MACHAKOS UNIVERSITY

University Examinations for 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTING AND INFORMATION TECHNOLOGY

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (COMPUTER SCIENCE)

SCO 308: DESIGN AND ANALYSIS OF ALGORITHMS

DATE: **TIME:**

INSTRUCTIONS

Answer Question ONE and any other TWO Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Define the following terms (4 marks)

i. Algorithm
ii. Instance of a problem
iii. Data structure
iv. Time complexity

b) What is the purpose of the following stack functions (4 marks)

i) Top ii) Pop

c) Give any three advantages of the array data structure over a linked list data structure (3 marks)

d) Describe three components of an algorithm that uses the divide and conquer approach to solve a programming problem (6 marks)

e) Give any 3 reasons why algorithms can be considered as a technology (3 marks)

f) Differentiate between bottom-up approach and top-down approach in dynamic programming (4 marks)

g) Below is a pseudo-code for bubble sort:

Bubble-Sort(A)

1. for i = 1 to length[A]
2. do for j = length[A] downto i + 1
3. do if A[j] < A[j-1]
4. then exchange A[j] with A[j-1]

(i) In terms of inputs and outputs, state the general computational problem that bubble sort solves (3 marks)

(ii) Prove that the bubble sort algorithm is correct in relation to the input (6,5,2,7,1) (3 marks)

QUESTION TWO (20 MARKS)

a) Define the following terms (3 marks)

i. Search tree
ii. Priority Queue
iii. Tree traversal

b) Give one factor that you would consider before choosing Greedy approach as opposed to Dynamic Programming approach to algorithm design. (2 marks)

c) Below is a pseudo code of a sorting algorithm:

SOME-SORT(A)

1. for j=2 to length[A]
2. do key = A[j]
3. i=j-1
4. while i>0 and A[i]>Key
5. do A[i+1]=A[i]
6. i=i-1
7. A[i+1]=key

(i) Give the actual name of the algorithm above (1 mark)

(ii) The above algorithm has a worst-case running time of n(n-1)/2. Express this value in terms asymptotic notation (3 marks)

(iii) Other than Worst-Case analysis, explain two other analyses that may be of interest to designers of algorithms and say why they are not commonly used. (4 marks)

d) The following function represents an example of a Divide and Conquer Algorithm.

$$T(n)=8T(n/2) + \Theta(n^2)$$

In relation to the above function, explain 'Divide and Conquer' paradigm for algorithm design

(3 marks)

e) In Mathematics and Computer science, dynamic programming is a method of solving complex problems by breaking them down into simpler sub problems in a recursive manner. Explain two properties exhibited by those problems. (4 marks)

QUESTION THREE (20 MARKS)

a) i) Outline any Four reasons why we need to study Data structures (4 marks)

ii) List 2 data structures that may be used for sorting and two that may be used for searching (4 marks)

b) Give a formal definition of the following asymptotic notations

(i) Big theta (**Θ**) notation (2 marks)

(ii) Big omega (Ω) notation (2 marks)

c) In algorithm analysis, we are usually more interested in getting the worst case running time. What are the reasons for this? (4 marks)

d) i) Both Dynamic Programming and Greedy approaches to algorithms are applied to optimization problems. What are optimization problems? (2 marks)

ii) Explain the term Memoization as used with dynamic programming (2 marks)

QUESTION FOUR (20 MARKS)

a) Explain recurrence and state three methods of solving recurrences (5 marks)

b) Explain any five components of greedy algorithms (5 marks)

c) Explain sequence of steps necessary when designing greedy algorithms (4 marks)

d) i) Give two properties that a liner list must adhere to (2 marks)

ii) Explain the following two list operations (4 marks)

i. Concatenate
ii. Append

QUESTION FIVE (20 MARKS)

a) With the help of the Merge Sort algorithm, show step by step process of sorting the array A= (36,25,40,2,7,80,15) [6 marks]
b) Describe binary search technique as one way of implementing divide and conquer algorithm (4 marks)
c) Explain three elements that characterize a dynamic programming algorithm (3 marks)
d) Compare and Contrast 'Divide & Conquer' Method and Dynamic Programming as methods of designing algorithms. (7marks)