Professional Engineers of Ontario

Annual Examinations – May 2014

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 **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, unless you **clearly** indicate which questions you want marked **on the front of your exam booklet.**
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 packet switching and circuit switching.

(5 marks)   a. Explain the difference between packet switched networks and circuit switched networks.

(5 marks)   b. "The LTE [cellular telephone] standard supports only packet switching." Discuss how this differs from earlier cellular standards, such as GSM.

(5 marks)   c. Of the following standards, protocols, or methods, state whether it is most useful for packet switching or circuit switching (if there is no difference, say so). Give a one-sentence explanation for each.
  - i. FDMA
  - ii. TCP/IP
  - iii. TDMA
  - iv. Ethernet

(5 marks)   d. For bursty traffic, which is better: packet switching or circuit switching? (Or are they both the same?) Explain.

(5 marks)   e. For traffic that operates under delay constraints, which is better: packet switching or circuit switching? (Or are they both the same?) Explain.

(25 marks) Question 2. 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. Why are directional antennas often used in cellular base stations?

(5 marks)   c. Explain duplexing, giving an example of time division duplexing (TDD) and frequency division duplexing (FDD).

(5 marks)   d. Consider a cellular system with total available bandwidth of 45 MHz. If the system contains 63 cells, and if the frequency reuse cluster size is 9, how much bandwidth is allocated to each cell?

(5 marks)   e. For the same system as in part (d), suppose FDMA is used, and suppose the system must accommodate at least 14,000 simultaneous users. What is the maximum bandwidth that can be given to each user?

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

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

(5 marks)   b.   How does an Aloha network operate differently from CSMA/CD? Are collisions possible in Aloha?

(10 marks)   c.   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)   d.   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. 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. (Be brief; marks may be deducted for unnecessary detail!)

(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 FTP protocol.
      ii.   The UDP protocol.
      iii.   Ethernet.
      iv.   Routing.
      v.   End-to-end packet delivery.
      vi.   Encryption and decryption.
      vii.   Point-to-point protocol (PPP).
      viii. Modulation and demodulation.

(25 marks)   Question 5. This question concerns shortest-path routing.

(15 marks)   a.   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 not be awarded unless Dijkstra's algorithm is correctly followed.
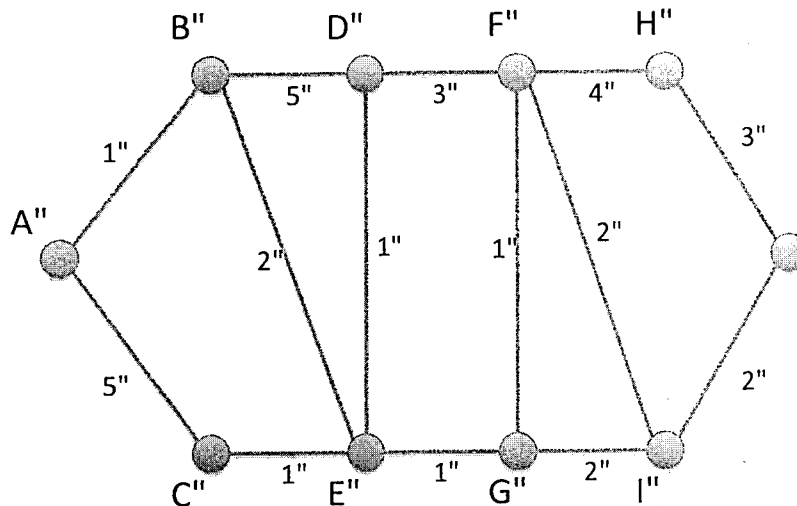
(10 marks)   b.   Suppose the cost of the link from C to E increases. What is the minimum increase of this cost at which your solution from part (a) would change, and what change would be made? (If it doesn't change for any higher cost, say so and explain.)