Professional Engineers of Ontario

Annual Examinations – December 2016

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; any Casio or Sharp approved model.
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." What cellular services are most affected by this change? Explain why in one sentence.

(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. For data traffic that needs no particular service guarantee, would you pick packet switching or circuit switching (or is there no difference)? Explain in 2-3 sentences.

(5 marks)   e. For data traffic that requires a constant data rate over a long period of time, would you pick packet switching or circuit switching (or is there no difference)? Explain in 2-3 sentences.

(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) why multi-path propagation can lead to signal loss, and give a brief example.

(5 marks)   c. Some implementations of LTE cellular technology include multiple-input, multiple-output (MIMO) transmission. Briefly explain MIMO and why it is beneficial (2-3 sentences).

(5 marks)   d. A city of size 52 km^2 is to be covered by a digital cellular phone network. The spectrum re-use cluster size is 13 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 39 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.   Consider a multi-hop network where each link has different capacity, and where the routers have finite-sized buffers. Why is congestion control necessary in this network?

(5 marks)   b.   Briefly explain (2-3 sentences) the difference between TCP and UDP, and give an example application of each.

                   c.   Using TCP, suppose the initial window size is 1, and the congestion
(10 marks)   threshold is 32. 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.   Encryption and decryption.
           ii.   The TCP/IP protocol.
           iii.   Ethernet.
           iv.   Routing.
           v.   SMTP, HTTP, or FTP.
           vi.   The UDP protocol.
           vii.   Character display, such as ASCII.
           viii.   Error detection over a *single* link.

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

Apply Dijkstra's algorithm to find the paths from **node F** 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.