NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF APPLIED SCIENCE
COMPUTER SCIENCE DEPARTMENT
SUPPLEMENTARY EXAMINATIONS JULY 2000

SUBJECT: ADVANCED PROGRAMMING
CODE: SCS 4105

INSTRUCTIONS TO CANDIDATES
This paper consists of seven (7) questions.
Answer any five (5) questions.
All questions carry equal marks.

Time: 3 hours

1. (a) Write functions to count the number of nodes in a binary tree, the number of leaves, the number of right children, and the height of the tree.   [10]

  (b) Write a function to delete all leaves from a binary tree.   [10]

2. (a) How many keys can a B-tree of order m and of height h hold?   [8]

  (b) Write a procedure, which prints out the contents of a B-tree in ascending order. [12]

3.   A *cocktail shaker sort* designed by Donald Knuth is a modification of bubble sort in which the direction of "bubbling" changes in each iteration: in one iteration the smallest element is bubbled up, in the next the largest is bubbled down, in the next the second smallest is bubbled up, and so forth. Implement this new algorithm and explore its complexity.   [20]

4. (a) What is the maximum height of a B^+-tree with n keys?   [5]

  (b) Consider the following programming task: Read in pairs of cities, strings of length 20 at most, where each pair of cities is connected by a highway, and then print out a list of cities which are directly connected to three or more other cities. Describe how to implement this program using the ADT simple database.   [15]

5. (a) Explain the following terms as they relate to hashing
   i) chaining,
   ii) perfect hash function
   iii) linear probing
   iv) quadratic probing,
   v) random probing, ...

   [5]

   b) Write a C function *search(table, key)* that searches a hash table for a record with a key *key*. The function accepts an integer key and a table declared by

   ```
   struct record {
           KEYTYPE k;
           RECTYPE r;
           int flag;
   } array[TABLESIZE];
   ```

   table[i] .k and *table[i]* are the *ith* key and record, respectively. *table[i].flag* equals FALSE if the *ith* table position is empty and TRUE if it is occupied. The routine returns an integer in the range 0 to *TABLESIZE - 1*.
   Assume the existence of a hashing routine, *h(key)*, and a rehashing routine *rh(index)* that both produce integers in the range 0 to *TABLESIZE - 1*. [15]

6. a) What is a 2-3 Tree? [5]

   b) Discuss with illustrations, algorithms for insertion into a 2-3 Tree. [15]

7. Briefly describe the following methods of selecting a free block of memory to be used when implementing dynamic memory management.
   - first -fit
   - best-fit
   - worst-fit
   Give the algorithms for implementing any two of the above. [20]

END OF QUESTION PAPER