

National Examinations – May 2017

16-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 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 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. In LTE, the physical resource block (PRB) contains 12 subcarriers; each subcarrier is used to transmit 7 symbols. Suppose each symbol is selected from a 64-QAM constellation, and suppose four symbols from the entire PRB are used as reference symbols to estimate the channel, and cannot be used for data. If the PRB lasts 0.5 ms, what is the peak data rate of a PRB (in bits/s)?
- (5 marks) c. A city of size 35 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 42 MHz, and FDM is used where each user is allocated 25 kHz including guardband, how many users can simultaneously use the system? How many can simultaneously use the system per cell?
- (5 marks) d. Briefly explain why “multipath fading” causes signal loss in mobile networks.
- (5 marks) e. Most cellular systems use frequency division duplexing. Briefly explain this concept.

(25 marks) Question 2. This question concerns transport layer protocols.

- (5 marks) a. Suppose you have a video streaming application over a mobile wireless link. Would you use TCP or UDP? Briefly explain your choice.
- (5 marks) b. Using an example, illustrate why end-to-end congestion control is necessary in large wired networks, where links have different capacities.
- (5 marks) c. In a wired network, packet loss is usually caused by congestion, but in a wireless network, packet loss is often caused by momentary fading. Why is TCP suboptimal in a wireless network?
- (5 marks) d. Using TCP, suppose the initial window size is 1, and the congestion threshold is 64. Assuming all packets are acknowledged, give an example showing how the window size evolves up to and beyond the threshold.
- (5 marks) e. Repeat part b, assuming a packet in the fourth window is not acknowledged, and TCP enters slow start. In your example, illustrate all relevant features of TCP.

(25 marks) Question 3. 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 4. This question concerns medium access control protocols.

- (5 marks) a. In wireless networks, briefly explain the exposed terminal problem. Briefly explain how RTS-CTS methods can mitigate this problem.
- (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 an ALOHA network. Are collisions possible in ALOHA? Briefly 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? Briefly explain.
- (5 marks) e. Is the token ring protocol appropriate for a wireless network? Briefly explain.

(25 marks) **Question 5.** This question concerns IP packet routing.

- (5 marks) a. How many possible IP addresses are there in IPv4? (Ignore any reserved or special addresses and give the total possible number.) Does IPv6 give more, less, or the same number of addresses? Briefly explain.
- (10 marks) b. Consider the network of LANs in the diagram below. Dark squares are routers, and light squares are hosts. Give the IP routing tables at both routers, including netmasks and gateways.
- (5 marks) c. Give, and explain, the path through the network for a packet originating at 128.100.11.2 with destination 128.100.13.1.
- (5 marks) d. If you send a packet to the IPv4 address 127.0.0.1, where does it go? Briefly explain.

