LOYOLA COLLEGE (AUTONOMOUS) CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **MATHEMATICS**

FIRST SEMESTER – **NOVEMBER 2024**

PMT1MC04 – DATA STRUCTURES AND ALGORITHMS USING PYTHON

Date: 15-11-2024 Dept. No. Max. : 100 Marks

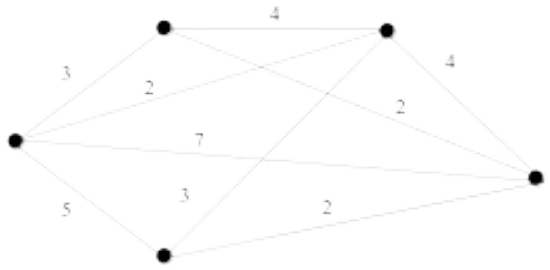
Time: 01:00 pm-04:00 pm

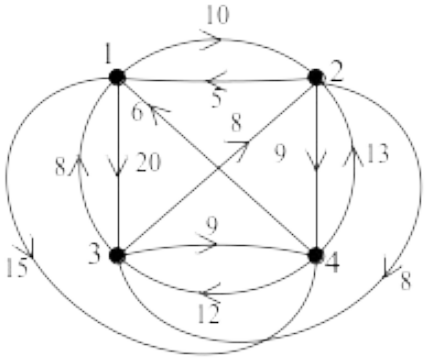
	SECTION A – K1 (CO1)	
	Answer ALL the questions	**(5 x 1 = 5)**
1	**Answer the following**	
a)	Distinguish the data types: Tuple and List.	
b)	Write the degree of a complete binary tree.	
c)	Find Θ-bound for $f(n)=n^2-\frac{n}{2}+1$.	
d)	What do you mean by principle of optimality?	
e)	What is meant by state space tree?	
	SECTION A – K2 (CO1)	
	Answer ALL the questions	**(5 x 1 = 5)**
2	**Multiple Choice Questions**	

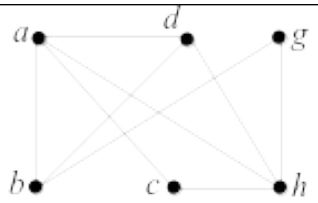
a)	The output of the given code when n = 4 is
	`def compute(n):`
	`  k=0`
	`  for i in range(2,n):`
	`  if n%i == 0:`
	`  k = k+3`
	`  return(k)`
	(i) 1 (ii) 2 (iii) 3 (iv) 4	

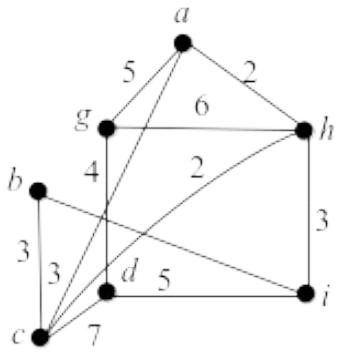
b)	Out of following linked list operations, which one requires O(1) time? (i) Insertion of an element at the beginning of the linked list. (ii) Insertion of an element at the third position of the linked list. (iii) Insertion of an element at the end of the linked list. (iv) None of the above.	
c)	Consider a heap data structure represented by the array 18, 13, 15, 8, 5, 10. The heap created after inserting the element 16 is (i) 18, 13, 15, 8, 5, 10, 16 (ii) 18, 13, 16, 15, 8, 5, 10 (iii) 18, 13, 16, 8, 5, 10, 15	

	(iv) 18, 15, 13, 10, 8, 16, 5.

d)	The weight of minimum spanning tree using Algorithm Kruskal for the following graph is  (i) 9 (ii) 10 (iii) 15 (iv) 20
e)	The 2-SAT problem is in class (i) P (ii) NP (iii) NP-complete (iv) NP-hard
	SECTION B – K3 (CO2)
	Answer any THREE of the following **(3 x 10 = 30)**
3	Design a code for the situation and write the output when n = 16. 1 **Algorithm** Sequence(n) 2 { 3 **read** n # n is a positive integer. 4 **while** ($n \neq 1$) **do** 5 **if** (n is even) **then** 6 $n \leftarrow n / 2$ 7 **if** (n is odd) **then** 8 $n \leftarrow n \times 3$ 9 $n \leftarrow n + 1$ 10 **write** n 11 }
4	Describe a doubly linked list data structure and devise a program for insertion and deletion of node from doubly linked list.
5	Consider the following algorithm: 1 **Algorithm** compute(a, n) 2 { 3 $a \leftarrow 0$ 4 $i \leftarrow 1$ 5 **while** (i <= n) **do** 6 $j \leftarrow n$ 7 **while** (j = 0) **do** 8 $j \leftarrow j$ // 2 9 $a \leftarrow a + 1$ 10 $i \leftarrow i \times 2$ 11 **return** a

	12 } Answer the questions: (a) What is worst-case time for the algorithm? (b) What does the algorithm compute? (c) Create a code for the algorithm using **for** loop.
6	Formulate an algorithm to solve the travelling salesman problem and obtain a tour with minimum cost with start vertex labelled 1 for the following graph: 
7	Explain deterministic and non-deterministic algorithms. Give examples for each.
	SECTION C – K4 (CO3)
	Answer any TWO of the following **(2 x 12.5 = 25)**
8	Develop an algorithm and its equivalent code to insert and delete element from stack data structure. If top < 0 in a stack[0 : 2], what would be the output after inserting elements A, B, M, D into stack.
9	Write algorithm Heapify(*a*, *n*) to create a heap out of *n* arbitrary elements and validate it on the array *a*[1 : 6] = (10, 25, 60, 80, 30, 40).
10	Formulate an algorithm to obtain optimal solution for solve knapsack problem using greedy strategy and give its proof of correctness. Use the algorithm, to determine the optimal solution when $(p_1, p_2 \ldots p_5)=(33,20,10,9,15), (w_1, w_2 \ldots w_5)=(8,7,6,5,3), n=5$ and $m=20$.
11	Write an algorithm to generate a spanning tree for a connected graph *G* by employing breadth-first traversal technique and construct a spanning tree for the following graph using the algorithm.



	SECTION D – K5 (CO4)
	Answer any ONE of the following **(1 x 15 = 15)**
12	Present an algorithm to search an element with key *x* in a binary search tree. Validate the algorithm on a binary search tree with key values 78, 99, 45, 23, 14, 71, 6, 80, 95 and *x* = 44, 95.
13	Devise an algorithm to find a minimum cost spanning tree and give its implementation in Python. Construct a minimum cost spanning tree for the following graph using the algorithm. 
	SECTION E – K6 (CO5)
	Answer any ONE of the following **(1 x 20 = 20)**
14	Propose a sorting algorithm which divides the array and then merges them in a sorted manner. Analyze the running time of the algorithm, validate the algorithm on sequence 70, 30, 50, 10, 55, 75, 3 and sketch the tree of calls.
15	Design a recursive algorithm for sum of subsets problem and write its implementation in Python. Find all possible subsets when *w* = {2, 3, 5, 7, 8, 10} that sums to *m* = 15 using algorithm and construct the portion of state space tree.

$$$$$$$$$$$$$$$