

Year	Year 3
Semester	Semester 1 Repeat
Date of Examination	Thursday 18th August 2011
Time of Examination	10.00am - 12.00pm

Prog Code	BN302	Prog Title	Bachelor of Science in Computing in Information Technology	Module Code	COMP H3011
Prog Code	BN013	Prog Title	Bachelor of Science in Computing in Information Technology	Module Code	COMP H3011
Prog Code	BN104	Prog Title	Bachelor of Science (Hons.) in Computing in Information Technology	Module Code	COMP H3011

Module Title	Data Structures and Algorithms (Autumn Repeat)
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Internal Examiner(s): *Dr. Simon McLoughlin*
External Examiner(s): *Mr. John Dunnion*
Dr. Richard Studdert

Instructions to candidates:

- 1) To ensure that you take the correct examination, please check that the module and programme which you are following is listed in the tables above.
- 2) This paper consists of five questions
- 3) Candidates should answer any four questions
- 4) All questions carry equal marks

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Question 1: Answer all parts, (25 marks)

- a) Explain the concept of an Abstract Data Type (ADT). Use a diagram to support your answer. (4 marks)
- b) Discuss the implications of implementing an ADT List over
- i. an array
 - ii. a reference based linked list
- (4 marks)
- c) Write a Java method that will add an item to an ADT List implemented over an array. You may assume the existence of the other class members of ListArrayBased. (5 marks)
- d) Describe, with the aid of a diagram and suitable fragments of Java code, how you would remove a specific node from a linked list. Make sure to account for any special cases. You may assume the existence of a `Node find(int index)`, method and other class members in ListReferenceBased.

Use nodes `prev` and `curr` in this task.

Explain your diagram.

(12 marks)

(Total 25 marks)

Question 2: Answer all parts, (25 marks)

- a) Briefly explain the defining characteristic or property, of a Stack. How might this property be mapped to an ADT List. (5 marks)
- b) A simple application of the Stack is checking for palindromes, i.e. words that are spelled the same going forward and in reverse e.g. racecar, navan.

Write a Java method called isPal that accepts a string argument and returns true if it is a palindrome and false if not. The method must use a stack for solving the problem.

public static boolean isPal(String str) (8 marks)

- c) Write Java code that implements the ADT Stack "pop" method implemented over:
- i. An array
 - ii. A linked list
 - iii. An ADT List

public Object pop() throws StackException

You may assume the existence of the Node class, the StackException class and the helper methods in the Stack classes e.g. isEmpty(), isFull() etc.

(12 marks)

(Total 25 marks)

Question 3: Answer all parts, (25 marks)

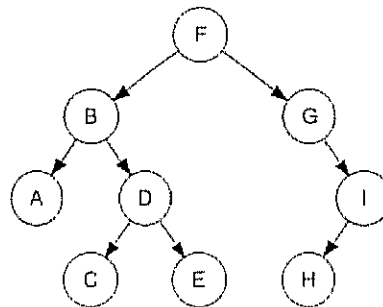
a) Explain, with the aid of diagrams, the following ADT Tree terminologies:

- i. Leaf of a Tree
- ii. Height of a Tree
- iii. Complete Tree
- iv. Descendant of a node, n

(6 marks)

b) For the following diagram of a Binary Tree, list the order of node visitation for a:

- i. preorder traversal
- ii. inorder traversal
- iii. postorder traversal



(6 marks)

c) Construct a sorted ADT Binary Tree using the following list of names:

Tony, Brian, Simon, Geraldine, Kevin, Catherine, Laura, Mary, Orla

Draw diagrams of the binary tree and the array based representation of the binary tree. Include in the latter diagram, for each `leftChild` and `rightChild`, the values held in the array. Also show the values for `root` and `free` variables.

(8 marks)

d) Describe a simpler array based representation if the binary tree were known to be complete?

(5 marks)

(Total 25 marks)

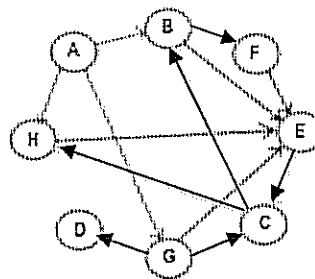
Question 4: Answer all parts, (25 marks)

a) Explain, with the aid of diagrams, the following graph terminologies:

- i. Complete Graph
- ii. Digraph
- iii. Connected Component
- iv. Adjacent Vertices

(6 marks)

b) Consider the following digraph:



List the order the vertices are visited in a:

- i. Depth First Traversal
- ii. Breath First Traversal

(2 marks)

(2 marks)

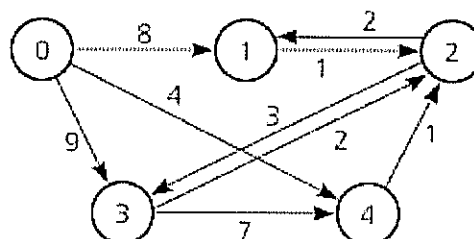
c) For the digraph in part (b) above list :

- i. Adjacency Matrix
- ii. Adjacency List

(2 marks)

(2 marks)

d) Describe Dijkstra's Shortest Path Algorithm and apply it to the digraph below to find the shortest paths from node 0, to all other nodes.



(11 marks)

(Total 25 marks)

Question 5: Answer all parts, (25 marks)

- a) Explain in brief your understanding of the phrase "Analysis of Algorithms". Make reference to an algorithm's growth rate, execution time and Big O notation in your answer.

(4 marks)

- b) Simplify the following expressions and express them in Big O notation.

- i. $3*n + n - n * \log_2 n$
- ii. $\log_2 n + 12n + 12n$
- iii. $O(n^3) + O(2^n)$
- iv. $n^3 + n^2 * n^2$

List the above complexity measures in order of growth rate.

(5 marks)

- c) What is the worst case performance of linear and binary search? For each search explain how the worst case performance is derived.

(6 marks)

- d) Put the following recurrence relation into closed form:

$$a(n) = a(n-1) + n - 1$$

subject to the initial condition

$$a(1) = 3$$

(10 marks)

Total (25 marks)