Professional Engineers of Ontario

Annual Examinations – May 2015

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." Why did LTE make this change from earlier 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.   CDMA
  ii. TCP/IP
  iii. TDMA
  iv. Ethernet

(5 marks)   d.   Give two features of a data stream that make packet switching better than circuit switching, and explain in one sentence each.

(5 marks)   e.   Give two features of a data stream that make circuit switching better than packet switching, and explain in one sentence each.

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

(5 marks)   a.   Explain, giving an example, the concept of "spatial reuse of frequencies".

(5 marks)   b.   Explain (in one sentence) "co-channel interference". Where in a cell might co-channel interference be worst? Explain (in one sentence).

(5 marks)   c.   Explain (in one sentence) why multi-path propagation can lead to signal loss, and give a brief example.

(5 marks)   d.   A city of size 28 km^2 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 km^2. 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?

(5 marks)   e.   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?

(25 marks)   **Question 3.** This question concerns the transport layer.

(5 marks)   a. TCP and UDP are the two most prominent transport layer protocols in use. Briefly explain the major differences between these protocols.

(5 marks)   b. Give an example of an application that is better for TCP, and one that is better for UDP.

(10 marks)   c. 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.

(5 marks)   d. Considering the same setup as in part b, suppose a packet in the third window is not acknowledged. Give the congestion window sizes for the first eight TCP windows.

(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 HTTP protocol.
   ii. The TCP/IP protocol.
   iii. Ethernet.
   iv. Routing.
   v.   End-to-end packet delivery.
   vi. Encryption and decryption.
   vii. Character display, such as ASCII.
   viii. Signal voltages.

(25 marks)   **Question 5.** This question concerns medium access control protocols.

(5 marks)   a. In wireless networks, explain the hidden terminal problem and the exposed terminal problem. Explain how RTS-CTS methods can mitigate both problems.

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

(5 marks)   c. Briefly explain the operation of a token-ring network. Are collisions possible in token ring? Explain.

(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.

(5 marks)   e. Why is an Aloha network much less efficient than CSMA/CD? In what application is Aloha more appropriate than CSMA/CD?