

Professional Engineers of Ontario

Annual Examinations – December 2012

07-Elec-B4

Information Technology Networks

3 Hours Duration

Notes:

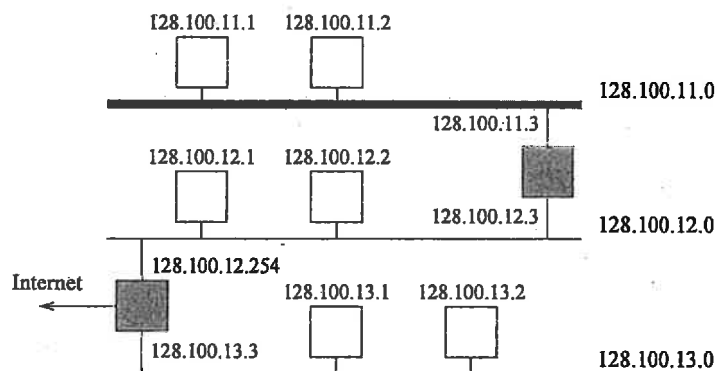
1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made.
2. This is a closed book exam. One of two calculators is permitted any Casio or Sharp approved models.
3. There are **5 questions** on this exam. **Any 4 questions constitute a complete paper.** Only the first 4 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.

(25 marks) Question 1. This question concerns cellular telephony.

- (5 marks) a. Explain, giving an example, why dividing space into “cells” increases the number of users who can simultaneously use a given wireless bandwidth.
- (5 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. Assuming binary signaling, what is the duration of each bit?
- (5 marks) c. Modern cellular systems use MIMO to transmit data. Briefly describe this method and its features.
- (5 marks) d. 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 FDMA 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?
- (5 marks) e. 4G networks are entirely packet switched. Briefly explain the impact of this on voice calls.

(25 marks) Question 2. This question concerns IP packet routing.

- (12 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 each router.
- (8 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.
- (5 marks) c. Give, and explain, two advantages of IPv6 over IPv4.



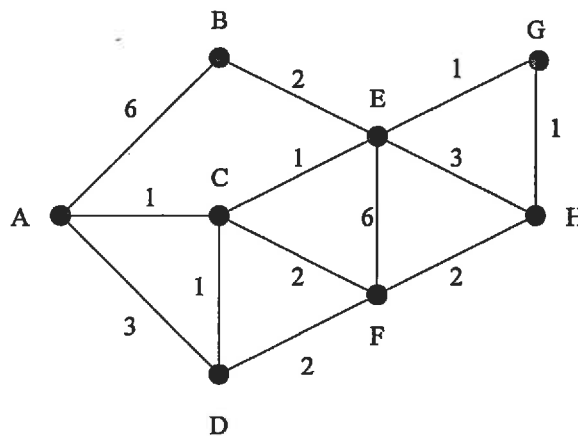
(25 marks) **Question 3.** This question concerns medium access control protocols.

(10 marks) a. Briefly discuss the operation of CSMA/CD in Ethernet, making specific reference to collisions, and recovery from collisions.

(10 marks) b. In a wireless network, briefly explain the hidden terminal problem, and the exposed terminal problem. Explain how RTS-CTS-ACK control messages solve these problems.

(5 marks) c. Using any medium access control scheme, what is the shortest period of time that could pass before a collision is detected? Explain.

(25 marks) **Question 4.** Apply Dijkstra's algorithm to find the paths from node H to all other nodes in the following network, with the given edge distances. Show all work: no marks will be awarded unless you clearly apply Dijkstra's algorithm. (You may wish to explain your steps for clarity.)



(25 marks) **Question 5.** This question concerns layered architecture.

(5 marks) a. What is the advantage of using a layered architecture when designing networks?

(10 marks) b. Name each layer of the OSI seven-layer model, and describe it in one sentence.

(10 marks) c. Of the seven layers in the OSI model, name the layer (or layers, if more than one) where each of the following is used or found.

- i. The TCP/IP protocols.
- ii. The HTTP protocol.
- iii. Error-control coding.
- iv. Conversion of character codes, e.g. EBCDIC to ASCII.
- v. In-order delivery of packets.
- vi. Routing.
- vii. Signal voltages.

Marking Scheme

1. 25 marks
 - a. 5 marks
 - b. 5 marks
 - c. 5 marks
 - d. 5 marks
 - e. 5 marks
2. 25 marks
 - a. 12 marks
 - b. 8 marks
 - c. 5 marks
3. 25 marks
 - a. 10 marks
 - b. 10 marks
 - c. 5 marks
4. 25 marks (no subdivisions)
5. 25 marks
 - a. 5 marks
 - b. 10 marks
 - c. 10 marks