

Bingham University Karu
Faculty of Science and Technology
Department of Computer Science

Second Semester Examination 2020/2021 Academic Session

Course Code: CMP418

Time: $2\frac{1}{2}$ hours

Credit Unit: 3 Units

Course Title: Algorithm and Complexity Analysis

Instruction: Answer any four questions

Question One: Asymptotic Notational Problem

- a) Use empirical analysis to analyze each function given below and rearrange the functions in increasing order of growth (after computing for $n=1000$). Use $n = 10, 50, 100, 200, 300, 400, 500, 1000$ (5 Marks)

$$f_1 = n^2, \quad f_2 = n, \quad f_3 = n^2 \log_2 n, \quad f_5 = \log_2 n^2$$

- b) With the aid of a diagram *define* and *differentiate* between the following three asymptotic notations
- i. Big O notation (2 Marks)
 - ii. Big Omega (Ω) notation (2 Marks)
 - iii. Theta (Θ) notation (2 Marks)

Question Two: Analysis of Algorithm

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Algorithm BHU
    for i ← 0 to n - 2 do
        for j ← i + 1 to n - 1 do
            if A[i] = A[j] return false
        return true
```

- a) Write the general plan for the analysis of non-recursive algorithms (5 Marks)
- b) What is algorithm BHU above computing? (1 Mark)
- c) Is the algorithm BHU Stable? (1 Mark)
- d) Is algorithm BHU in place? (1 Mark)
- e) Use the five steps in Q2a to analyze algorithm BHU. (7 Marks)

Question Three: Brute Force - Exhaustive Search

You are paid to lead a software development project, which comprises four (4) subsystems; a company can implement only one subsystem at a time. That is, each company can handle exactly one subsystem and each subsystem should be handled by only one company at a time. The cost that would accrue if the i th company is awarded to develop the j th subsystem is given as Total Cost $C[i, j]$ for each pair $i, j = 1, 2, 3, 4$. As shown in the table below,

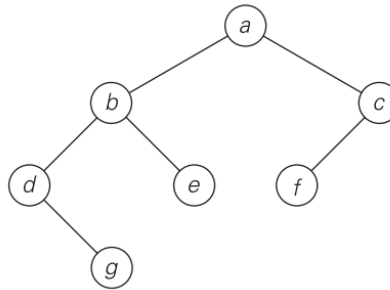
- a. Find the assignment with the most minimum total cost. (6 Marks)
- b. Find the assignment with the most maximum total cost. (6 Marks)
- c. How much would you have lost after all possible assignments? (3 Marks)

Company	Subsystems 1	Subsystems 2	Subsystems 3	Subsystems 4
Company 1	9	2	7	8
Company 2	6	4	3	7
Company 3	5	8	1	8
Company 4	7	6	9	4

Question Four: Decrease and Conquer

a) what is the *preorder*, *inorder*, and *postorder* representation of the following tree?

(6 Marks)



b) There are three major methods of implementing decrease and conquer. List and explain each. (3 Marks)

c) How many iterations do you need to search for $k=70$, $k = 85$, & $k = 31$ when you apply a binary search algorithm? (6 Marks)

0	1	2	3	4	5	6	7	8	9	10	11	12
3	14	27	31	39	42	55	70	74	81	85	93	98

Question Five: Divide and Conquer

a) Given the general condition of divide-and-conquer recurrence relationship as $T(n) = T(n/b) + f(n)$ such that $a \geq 1$ and $b > 1$. **State the master theorem** (5 Marks)

b) Use the *Masters' Theorem* to derive the complexity class of the following functions

i. $T(n) = 8 T(\frac{n}{2}) + 1$ (2½ Marks)

ii. $T(n) = 2 T(\frac{n}{6}) + n^3$ (2½ Marks)

c) Sort the array below using merge sort algorithm. Make sure you show each steps of divide and conquer

(5 Marks)

0	1	2	3	4	5	6	7
9	4	3	10	8	2	6	4

Question Six: Transform and Conquer

a) There are three major variations of Transform and Conquer techniques for problem-solving, explain each of the three with examples. (5 Marks)

b) Four properties qualify a tree as a Heap (Max or Min), least and explain each of the properties (5 Marks)

c) Transform the array below into a maxheap. Make sure you show each step of the transformation process

(5 Marks)

0	1	2	3	4	5	6
	2	9	7	6	5	8