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UNIVERSITY REGULAR EXAMINATIONS

2012/ 2013 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY

COURSE CODE: BIT 111

COURSE TITLE: DISCRETE STRUCTURES 1

DATE: 14TH NOVEMBER 2013 **TIME:** 2.00pm – 5.00 pm

INSTUCTIONS

Answer **ALL** questions in section A and any THREE questions from section

QUESTION 1 (COMPULSORY) [30 MARKS]

a) Distinguish between a queue and a stack. **[2 marks]**

b) Why is sorting necessary? **[1 marks]**

c) Describe briefly **[4 marks]**
   i. any one sorting algorithm and
   ii. any one searching algorithm

d) Illustrate the operation of the sorting algorithm described in part (c) `i` above on the following list of integers **[2 marks]**

   57, 23, 11, 74, 39, 40, 65

e) The diagram below shows an array representation of a binary tree. Draw the tree. [4 marks]

D	A	T	A	S	T	R	U	C	T	U	R	E

f) Write the code segment which is used to insert a new node, referenced by the reference variable `newNode`, between the nodes referenced by the reference variables `prev` and `curr` in a linear linked list. **[3 marks]**

g) Suppose we begin with an empty stack, and perform the following operations: push 7, push 2, push 9, push 6, pop, pop, peek, push 1, push 3, peek, push 8, pop, peek, pop, pop, push 5, push 4, pop, pop, pop, push 8. What is contained on the stack when we are done? Write out the contents from top to bottom. **[2 marks]**

h) The two most fundamental data structures are arrays and linked lists. Briefly describe the two data structures **[2 marks]**

i) Given two scenarios: the first in which a problem solution involves a dynamic list (i.e. list in which there are a lot of deletions and insertions) and the second in which a problem involves many accesses to the interior values of a list. State with reasons which data structure will be suitable for each of the two scenarios? **[3 marks]**

j) Name and describe the two types of algorithm efficiency. **[2 marks]**

k) Outline any two applications of the stack data structure **[2 marks]**

l) Give a definition of the following as they relate to algorithms: **[4 marks]**
   i) Big oh (O)
   ii) Big omega (Ω)
   iii) Big theta (Θ)
   iv) Worst-case algorithmic analysis

QUESTION 2 **(20 marks)**

a) What is the function of the variable head when used with a linked list? What is the data type of the head variable? **[2 marks]**

b) Draw a diagram of a linked list that contains nodes with data items of type String that contains the name of a city and type double that contains a pollution index. Include an instance variable named head to indicate the beginning of the list. Insert the following nodes: Franklin, 15.7, Chicago, 23.2, Denver, 7.2. **[3 marks]**

c) Create a generic Node class to represent the linked list depicted in your diagrams above. **[10 marks]**

d) Write a method called displayList that displays the data items in the Node class created in number (c) above. **[5 marks]**

QUESTION 3 **(20 marks)**

a) Distinguish between a binary search tree and a binary tree. **[2 Marks]**

b) Draw the resulting binary search tree inserting the following values in the given order: 7, 10, 5, 12, 1, 3, 9. **[2 marks]**

c) What problem does binary search tree suffer from? **[2 marks]**

d) Describe any two methods for storing binary trees in the computer **[4 marks]**

e) Determine the expression tree for the following expression: **[4 marks]**

(2 * x) / (5 + 3 * y) - (4 * z - 1)

f) Construct a Huffman code for the following data: **[6 marks]**

Character	A	B	C	D	E
Probability	0.1	0.1	0.2	0.2	0.4

g) Encode the text ABACABAD using the code of question b) above. **[2 marks]**

h) Decode the text whose encoding is 100010111001010 in the code of question b). **[2 marks]**

Question 4

a) Describe why a very large hash table will likely increase the performance (i.e. faster additions and lookup) at the expense of wasting memory, and vice versa, why a small hash table will use less memory but result in a decrease in performance. **[4 marks]**

b) What is our goal for a hashing function? [2 marks]

c) Define the following as relates to hash tables:
   i. Collision [1mark]
   ii. Perfect hashing function [1 mark]
   iii. Load factor [2 marks]

d) Briefly describe one algorithm that is used for resolving collisions in a hash table. [4 marks]

e) Draw a hash table with open addressing and a size of 9. Use the hash function "k%9". Insert the keys: 5, 29, 20, 0, 27 and 18 into your table (in that order). [6 marks]

Question 5

a) Briefly describe any three algorithmic design techniques giving an example of a problem that applies the technique. **[8 marks]**

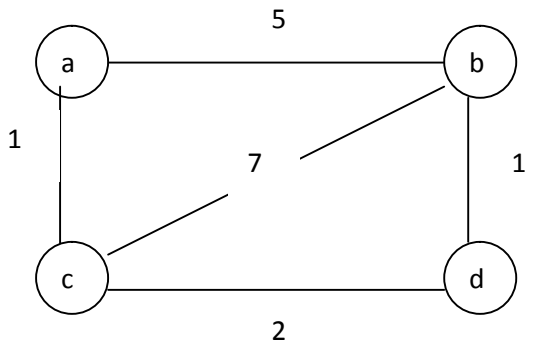
b) Draw the directed graph that is represented by the following:
Vertices: 1, 2, 3, 4, 5, 6, 7
Edges: (1, 2), (1, 4), (2, 3), (2, 4), (3, 7), (4, 7), (4, 6), (5, 6), (5, 7), (6, 7)

i. Is the resulting graph connected? **[1 marks]**
ii. Is the resulting graph complete? **[1 marks]**

c) Describe two principal methods for representing graphs for computer algorithms **[4 marks]**

d) If a graph is sparse which representation will you use and why? [2 marks]

e) Consider the weighted graph given below:



Represent the weighted graph using the two representation methods described in part (d) above. **[4 marks]**