UNIVERSITI SAINS MALAYSIA

Stamford College

First Semester Examination
2004/2005 Academic Session
October 2004

External Degree Programme
Bachelor of Computer Science (Hons.)

CPT201 – Design & Analysis of Algorithms

Duration : 2 hours

INSTRUCTIONS TO CANDIDATE:

- Please ensure that this examination paper contains **FIVE** questions in **FIVE** printed pages before you start the examination.
- Answer any **FOUR** questions.
- On each page, write *only your **Index Number***.

1. (a) Order the following list of functions in terms of big O notation (smallest growth rate on the left), and group together (say by circling together) the ones that are the big O of the other.

$6N\log N$ $4N^{3/2}$ 2^N $N\log_4 N$ $5N$ 4^N $4^{\log N}$ N^3

(20/100)

(b) Give an O(mn) algorithm to determine if set A is a subset of set B. Prove that your algorithm runs in the desired time.

(30/1000)

(c) You are to sort an array which is so large so much so that an $O(N^2)$ algorithm and the use of additional data (e.g. stack space) may not be satisfactory. However you are told that the array to be sorted is often nearly sorted. Would it be appropriate to use merge sort to sort the array? What would be the most appropriate sorting algorithm to carry out this task? Justify your answers.

(30/100)

(d) Identify and give an example of best case and worst case data sets for the merge sort algorithm.

(20/100)

2. (a) (i) What would you do to the treesort algorithm if you need to sort a list into descending order instead of ascending order?

(ii) Trace the treesort algorithm as it sorts the array 40 30 50 20 60 70 into descending order as what you have suggested in 2(a)(i) above.

(30/100)

(b) (i) List the operations that define the ADT table together with a brief description of each operation.

(ii) Which of the ADT table operations could be used to empty an existing table of array-based implementation? Describe how you would use the operation to carry out the task.

(30/100)

(c) Describe what would happen in term of moves and compares, in HeapInsert (insertion into a heap as given in lecture) if the original data

(i) is in sorted order.

(ii) consist of keys with the same value.

(iii) is already a heap.

(iv) is descending order.

Illustrate your answers by using the following sets of data: 1 2 3 4 5 for 2(c)(i), 2 2 2 2 2 for 2(c)(ii), 5 4 3 1 2 for 2(c)(iii), and 5 4 3 2 1 for 2(c)(iv) respectively.

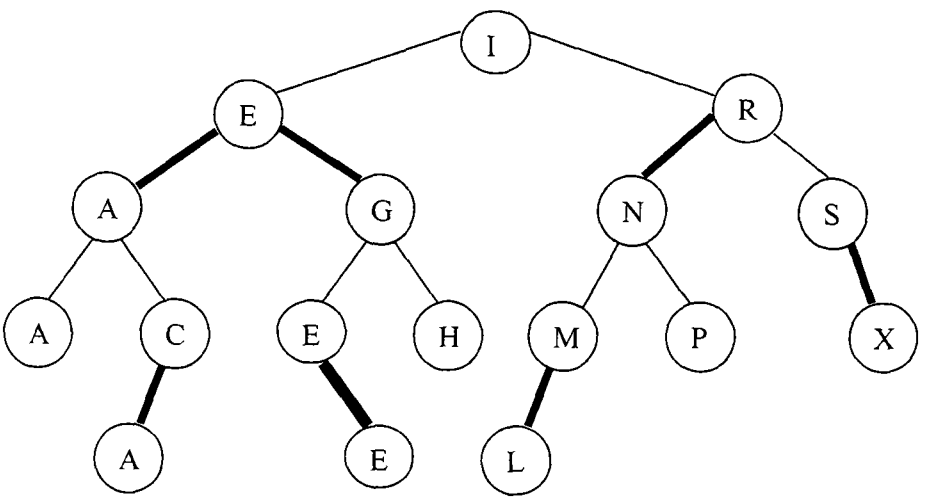
(40/100)

3. (a) (i) Explain the concepts of red-black tree and 2-3-4 tree.

(ii) Why do we use red-black representation to represent 2-3-4 tree?

(iii) Write an inorder traversal algorithm (pseudocode) that would visit the nodes of a red-black tree, and at the same time would print the type of link i.e. red or black link, which the traversal algorithm has gone through.

(iv) What would be printed if you use your algorithm in 3(a)(iii) above to print the type of links for the following red-black tree? (Note: Red links – thick lines, black links – normal line)



(v) What 2-3-4 tree repsresents the red-black tree given in (iv) above?

(60/100)

(b) Following is a hash table for 10 integers created by using the hashing function h1(key) = key % 10. Collisions were resolved by using linear probing.

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
10	430	21	23	54	235	51	17	37	28

(i) Is the hash function a good function? Justify your answer.

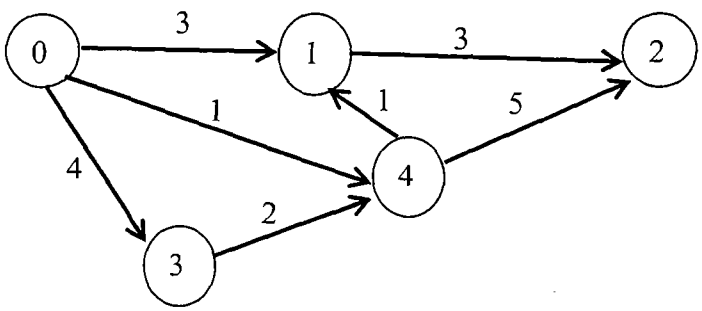
(ii) Give a possible sequence of insertion of integers into the hash table which was originally empty.

(iii) For each integer, compute the number of comparisons required to find the integer. Using these results, compute the average number of comparisons for a search in this hash table.

(40/100)

4. (a) (i) Why is it that adjacency matrix representation is appropriate for Dijkstra shortest path algorithm and not adjacency list representation?

(ii) Perform Dijktsra shortest-path algorithm on the following graph by tracing it using the tabular format as given in lecture.



(45/100)

(b) We stated that a minimum spanning tree will always contain N-1 edges for a graph of N vertices. Provide a logical argument to prove this claim. (Hint: Use proof by contradiction).

(15/100)

(c) (i) Describe ReadBlock and WriteBlock (as given in lecture) and state the reason why we need them for external method.

(ii) Write a function (pseudocode) that will read block of an external file sequentially and process (visit) the record sequentially in each block and rewrite the updated record back onto the file.

(40/100)

5. (a) (i) Describe the first-fit method and the best-fit method.

(ii) Which of these methods is a better one?

(25/100)

(b) Describe using your own words the algorithm DisposePtr (as given in lecture) and using graphical illustrations if appropriate.

(30/100)

(c) The following algorithm finds a substring in a given string. The algorithm returns the position in *source* of the *first* occurrence of substring *target*, and returns –1 if unsuccessful.

```
int Find (const String& source, const String& target)
{
   if (source or target is empty)
      return -1;          // no match possible
   int current = 0;       // possible location in this
   while (complete match not found
                          && any characters left in source)
      if (current character in source!=first target character)
            current++;
      else{do                    // found a partial match
                  Step through source and target together
            while(chars left to compare && still have a match);
            if (no more target characters to inspect)
                  return current;  // found a full match.
            else current++; // keep looking
      }
   return -1; // no match found
}
```

Modify the algorithm so that all occurrences are located and all the positions at which the occurrences are found are put in a queue. Use ADT queue.

(25/100)

(d) Produce a Huffman code for the alphabet a, b, c, d where the letters have respective frequencies: 0.3, 0.25, 0.20, 0.25.

(20/100)

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