



# MASENO UNIVERSITY

## UNIVERSITY EXAMINATIONS 2017/2018

### SECOND YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY

#### CITY CAMPUS

#### CIT 203: DATA STRUCTURES AND ALGORITHMS

Date: 28<sup>th</sup> February, 2018

Time: 2.00 - 5.00pm

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#### INSTRUCTIONS:

- Answer ALL Questions in Section A and any other TWO in Section B.
- Use a new page for every question attempted and indicate the question number on the space provided on each answer booklet
- Fasten together all loose answer sheets used
- Mobile phones and PDAs are NOT allowed in the exam room



**INSTRUCTIONS: Answer question ONE and any other TWO questions**

**QUESTION ONE (30 Marks)**

(a) Explain briefly the following terms:

- (i) Data abstraction
- (ii) Dummy head node
- (iii) Selection sort
- (iv) Recursion (8 Marks)

(b) Outline the major data structures used in the following areas: RDMS, Network data models and Hierarchical data model. (3 Marks)

(c) Explain any four reasons why analysis of algorithm is necessary. (4 Marks)

(d) (i) Explain the main advantage of implementing a stack using dynamic memory allocation (linked list) as opposed to static memory allocation (array). (2 Marks)

(ii) Suppose that we perform the operation shown below on a stack. Assume that the stack is initially empty. In what order will the element be popped, push A, push B, Push C, Pop, Pop, Push D, Pop, and Pop. (2 Marks)

(e) (i) Distinguish between a binary tree and a binary search tree. (4 Marks)

(ii) Beginning with an empty binary search tree what BST is formed when insert the following values in the order given: 50,40,45,47,46,41,35. (4 Marks)

(f) Suppose that you sort a large array of integers by using merge sort. Next you use a binary search to array. Finally, you display all the integers in the sorted array.

(i) Which algorithm is faster in general: the merge sort or the binary search? Explain in terms of the Big O notation. (3 Marks)

(ii) Which algorithm is faster in general: the binary search or displaying the integers? Explain in terms of the Big O notation. (2 Marks)

**QUESTION TWO (20Marks)**

(a) State any four areas where data structures are used extensively. (4 Marks)

(b) Distinguish between the following types of lists:

- (i) Sorted list and linked list
- (ii) Circular list and doubly-linked list (4 Marks)

(c) (i) Define the concept of 'column-major' ordering the multidimensional arrays (2 Marks)

- (ii) What is the address of A [0,0] in an array stored linearly in column-major ordering beginning in address alpha if it is declared as A [-1..5,-2..2] (2 Marks)
- (d) (i) Explain two advantages of a linked list as compared to an array
- (ii) Discuss two disadvantages of a linked list as compared to an array. (4 Marks)

### QUESTION THREE (20Marks)

- (a) Draw the expression tree  $((A + B) * C - (D - E)^(F + G))$  and then use the tree to obtain the prefix and postfix in the expression (6 Marks)
- (b) Use a stack to evaluate the following postfix expression: ABC\*-DEF/-G\*+. Show the status of stack after each step of the algorithm. Assume the following values for the identifies: A=9,B=3,C=2,D=8,E=6,F=2,G=3. (4 Marks)
- (c) (i) Consider the vowels from a tree with 'O' as the root and its children are 'U','I','A', left to right and "E" is the only child of "I". Reconstruct this tree as a binary tree. (4 Marks)
- (ii) Show how the vowel binary tree of (i) above would appear in single array and three-array form. (Note in three-array form, the vowels are to be sorted in alphabetical order) (6 Marks)

### QUESTION FOUR (20Marks)

- a) (i) What is a priority queue? Is a priority queue a kind of queue? (3 Marks)
- (ii) How can stacks and ordinary queue be simulated using a priority queue? (2 Marks)
- b) Robot walking function can be defined by the following recurrence relation
- i) Write down the C++ function that implements the definition indicating the preconditions and post conditions. (4 Marks)
- ii) Compute the first 6 sequences of the function. (2 Marks)
- c) (i) Discuss the motivation behind the use of recursion (2 Marks)
- (ii) Explain how the divide and conquer technique works. (2 Marks)
- d) (i) Explain how the merge algorithm works? What properties must the input have? (4 Marks)
- (ii) What is the worst-case time of merge algorithm? [1 Mark]

### QUESTION FIVE (20Marks)

- a) (i) Explain how bubble sort works? .
- (ii) Trace bubble sort as it sorts the following array in ascending order:
- 25    30    20    80    40    60
- (4 Marks)
- b) Convert the following infix expression to equivalent postfix form: Show the status of the stack after each of the algorithms.

(i)  $(A-B*C)/D-(E+F)$  (3 Marks)

(ii)  $A/(B*C/D)+E$  (3 Marks)

- c) Estimate how many times faster an average successful search will be in a sorted array of one million elements if it is done by binary search versus sequential search (4 Marks)

- d) What is the order of magnitude for the following expression

(i)  $2n \log_2 n + n^2$ ,    (ii)  $\frac{(n+1)(n \log_2 n)}{n^2 + n}$  (4 Marks)