Semester Two of Academic Year (2015---2016) of BDIC

《 Data Structures and Algorithms 2 》

Module Code: COMP2003J

Exam Paper A

Exam Instructions: Answer Any TWO Questions

Honesty Pledge:

I have read and clearly understand the Examination Rules of Beijing University of Technology and University College Dublin and am aware of the Punishment for Violating the Rules of Beijing University of Technology and University College Dublin. I hereby promise to abide by the relevant rules and regulations by not giving or receiving any help during the exam. If caught violating the rules, I would accept the punishment thereof.

Pledger: ___________ **Class No:** ___________

BJUT Student ID: ___________ **UCD Student ID**___________

Notes:

The exam paper has 3 questions on 7 pages, with a full score of 100 points. You are required to use the given Examination Book only.

Instructions for Candidates

Answer any **TWO** questions. All questions carry equal marks.

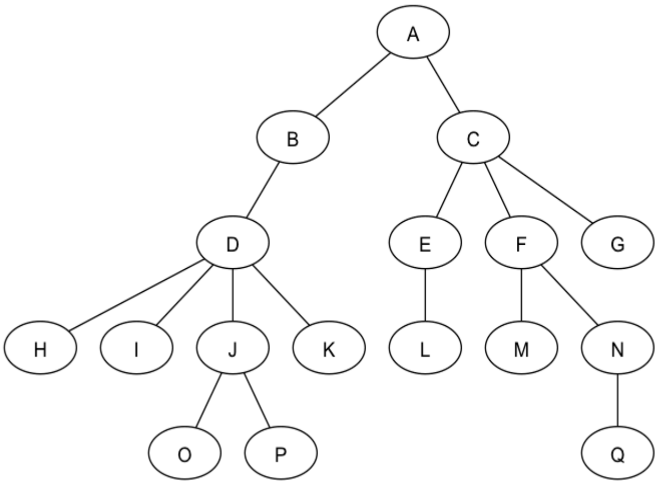
Instructions for Invigilators

No special instructions.

Obtained score

Question 1:

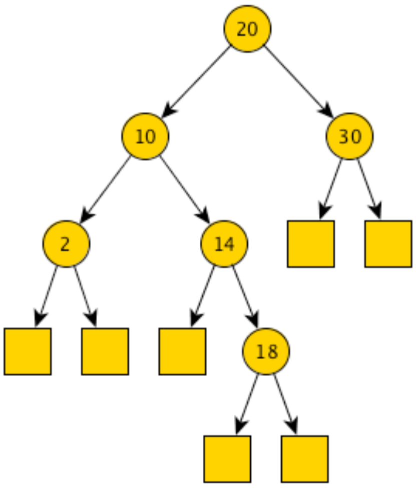
(a) Study the tree below and answer the questions that follow.



(i) List the siblings of P.
(ii) List the tree's external nodes.
(iii) What is the height of the tree?
(iv) What is the depth of M?
(v) Is this tree a binary tree? Explain your answer.
(vi) List the ancestors of J.
(vii) What is the degree of D?
(viii) Is (A,C,E,C,F) a path? Explain your answer.
(ix) Is Q a descendent of C? Explain your answer.
(x) List the children of L.

[10 marks]

(b) Study the tree below and then answer the questions that follow.



Assume that the tree above is a **Binary Search Tree**. Draw the state of the tree after performing the following operations. In your answer, you should show the tree's state after each step:

(i) Insert 3
(ii) Insert 17
(iii) Remove 18
(iv) Remove 20
(v) Insert 21

[10 marks]

(c) Assume that the tree from part (b) is a **Splay Tree**. Draw the state of the tree after performing the following operations. In your answer, you should show the tree's state after each step, and indicate any restructuring that is required.

(i) Insert 12
(ii) Find 2
(iii) Remove 18
(iv) Remove 14

[15 marks]

(d) What are the properties that define an **AVL Tree**? Is it possible for the tree in part (b) to be an AVL Tree? Explain your answer.

[6 marks]

(e) Explain how you would implement a *link-based binary tree*. In your answer, describe the internal structure of a node, identify what key data you must keep track of, and illustrate your description with a diagram of an example tree that contains three nodes.

[9 marks]
[Total 50 marks]

Obtained score

Question 2:

(a) The Boyer-Moore algorithm is a well-known pattern matching algorithm.

i) What are the two heuristics used in the design of the Boyer-Moore algorithm?

[4 marks]

ii) Describe in detail how the Boyer Moore algorithm works. To illustrate your answer, show how it would find the pattern "example" in the text "here is a simple example".

[10 marks]

iii) In the worst case, the Boyer Moore algorithm runs in O(*nm*) time (where *n* is the length of the text and *m* is the length of the pattern). Show an example of a worst case scenario, and explain why the Boyer Moore algorithm is useful in practice.

[4 marks]

(b) One implementation of a Priority Queue data structure is to use a *Heap*.

(i) Define the two key properties that distinguish a heap.

[4 marks]

(ii) Draw the heap that would be obtained after the following operations. Show the state of the heap after each operation.

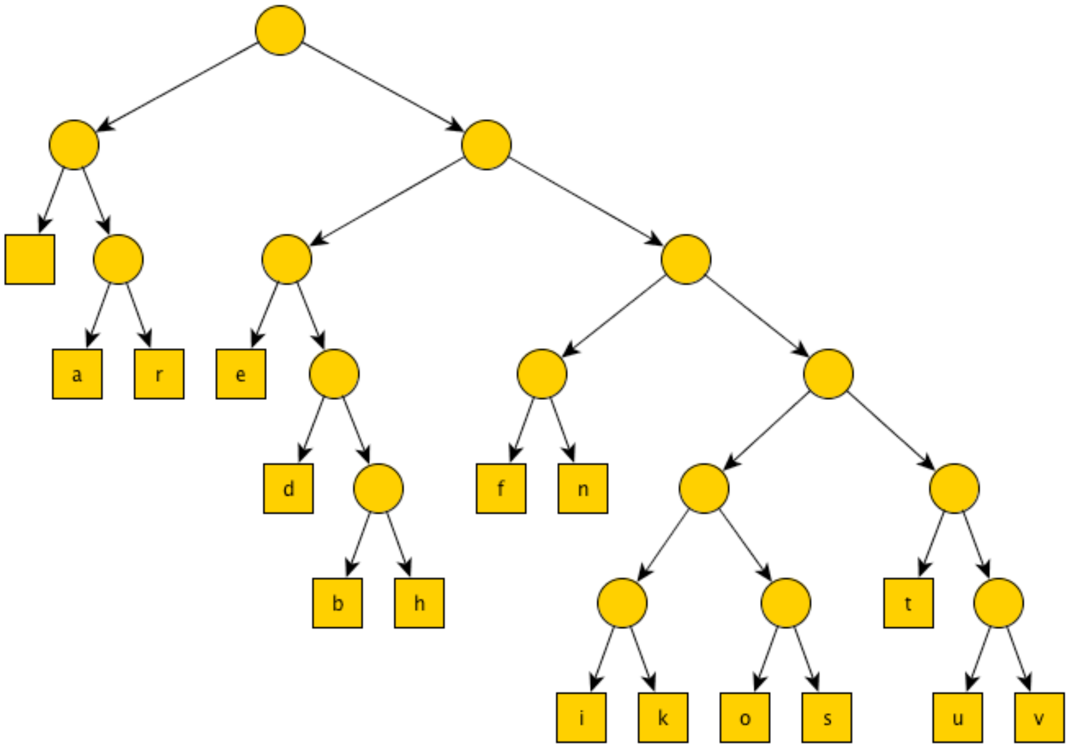
insert(20), insert(22), insert(5), insert(8), insert(2),
remove(), remove(), insert(14), remove(), insert(7)

[10 marks]

(c) What is *Huffman Encoding* used for? Explain in detail how a *Huffman Tree* is generated. Create a Huffman Tree for the string "big brown book" to illustrate your answer.

[10 marks]

(e) Study the Huffman Tree below and answer the questions that follow.



(i) Explain how a binary code can be used to find a character in the tree.

[5 marks]

(ii) What text does the following code represent?

10100100111111001110110011101111011

[3 marks]

[Total 50 marks]

Obtained score

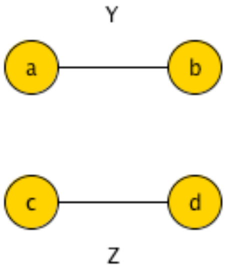
Question 3:

(a) An *edge matrix structure* is one way in which a graph can be implemented. For each of the following graph methods, state what the time complexity performance is when using an edge list structure to represent a graph with *n* vertices and *m* edges. Explain the reasons for this complexity in each case.

i) incidentEdges(v)
ii) areAdjacent(v,w)
iii) insertEdge(v, w, o)
iv) removeVertex(v)

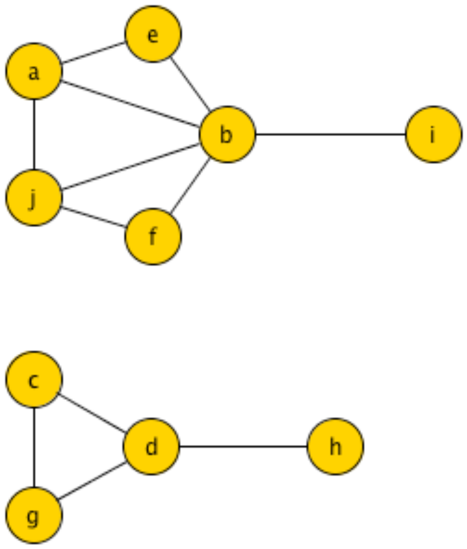
[8 marks]

(b) Draw a diagram to show how the following graph can be represented using an *adjacency matrix* structure. In your answer, describe each object type and data structure used to explain its purpose and what data it stores.



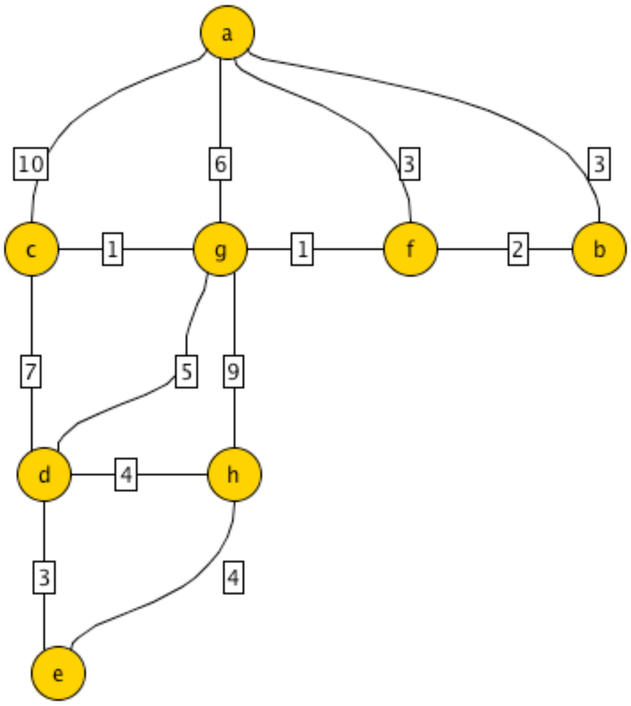
[14 marks]

(c) Explain in detail how a Depth First Search traversal is done. To illustrate your answer, show how a Depth First Search traversal would work for the following graph.



[12 marks]

(d) Explain in detail how Kruskal's algorithm can be used to generate a Minimum Spanning Tree. To illustrate your answer, show how Kruskal's algorithm can be used for the following graph.



[16 marks]
[Total 50 marks]