BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE

BSc HONOURS DEGREE IN COMPUTER SCIENCE

SWE217/CS401/CSH219: DESIGN AND ANALYSIS OF ALGORITHMS

DURATION: 2HOURS...30 MINUTES. TOTAL MARKS: ...100...

INSTRUCTIONS TO CANDIDATES

APR 2025

Answer all questions.

Question 1

a. Compare the worst case time complexities of the following internal sorting algorithms. [7]

Algorithm1

```
void straight_insertion (float a[ ] , int n) {
        int i, j;
        T temp;
        for (i = 1, i < n, i ++) {
        temp = a[ i ];
        j = i;
        while (temp <  a[j-1]) {
                a[j] = a[j -1];
                j --;
                }
                a[j] = temp;  }
        }
```

Algorithm2

```
void bubble_sort( float a[ ], int n) {
        int i, j;
        T temp;
        for (i =1;i < n; i++){
             for (j = n-1;j >=1; j--) {
                If( a[j-1] > a[j] ) {
        temp = a[j-1];
        a[j-1] = a[j];
        a[j] = temp;  }
        }
      }
}
```

b. Describe any <u>two</u> desirable characteristics of an algorithm. [4]

c. Show the following:

i. $3n^2 + 7n + 2$ is $O(n^2)$. [3]

ii. n^3 is not $O(7n^2)$. [3]

iii. $(n + a)^b = \Theta(n^b)$ for any real constants a and b, where $b > 0$. [4]

d. For an $O(2^n)$ algorithm, a friend tells you that it took 17 seconds to run her data set. You run your own data set with n = 7 on the same machine using the same program and it takes 68 seconds. What size was your friend's data set? [3]

Question 2

a. Explain how the brute force string matching algorithm works. [5]

b. Compare the boyer moore string matching procedure and Knutt -morris- Pratt algorithms. [6]

c. Illustrate how the boyer moore algorithm would look for the word "***<u>rithm</u>***" from the pattern ***"a pattern matching algorithm"***. [7]

Question 3

a. Consider sorting n numbers stored in array A by first finding the smallest element of A and exchanging it with the element in A[1]. Then find the second smallest element of A, and exchange it with A[2]. Continue in this manner for the first n-1 elements of A.

i. Write pseudo-code for this algorithm. [6]

ii. Compute its worst case running time. [5]

iii. Name this sorting algorithm. [1]

iv. What loop invariant does this algorithm maintain? [2]

v. Why does it need to run for only the first n-1 elements, rather than for all n elements? [2]

b. Explain any <u>five</u> steps for designing and analyzing algorithms. [10]

Question 4

a. Give any <u>three</u> applications of Minimum spanning tree? [3]

b. The edges of the graph in **figure.1** below were label in the order in which they were added to a spanning tree. Which algorithm was used to construct the tree? Explain your reasoning.

[7]

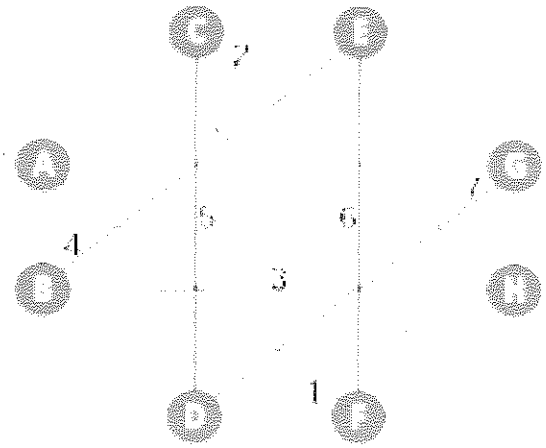

Figure.1: Spanning tree

c. The graph in **figure 2** below shows the times, in minutes to travel between ten cities. Use Dijkstra's algorithm to find the minimum time to travel from A to J. [6]

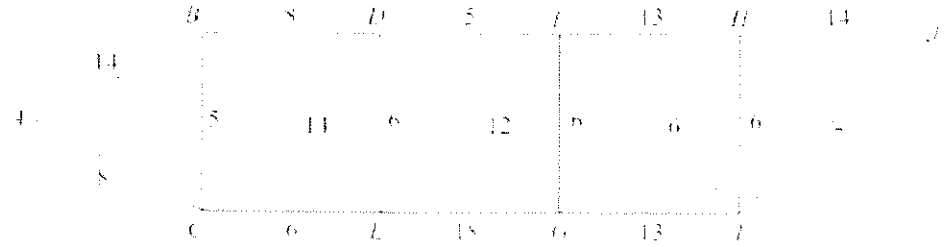

Figure 2: Time to travel between cities.

d. State the corresponding route. [1]

e. Construct an adjacent list for the graph. [3]

Question 5

Perform topological sort of the graph in figure 3 below and write down all valid topological sort orders.

[6]

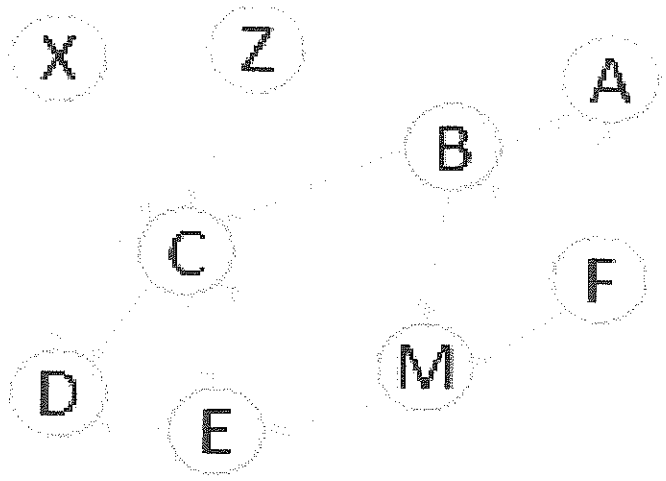

Figure 3: Topological Sort Graph.

Question 6

Choppies Supermarket opened a new shop in Bindura. On the opening day, they organized a promotion in which the give customers a knapsack and allow them to pick items from the shop for free. Figure 4 below show the capacity of the knapsack in kilograms, the weight of three items customers were allowed to choose and the value of each item. Find the maximum value of items a given customer can get for free.

[6]

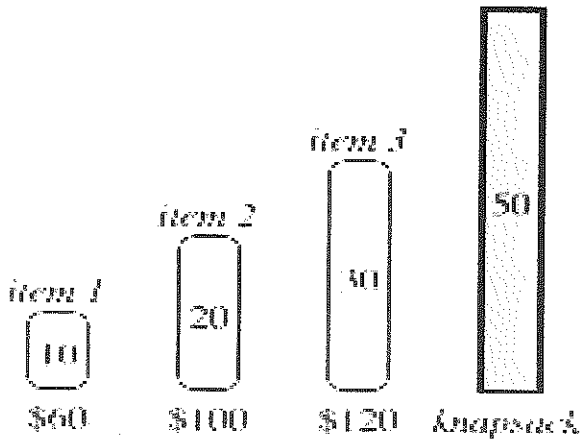

Figure 4: Knapsack Capacity in kilograms.

**********END OF PAPER**********