PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Department of Computer Engineering

Final Examination: Semester 2 **Academic Year**: 2009-2010

Date: 19th February, 2010 **Time**: 9:00 – **12:00 (3 hours)**

Subject Number: 241-423 **Room**: A401

Subject Title: Advanced Data Structures and Algorithms

Lecturer: Aj. Andrew Davison

Exam Duration: 3 hours

This paper has 4 pages.

Authorized Materials:

- Writing instruments (e.g. pens, pencils).
- Books (e.g. dictionaries) and calculators are **not** permitted.

Instructions to Students:

- *Answer questions in English.* Perfect English is **not** required.
- Attempt all questions.
- Write your answers in an answer book.
- Start your answer to each question on a new page
- Clearly number your answers.
- Any unreadable parts will be considered wrong.
- When writing programs, use good layout, and short comments; marks will not be deducted for minor syntax errors.
- The marks for each part of a question are given in brackets (...).

Question 1

(20 marks; 20 minutes)

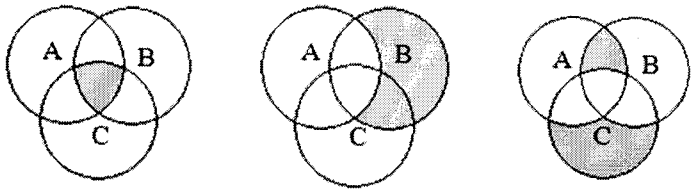
a) Implement the Stack push() and pop() operations using *two* Queue objects. Assume the existence of a suitable Queue class (e.g. as described in Part 9); do not implement Queue yourself. What are the running times of the Stack operations? (10)

b) Implement the Queue push() and pop() operations using *two* Stack objects. Assume the existence of a suitable Stack class (e.g. as described in Part 8); do not implement Stack yourself. What are the running times of the Queue operations? (10)

Question 2

(30 marks; 30 minutes)

a) Assuming the existence of suitable Set and Sets classes (e.g. as described in Part 10), write code which returns the shaded areas in terms of union, intersection, and difference for the sets A, B, and C for parts (1)-(3). Do not implement the union, intersection, and difference operation. (10)



(1) (2) (3)

b) Explain the purpose of collection views in maps using words, diagrams, and **small** code fragments. (20)

Question 3

(30 marks; 30 minutes)

Assume that a hash function gives the following results:

(i) keys 257 and 567 hash to 3

(ii) keys 734, 189, and 575 hash to 5.

(iii) keys 987 and 313 hash to 6.

(iv) keys 122 and 391 hash to 8.

a) Using linear probing on an 11-element array, perform the insertions in the order 257, 987, 122, 575, 189, 734, 567, 313, 391. Show all your working. (10)

b) Repeat part (a), but reverse the insertion order (i.e. 391 is inserted first, and 257 last). (10)

c) Assume you have an m-element table, and your hash function uniformly distributes indicies over the table.What is the probability of hashing to location p?

Once data occupies table location p, location p+1 can be occupied by data hashing to location p or location p+1. What is the probability of filling location p+1?

What is the probability of filling location p+2?

With the help of the preceding maths, explain why clustering occurs. (10)

Question 4

(55 marks; 55 minutes)

a) Heapify the following array, {34, 21, 19, 5, 62, 23, 4}, creating a max heap. Draw all the stages in the heapification, and summarize what is happening. Also show the resulting array. [Do not include any code.] (10)

b) Perform a Heap sort on the array result from part (a). *Only draw the first three stages* in the sort, where the largest three elements of the array are put into ascending order position. Explain in words what is happening. [Do not include any code.] (15)

c) Draw the final sorted heap, and the corresponding sorted array. Briefly explain in words the number and types of operations that led to this result. [Do not include any code.] (10)

d) What are the differences between a binary search tree and a min heap? (10)

e) What are minimum and maximum number of elements in a heap of height h? (10)

Question 5

(20 marks; 20 minutes)

a) Construct a 2-3-4 tree from the sequence {20, 30, 5, 45, 25, 36, 42, 33, 55, 3, 2, 4, 67, 28}. Show all your working. (10)

b) Draw a red-black representation of the tree in part (a). Show all your working. (10)

Question 6

(25 marks; 25 minutes)

a) Give the last occurrence function table for the Boyer-Moore algorithm when using the pattern:

"abacba"

The alphabet consists of the lowercase letters {a, b, c, d}. Explain your answer in words. (5)

b) Show how the "abacba" pattern is moved when it is matched using Boyer-Moore against the string:

"abaceaababdaabacba"

Explain your answer in words. (10)

c) Give one advantage of using Knuth-Morris-Pratt instead of Boyer-Moore for patten matching. Do **not** include any code fragments in your answer. (10)

--- End of Examination ---