考試科目	計算機概論	所別	數位內容碩士學位學程/資訊技術組 5152	考試時間	3月7日(日)第三節

(10%) 1. Calculate the bandwidth × delay product for the following links. Use one-way delay, measured from first bit sent to first bit received.

(a) A 1.5-Mbps T1 link, with a transcontinental one-way delay of 50ms.
(b) A 1.5-Mbps T1 link through a satellite in geosynchronous orbit, 35,900km high. The only delay is speed-of-light propagation delay.

(10%) 2. An IEEE 802.5 token ring has five stations and a total wire length of 230m. How many bits of delay must the monitor insert into the ring? Do this for both 4 and 16 Mbps; use a propagation rate of 2.3×10^8 m/s.

(10%) 3. An Ethernet switch is simply a bridge that has the ability to forward some number of packets in parallel, assuming the input and output ports are all distinct. Suppose two such N-port switches, for a large value of N, are each able to forward individually up to three packets in parallel. They are then connected to one another in series by joining a pair of ports, one from each switch; the joining link is the bottleneck as it can, of course, carry only one packet at a time.

(a) Suppose we choose two connections through this combined switch at random. What is the probability that both connections can be forwarded in parallel? (Hint: This is the probability that at most one of the connections crosses the link.)
(b) What if three connections are chosen at random?

(10%) 4. Suppose host A is sending to a multicast group; the recipients are leaf nodes of a tree rooted at A with depth N and with each nonleaf node having k children; there are thus k^N recipients.

(a) How many individual link transmissions are involved if A sends a multicast message to all recipients?
(b) Suppose A sends to all recipients, but some messages are lost and retransmission is necessary. Unicast retransmissions to what fraction of the recipients is equivalent, in terms of individual link transmissions, to a multicast retransmission to all recipients?

(10%) 5. Suppose TCP operates over a 1-Gbps link.

(a) Assuming TCP could utilize the full bandwidth continuously, how long would it take the sequence numbers to wrap around completely?
(b) Suppose an added 32-bit timestamp field increments 1,000 times during the wraparound time you found above. How long would it take for the timestamp to wrap around?

備註	試題隨卷繳交

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6. **[Logic Gates]** (1) Write down the truth table for XOR gate (A,B: input, C:output). (3%) (2) Implement XOR using basic logic gates (AND, OR, NOT). (3%) (3) Show how an XOR gate can be used as an INVERTER. (4%) (4) Use only XOR gates to generate the parity bit for a 4-bit (not including the parity bit) even-parity system. (5%)

7. **[Run-length Encoding]** (1) Encode the string DDDDDDCCCTTTTTTTTT using run-length encoding and compute the compression ratio. (6%) (2) Does RLE always save space? If so, prove it. If not, give a counterexample. (4%)

8. **[Boolean Algebra]** (1) Prove DeMorgan's theorem in N-variables. (4%) (2) Show the universality of NAND gate by implementing AND, OR, NOT using only NAND gates. (6%)

9. **[Entropy, Huffman coding]** Huffman coding is an entropy coding algorithm used for lossless data compression. The definition calls for the computation of the entropy: $H = \sum_i p_i \log_2 \frac{1}{p_i}$ where p_i is the probability of the i-th symbol.

   (1) Show that a symbol with zero probability will have zero contribution to the entropy. (6%)

   (2) When will H be maximized and minimized? (4%)

10. **[Touch Screen]** Touch screens have gained a lot of popularities recently. There are several technologies used to implement touch screens, including resistive, capacitive, infrared and surface acoustic wave (SAW) touch screens. Pick one that you are familiar with and explain how it works. (5%)

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