Professional Engineers of Ontario

Annual Examinations – May 2009

07-Elec-B4
Information Technology Networks

3 Hours Duration

Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made.
2. This is a closed book exam. A PEO-approved non-programmable calculator is permitted.
3. There are 6 questions on this exam. Any 5 questions constitute a complete paper. Only the first 5 questions as they appear in your answer book will be marked.
4. Marks allocated to each question are noted in the left margin. A complete paper is worth 100 marks.
1. This question concerns shortest-path routing.

   a. Briefly explain Dijkstra's algorithm for finding the shortest paths from a given node to all other nodes in the network.

   b. Apply Dijkstra's algorithm to find the paths from node A to all other nodes in the following network, with the given edge distances. Show all work.

   (20 marks)

2. This question concerns cellular telephony.

   a. Explain, giving an example, why dividing space into "cells" increases the number of users who can simultaneously use a given wireless bandwidth.

   b. Give, and explain, one advantage of CDMA over TDMA. Give one example of a cellular standard employing CDMA, and one example of a standard employing TDMA.

   c. A city is to be covered by a digital cellular phone network. The spectrum re-use cluster size is 7 cells. Suppose the system bandwidth is 56 MHz, and FDMA is used. If the system must support 320 users per cell, and ignoring guard bands, how much bandwidth can be allocated to each user?

   d. For the system described in part c, suppose the size of the city is 14 km², and assume that the cells can perfectly fit the city size without overlap. Also assume that the users are uniformly distributed across the city. If the system must support a total of 8,960 simultaneous users across the city, how large (in area) should each cell be?

   e. Explain the difference between "hard handoff" and "soft handoff".

   (20 marks)
3. This question concerns transport layer protocols.

   a. TCP and UDP are the two most prominent transport layer protocols in use. Briefly explain the major differences between these protocols.

   b. Briefly discuss the operation of congestion control in the TCP protocol, making specific reference to the congestion window, slow start, fast retransmit, and fast recovery.

   c. Suppose a TCP protocol is used with a congestion threshold of 16. Give the congestion window sizes for the first six TCP packets, assuming that TCP starts with a window size of 1 and all packets are acknowledged.

4. This question concerns medium access control protocols.

   a. Briefly discuss the operation of ALOHA, making specific reference to the protocol's behavior as a result of collisions.

   b. Assuming that the rate of packet transmissions in an ALOHA network is \( G \), and that packet transmissions are Poisson distributed, show that the throughput of an ALOHA network is given by \( Ge^{-2G} \).

   c. Using any medium access control scheme in which collisions are allowed, what is the longest period of time that could pass before a collision is detected? Explain.

5. This question concerns local area networks.

   a. Briefly explain the medium access control method in Ethernet, making specific reference to collisions and recovery from collisions.

   b. Briefly explain the operation of a token-ring network. Give two allowed token-reinsertion strategies and discuss their effects on network performance.

   c. Give one advantage and one disadvantage of using a channelized medium access control method, such as FDMA, instead of either Ethernet or Token Ring.
(20 marks) 6. This question concerns IP packet routing.

(16 marks) a. Consider the network of LANs in the diagram below. Dark squares are routers, and light squares are hosts. Give the IP routing tables at both routers.

(4 marks) b. Give, and explain, the path through the network for a packet originating at 128.100.11.1 with destination 128.100.192.1.
Marking Scheme

1. 20 marks total
   a) 5 marks
   b) 15 marks
2. 20 marks total
   a) 4 marks
   b) 3 marks
   c) 5 marks
   d) 5 marks
   e) 3 marks
3. 20 marks total
   a) 4 marks
   b) 12 marks
   c) 4 marks
4. 20 marks total
   a) 5 marks
   b) 10 marks
   c) 5 marks
5. 20 marks total
   a) 8 marks
   b) 8 marks
   c) 4 marks
6. 20 marks total
   a) 16 marks
   b) 4 marks