NATIONAL UNIVERSITY OF SINGAPORE

EXAMINATION FOR THE DEGREE OF
B. ENG. (ELECTRICAL) / B.ENG. (COMPUTER ENGINEERING)

(Semester I: 2002/2003)

EE3204 - COMPUTER COMMUNICATION NETWORKS I

November 2002 - Time Allowed: 2 Hours

INSTRUCTIONS TO CANDIDATES:

1. This paper contains **SIX** (6) questions and comprises **SIX** (6) pages.

2. Answer any **TWO** (2) questions from Section I and any **TWO** (2) questions from Section II . Each question carries 25 marks.

3. Calculators are allowed.

4. This is a CLOSED BOOK examination.

Section I

Q.1

(a) A data-link layer uses stop-and-wait protocol for transferring data from node A to node B through a 10 Mbps link which is 100 km long. Because of a hardware bug in the network adapter of node A, every third frame sent by it is in error. The propagation speed is assumed to be 1 km per 5 μs. The data frame size is 1000 Bytes and ACK frame size is 25 Bytes. The ACK frame transmission time is not negligible. Ignore other overheads. Determine the link utilization achieved.

(10 marks)

(b) Node A transfers 1000-bit frames to node C through node B. Link A-B is 4000 km long and link B-C is 2000 km long. Between nodes A and B selective-repeat flow control with window size 3 is used and between nodes B and C stop-and-wait flow control is used. Node A transmits at the rate of 100 kbps and node B transmits at the rate of 200 kbps. Node B starts its transmission as soon as it receives the first frame (in full) from node A. The propagation delay is 5 μs per km on each of the links. Assume that the communication is error-free and the ACK is sent as soon as a frame is received. Since node A transfers frames at a rate higher than that of node B, some frames need to be buffered at node B before they are transmitted to node C. Determine the buffer size required at node B if 300 frames need to be transferred from A to C. Suggest TWO solutions to avoid the need for such a buffer.

(15 marks)

Q.2

(a) A 10-Mbps CSMA/CD which is 2 km long transfers 250 Byte frames and achieves a throughput of 5 Mbps. The link propagation delay is 5 μs per km. What is the mean number of contention slots between two successful frame transmissions? What is the probability that exactly one node attempts a transmission in a slot? What is the throughput achieved if 200 Byte frames are transferred? Make necessary assumptions.

(10 marks)

(b) What purposes do the bits A and C serve in a 802.5 token ring? Why are these bits not covered by the CRC in the frame?

(10 marks)

(c) What signal-to-noise ratio (in dB) is needed to put a T1 carrier (1.5 Mbps) on a 50 kHz line?

(5 marks)

Q.3

(a) 12 PCs and one server are to be connected by an Ethernet LAN. The cost of an 1-Mbps adapter is $10 and that of a 10-Mbps adapter is $100. It is required to backup 1000 MB of data from the hard disk of each PC to a tape drive on the server everyday. Which of these two network adapters you will choose? Justify your answer.

(5 marks)

(b) A link-level protocol uses CRC-8 (whose divisor polynomial is x^8+x^2+x+1) for error detection. When a frame is transferred by using this protocol, 9 bits are corrupted. Can the receiver detect the error? Justify your answer.

(5 marks)

(c) Ten 9600-bps input links are multiplexed using TDM onto an output link. What is the bit-rate required by the output link when fixed TDM is used? Assuming that we wish to limit the average utilization of the output link to 90%, and assuming that each of the input link is busy for 60% of the time, what is the bit-rate required by the output link when statistical TDM is used.

(5 marks)

(d) What is the baud rate required by 10BASE5 Ethernet and 100 Mbps FDDI ring? Explain.

(5 marks)

(e) Assume that host A is transferring frames to host B using sliding window protocol with window size 10 through a 100 km-long 10 Mbps link with a propagation speed of 5 μs per km. Assume that each frame carries 125 bytes of data and the frames are numbered from 0. What is the current window size when the ACK for frame 0 is received by host A assuming that the communication is error-free?

(5 marks)

Section II

Q.4 Consider the network shown in Figure Q4 where all links are uni-directional.

(a) Illustrate Dijkstra's algorithm to solve for the shortest path spanning tree from Node 1 to all other nodes. Keeping the nodes in the same position shown in Figure Q4, sketch this tree.

(10 marks)

(b) Illustrate Dijkstra's algorithm to solve for the shortest path spanning tree from all other nodes to Node 1. Keeping the nodes in the same position shown in Figure Q4, sketch this tree.

(10 marks)

(c) Under what conditions would the trees in Q.4(a) and Q.4(b) be identical?
(5 marks)

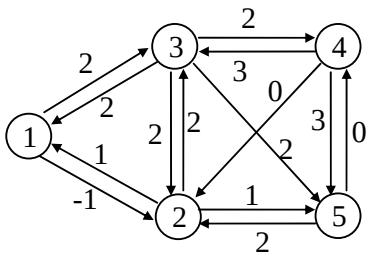

Figure Q4

Q.5 Figure Q5 illustrates a network with arc costs as shown. At initial state, nodes 1, 2 and 3 have already found the shortest path route to common destination node 4. Now assume that at time 0, the link (3,4) was cut and nodes start to update their distance vector records once every 3 seconds in this order: Node 3 updates at 0 second, then Node 2 at 1 second, then Node 1 at 2 seconds, then Node 3 again at 3 seconds and the sequence repeats. Assume that before every node update, the most recent distance vector information has already been disseminated to every node.

(a) At what time will the distance vectors of all three nodes stabilize?

(10 marks)

(b) Now assume that at time 10 seconds, the link (3,4) is restored. Assuming that the same sequence of updates with Node 3 updating at 10 second, followed by Node 2 at 11 seconds, then Node 1 at 12 seconds, then Node 3 again at 13 seconds and the sequence repeats, at what time will the distance vectors of all three nodes stabilize.

(10 marks)

(c) What conclusions can be drawn in regard to the examples in Q.5(a) and Q.5(b) about distance vector routing? Will this problem also arise for link state routing? Justify your answer.

(5 marks)

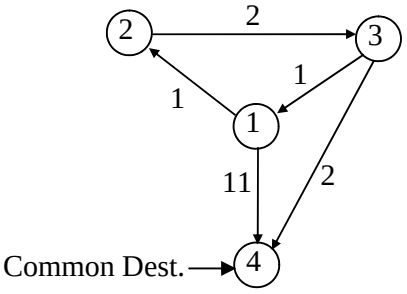

Figure Q5

Q.6 Figure Q6 shows an extended LAN using eight IEEE 802.1 compliant bridges for interconnection. Bridge modules all begin with prefix “B” followed by a number. The ports associated with each bridge are also numbered as shown in the figure. LANs 1-6 are also labeled using prefix “L” as shown.

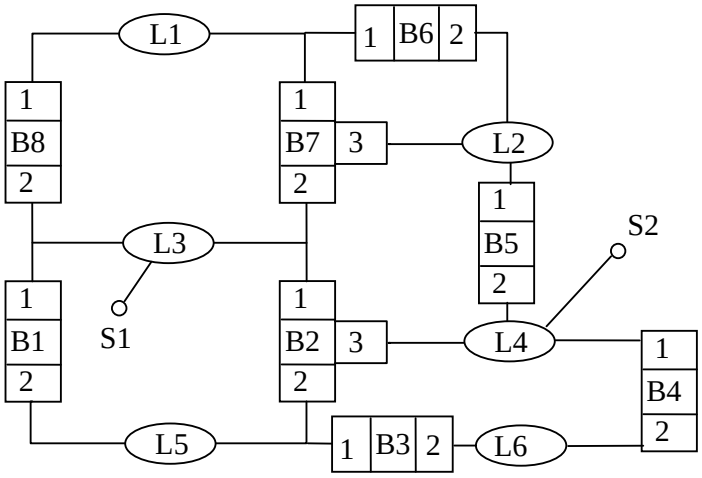

Figure Q6

(a) Explain the following terms: Transparent bridge, Spanning Tree Bridge, Backward Learning Algorithm. Highlight any relationships between these three concepts.

(5 marks)

(b) In Figure Q6, list out the forwarding tables of the bridges after node S1 (in L3) has sent a frame to node S2 (in L4) and S2 responds back to S1 with its own frame. Assume that the bridges adhere to transparent bridge protocols.

(20 marks)

END OF PAPER