EECS 122 - COMMUNICATION NETWORKS - ***Fall 1998***
Final Examination - 12/15/1998.
Name (Last, First): SID: Score:

Please answer neatly on these pages. Good luck!

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1. True or False [10%]. (Check one box per question.)

1. An IP router maintains a soft-state for each connection.	T[ ]	F[ ]
2. ATM cells contain only 48 bytes of payload to limit the cell error rate.	T[ ]	F[ ]
3. Typically, a modulation scheme that is more robust against errors is more spectrally efficient.	T[ ]	F[ ]
4. Packet switching is more efficient than circuit switching to carry long lasting constant bit rate streams.	T[ ]	F[ ]
5. Call admission control is required to guarantee quality of service.	T[ ]	F[ ]
6. Layer 2 switches limit the scope of ARP requests.	T[ ]	F[ ]
7. Lempel-Ziv's algorithm replaces strings by pointers to dictionary entries.	T[ ]	F[ ]
8. Virtual circuits are more reliable than datagrams.	T[ ]	F[ ]
9. BGP prevents loops by computing a spanning tree.	T[ ]	F[ ]
10. In ATM, the VPI/VCI is fixed along the path of a connection.	T[ ]	F[ ]

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2. Multiple Choice [20%] For each question, check one or more boxes as appropriate

2.1 [2%] The capacity of a channel that corrupts bits independently with BER = 0.5 and transmits at 1 Mbps is equal to

a. 0.5 Mbps	[ ]
b. 0.75 Mbps	[ ]
c. 0.25 Mbps	[ ]
d. 0 bps	[ ]

2.2 [3%] If the interarrival times of busses are equally likely to be 10 and 40 minutes, then the average waiting time of a passenger who shows up at a random time at the bus stop is

a. 25 minutes	[ ]
b. 12.5 minutes	[ ]

c. 17 minutes	[ ]

2.3 [2%] Packets arrive in batches of 100 at a link. The average length per packet is 500 bytes. The link transmission rate is 1 Mbps. The average delay per packet is (select the most accurate answer)

a. at least 0.2s	[ ]
b. at least 0.4s	[ ]
c. at least 2ms	[ ]
d. at most 0.4s	[ ]
e. none of the above	[ ]

2.4 [3%] In a queue with high and low priorities (non-preemptive, as discussed in class and in the book and notes), as the arrival rate of low priority packets increases, the average delay of high-priority packets

a. increases	[ ]
b. does not change	[ ]
c. decreases	[ ]
d. may increase or decrease	[ ]

2.5 [2%] A code with minimum distance 5 can

a. correct up to 3 bit errors	[ ]
b. detect up to 4 bit errors	[ ]
c. correct up to 2 bit errors	[ ]
d. detect up to 3 bit errors	[ ]
e. detect up to 5 bit errors	[ ]

2.6 [2%] The Huffman code

a. achieves the entropy rate of a source	[ ]

b. achieves the entropy rate of the source if the source symbols are independent and identically distributed	[ ]
c. minimizes the average number of bits per symbol over all possible codes	[ ]
d. none of the above	[ ]

2.7 [2%] In a fiber optic digital link,

a. dispersion limits the (bit rate)x(length) product	[ ]
b. attenuation limits the length	[ ]
c. dispersion limits the bit rate	[ ]
d. if the fiber is single mode, it still has dispersion	[ ]
e. WDM increases the bit rate by reducing dispersion	[ ]

2.8 [2%] In public key cryptography,

a. the encryption rule is public	[ ]
b. the decryption rule is public	[ ]
c. the encryption and decryption are numerically hard	[ ]
d. the keys must be distributed with a secure channel	[ ]

2.9 [2%] Random Early Detection, RED,

a. reduces the chances of successive losses of a connection	[ ]
b. modifies the retransmission mechanism of TCP	[ ]
c. modifies the window adjustment algorithm of TCP	[ ]
d. reduces the bias of TCP in favor of connections with a short round-trip time	[ ]

3. Problem [15%]. A collection of networks and subnetworks is shown in the figure below. All the links are Ethernet links. The lower case addresses are MAC addresses and the upper case addresses are IP addresses in the net.subnet notation. For instance, r21 is the Ethernet MAC address of that interface of R2.

a) Fill in the following tables:

b) Specify the addresses in the Ethernet and IP headers of a packet from A to H as it travels from R2 to R3:

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4. Problem [10%]. A stream of packets arrives at point Q as a Poisson process with rate 2,000 packets/s. The packets have 400 bits with probability 0.5 and 4000 bits with probability 0.5. With probability p = 0.8, each packet is, independently of the other packets, sent to node R1 and is sent to node R2 othewise. The output rate of R1 is 4 Mbps and that of R2 is 1 Mbps.

Calculate the average delay per packet.

Hint: The packets arrive as Poisson processes at R1 and R2. Recall the average delay formula for an M/G/1 queue with Poisson arrival rate A and independent service times distributed as the random variable S:

5. Problem [15%]. Consider a transmission of data from S to R below. The packets have a fixed size equal to 1 KByte. Each acknowledgment is in a packet with 40 bytes (consisting of an IP header and a TCP header). The packets are transmitted reliably and acknowledgment packets are transmitted correctly with probability 0.95 each. Host R sends back an ACK with the next packet number it expects. Host S has a timeout value equal to a "round-trip time" and implements Go Back N with a window size computed to "fill up the pipe" exactly in the absence of errors.The propagation time is 1ms in each direction. Neglect processing times.

a. What is the window size?

b. Calculate the average throughput (in packets per second) of the connection from S to R.

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6. Problem [15%]. Consider the network below. Each switch implements a round-robin service of its three queues. That is, the switch serves one cell from queue 1, then one cell from queue 2, then one cell from queue 3 and repeat this cycle forever. It may happen that a queue overflows if it is not served fast enough. This mechanism protects streams aginst misbehaving connections. The switch skips empty queues.

Calculate the maximum value of A in the figure so that no cell from that stream is lost because of buffer overflow.

7. Problem [15%]. Consider the wireless packet network shown in the figure. Four stations share a slotted ALOHA channel by transmitting with probability 0.25 each in every slot, independently of one another. In addition to the risk of collision, packets that are transmitted also face transmission errors. Assume that errors corrupt packets that were otherwise successfully transmitted with probability 0.1. Acknowledgments are given priority and are corrupted by errors with probability 0.1.

Specifically, assume that A transmits a packet to B. If the transmission is successful (possibly with errors), then B gets the channel for one slot to transmit one ACK: no other station interrupts the transmission of B's ACK. With this procedure, the transmission of a packet by A is complete with some probability after 2 slots. If that transmission is not complete, then A knows that it must try later to transmit that packet.

Calculate the average reliable throughput of packets over this channel, in packets per slot.