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

Discipline: B.Tech (All branches)

Course name and Code: Data Structure Laboratory (CS29001)

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

Instructor Name: Dr. Suchismita Das

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

Sample Output:

Resultant Matrix in 3-tuple format
4 5 5
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
a. Push
b. Pop
c. check stack is empty or not
d. check stack is full or not
e. 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.

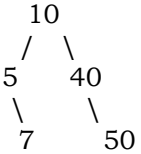
❖ **Tree**

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.

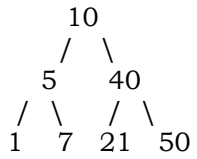
9.2 In addition to the **9.1**, perform the following menu driven operations on BST.
i. insert an element to the BST
ii. display the largest element
iii. display the smallest element
iv. height of a node
v. count number of leaf nodes

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:

Continuous Evaluation components				
Sr#	**Area**	**Mark**	**#**	**Total**
1	**Internal Sending**			
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
End semester evaluation				
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/
- RS3. Geeks for geeks - http://www.geeksforgeeks.org/

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