



# 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:

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## INSTRUCTIONS

Answer Question ONE and any other TWO Questions

### QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Define the following terms (4 marks)
- Algorithm
  - Instance of a problem
  - Data structure
  - Time complexity
- b) What is the purpose of the following stack functions (4 marks)
- Top
  - 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  $\text{length}[A]$
  2.     do for  $j = \text{length}[A]$  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  $\text{length}[A]$
  2.     do  $\text{key} = A[j]$
  3.          $i=j-1$
  4.         while  $i>0$  and  $A[i]>\text{key}$
  5.             do  $A[i+1]=A[i]$
  6.              $i=i-1$
  7.      $A[i+1]=\text{key}$
- (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 ( $\Theta$ ) notation (2 marks)
- (ii) Big omega ( $\Omega$ ) 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)