

UNIVERSITY OF LONDON

GOLDSMITHS COLLEGE

B. Sc. Examination 2004

COMPUTING AND INFORMATION SYSTEMS

IS52017A(CIS223) Data Communication and
Algorithms

Duration: 3 hours

Date and time: May 2004

Answer FOUR questions only.

Full marks will be awarded for complete answers to FOUR questions.

You must answer TWO questions from section A and TWO questions from section B.

There are 100 marks available on this paper

Electronic calculators may be used. The make and model should be specified on the script and the calculator must not be programmed prior to the examination.

**THIS EXAMINATION PAPER MUST NOT BE
REMOVED FROM THE EXAMINATION ROOM**

Section B

Question 4

- (a) Consider the big $O()$ behaviour of the code below in terms of N . Discuss briefly its time complexity. [4]

```
k=1;
repeat
  k = 2*k;
until k >= N;
```

- (b) A binary search tree is constructed by inserting the following values in the order given: 6 7 1 5 3 2 4. Draw the binary search tree constructed in a diagram. [3]
- (c) What is a (binary) heap? Describe the *two* properties of a heap. [3]
- (d) Consider the list of integers in the array below, where i is the index of the array. Let the target be 9.

i	1	2	3	4	5	6	7
A[i]	7	4	8	3	9	1	2

Using the above list as an example, discuss briefly the difference between the approach of *sequential search* algorithm and of *binary search* algorithm. [6]

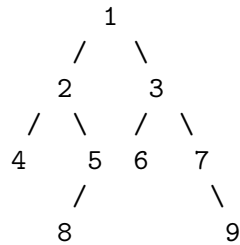
- (e) Using standard methods (or procedures) on queues and stacks, e.g. enqueue(Q,x), dequeue(Q,y), push(S,x), pop(S,y), Empty(S) and Empty(Q), write another Java method that will start with a queue and an empty stack and use the stack to reverse the order of all the items in the queue. [5]
- (f) Draw a quad-tree for the following 8×8 black-white(B-w) pixel rectangle: [4]

12345678

1	wwwwwww
2	wwwwwwwB
3	wwwwwwBB
4	wwwwwBBB
5	wwwwBBw
6	wwwBBBw
7	wwwBBBB
8	wwBBBBBB

Question 5

- (a) Consider a binary tree of numbers as shown below:



List the numbers encountered in a *preorder* traversal on the tree. [3]

- (b) Define a class `TreeNode` in Java which provides a reference-based implementation for the ADT binary tree. Each `TreeNode` should contain at least *three* data fields, namely `leftChild`, `treeItem` (Object type) and `rightChild`, and the necessary operations for initialising and accessing a tree node. [9]
- (c) Write a recursive method in Java to perform an *inorder* traversal of a binary tree printing the `treeItem` field of each node. [5]
- (d) Consider the adjacency matrix below. Draw in a diagram the graph which is represented by the matrix and derive the adjacency list for the graph. [4]

A	B	C	D	E
A	0	0	0	1
B	1	0	0	0
C	0	0	0	0
D	0	0	0	0
E	0	1	1	0

- (e) Draw a figure to illustrate step by step the comparisons done by the Boyer-Moore pattern matching algorithm for the case in which the text T and the Pattern P are: [4]

T: a b a c a a b a d c a b a c a b a a b b
 P: a b a c a b

Question 6

- (a) A (binary) heap can be implemented easily by an array. Given a heap stored in the array below, illustrate the heap structure in a diagram. [6]

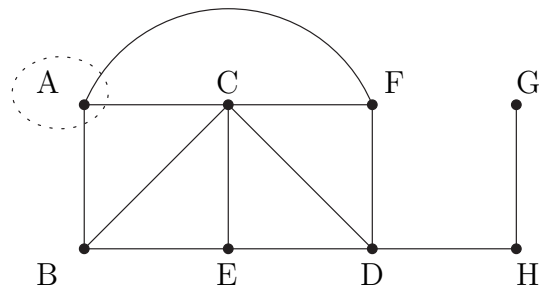
1 6 5 14 12 10 8 15

- (b) Using an array of integers (7,4,8,3,9,1,2) as an example, demonstrate the difference between *insertion sort* algorithm and *selection sort* algorithm by tracing the state of the array used on completion of each run of the algorithms. [8]

- (c) Consider a connected graph below. Starting from vertex **A**, write the vertex sequence in the order that each vertex is visited applying the [6]

(i) *depth first* traversal algorithm

(ii) *breadth first* traversal algorithm.



- (d) Write a recursive method in Java that prints out a given string backwards. The method would take two arguments: a string and the size of the string. [5]