



**School of Computer Engineering**  
**KIIT deemed to be University**  
**Laboratory Lesson Plan – Autumn 2024 (3<sup>rd</sup> Semester)**

Discipline: B.Tech (All branches)

Course name and Code: Data Structure Laboratory (CS29001)

L-T-P-Cr : 0-0-2-1

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**Course Contents:**

The course focuses on basic and essential topics in data structures and algorithms, including:

- Introduction (Structure, pointer, Dynamic Memory allocation and de-allocation)
- Arrays (following operations to be performed)
  - Insert, Delete, Linear search, Traversal, smallest and largest element, reverse the array element, sorting and searching an element in a dynamic array.
- Sparse Matrix (3-tuple format, transpose, addition operation)
- Single Linked list
  - Traversal of the list.
  - Check if the list is empty.
  - Insert a node at the certain position (at beginning/end/any position).
  - Delete a node at the certain position (at beginning/end/any position).
  - Delete the node for a given key.
  - Count the total number of nodes.
  - Search for an element in the linked list.
  - sort the list in ascending order
  - Reverse the list
  - Polynomial representation (single variable)
- Double and Circular Linked list
  - Insert a node at the certain position (at beginning/end/any position).
  - Delete a node at the certain position (at beginning/end/any position).
  - Traversal of the list.
- Stacks (using Array and single linked list)
  - Push
  - Pop
  - check stack is empty or not
  - check stack is full or not
  - display stack elements
  - infix to postfix expression

- Linear Queues (using Array and single linked list)
  - Enqueue
  - Dequeue
  - IsEmpty
  - IsFull
  - Traverse
- Circular Queue (using array)
  - Enqueue
  - Dequeue
  - IsEmpty
  - IsFull
  - Traverse
- Deques (both Input restricted and output-restricted using static array)
  - Enqueue
  - Dequeue
  - IsEmpty
  - IsFull
- Priority Queue (using linked list)
  - Enqueue
  - Dequeue
  - Traverse
- Trees (Binary search tree using linked list)
  - preorder traversal
  - postorder traversal
  - inorder traversal
  - search an element
  - insert an element to the BST
  - display the largest element
  - display the smallest element
  - height of a node
  - count number of leaf nodes
- Graph (un-directed graph using Adjacency Matrix)
  - Display degree of each vertex
  - BFS traversal
  - DFS Traversal
- Sorting
  - Insertion sort
  - Selection sort
  - Merge sort
  - Quick sort
  - Heap sort
- Searching
  - Binary search

## **List of Experiments (Day wise):**

**❖ Introduction****Lab-1 Assignments**

**1.1** Write a program to read two numbers and compare the numbers using function call by address.

**Sample Input:**

Enter two numbers: 50 80

**Sample Output:**

50 is smaller than 80

**Sample Input:**

Enter two numbers: 40 10

**Sample Output:**

40 is greater than 10

**Sample Input:**

Enter two numbers: 50 50

**Sample Output:**

Both numbers are same

**1.2** Write a program to create an array of n elements using dynamic memory allocation. Calculate sum of all the prime elements of the array using function and de-allocate the memory of the array after its use.

**Sample Input:**

Enter size of the array: 5

Enter array elements: 3 9 7 4 8

**Sample Output:**

Sum =10

**1.3** Write a program to create a structure to store the information of n number of Employees. Employee's information includes data members: Emp-id, Name, Designation, basic\_salary, hra%, da%. Display the information of employees with gross salary. Use array of structure.

**Sample Input:**

Enter no.of employees: 2

Enter employee 1 information:

Avneesh

Professor

10000

15%

45%

Enter employee 2 information:

Avantika

Professor

20000

10%

35%

**Sample Output:**

Employee Information:

Name: Suchismita

Designation: Professor

Basic Salary:10000

HRA %: 15%

DA %: 45%

Gross Salary: 14500

Name: Sarita

Designation: Professor

Basic Salary: 20000

HRA %: 10%

DA %: 35%

Gross Salary: 29000

**1.4** Write a menu driven program to create a structure to represent complex number and perform the following operation using function :

1. addition of two complex number (call by value)
2. multiplication of two complex number (call by address)

**Sample Input/Output:**

Enter complex number 1: 3 4  
Enter complex number 2: 4 5

MENU

1. addition
  2. multiplication
- Enter your choice: 1

Sum=7+9i  
Enter your choice: 2

Sum=4+19i

**❖ Array****Lab-2 Assignments**

**2.1** WAP to create a 1-D array of n elements and perform the following menu based operations using function.

- a. insert a given element at specific position.
- b. delete an element from a specific position of the array.
- c. linear search to search an element
- d. traversal of the array

**Sample Input/Output:**

Enter size n : 5  
Enter element of array:  
Enter Array elements: 10 23 45 37 52  
\*\*\*MENU\*\*\*  
1. Insert  
2. Delete  
3. Linear Search  
4. Traverse  
5. Exit  
Enter option: 1  
Element to insert: 61 Enter Position: 2  
Element inserted  
Enter option: 4  
Array Elements: 10 23 61 45 37 52

**Note: Other menu choices are similarly needs to verify.**

**2.2** Write a program to perform the following operations on a given square matrix using functions:

- i. Find the no.of nonzero elements
- ii. Display upper triangular matrix
- iii. Display the elements of just above and below the main diagonal

**Sample Input:**

Enter size of the square matrix: 4  
Enter elements of the matrix:  
8 2 1 0  
1 0 7 6  
0 6 2 4  
3 9 5 0

**Sample Output:**

Nonzero elements : 12  
Upper triangular matrix:  
2 1 0  
7 6  
4

**2.3** WAP to represent a given sparse matrix in 3-tuple format using 2-D array.

**Sample Input:**

Enter size of the sparse matrix: 4 5  
Enter elements of sparse matrix: 0 0 33 0 0 0 17 0 0 0 0 0 0 46 0 0 0 0 0 51

**Sample Output:**

sparse matrix in 3-tuple format  
4 5 4  
0 2 33  
1 1 17  
2 3 46  
3 4 51

**Lab-3 Assignments**

**3.1** WAP to perform transpose of a given sparse matrix in 3-tuple format.

**Sample Input:**

Enter sparse matrix in 3-tuple format  
4 5 4  
0 2 33  
1 1 17  
2 3 46  
3 4 51

**Sample Output:**

Transpose of sparse matrix:  
R C Element  
5 4 4  
1 1 17  
2 0 33  
3 2 46  
4 3 51

**3.2** WAP to perform addition of two given sparse matrix in 3-tuple format.

**Sample Input:**

Enter sparse matrix-1 in 3-tuple format

```
4 5 4
0 3 30
1 1 10
2 3 40
3 4 21
```

Enter sparse matrix-2 in 3-tuple format

```
4 5 4
0 2 65
1 1 12
2 3 45
3 3 71
```

**Sample Output:**

Resultant Matrix in 3-tuple format

```
4 5 6
0 2 65
0 3 30
1 1 22
2 3 85
3 3 71
3 4 21
```

**3.3** WAP to represent the polynomial of single variable using 1-D array and perform the addition of two polynomial equations.

**Sample Input:**

Enter maximum degree of x: 2

Enter Polynomial-1 from lowest degree to highest degree : 4 2 3 (Hint:  $4+2x+3x^2$ )

Enter Polynomial-2: 6 5 2

**Sample Output:**

Resultant Polynomial:  $5x^2+7x^1+10x^0$

**❖ Linked list****Lab-4 Assignments**

**4.1** Write a program to create a single linked list of n nodes and perform the following menu-based operations on it using function:

- i. Insert a node at specific position
- ii. Deletion of an element from specific position
- iii. Count nodes
- iv. Traverse the linked list

**Sample Input/Output:**

Enter number of nodes: 5

Enter the elements: 17 23 47 11 78 92 51

MENU:

```
1. Insert the node at a position
2. Delete a node from specific position
3. Count
4. Traversal
5. Exit
Enter choice: 1
Enter element: 66
Enter position: 2
Node inserted
Enter choice: 4
The list is: 17-> 66->23-> 47-> 11-> 78-> 92-> 51
Enter the choice: 3
The total number of nodes: 8
```

**Note: Other menu choices are similarly needs to verify.**

**4.2** In addition to **4.1**, perform following operations using function on the single linked list:

- i. search an element in the list
- ii. sort the list in ascending order
- iii. reverse the list

**Sample Input/Output:**

```
Enter number of nodes: 5
Enter the elements: 17 23 47 11 78 92 51
MENU:
1. Insert the node at a position
2. Delete a node from specific position
3. Count
4. Traverse
5. Search
6. Sort
7. Reverse
8. Exit
Enter choice: 1
Enter element: 66
Enter position: 2
Node inserted
Enter choice: 4
The list is: 17-> 66->23-> 47-> 11-> 78-> 92-> 51
Enter the choice: 5
Enter element to be searched: 23
Element found at node-3
Enter the choice: 7
Reverse list: 51->92->78->11->47->23->66->17
```

**Note: Other menu choices are similarly needs to verify.**

**4.3** Write a program to represent the polynomial equation of single variable using single linked list and perform the addition of two polynomial equations.

**Sample Input:**

Polynomial-1:

Enter the Maximum power of x: 2

Enter the coefficient of degree 2: 4

Enter the coefficient of degree 1: 3

Enter the coefficient of degree 0:2

Polynomial-2:

Enter the Maximum power of x: 3

Enter the coefficient of degree 3: 5

Enter the coefficient of degree 2: 4

Enter the coefficient of degree 1:6

Enter the coefficient of degree 0:10

**Sample Output:**

Sum:  $5x^3+8x^2+9x^1+12x^0$ .

**Lab-5 Assignments**

**5.1** Write a program to create a double linked list and perform the following menu-based operations on it:

- i. insert an element at specific position
- ii. delete an element from specific position
- iii. Traverse the list

**Sample Input/Output:**

Enter number of nodes: 5

Enter the elements: 17 23 47 11 78 92 51

MENU:

1. Insert the node at a position
2. Delete a node from specific position
3. Traversal
5. Exit

Enter choice: 1

Enter element: 66

Enter position: 2

Node inserted

Enter choice: 3

The list is: 17-> 66->23-> 47-> 11-> 78-> 92-> 51

**Note: Other menu choices are similarly needs to verify.**

**5.2** Write a program to create a circular linked list and display the elements of the list.

**Sample Input:**

Enter no.of nodes: 5

Enter info of node1: 30

Enter info of node1: 50

Enter info of node1: 40

Enter info of node1: 20

Enter info of node1: 70



**Sample Output:**

Clinkedlist: 30 50 40 20 70

**5.3** Write a program to represent the given sparse matrix using header single linked list and display it.

**Sample Input:**

Enter size of the sparse matrix: 4 5

Enter elements of sparse matrix: 0 0 33 0 0 0 17 0 0 0 0 0 0 46 0 0 0 0 0 51

**Sample Output:**

sparse matrix in 3-tuple format

```
4 5 4
0 2 33
1 1 17
2 3 46
3 4 51
```

**❖ Stack****Lab-6 Assignments**

**6.1** Write a menu driven program to create a stack using array and perform the following operation using function

- Push
- Pop
- check stack is empty or not
- check stack is full or not
- display stack elements

**Sample Input/Output:**

Main Menu

1. Push
2. Pop
3. IsEmpty
4. IsFull
5. Traverse
6. Exit

Enter option: 1

Enter element to be pushed into the stack: 22

Enter option: 1

Enter element to be pushed into the stack: 33

Enter option: 1

Enter element to be pushed into the stack: 44

Enter option: 1

Enter element to be pushed into the stack: 88

Enter option: 1

Enter element to be pushed into the stack: 66

Enter option: 5  
Stack: 66 88 44 33 22  
Enter option: 2  
66 deleted from Stack  
Enter option: 3  
Stack empty: False

**Note: Other menu choices are similarly needs to verify.**

**6.2** Write a menu driven program to create a stack using linked list and perform the following operation using function

- a. Push
- b. Pop
- c. IsEmpty
- d. display the stack elements

**Sample Input/Output:**

Main Menu

- 1. Push
- 2. Pop
- 3. IsEmpty
- 4. Traverse
- 5. Exit

Enter option: 1  
Enter element to be pushed into the stack: 12  
Enter option: 1  
Enter element to be pushed into the stack: 35  
Enter option: 1  
Enter element to be pushed into the stack: 24  
Enter option: 1  
Enter element to be pushed into the stack: 8  
Enter option: 1  
Enter element to be pushed into the stack: 41  
Enter option: 4  
Stack: 41 8 24 35 12  
Enter option: 2  
41 deleted from Stack

**Note: Other menu choices are similarly needs to verify.**

**6.3** Write a program to convert infix expression to postfix expression using stack.

**Sample Input:**

Enter infix expression: (a+b)/c\*d-e^f

**Sample Output:**

Postfix:  $ab+c/d*ef^-$

### ❖ Queue

#### **Lab-7 Assignments**

**7.1** Write a menu driven program to create a linear queue using array and perform Enqueue, Dequeue, Traverse, IsEmpty, IsFull operations.

#### **Sample Input/Output:**

```
Enter the size of Queue: 5
Main Menu
1. Enqueue
2. Dequeue
3. IsEmpty
4. IsFull
5. Traverse
6. Exit
```

```
Enter option: 1
Enter element: 15
Enter option: 1
Enter element: 23
Enter option: 1
Enter element: 40
Enter option: 5
Queue: 15 23 40
Enter option: 2
Element deleted
Enter option: 5
Queue: 23 40
```

**Note: Other menu choices are similarly needs to verify.**

**7.2** Write a menu driven program to implement linear queue operations such as Enqueue, Dequeue, IsEmpty, Traverse using single linked list.

#### **Sample Input/Output:**

```
Main Menu
1. Enqueue
2. Dequeue
3. IsEmpty
4. Traverse
5. Exit

Enter option: 1
Enter element: 55
Enter option: 1
```

Enter element: 23  
Enter option: 1  
Enter element: 46  
Enter option: 4  
Queue: 55 23 46  
Enter option: 2  
Element deleted  
Enter option: 4  
Queue: 23 46

**Note: Other menu choices are similarly needs to verify.**

**7.3** Write a menu driven program to implement circular queue operations such as Enqueue, Dequeue, Traverse, IsEmpty, IsFull using array.

**Sample Input/Output:**

Enter Queue size: 3

Main Menu

1. Enqueue
2. Dequeue
3. IsEmpty
4. IsFull
5. Traverse
6. Exit

Enter option: 1  
Enter element: 25  
Enter option: 1  
Enter element: 36  
Enter option: 1  
Enter element: 42  
Enter option: 5  
CQueue: 25 36 42  
Enter option: 2  
Element deleted  
Enter option: 5  
CQueue: 36 42  
Enter option: 2  
Element deleted  
Enter option: 5  
CQueue: 42  
Enter option: 3  
Queue Empty: False

**Lab-8 Assignments**

**8.1** Write a menu driven program to implement Deques (both Inputrestricted and output-restricted) and performed operations such as Enqueue, Dequeue, Peek, IsEmpty, IsFull using static array.

**Sample Input/Output:**

Input restricted Dequeue Menu

1. Insert at right
2. Delete from left
3. Delete from right
4. Display
5. Quit

Enter choice: 1  
Enter element: 87  
Enter choice: 1  
Enter element: 32  
Enter choice: 4  
Deque: 87 32  
Enter choice: 2  
87 deleted  
Enter choice: 4  
Deque: 32

**Note: Other menu choices are similarly needs to verify.**

**8.2** Write a menu driven program to implement priority queue operations such as Enqueue, Dequeue, Traverse using linked list.

**Sample Input/Output:**

Main Menu

1. Enqueue
2. Dequeue
3. Display
4. Exit

Enter option: 1  
Enter element: 34  
Enter priority: 1

Enter option: 1  
Enter element: 23  
Enter priority: 3  
Enter option: 1  
Enter element: 46  
Enter priority: 2  
Enter option: 3  
Priority Queue:  
Priority    Item  
1           34

2        46  
3        23

**Note: Other menu choices are similarly needs to verify.**

❖ **Tree**

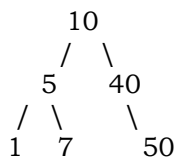
**Lab-9 Assignments**

**9.1** Write a program to create a binary search tree of n data elements using linked list and perform the following menu driven operations:

- i. preorder traversal
- ii. postorder traversal
- iii. inorder traversal
- iv. search an element

**Sample Input/Output:**

Enter number of nodes: 6  
Enter elements of BST: 10 5 1 7 40 50  
BST Created:



MAIN MENU

1. Preorder
2. Postorder
3. Inorder
4. Search
5. Exit

Enter option: 1  
Preorder: 10 5 1 7 40 50  
Enter option: 2  
Postorder: 1 7 5 50 40 10

**Note: Other menu choices are similarly needs to verify.**

**9.2** In addition to the **9.1**, perform the following menu driven operations on BST.

- i. insert an element to the BST
- ii. display the largest element
- iii. display the smallest element
- iv. height of a node
- v. count number of leaf nodes

**Sample Input/Output:**

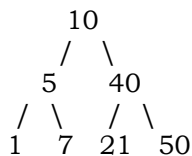
MAIN MENU

1. Insert
2. Largest
3. Smallest

4. Height
5. Count leaf nodes
6. Exit

Enter option: 1

Enter element to insert in BST: 21



Enter Option: 2

Largest element in BST=50

**Note: Other menu choices are similarly needs to verify.**

**9.3** In addition to **9.2**, perform deletion of an element in the BST using function.

### ❖ Graph

#### Lab-10 Assignments:

**10.1** WAP to create an un-directed graph using Adjacency Matrix Method and display the degree of each vertex.

#### Sample Input:

Enter number of vertex: 5

Vertices 1 & 2 are Adjacent ? (Y/N) :y

Vertices 1 & 3 are Adjacent ? (Y/N) :n

Vertices 2 & 1 are Adjacent ? (Y/N) :y

Vertices 2 & 3 are Adjacent ? (Y/N) :y

Vertices 3 & 1 are Adjacent ? (Y/N) :n

Vertices 3 & 2 are Adjacent ? (Y/N) :y

#### Sample Output:

Vertex	Degree
--------	--------

1	1
---	---

2	2
---	---

3        1

**10.2** In addition to **10.1**, display DFS traversal sequence of the undirected graph.

**Sample Input:**

Adjacency Matrix:

```
0 1 1 1 0
1 0 0 0 1
1 0 0 0 1
1 0 0 0 1
0 1 1 1 0
```

Enter start vertex: 0

**Sample Output:**

Deapth First Search: 0 1 4 2 3

**10.3** In addition to **10.1**, display BFS traversal sequence of the undirected graph.

**Sample Input:**

Enter number of vertex: 5

Enter Adjacency Matrix:

```
0 0 1 1 0
0 0 0 1 1
1 0 0 1 0
1 1 1 0 0
0 1 0 0 0
```

Enter start vertex: 0

**Sample Output:**

Breadth First Search: 0 2 3 1 4

**10.4** WAP to create a directed graph using Adjacency Matrix Method and display the degree of each vertex.

**Sample Input:**

Enter number of vertex: 3

Vertices 1 & 2 are Adjacent ? (Y/N) :n

Vertices 1 & 3 are Adjacent ? (Y/N) :y

Vertices 2 & 1 are Adjacent ? (Y/N) :y

Vertices 2 & 3 are Adjacent ? (Y/N) :y

Vertices 3 & 1 are Adjacent ? (Y/N) :n

Vertices 3 & 2 are Adjacent ? (Y/N) :y



**Sample Output:**

Vertex	In_Degree	Out_Degree	Total_Degree
1	1	1	2
2	1	2	3
3	2	1	3

**❖ Sorting****Lab-11 Assignments:**

**11.1** Write a program to sort array of elements in ascending and descending order by insertion sort using function.

**Sample Input:**

Enter no.of elements: 5  
Enter elements: 22 55 33 88 44

**Sample Output:**

Ascending order: 22 33 44 55 88  
Descending order: 88 55 44 33 22

**11.2** Write a program to sort array of elements in ascending and descending order by selection sort using function.

**Sample Input:**

Enter no.of elements: 5  
Enter elements: 11 55 22 66 33

**Sample Output:**

Ascending order: 11 55 22 33 66  
Descending order: 66 55 33 22 11

**11.3** Write a program to perform quick sort on array of elements to arrange it in ascending order using function.

**Sample Input:**

Enter no.of elements: 5  
Enter elements: 70 50 40 20 10

**Sample Output:**

Ascending order: 10 20 40 50 70

**Lab-12 Assignments:**

**12.1** Write a program to perform merge sort on array of elements to arrange it in ascending order using function.

**Sample Input:**

Enter no.of elements: 6  
Enter elements: 10 30 40 60 20 80

**Sample Output:**

Ascending order: 10 20 30 40 60 80

**12.2** Write a program to perform heapsort on array of elements to arrange it in ascending order using function.

**Sample Input:**

Enter no.of elements: 8  
Enter elements: 52 31 25 14 27 38 46 50

**Sample Output:**

Ascending: 14 25 27 31 38 46 80

**12.3** Write a program to search a given element within array using binary search.

**Sample Input:**

Enter elements: 52 31 25 14 27 38 46 50  
Enter element to be searched: 27

**Sample Output:**

Element found

**Grading Policies:**

<b>Continuous Evaluation components</b>				
<b>Sr#</b>	<b>Area</b>	<b>Mark</b>	<b>#</b>	<b>Total</b>
<b>1</b>	<b>Internal Sending</b>			
1.1	Lab record evaluation	1	10	10
1.2	Quiz	5	2	10
1.3	Viva	5	2	10
1.4	Program Execution	2	10	20
1.5	Class Participation	1	10	10
Total				60
<b>End semester evaluation</b>				
2.1	Program Execution	15	1	15
2.2	Viva	10	1	10
2.3	Quiz	15	1	15
Total				40

**Reference Materials:-****Reference Book:**

- RB1. Data Structures, Schaum's OutLines, Seymour Lipschutz, TATA McGraw Hill
- RB2. Data Structures using C by Aaron M. Tenenbaum, Yedidyah Langsam, Moshe J. Augenstein. Pearson, 1st Edition
- RB3. Data Structures A Pseudocode Approach with C, 2nd Edition, Richard F. Gilberg, Behrouz Forouzan, CENGAGE Learning, India Edition
- RB4. Data Structures Using C, Second Edition, Reema Thereja, Oxford University Press
- RB5. Data Structures and Algorithm Analysis in C, Mark Allen Weiss, Pearson Education, 2nd Edition.

**Reference Site:**

- RS1. NPTEL - <https://onlinecourses.nptel.ac.in/explorer>
- RS2. Tutorials Point - [https://www.tutorialspoint.com/data\\_structures\\_algorithms/](https://www.tutorialspoint.com/data_structures_algorithms/)
- RS3. Geeks for geeks - <http://www.geeksforgeeks.org/>

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