## **Professional Engineers of Ontario**

Annual Examinations - Dec 2008

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.

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- (20 marks) 1. This question concerns cellular telephony.
- (4 marks)

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

  b. The GSM system uses TDM to transmit data. Eight users share a TDM frame of duration 4.615 milliseconds (ms), where each user transmits a 148-bit data frame. There is a guard time of 0.030 ms. What is the peak bit rate of the user?
- (10 marks)

  c. A city of size 28 km² is to be covered by a digital cellular phone network. The spectrum re-use cluster size is 7 cells, and each cell has area 1 km². Assume that the cells perfectly fit the city size without overlap. If the system bandwidth is 49 MHz, and FDM is used where each user is allocated 25 kHz including guardband, how many users can simultaneously make calls in the system? How many can simultaneously make calls per cell?
- d. What is the term for the actions taken by the network to handle a user moving from one cell to another?
- (20 marks) 2. This question concerns transport layer protocols.
- (12 marks)

  a. 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.
- (4 marks)
   b. Suppose a TCP protocol is used with a congestion threshold of 64. Give the congestion window sizes for the first ten TCP packets, assuming that TCP starts with a window size of 1 and all packets are acknowledged.
- (4 marks) c. Under what circumstances is it preferable to use UDP rather than TCP?
- (20 marks) 3. This question concerns medium access control protocols.
- (8 marks)

  a. Briefly discuss the operation of CSMA/CD in Ethernet, making specific reference to collisions, and recovery from collisions.
- (4 marks) b. Using CSMA/CD in Ethernet, what is the longest period of time that could pass before a collision is detected?
- (4 marks) c. Explain how collisions are avoided in "token ring" networks.
- (4 marks)

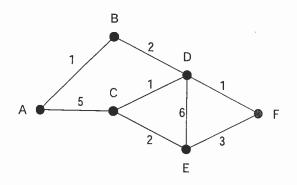
  d. Explain the network's response to a collision in an ALOHA network.

  When might ALOHA be preferable to CSMA/CD?

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(20 marks)

- 4. This question concerns routing in packet-switched networks.
- (5 marks)
- a. Briefly explain Dijkstra's algorithm for finding the shortest paths from a given node to all other nodes in the network.
- (15 marks)
- 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)

5. This question concerns the Internet Protocol (IP), versions 4 and 6.

(10 marks)

a. Consider the following IPv4 routing table.

Destination	Mask	Next Hop
127.0.0.1	255.255.255.255	127.0.0.1
129.97.48.0	255.255.240.0	129.97.54.1
129.97.152.0	255.255.255.128	129.97.152.1
129.97.152.128	255.255.255.128	129.97.152.183
default	0.0.0.0	129.97.0.1

Identify the next hop for the following IP address destinations:

- i. 129.97.56.254
- ii. 129.97.152.129
- iii. 129.128.0.1
- iv. 129.97.152.1
- v. 129.97.48.1

(2 marks)

b. For what purpose is the reserved IPv4 address 127.0.0.1 used?

(2 marks)

c. A vendor approaches you and offers to sell your company exclusive use of the 192.168.x.x IPv4 address space. Is this offer legitimate? Explain.

(6 marks)

d. Give three advantages of IPv6 over IPv4.

(20 marks) 6. This question concerns the data link layer and peer-to-peer protocols.

(5 marks)

a. Briefly describe how cyclic redundancy checks (CRCs) detect whether a packet contains an error, making specific reference to CRC encoding with generator polynomials.

(5 marks) b. For a CRC system, let the generator polynomial be  $g(x) = x^2 + 1$ . If the information polynomial is  $i(x) = x^5$ , give the output of the CRC encoder.

 (8 marks)
 c. Briefly describe the operation of ARQ, specifically describing stop-andwait ARQ as well as go-back-n ARQ.

(2 marks)

d. If propagation delay is large with respect to the packet size, which is more efficient: stop-and-wait ARQ or go-back-n ARQ? Explain.

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