LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

FIRST SEMESTER – **NOVEMBER 2023**

PMT1MC04 – DATA STRUCTURES AND ALGORITHMS USING PYTHON

Date: 08-11-2023 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**	

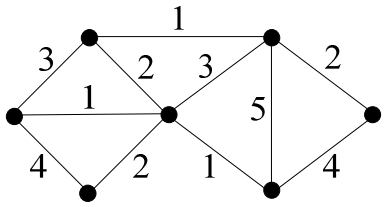
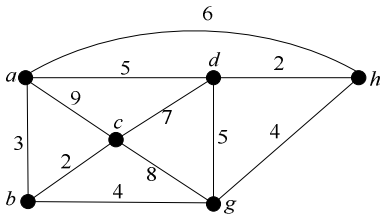
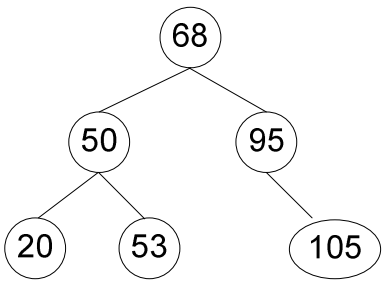
a)	How many numbers will be displayed when the following Python script is executed?
	`def check(n):`
	`  for i in range(n):`
	`  print(i)`
	`  return`
	`check(10)`	

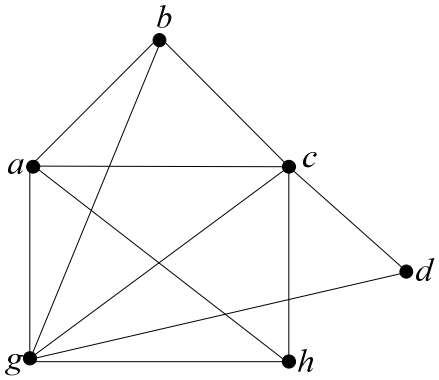
b)	List the operations that can be performed on a linear data structure.	
c)	What is the ω-notation for the function $f(n) = 10n^2 + 7$?	
d)	Write the difference between the subset paradigm and ordering paradigm in greedy technique.	
e)	State Cook's theorem.	

SECTION A – K2 (CO1)

	Answer ALL the questions	**(5 x 1 = 5)**
2	**Choose the correct answer**	
a)	Which statement is used to terminate the execution of the nearest enclosing loop in which it appears? (i) pass (ii) break (iii) continue (iv) jump	
b)	Maximum number of nodes in a binary tree of depth 6 is (i) 16 (ii) 32 (iii) 63 (iv) 64	

c)	The time complexity of the given algorithm is
	Algorithm Count(n)
	{
	for $i \leftarrow n$ / 2 to n do
	$j \leftarrow 1$
	while (j + n /2 <= n) **do**
	break
	$j \leftarrow j$ * 2
	write j
	}
	(i) $O(1)$ (ii) $O(n / 2)$ (iii) $O(n)$ (iv) $O(logn)$	

d)	The minimum-cost spanning tree of the graph is  (i) 7 (ii) 9 (iii) 10 (iv) 12
e)	Worst-case efficiency for a polynomial-time algorithm on an input size of *n* is (i) $O(1)$ (ii) $O(p(n))$ (iii) $O(p(n^2))$ (iv) $O(p(logn))$.
	SECTION B – K3 (CO2)
	Answer any THREE of the following **(3 x 10 = 30)**
3	Devise an algorithm and its Python script to compute the sum of the series $\sum_{i=1}^{n} \frac{2i+1}{i(i+1)(i+2)}$ for a given *n*.
4	What are circular queues? Develop a Python implementation to insert, delete and count the elements in a circular queue.
5	(a) Describe the control abstraction for divide and conquer strategy. (b) Predict the tight asymptotic bound for the given recurrence relation: $T(n) = \begin{cases} 3T(n-1), & if\ n > 0 \\ 1, & otherwise \end{cases}$
6	State Prim's algorithm and draw the minimum-cost spanning tree for the following graph with start vertex *d*. 
7	(i) What do you mean by 2 SAT problem? (ii) To which complexity class does 2 SAT belong? Interpret your answer. (iii) Sketch a graph for the propositional formula $F = (x_1 \vee \overline{x_2} \vee \overline{x_3}) \wedge (\overline{x_1} \vee x_2 \vee x_3) \wedge (x_1 \vee x_2 \vee x_3)$ in CNF. (4 + 3 + 3)
	SECTION C – K4 (CO3)
	Answer any TWO of the following **(2 x 12.5 = 25)**
8	Outline a recursive search algorithm in a binary search tree and give its Python implementation. Verify the algorithm on the following binary search tree when *x* = 59. 
9	Develop an algorithm to create a heap and analyze it. Use the algorithm, to construct a heap for the

	list 10, 20, 60, 5, 70, 3.
10	Formulate a dynamic programming algorithm for the longest common subsequence problem. Demonstrate its performance between the strings: X = TAAAATTT and Y = AAAAATAT. What would be the complexity of the algorithm?
11	Trace a depth-first search traversal on the given undirected graph starting at vertex *c* by describing a relevant algorithm. 
	SECTION D – K5 (CO4)
	Answer any ONE of the following **(1 x 15 = 15)**
12	Construct an algorithm to insert and delete elements from a linear data structure which works on last-in, first out principle and its Python implementation. Verify your algorithm by giving suitable examples.
13	Propose an algorithm for knapsack problem using greedy strategy and give its proof of correctness. Obtain an optimal solution to the knapsack instance: n = 5, m = 10, $(w_1, w_2, w_3, w_4, w_5) = (3, 3, 2, 5, 1)$, $(p_1, p_2, p_3, p_4, p_5) = (10, 16, 10, 12, 8)$.
	SECTION E – K6 (CO5)
	Answer any ONE of the following **(1 x 20 = 20)**
14	Design a divide and conquer sorting algorithm that works by partitioning the elements of an array $A[1 : n]$ and compute its average-case complexity. Validate the algorithm on the array $A[1 : 7]$ = [45, 55, 75, 12, 25, 15, 5].
15	(a) Devise an algorithm to find the shortest-path to a given vertex from each other vertex of a connected directed graph with non-negative weights assigned to its edges. Does the algorithm work for negative weights? Justify your answer with an example. (8 marks) (b) Create a recursive algorithm for the sum of subset problem. Illustrate its performance when w = {1, 2, 5, 6, 8} and m = 9. (12 marks)

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