RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
Second Year Semester I Examination-September/October 2014

COM 1303 DATA STRUCTURES & ALGORITHMS

Timer Allowed: 3 hours

INSTRUCTIONS TO CANDIDATES

- This paper contains <u>five (05)</u> questions on <u>five (05)</u> pages including this page.

- Answer **all** questions.

- This examination accounts for 60% of the course assessment. The total maximum mark attainable is 100. The marks assigned for each question and section, thereof are indicated in square brackets.

- This is a **closed book** examination.

- Mobile phones or any other communication devices are not permitted.

- Clearly state the assumptions you make. If you have any doubts regarding the interpretation of the wording of a question, make your own decision, but clearly state it on the script.

1 (a) Briefly describe what is a **data structure**?

[2 mark]

   (b) Name and briefly describe <u>three (03)</u> types of **data structure operations**.

[4.5 marks]

   (c) Take ATM machine scenario below.

A user can put is ATM card to the ATM machine. If the ATM recognizes the card (as a card belonging to the same bank as the ATM), it will prompt for a 4 digit PIN number. User has three chances to enter the correct PIN number before the card is ejected. If the correct PIN number is entered user has two options to either check the balance or make cash withdrawal.

In cash withdrawal user can type amount he/she needs to withdraw. If the user makes an error he is given the chance again enter the amount.

User can exit the ATM or again do another action (cash withdrawal/balance check) after a cash withdrawal or a balance check. If the user needs another action he/she has to enter the PIN number again. If the user chooses to exit the ATM then the card is ejected from the machine.

Write an algorithm for the above ATM scenario. You do not have to explain the communication between the bank and the ATM in your algorithm.

[8 marks]

   (d) Why do you use plain, simple English to write an algorithm (instead of a particular programming language)?

[1.5 marks]

   (e) Briefly describe what linear and non-linear data structures are, and write two examples for each.

[2 marks]

   (f) Briefly describe the two basic ways of representing linear data structures in the computer memory.

[2 marks]

2 (a) Write a C program to insert an element to any position in an Array. Assume the array is **circular array** and if the array is full, display an appropriate message.

[6 marks]

   (b) What are the **lower bound** and the **upper bound** in an array?

[1 mark]

(c) Briefly describe the data structure **stack** and the two operations which are associated with stacks.

[3 marks]

(d) Converting a decimal number to binary is done by repeatedly dividing the number by 2 and taking the remainder until the number is zero. Algorithm is given below.

1. Read the Number.
2. Repeat while Number > 0 (zero)
3. [Print the remainder after dividing Number by 2] Print Number % 2.
4. Make Number = Number / 2.
5. Repeat from step 2.

However if you write a program according to the above algorithm what you would get is the inverse of answer (answer printed from reverse order). This is because actual computer prints from left to right.

Correct this problem using a stack and re-write the algorithm.

[10 marks]

3 (a) In an array representation of the queue how would you indicate that the queue is empty?

[1 marks]

(b) Briefly describe what are **front** and **rear** in a queue?

[2 marks]

(c) Write a C function to check whether a queue is **empty**.
   - If empty return 1 and if full return 0.
   - **int maxSize** is the size of the array used to create queue.
   - You can use variables such as front/rear.

[3 marks]

(d) Briefly describe what a **circular queue** is.

[2 marks]

(e) Describe the advantage of a **linked list** over a **queue**.

[2 marks]

(f) What is the name used to identify the pointer of **last node** in a linked list?

[1 marks]

(g) Assume that you are creating a list of students according to their marks. You have a list of students with total marks for each student. There are 100 students in the list. Part of the list can be seen in the Table given bellow.

Name	Total mark (out of 1000)
KSD Kumara	575
RNNS Perera	782
RKW Liyanage	458
SSKD Silva	790
LMNP Ruwan	547

Now you need to create an ordered linked list on your computer. Write an algorithm to create a linked list to store these details. Student's name and his mark should be stored in each node. The linked list should be a sorted linked list according to the marks in descending (from highest to lowest) order.

When a student's name and marks entered, that node should be inserted in the appropriate place in the linked list.

Name all the variables and arrays that you may use.

[9 marks]

4 (a) Describe a reason for each why space complexity and time complexity are important.

[3 marks]

(b) Write down the Big O values for following functions?
   (i) $T(n) = 5 n^3 + 2n^2 + 7$
   (ii) $T(n) = n^n + n^2 + 5n$

[2 marks]

(c) Briefly describe what a **hash collision** is.

[1 marks]

(d) Briefly describe a problem that may arise due to using an **Overflow Area** to solve hash collisions.

[2 marks]

(e) Write the algorithm to describe how you would use **Quadratic Probing** to solve a hash collision. The Hash Table you are using has been created using an Array named **Hsh_Table**.

[8 marks]

(f) Following diagram shows an array which shows the **sequential representation of a binary tree.** Draw the **binary tree** which is represented by array bellow.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
23	11	45	8	15	32	49		10				30		52

[3 marks]

(g) Is the tree in above 4 (f) a **binary search tree**? Briefly explain your answer.

[1 mark]

5 (a) Write down the algorithm for bubble sort.

[5 marks]

(b) Write the C function for bubble sort using **recursion**. Clearly identify the variables used.

[5 marks]

(c) Show step by step status of the following array when applied with selection sort.

0	1	2	3	4	5
23	11	45	8	15	32

[2 marks]

(d) Show step by step status of the following array when applied with merge sort.

0	1	2	3	4	5	6	7
23	11	45	8	15	32	49	4

[2 marks]

(e) Write the C function to search through an array using **recursion**.

[3 marks]

(f) Can you use binary search to the array in **5 (d)**. Briefly explain why?

[1 marks]

(g) Compare and contrast binary search with linear search.

[2 marks]