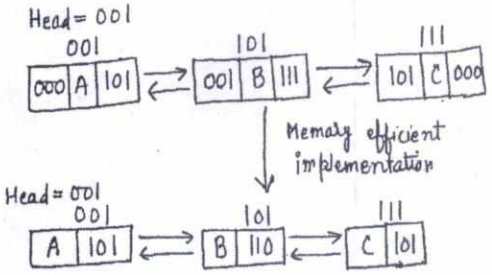
Roll Number:_____

Thapar Institute of Engineering & Technology
Department of Computer Science and Engineering
END SEMESTER EXAMINATION

B. E. **(COE/CSE): 2nd Year and 3rd Semester**
11th Dec., 2023
Monday, Time– 2:00 To 5:00 PM
Time: 3 Hours, Max Marks: 60 (Weightage: 35)

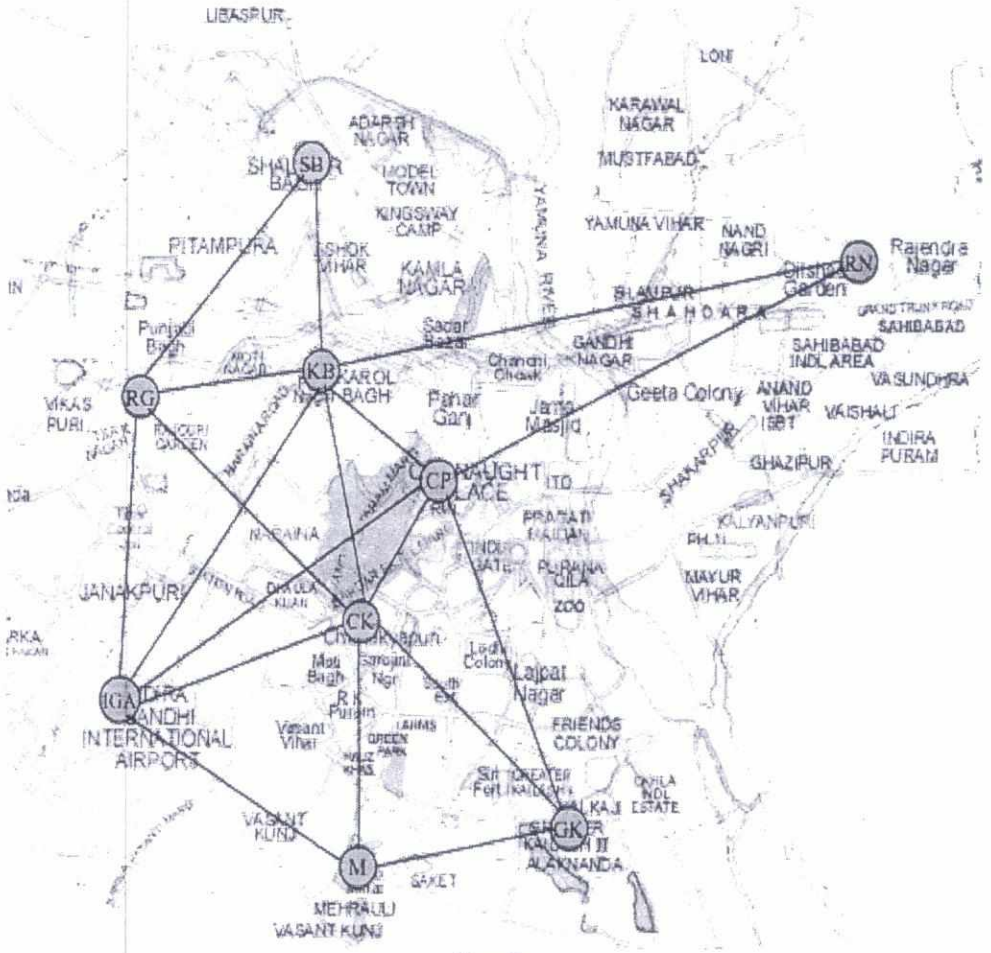
Course Code: UCS301
Course Name: Data Structures
Name of Faculty: Tarunpreet Bhatia, Simranjit Kaur, Mandeep Bajwa, Vaibhav Pandey, Gourav Jain, Chinmay Panigrahy, Mahak Gambhir, Manisha Kaushal

Note: Attempt any 4 questions. Answer all sub-parts of each question at one place. Do mention Page No. of your attempt at front page of your answer sheet. Assume missing data (if any).

Q.1	(a) Given an expression string E = "[0]{}{[00]0}", write an algorithm to examine whether the pairs and the orders of "{", "}", "(", ")", "[", "]" are correct or not in the given expression using stack as an intermediate data structure. You can use stack STL functions.	(3)
	(b) Consider inserting the keys 3, 6, 11, 13, 8 into a hashtable of size m=10. Show the result of this insertion using (i) Quadratic probing with hash function $h(k) = (2k + 3)\ mod\ m$ (ii) Double hashing collision resolution technique with first hash function as $h1(k) = (2k + 3)\ mod\ m$ and second hash function as $h2(k) = (3k + 1)\ mod\ m$. Draw the resultant hash table in both the cases.	(5)
	(c) Show the execution of heapsort on array $A = \{17, 9, 51, 33, 5, 12\}$ arranging elements in ascending order. What will be the worst-case time complexity of heapsort?	(6+1)
Q.2	(a) Draw a resultant Binary Search Tree (BST) by sequentially inserting the elements 8, 16, 4, 6, 19, 1, 11, 2, 32, 17, 14, 12, 30, 15, 18, 9 in the given order. Delete 32 and then 16 from the BST and draw the resultant BST after each deletion.	(4+2)
	(b) Considering the tree obtained after Q.2 (a) to be an AVL tree, apply the sequence of operations: (i) Insert 16 (ii) Insert 10 (iii) Delete 6. After each insertion or deletion that includes rotation, redraw the respective AVL tree.	(4)
	(c) Given a sorted doubly linked list and a value 'x' to insert, write an algorithm/pseudocode to insert the value in sorted way.	(5)
Q.3	(a) Consider the memory efficient implementation of doubly linked list using only one pointer value x→*np* per item instead of the usual two pointers (*next* and *prev*). All pointer values can be interpreted as *t*-bit integers, and x→*np* is defined as x→*np* = x→*next* XOR x→*prev*, i.e., the *t*-bit "exclusive-or" of x→*next* and x→*prev*. Assume the value NULL is represented by 0. **Fig. 1** shows the example of this memory efficient implementation. Design an efficient algorithm to search for the given element *k* and then delete a node with key element *k* in these types of memory efficient doubly linked lists.  **Fig. 1**	(8)
	(b) Given an array of daily price of a stock for n days, design an algorithm/pseudocode to find the stock's span of the n days using stack as an intermediate data structure. Stock span of the stock's price of the current day is defined as the maximum number of days (starting today and going backwards) for which the stock price was less than or equal to the price of the current day. E.g Input={90, 40, 20, 30, 80, 60, 100} and Output = {1, 1, 1, 2, 4, 1, 7}	(5)
	(c) Consider the pseudocode of a function named *fun*() (shown in **Fig. 2**) that takes a Queue Q as an argument. It uses a stack S to do some processing. A queue Q = {5, 7, 1, 3, 8, 9} is passed as an argument to the function *fun*(). Assume that FRONT points to element "5" and REAR points to element to "9". isEmpty() function returns true if Q/S is empty. push(S, deQueue(Q)) removes an item from Q and inserts the removed item to S and enQueue(Q, pop(S)) pops an item from S and inserts the popped item to Q. What will be the content of queue Q after the execution of the pseudocode?	(2)

```
void fun(Queue Q)
{
  //Create an empty stack S
   Stack S;
   while (!isEmpty(Q))
     push(S, deQueue(Q));
   while (!isEmpty(S))
     enQueue(Q, pop(S));
}
```

Fig. 2

Q.4	The state government is planning to build a Metro Rail network for Delhi to boost the communication between the 9 population centres (as shown in **Fig. 3**) namely Rajouri Garden (RG), Indira Gandhi International Airport (IGA), Connaught Place (CP), Mehrauli (M), Rajendra Nagar (RN), Karol Bagh (KB), Shalimar Bagh (SB), Chanakya Puri (CK) and Greater Kailash (GK). The construction costs are proportional to the total length of the metro system which depends on the distance between the centres. All feasible railway links between these centres are given in the form of triplets. A triplet (i, j, d_{ij}) represents the distance d_{ij} (in km) between the two centres i and j. The triplets corresponding to the above centres are as follows: (IGA, RG, 25), (RG, SB, 10), (IGA, CK, 16), (CK, CP, 2) (KB, SB, 8), (IGA, KB, 19), (RG, KB, 3), (IGA, CP, 25), (IGA, M, 14), (M, GK, 12), (GK, CK, 6), (KB, RN, 24), (GK, CP, 17), (CP, KB, 4), (CP, RN, 22), (CK, KB, 10), (M, CK, 4), (RG, CK, 12).  **Fig. 3** (a) Design an algorithm to build a robust rail network such that the distance between IGA and other cities will be minimum. Apply your algorithm to find the shortest-path and shortest-distance between IGA and other cities. Illustrate each intermediate step. (b) You also need to construct the railway network (starting from IGA) with minimum construction cost. What is the minimum cost of such network? Show intermediate steps.	(4+6) (5)
Q.5	(a) Write an algorithm/pseudocode for graph traversal using Breadth First Search (BFS) approach. Consider the directed graph G(V, E) with vertex set {A, B, C, D, E, F, G, H, I} and edge set {AE, AG, GH, GE, HI, EF, IC, BA, BC, DC, EG, FC, HE, FD}, show the adjacency list representation of G. Find the BFS traversal sequence mentioning the distance and predecessor for each vertex of G from starting vertex A. Whenever there is a choice of vertex, follow lexicographic (alphabetic) order. You need to show intermediate steps for finding the sequence. Determine the worst-case time complexity of your algorithm. (b) The preorder traversal of a certain BST is 12, 8, 6, 2, 7, 9, 10, 16, 15, 19, 17, 20. If the value 14 is then added to this tree, what is the postorder traversal of the resulting tree?	(10) (5)

**********ALL THE BEST**********