



MACHAKOS UNIVERSITY

University Examinations for 2020/2021

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: 10/8/2021

TIME: 8:30 – 10:30 AM

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 (3 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 (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 what is 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 $A = (36, 25, 40, 2, 7, 80, 15)$ (3 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. (7 marks)