Final Assessment Test - April 2019

VIT

Course: CSE2003 - Data Structures and Algorithms

Class NBR(s): 2458 / 2459 / 2461 / 2462 / 2463 / 2466 / 2471 / 2472 / 2474 / 2476 / 2483 / 2485 / 3339

Slot: G1

Time: Three Hours

Max. Marks: 100

Answer any TEN Questions
(10 X 10 = 100 Marks)

a) Solve the following problem and give proof of correctness for the same. (Hint: check the pre-conditions and post-conditions)

Problem: There are four people who want to cross a rickety bridge. They all begin on the same side. You have 17 minutes to get them all across to the other side. It is night time and they have one flash light. A maximum of two people can cross the bridge at one time. Any part that crosses, either one or two people, must have the flash light with them. The flash light must be walked back and forth. It cannot be thrown. Person A takes 1 minute to cross the bridge. Persons B, C and D take 2, 5 and 10 minutes respectively. A pair must walk together at the rate of the slower pearson's pace.

b) Consider the following algorithm

```
Algorithm fun(n)
//input: a non-negative integer "n"
s ← 0
for i ← 1 to n do
    s ← s + i * i
return s
```

i. What does this algorithm compute?
ii. How many times does the loop get executed?
iii. Suggest an improvement or a better algorithm with suitable assumptions.

a) *Elucidate recursive factorial pseudo code. Write its recurrence relation and compute its time complexity.*

b) Solve the given recurrence relations using master method.

i) $T(n) = 3T(n/2) + n^2$

ii) $T(n) = 4T(n/2) + n^2$

Solve the following recurrence relation using recursion tree method.

$T(n) = 2T(n/2) + n$

Show that the obtained solution is correct by using substitution method.

Consider a hashing mechanism (Type A) which accepts integer keys, k, of maximum five digits and calculates the hash table size p as the minimum prime number which is larger than the number of keys entered (for eg., if the number of keys are 5, the hash table size p is 7).

The hashing function takes the sum of the squares of the digits in 1's place, 100's place and 10,000's place of k as input and applies modular p operation, resulting in the value x. Thus the key k gets stored in x location of the hash table. If x location is already occupied by some other element, then the key k is rotated towards right by one digit. Then again hashing function takes the sum of the squares of the digits in 1's place, 100's place and 10,000's place of k as input and applies modular p operation, resulting in the value y. Now the key k is placed y locations away from its original intended location x. If collision occurs for the second time, rotate right the original key k by two digits and repeat the process to get one more value of y, and the key is placed new y locations away from x, and so on.

If the key has less than five digits, then appropriate zero padding is required (in the most significant digits) to compute x and y. Compare the performance in terms of number of collisions of hashing mechanism Type A with general modulo division hashing function with linear probing method (Type B). Show the content of the resultant hash table for each of the hashing approaches (i.e.) Type A and Type B.

The key elements are 12345, 25378, 2543, 71356, 99919, 23151, 131, 4217.

Convert the Infix expression A / B ^ C ^ D * (E – A) * C to prefix and postfix notation. Note: ^ represent exponentiation operation.

a) Show how linked list can be used to represent the polynomial expression $5x^4 + 7x^2 + 9x + 3$. Also develop an algorithm to add two polynomials of one variable using linked list. [5]

b) Imagine we have an empty stack of integers. ADD(), SUB(), MUL() and DIV() functions represents the arithmetic +, -, * and / operations respectively. Operations are performed by considering T1 as right operant and T2 as left operand. Give the diagrammatic representation of stack content after each operation. [5]

```
push (12);  push (14);
push (16);  push(18);
pop ();
ADD(); MUL();
push(12);
DIV();
push(10);
SUB();  pop();
```

a) What is a heap? Consider the elements given below: [5

18, 20, 19, 41, 15, 10, 7, 22, 3, 12

Construct max heap tree (step by step construction is expected).

b) Construct unique binary tree using the given pair of tree traversals. (step by step construction is expected) [5

Preorder - 7, 1, 0, 3, 2, 5, 4, 6, 9, 8, 10

Inorder - 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

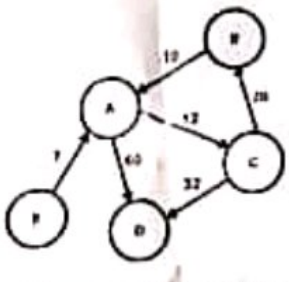
Solve 0/1 knapsack problem for the data given below using dynamic programming method and find the optimal solution.

n=4 items, capacity of knapsack M=8

Item i	Value v_i	Weight w_i
1	15	1
2	10	5
3	9	3
4	5	4

9. Apply quick sort to sort the list V, I, T, V, E, L, I, O, K, E in alphabetical order using the first element as pivot element. Write and trace the pseudo code.

10. State Dijkstra's algorithm. Consider the given graph, find the shortest path from node E to all other nodes using Dijkstra's algorithm.



11. a) Define the following terminologies with respect to computational complexity classes. [5

i. Tractable problems
ii. Intractable problems
iii. Decidable problems
iv. Undecidable problems

b) Propose your own string pattern matching algorithm or discuss about any one existing string pattern matching algorithm related to search engines. [5