etc., are necessary because all computer architectures don't agree on the order in which to number the bytes within a word.

13. A data link protocol that includes the length of the payload field within the packet header doesn't need to use bit stuffing or character stuffing for data transparency.

14. Frequency hopping is a technique in each node in a wireless network rapidly changes the frequency of its radio transmitter.

15. The Go-Back-N data link layer protocol is a sliding window data link protocol that uses a receive window size of one frame.

16. The name "TTRT" is one of the flags in the code field of the TCP header. It indicates that the sender wishes to terminate the "TCP reverse traffic".

17. In a token ring, the terms "early token release" and "multiple token operation" mean the same thing.

18. Because the IP layer was defined as a "best effort" (rather than "reliable") service, IP routers are allowed to throw away packets if they want to.

19. Under Manchester encoding, every data bit has a state change, from either "hi" to "low" or from "low" to "hi", at its midpoint.

20. The general concept of defining network protocols in terms of multiple layers separated by clean interfaces is important. However, the specific partitioning method for these functions to create exactly 7 layers, as described in the OSI Reference Model, is really quite arbitrary.

Problem 2. In the TCP protocol, timeouts are not used on both sides of the connection. More specifically, if we assume that Alice is sending data segments to Bob, then Alice sets a timeout for each of the data segments she sends, which will trigger the retransmision of that segment if the timeout expires before the corresponding ACK arrives. However, Bob does not use any timeouts or retransmissions for the ACK packets he sends to Alice. Each time Bob receives a data segment from Alice, he sends one ACK packet to Alice.

1. Briefly explain why TCP does not need to use timeouts and retransmission of ACK packets to avoid deadlocks in this case. Be sure to explain what happens when a data segment and/or the associated ACK is lost.

2. At some point during the connection, suppose Bob decides he must temporarily stop Alice from sending any more data by reducing the size of his advertised window to zero bytes. In this case, notice that Alice cannot predict when Bob will decide he is ready to receive more data from Alice. Therefore, if Bob tried to restart the data transfer by sending some sort of notification message to Alice, giving her permission to resume transmitting, the TCP connection would deadlock if Bob's resume notification message got lost. (Remember that timeouts are only used by Alice, for data segments travelling from Alice to Bob.) Obviously TCP doesn't have this problem. Briefly explain how TCP restarts the connection without risking a deadlock.

Problem 3. Suppose Alice, who uses a dialup modem to connect to the Internet through Ivan.net (her ISP), wishes to upload a large file to one of her former classmates from UCR, who now runs a major Internet server called by Bob.com. Assume that Alice's modem connects to Ivan.net at a data rate of exactly 28,000 bits/sec through a 4 kilometer copper line, and that Ivan.net has a high bandwidth connection through the Internet core to Bob.com. Typical one-way latencies between Ivan.net and Bob.com are approximately 50 msec., and the minimum link speed is at least 100 Mbps. Also assume that Alice sends 350-byte data packets (including the overhead of all protocol layers), and that Bob.com returns a 70-byte ACK immediately after receiving each data packet.

1. Calculate the transmission time and approximate one-way propagation delays for both data packets and ACKs on both the modem link and the Internet backbone. (You may assume a velocity of 2×10^8 m/sec. in the copper line.)

2. Find the minimum RTT over this path.

3. Suppose Alice messed up her TCP configuration, so she decides to try using UDP instead. Since UDP does not include any flow control, she sets her application to send one UDP packet every 50 msec. Draw a timing diagram to show what happens to the first 25 packets sent by Alice, assuming her modem includes an internal buffer that can hold 10 packets.

4. Repeat the previous question assuming Alice used TCP using slow-start instead.

Problem 4. Consider an Ethernet broadcast domain that includes the following five hosts named "Alice", "Bob", "Carl", "Doug", and "Elvis". Assume that Alice has a 48-bit Ethernet address E_A and a 32-bit IP address I_A, that Bob has Ethernet address E_B and IP address I_B, and so on. Also assume that Doug acts as the name server for this domain and Elvis acts as the router that connects everyone on this domain to the outside world, and that all of the devices in this problem have been manually configured to know that the IP addresses for the name server and router are I_D and I_E, respectively.

1. Briefly explain the ARP protocol, and what type of addresses it is used to find.

2. Briefly explain the DNS protocol, and what type of addresses it is used to find.

3. Neither the DNS protocol nor ARP runs on top of TCP, even though they both use the IP protocol. Why don't they use TCP also?

4. Suppose Alice wants to open a TCP connection to Bob across the Ethernet. Assume that because of a power failure she doesn't remember any information about him besides his name. Outline the steps she must take to gather enough information about Bob to send him the first TCP "open" packet.

5. How would these steps change if Alice had wanted to connect with some host outside this domain?

6. If the network contained a shared hub (or repeater) in the middle, then every packet that was sent to or from Alice would also reach Carl. However, suppose we replace the shared hub by an Ethernet switch (i.e., a layer 2 transparent bridge), so that each of our five hosts is connected to a different switch port. Which of the packets (if any) that were part of Alice's connection setup with Bob would reach Carl now?