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Dr B R Ambedkar National Institute of Technology, Jalandhar

B Tech 4th Semester (Computer Science and Engineering)

CSPC-206, Design and Analysis of Algorithms

End-Semester Examination, May-2024

Duration: 03 Hours Max. Marks: 50 Date: 20th May 2024

Marks Distribution & Mapping of Questions with Course Outcomes (COs)											
Question Number	1	2	3	4	5	6	7	8	9		
Max. Marks	6	6	6	5	5	5	5	6	6		
CO No.	2	1	3	3	4	1	3	3	4		
*Cognitive Level	**Ap**	**An**	**C**	**An**	**An**	**Ap**	**E**	**C**	**E**		
**Section/Chapter/Unit											

Note:

1. Attempt all the questions.
2. **Answers without explanations and necessary steps will not be accepted even if the final answer is correct.**

1. **(3+3)**

a. Give the final sequence of following list of numbers which are sorted using modified merge sort and modified condition is: p+2<=r

6, 10, 20, 15, 12, 30, 40, 16

b. Derive the Huffman tree along with the corresponding code assignments for the provided dataset. Also calculate the average code length and percentage reduction in size of code w.r.t fixed length code.

Characters	**Frequencies**
a	**10**
e	**15**
i	**12**
o	**3**
u	**4**
s	**13**

t	1

2. Calculate the time and space complexity of following functions:

```
void recursiveFun4(int n, int m, int o)
{
if (n <= 0)
{
printf("%d, %d\n",m, o);
}
else
{
recursiveFun4(n-1, m+1, o);
recursiveFun4(n-1, m, o+1);
}
}
```

```
int recursiveFun5(int n)
{
for (i = 0; i < n; i += 2) {
// do something
}

if (n <= 0)
return 1;
else
return 1 + recursiveFun5(n-5);
}
```

(3 +3)

3. Consider the below problem statement. There are 100 different types of caps each having a unique id from 1 to 100. Also, there are 'n' persons each having a collection of a variable number of caps. One day all of these persons decide to go to a party wearing a cap but to look unique they decide that none of them will wear the same type of cap. So, write an algorithm to count and print the number of arrangements or ways such that none of them is wearing the same type of cap. Constraints: 1 <= n <= 10 Example:
The first line contains the value of n, next n lines contain collections of all the n persons.

Input:

3
5 100 1 // Collection of the first person.
2 // Collection of the second person.
5 100 // Collection of the third person.

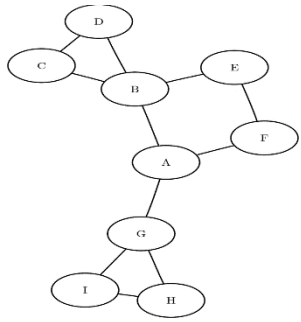
Output:

4

Explanation: All valid possible ways are (5, 2, 100), (100, 2, 5),

(1, 2, 5) and (1, 2, 100) **(6)**

4. Consider the graph given below. Find whether the graph is biconnected graph or not. Represent the steps in terms of table showing low and visited value of each vertex. Also identify whether the graph consists of any biconnected component? If so then print all possible components.



(5)

5. True or false?
    a. The Divide-and-Conquer technique can potentially reduce the running time to below O(n^2).
    b. Dynamic programming can enhance algorithm efficiency compared to brute force methods by leveraging additional memory resources.
    c. When employing dynamic programming to tackle a problem, each subproblem must be decomposed into two or more subproblems.
    d. If an algorithm demonstrates a best-case complexity of O(m) and a worst-case complexity of O(n) the overall complexity of the algorithm is not necessarily O(m). It depends on various factors including how m and n relate to each other.
    e. If n=1, an imaginary solution for the N queen problem exists. **(5)**
6. Given a set of n cities represented by their coordinates in a 2D plane, find the shortest possible route that visits each city exactly

once and returns to the original city. Additionally, calculate the total distance of this route and the maximum distance between any two consecutive cities in this route. **(5)**

7. Consider a chessboard 8*8. Find minimum number of queens that could be placed on the chessboard such that every square is under attack. Write an algorithm and also determine their position. **(5)**

8. Let's first define a job assignment problem. In a standard version of a job assignment problem, there can be N jobs and N workers. To keep it simple, we're taking 3 jobs and 3 workers in our example:

	Job 1	Job 2	Job 3
A	9	3	4
B	7	8	4
C	10	5	2

We can assign any of the available jobs to any worker with the condition that if a job is assigned to a worker, the other workers can't take that particular job. We should also notice that each job has some cost associated with it, and it differs from one worker to another. Here the main aim is to complete all the jobs by assigning one job to each worker in such a way that the sum of the cost of all the jobs should be minimized. Solve above given problem along with algorithm using branch and bound. State your assumptions (if any) and draw the state-space diagram. **(6)**

9. What is the longest increasing subsequence of the list 5, 3, 4, 8, 7, 10? Design a dynamic programming algorithm for longest increasing subsequence. Consider the decision version of the max flow problem: given a capacitated graph and a value k, determine if there is a flow of size k. Is this problem in NP? Justify your answer. **(6)**

*******End of Question Paper*******