Programme Name/s	: Cloud Computing and Big Data/ Computer Technology/ Computer Engineering/ Computer Science & Engineering/ Computer Hardware & Maintenance/ Information Technology/ Computer Science & Information Technology
Programme Code	: BD/ CM/ CO/ CW/ HA/ IF/ IH
Semester	: Third
Course Title	: DATA STRUCTURE USING C
Course Code	: 313301

I. RATIONALE

One of the most important courses in information and communication technology is data structures. Data organization or structuring is essential for developing effective algorithms and programs. Students will get the ability to develop logic to solve problem using principles of data structure with the aid of this course.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Implement algorithm using relevant Data Structures.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Perform basic operations on Arrays.
- CO2 - Apply different Searching and Sorting methods.
- CO3 - Implement basic operations on Linked List.
- CO4 - Perform operations on Stack using Array and Linked List Implementations.
- CO5 - Perform operations on Queue using Array and Linked List Implementations.
- CO6 - Create and Traverse Tree to solve problems.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
																	Practical				
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313301	DATA STRUCTURE USING C	DSU	DSC	3	1	4	-	8	4	3	30	70	100	40	50	20	25#	10	-	-	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Classify the given type of Data Structures based on their characteristics and space. TLO 1.2 Perform operations on the given type of Data Structure.	**Unit - I Introduction to Data Structures** 1.1 Introduction: Concept and Need of Data Structure, Definition, Abstract Data Type 1.2 Types of Data Structures: (i) Linear Data Structures (ii) Non-Linear Data Structures 1.3 Operations on Data Structures: (i) Traversing (ii) Insertion (iii) Deletion	Lecture Using Chalk-Board Presentations
2	TLO 2.1 Develop algorithm to search the given key using different Searching Techniques. TLO 2.2 Create algorithm to sort data using a given method.	**Unit - II Searching and Sorting** 2.1 Searching: Searching for an item in a data set using the following methods: (i) Linear Search (ii) Binary Search 2.2 Sorting: Sorting of data set in an order using the following methods: (i) Bubble Sort (ii) Selection Sort (iii) Insertion Sort (iv) Quick Sort (v) Merge Sort	Lecture Using Chalk-Board Demonstration Presentations Hands-on
3	TLO 3.1 Differentiate between Static and Dynamic Memory Allocation. TLO 3.2 Create a suitable structure using a Linked List to represent a Node. TLO 3.3 Create Algorithm to add or remove a specified item from a Linear Linked List.	**Unit - III Linked List** 3.1 Difference between Static and Dynamic Memory Allocation. 3.2 Introduction to Linked List, Terminologies: Node, Address, Pointer, Information field / Data field, Next pointer, Null Pointer, Empty List. 3.3 Type of Lists: Linear List, Circular List, Representation of Doubly Linked List. 3.4 Operations on a Singly Linked List: Creating a Linked List, Inserting a new node in a Linked List, Deleting a node from a Linked List, Searching a key in Linked List, Traversing a Singly Linked List. 3.5 Applications of Linked List.	Lecture Using Chalk-Board Demonstration Presentations Hands-on

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Represent Stack using Array and Linked List. TLO 4.2 Create Algorithm to carry out the PUSH and POP operations in a Stack. TLO 4.3 Use Stack to transform the given expression from Infix to Postfix. TLO 4.4 Evaluate Postfix Expression.	**Unit - IV Stack** 4.1 Introduction to Stack: Definition, Stack as an ADT, Operations on Stack-(Push, Pop), Stack Operation Conditions – Stack Full / Stack Overflow, Stack Empty /Stack Underflow. 4.2 Stack Implementation using Array and representation using Linked List. 4.3 Applications of Stack: Reversing a List, Polish Notations, Conversion of Infix to Postfix Expression, Evaluation of Postfix Expression. 4.4 Recursion: Definition and Applications.	Lecture Using Chalk-Board Demonstration Presentations Hands-on
5	TLO 5.1 Represent Queue using Array and Linked List. TLO 5.2 Explain the characteristics of different types of Queue. TLO 5.3 Create Algorithm to carry out the INSERT and DELETE Operations on a Queue.	**Unit - V Queue** 5.1 Introduction to Queue: Queue as an ADT, Queue representation in memory using Array and representation using a Linked List. 5.2 Types of Queues: Linear Queue, Circular Queue, Concept of Priority Queue, Double-Ended Queue. 5.3 Queue Operations: INSERT, DELETE, Queue Operation Conditions: Queue Full, Queue Empty. 5.4 Applications of Queue.	Lecture Using Chalk-Board Demonstration Presentations Hands-on
6	TLO 6.1 Describe the given Tree Terminology. TLO 6.2 Create a Binary Search Tree based on the provided data. TLO 6.3 Create Algorithms to Traverse the Tree using the given method. TLO 6.4 Create an Expression Tree. TLO 6.5 Create Heap.	**Unit - VI Tree** 6.1 Introduction to Trees Terminologies: Tree, Degree of a Node, Degree of a Tree, Level of a node, Leaf Node, Depth / Height of a Tree, In-Degree and Out-Degree, Path, Ancestor and Descendant Nodes. 6.2 Tree Types and Traversal methods, Types of Trees: General Tree, Binary Tree, Binary Search Tree (BST). Binary Tree Traversal: In-Order Traversal, Preorder Traversal, Post-Order Traversal. 6.3 Expression Tree, Heap	Lecture Using Chalk-Board Demonstration Presentations Hands-on

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Implement Array Operations.	1	* Write a 'C' program to perform following Operations on Array: Create, Insert, Delete, Display.	4	CO1
LLO 2.1 Implement Linear Search Method on Numbers.	2	Write a 'C' Program to Search a particular data from the given Array of numbers using: Linear Search Method.	2	CO2
LLO 3.1 Implement Linear Search Method on Strings.	3	* Write a 'C' Program to Search a particular data from the given Array of Strings using Linear Search Method.	2	CO2
LLO 4.1 Implement Binary Search Method on Numbers.	4	* Write a 'C' program to Search a particular data from the given Array of numbers using Binary Search Method.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Implement Binary Search Method on Strings.	5	Write a 'C' Program to Search a particular data from the given Array of Strings using Binary Search Method.	2	CO2
LLO 6.1 Apply Bubble Sort method for Sorting Numbers.	6	* Write a 'C' Program to Sort an Array of numbers using Bubble Sort Method.	2	CO2
LLO 7.1 Apply Bubble Sort method for Sorting Strings.	7	Write a 'C' Program to Sort an Array of Strings using Bubble Sort Method.	2	CO2
LLO 8.1 Apply Selection Sort for Sorting Numbers.	8	* Write a 'C' Program to Sort an Array of numbers using Selection Sort Method.	2	CO2
LLO 9.1 Apply Selection Sort for Sorting Strings.	9	Write a 'C' Program to Sort an Array of Strings using Selection Sort Method.	2	CO2
LLO 10.1 Apply Insertion Sort for Sorting Numbers.	10	* Write a 'C' Program to Sort an Array of numbers using Insertion Sort Method.	2	CO2
LLO 11.1 Apply Insertion Sort for Sorting Strings.	11	Write a 'C' Program to Sort an Array of Strings using Insertion Sort Method.	2	CO2
LLO 12.1 Create Singly Linked List.	12	* Write a 'C' Program to Implement Singly Linked List with Operations: (i) Insert at beginning, (ii) Search, (iii) Display	2	CO3
LLO 13.1 Perform given Operations on Singly Linked List.	13	* Write a C Program to Implement Singly Linked List with Operations: (i) Insert at end, (ii) Insert After, (iii) Delete (iv) Display	2	CO3
LLO 14.1 Create Polynomials using Linked List.	14	Write a C Program to Create Two Polynomials using a Linked List.	2	CO3
LLO 15.1 Perform the Addition of Two Polynomials using a Linked List.	15	* Write a 'C' Program to add Two Polynomials using a Linked List.	2	CO3
LLO 16.1 Perform Operations on the Stack using the Array.	16	* Write a 'C' Program to perform PUSH and POP Operations on Stack using an Array.	2	CO4
LLO 17.1 Perform Operations on the Stack using a Linked List.	17	* Write a 'C' Program to perform PUSH and POP Operations on a Stack using a Linked List.	2	CO4
LLO 18.1 Apply recursive procedure to multiply two numbers.	18	* Write a 'C' program to perform multiplication of two numbers using recursion.	2	CO4
LLO 19.1 Apply recursive procedure to reverse the string.	19	Write a 'C' program to print given string in reverse using recursion.	2	CO4
LLO 20.1 Apply recursive procedure to display linked list in reverse.	20	Write a 'C' program to create a Singly Linked List and traverse in reverse order using recursion.	4	CO3 CO4
LLO 21.1 Perform Operations on Linear Queue using Array.	21	* Write a 'C' Program to perform INSERT and DELETE Operations on Linear Queue using an Array.	2	CO5
LLO 22.1 Perform Operations on Linear Queue using Linked List.	22	* Write a 'C' Program to perform INSERT and DELETE operations on Linear Queue using a Linked List.	2	CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 23.1 Perform Operations on Circular Queue using Array.	23	* Write a 'C' Program to perform INSERT and DELETE operations on Circular Queue using an Array.	2	CO5
LLO 24.1 Perform Operations on Circular Queue using a Linked List.	24	Write a 'C' Program to perform INSERT and DELETE operations on Circular Queue using a Linked List.	2	CO5
LLO 25.1 Implement Priority Queue using Linked List.	25	Write a 'C' Program to Create a Priority Queue using a Linked List.	4	CO5
LLO 26.1 Implement Binary Search Tree and perform In-Order Traversal.	26	* Write a 'C' Program to Implement BST (Binary Search Tree) and Traverse in In-Order.	2	CO6
LLO 27.1 Implement Tree Traversal Operations.	27	Write a 'C' Program to Traverse BST in Preorder, and Post-Order.	2	CO6

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer System with all necessary Peripherals and Internet Connectivity. 'C' Compiler / GCC Compiler/ Online 'C' Compiler	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Data Structures	CO1	2	2	2	0	4
2	II	Searching and Sorting	CO2	8	2	2	8	12
3	III	Linked List	CO3	12	2	4	10	16
4	IV	Stack	CO4	8	2	4	6	12
5	V	Queue	CO5	6	2	2	6	10
6	VI	Tree	CO6	9	2	4	10	16
		Grand Total		**45**	**12**	**18**	**40**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Continuous Assessment based on Process and Product related Performance Indicators. Each practical will be assessed considering 60% weightage to Process and 40% weightage to Product

Summative Assessment (Assessment of Learning)

- End semester Examination, Lab performance, Viva-Voce

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	-	-	1	-	-	1			
CO2	2	2	2	1	-	-	1			
CO3	2	2	2	1	1	1	1			
CO4	2	2	2	1	-	1	1			
CO5	2	2	2	1	-	1	1			
CO6	2	2	2	1	-	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Lipschutz	Data Structures with 'C' (SIE) (Schaum's Outline Series)	McGraw Hill Education, New Delhi ISBN: 978-0070701984
2	Balgurusamy, E.	Data Structures using 'C'	McGraw Hill Education, New Delhi 2013, ISBN: 978-1259029547
3	ISRD Group	Data Structures using 'C'	McGraw Hill Education, New Delhi 2013, ISBN: 978-12590006401
4	Yashwant Kanetkar	Understanding Pointers in C	BPB ISBN 8170298911

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.javatpoint.com/data-structure-introduction	For All Content
2	https://www.geeksforgeeks.org/introduction-to-data-structures/	For All Content
3	https://studytonight.com/data-structures/	For All Content
4	https://www.tutorialspoint.com/data_structures_algorithms/	For All Content
5	https://www.w3schools.in/data-structures/	For All Content
6	https://www.mygreatlearning.com/blog/data-structure-tutorial-for-beginners/	For All Content
7	https://byjus.com/gate/introduction-to-data-structure-notes/	For All Content

Sr.No	Link / Portal	Description
Note :		

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students