JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF INFORMATICS AND INNOVATIVE SYSTEMS

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR

3RD YEAR 1ST SEMESTER 2016/2017 ACADEMIC YEAR

MAIN CAMPUS (RESIT)

COURSE CODE: SCS 301

COURSE TITLE: DATA STRUCTURES AND ALGORITHMS

EXAM VENUE: **STREAM: BSc Acturial Science**

DATE: APRIL 2016   **EXAM SESSION:**

TIME: 2.00 HOURS

INSTRUCTIONS:

1. **Answer Question 1 (Compulsory) and ANY other two questions**
2. **Candidates are advised not to write on the question paper**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room**

QUESTION 1 [30 MARKS]

a) Give the running time of the following:

   i) $T(n) = 20n^3 + 10n \log n + 5$ (1 mark)

   ii) $T(n) = 2^{100}$ (1 mark)

b) Define the following as used in asymptotic notation

   i) Big-Oh (2 marks)

   ii) Big-Omega (2 marks)

   iii) Big-Omega (2 marks)

c) Consider the following recurrence equation, defining a function $T(n)$

$$T(n) = \begin{cases} 1 & \text{if } n < 2 \\ T(n-1) + 2^n & \text{otherwise,} \end{cases}$$

   Show by iterative substitution that $T(n) = 2^{n+1} - 1$. (6 marks)

d) Design an algorithm for computing the product of two positive integers m and n using only addition. (5 marks)

e) Name the three main programming paradigms or techniques. (3 marks)

f) Consider the following recurrence equations and characterize the running time using Master method.

   i) $T(n) = 4T\left(\frac{n}{2}\right) + n$ (4 marks)

   ii) $T(n) = 9T\left(\frac{n}{3}\right) + n^{2.5}$ (4 marks)

QUESTION 2 [20 MARKS]

a) What is meant by the term Abstract Data Type (ADT)? (2 marks)

b) Explain the following abstract data types.

   i) Priority queues (2 mark)

   ii) Queues (2 mark)

   iii) Hash tables (2 mark)

   iv) Trees (2 marks)

   v) Binary search tree (2 mark)

c) Write a simple algorithm to compute the maximum element in an array A containing n integers. (4 marks)

d) Explain what is desired when obtaining a minimum spanning tree from a graph. (4 marks)

QUESTION 3 [20 MARKS]

a) Describe briefly the following:

    i) Breadth First Search (3 marks)

    ii) Depth First Search (3 marks)

b) Give any three collision-handling schemes that may be used in a hash table. (3 marks)

c) The stack abstract data type (ADT) supports two methods namely, push(o), which inserts object o at the top of the stack, and pop() which removes from the stack and returns the top object on the stack.

    i) Write the algorithm to implement push(o). (3 marks)

    ii) Write the algorithm to implement pop() (3 marks)

d) What is the Task Scheduling problem? Clearly explain which programming paradigm is suitable to solve this problem. (5 marks)

QUESTION 4 [20 MARKS]

a) Name the two methods that are used in the amortization technique. (2 marks)

b) Explain what is meant by the term *"minimum spanning tree"* (2 marks)

c) Describe the four properties that a red-black tree must satisfy. (8 marks)

d) Consider the following recurrence equations and give the running time using the Master method.

    i) $T(n) = 8T(n/2) + n^2$ (4 marks)

    ii) $T(n) = 16T(n/2) + (nlogn)^4$ (4 marks)

QUESTION 5 [20 MARKS]

a) One commonly used sorting technique is the Merge Sort.

    i) Which programming paradigm is suited for this sorting technique? (2 mark)

    ii) Explain the steps undertaken in carrying out the technique in (i) above. (6 marks)

b) Explain the following terms clearly

    i) Graph. (2 marks)

    ii) Undirected graph. (2 marks)

    iii) Directed graph. (2 marks)

c) Write a simple algorithm to calculate the sum of 10 integers provided in a set S. Give the running time of your algorithm. What would be the best data structure to use for this algorithm? (6 marks)