Professional Engineers of Ontario

Annual Examinations – December 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. One of two calculators is permitted any Casio or Sharp approved models.
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.

(20 marks) 1. This question concerns the data link layer and peer-to-peer protocols.

(6 marks) a. Briefly describe how cyclic redundancy checks (CRCs) detect whether a packet contains an error.

(4 marks) b. In an error-detection code, suppose the minimum Hamming distance between any two valid codewords is d. How many errors can be detected?

(8 marks) c. Briefly describe the operation of ARQ, specifically describing stop-and-wait 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.

(20 marks) 2. This question concerns transport layer protocols.

(6 marks) a. Briefly explain the operation of congestion control in the TCP protocol.

(6 marks) b. Suppose a TCP protocol is used with a congestion threshold of 8. Give the congestion window sizes for the first six TCP windows, assuming that TCP starts with a window size of 1 and all packets are acknowledged.

(6 marks) c. Considering the same setup as in part b, suppose the a packet in the fourth window is not acknowledged. Give the congestion window sizes for the first six TCP windows, and the final value of the congestion threshold.

(2 marks) d. How does the TCP protocol differ from UDP?

(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?

(8 marks) c. In a wireless network, explain why the "hidden terminal problem" causes failures in CSMA. Why is this problem not observed in wired networks? Suggest a way to avoid this problem.

(20 marks) 4. 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.

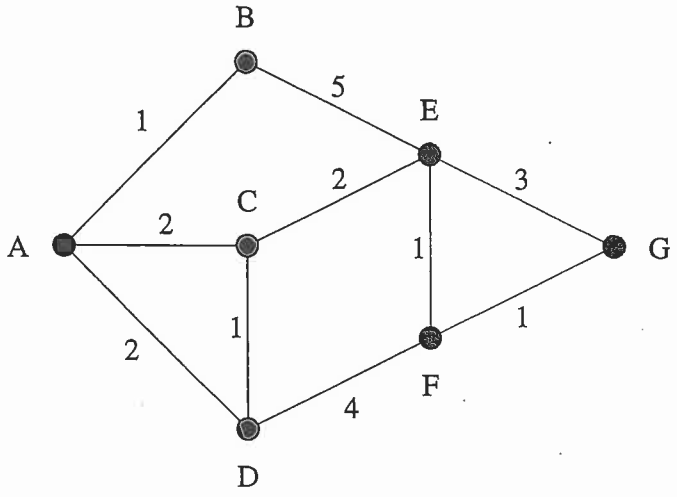
(4 marks) b. Explain the "near-far" problem in CDMA. How can this problem be mitigated?

(4 marks) c. Briefly explain how the available bandwidth is shared among users in a GSM system.

(4 marks) d. Suppose in a cellular system, 1400 simultaneous users can be supported in the entire system bandwidth. Suppose the cell reuse cluster size is 7, and suppose 70 cells are required to completely cover a city. How many simultaneous users can be supported in the city?

(4 marks) e. Explain the difference between "hard handoff" and "soft handoff".

(20 marks) 5. 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; credit will only be awarded for clearly following Dijkstra's algorithm.

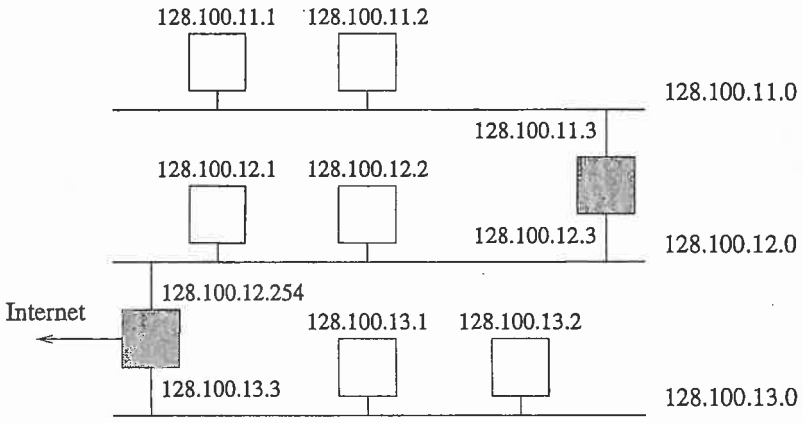


(20 marks) 6. This question concerns IP packet routing.

(10 marks) a. Consider the network of LANs in the diagram below. Dark squares are routers, and light squares are hosts. Give the IP routing table at the router bridging the 128.100.11.0 and 128.100.12.0 networks.

(6 marks) b. Give, and explain, the path through the network for a packet originating at 128.100.11.2 with destination 128.100.14.1.

(4 marks) c. Give, and explain, two advantages of IPv6 over IPv4.



Marking Scheme

1. 20 marks total
   a) 6 marks
   b) 4 marks
   c) 8 marks
   d) 2 marks
2. 20 marks total
   a) 6 marks
   b) 6 marks
   c) 6 marks
   d) 2 marks
3. 20 marks total
   a) 8 marks
   b) 4 marks
   c) 8 marks
4. 20 marks total
   a) 4 marks
   b) 4 marks
   c) 4 marks
   d) 4 marks
   e) 4 marks
5. 20 marks total (undivided)
6. 20 marks total
   a) 10 marks
   b) 6 marks
   c) 4 marks