Professional Engineers of Ontario

Annual Examinations – December 2013

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.** If you attempt more than 4 questions, clearly indicate which ones are to be graded; otherwise, 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 the WiFi and Bluetooth wireless protocols.

6 marks a. Briefly describe the structure of a Bluetooth piconet, including Master, Slave, and Parked devices. How many of each type of device are allowed?

6 marks b. How is the available spectrum shared among the nodes in a Bluetooth piconet? Give a detailed example.

6 marks c. In a WiFi network, what services are provided by each of Basic Service Set (BSS) and Extended Service Set (ESS)?

7 marks d. Briefly describe medium access sharing in WiFi, making specific reference to inter-frame spacing.

25 marks **Question 2.** This question concerns cellular telephony.

5 marks a. Explain the concept of spatial reuse. Why does this increase the number of users for a given bandwidth?

5 marks b. Some implementations of LTE cellular technology include orthogonal frequency division multiplexing (OFDM) and multiple-input, multiple-output (MIMO) transmission. Briefly explain both terms.

5 marks c. In a GSM system, TDMA is used with a frame length of 4615 μs. There are eight users per frame, where each user has a guard time of 30.5 μs. Each user sends 148 bits, of which 114 bits are data (the rest are control). What are the peak bit rate (including control bits) for all users, and the average data rate (data bits only) per user?

5 marks d. Consider a cellular system with total available bandwidth of 42 MHz. If the system contains 56 cells, and if the frequency reuse cluster size is 7, how much bandwidth is allocated to each cell?

5 marks e. For the system in part d, say FDMA is used, and each user requires 20 kHz. How many users can be served per cell? How many in the entire system?

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

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

5 marks b. In an Ethernet network, what is the longest possible amount of time that can elapse before a collision is detected?

10 marks c. In a wireless local area network, explain the hidden terminal problem and exposed terminal problem. Give and explain a wireless protocol that can solve these problems.

5 marks d. Give one advantage, and one disadvantage, of a channelized medium access control method (like FDMA), as compared to Ethernet.

25 marks **Question 4.** This question concerns transport layer protocols.

10 marks a. Using TCP, suppose the initial window size is 1, and the congestion threshold is 16. Assuming all packets are acknowledged, give an example showing how the window size evolves up to and beyond the threshold.

10 marks b. Suppose packet losses are caused mostly by a brief loss of signal (e.g., fading in a wireless network), rather than congestion. Discuss why TCP gives suboptimal performance in this scenario.

5 marks c. Give two differences between TCP and UDP.

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.

a. The SMTP protocol.
b. The TCP/IP protocols.
c. Congestion control.
d. Conversion of character codes, e.g. EBCDIC to ASCII.
e. Modulation and detection.
f. Collision avoidance.
g. End-to-end routing.