MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTING AND INFORMATION TECHNOLOGY

THIRD YEAR SPECIAL/SUPPLIMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (COMPUTER SCIENCE)

SCO 308: DESIGN AND ANALYSIS OF ALGORITHMS

DATE: 25/3/2021 **TIME: 2.00-4.00 PM**

INSTRUCTION: Answer Question ONE and any other TWO Question

QUESTION ONE (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) Write a pseudo-code for the Pop() and Push() operations of a stack abstract data type (4 marks)

QUESTION THREE (20 MARKS)

a) List the sequence of steps used to design greedy algorithms (3 marks)

b) What is the main disadvantage of greedy algorithms (1 mark)

c) A file contains the following characters with the frequencies given

A=20, C=57, G= 35, T= 44, S=40, B=70.

i. Develop a binary tree representation of the Hoffman code for the characters in the file. (4 marks)

ii. What is the cost of the tree? (3 marks)

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

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

f) Tremendous improvements in computing technology have resulted in large computer memory and fast processors/networks. Despite all these, efficiency of algorithms still determine how long it will take to solve problems. Use an example to support this argument. (3 marks)

QUESTION FOUR (20 MARKS)

a) Define loop invariants. Explain three things you must show about loop invariants (5 marks)

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

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

e) Explain sequence of steps necessary when designing greedy algorithms (5 marks)

QUESTION FIVE (20 MARKS)

a) Given the following list of numbers

7, 10, 5, 6, 12, 8, 3, 2, 15

i. Construct a binary tree assuming that the numbers are added to the tree in the order which they appear in the list (4 marks)

ii. Describe how you would remove the node with the value 7 from the tree. Draw the tree resulting from the deletion (6 marks)

b) The following is a partial implementation of the bubble sort algorithm in a program.

```
#include<stdio.h>
#define SIZE 10
void bubbleSort(int list(), int size)
{
}
void main()
{
}
```

Implement the program to provide the following features:

i. Complete the definition of the bubble sort function (6 marks)

ii. In the main function, print the array before it is sorted (2 marks)

iii. Sort the array using the bubble sort function and print the sorted array (2 marks)