**Course Handout for .....2nd Year .....B-TECH, IT..... PROGRAM**

| | |
|---|---|
| **Course Title** | : DATA STRUCTURE AND ALGORITHMS |
| **Course Code** | : PCC-CS301 |
| **L-T-P-S Structure** | : 3-0-4 |
| **Credits** | : 3 |
| **Pre-requisite** | :Basic Computation and Principles of C, Mathematics(Set Theory) |
| **Course Coordinator** | : Ms. Sathi Ball |
| **Team of Instructors** | : NA |
| **Teaching Associates (For LAB only)** | :Mr.MAINAK SANYAL , Ms. SNEHA SAHA |

**Course Objective:**

Students will be capable to demonstrate the basic concept of data structures and implement it through C programming language and compute asymptotic notations of an algorithm to analyse the consumption of resources (time/space).

**COURSE OUTCOMES (COs):**

| CO No | Course Outcome (CO) | Blooms Taxonomy Level (BTL) | Target % |
|---|---|---|---|
| CO1 | **Describe** concepts of data structures, pseudo-code and define asymptotic notations to analyze the performance of algorithms. | **(BT-Level 2)** | 60% |
| CO2 | **Implement** various operations on array and linked list data structures. | **(BT-Level 3)** | 60% |
| CO3 | **Solve** different problems involving stack and queue data structures as well as problems of recursive nature. | **(BT-Level 3)** | 60% |
| CO4 | **Utilize** the knowledge of non-linear data structures like trees and graphs to design algorithms for various applications. | **(BT-Level 3)** | 60% |
| CO5 | **Verify** various algorithms for Sorting, Searching and Hashing. | **(BT-Level 5)** | 60% |

PROGRAM OUTCOMES (POs):

| PO Number | Description |
|---|---|
| 1. **Engineering Knowledge** | Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| 2. **Problem Analysis** | Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. |
| 3. **Design/ development of solutions** | Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. |
| 4. **Conduct investigations of complex problems** | Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| 5. **Modern tool usage** | Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations. |
| 6. **The engineer and society** | Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| 7. **Environment and sustainability** | Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| 8. **Ethics** | Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| 9. **Individual and team work** | Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |

| PO Number | Description |
|---|---|
| 10. **Communication** | Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| 11. **Project management and finance** | Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| 12. **Lifelong learning** | Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

**Mapping of Course Outcomes and Program Outcomes: (Sample Attached)**

| Course Outcomes | Program Outcomes | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12 | 1. | 2. |
| PCC-CS301.1 | 1 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 |
| PCC-CS301.2 | 2 | 2 | -- | -- | 2 | -- | -- | -- | 2 | -- | -- | -- | 1 | 1 |
| PCC-CS301.3 | 2 | 2 | -- | -- | 2 | -- | -- | -- | 2 | -- | -- | 1 | 1 | 1 |
| PCC-CS301.4 | 2 | 2 | -- | -- | 2 | -- | -- | -- | 2 | -- | -- | 1 | -- | 1 |
| PCC-CS301.5 | 3 | 3 | -- | -- | 2 | -- | -- | -- | 2 | -- | -- | 1 | -- | 1 |
| PCC-CS301 | 2 | 2 | -- | -- | 2 | -- | -- | -- | 2 | -- | -- | 1 | 1 | 1 |
| PCC-CS301.1 | 1 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 |

1 = courses in which the student will be exposed to a topic
2 = courses in which students will gain competency in that area
3= courses in which students will master that skill

**SYLLABUS:**

**Course Content:**

**Module 1: [10L]**

Introduction: Basic Terminologies: Elementary Data Organizations, Data StructureOperations: insertion, deletion, traversal etc.; Analysis of an Algorithm, AsymptoticNotations, Time-Space trade off. Searching: Linear Search and Binary Search Techniquesand their complexity analysis.

**Module 2: [9L]**

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexityanalysis, Applications of Stacks: Expression Conversion and evaluation – correspondingalgorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, CircularQueue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

**Module 3: [10L]**

Linked Lists: Singly linked lists: Representation in memory, Algorithms of severaloperations: Traversing, Searching, Insertion into, Deletion from linked list; Linkedrepresentation of Stack and Queue, Header nodes, Doubly linked list: operations on it andalgorithmic analysis; Circular Linked Lists: all operations their algorithms and thecomplexity analysis.

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded BinaryTree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and theiralgorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree:definitions, algorithms and analysis

**Module 4: [9L]**

Sorting and Hashing: Objective and properties of different sorting algorithms:Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort;Performance and Comparison among all the methods, Hashing.Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

**TEXT BOOKS:**


1) Data Structure and Algorithms , Seymour Lipschutz, TMH Publications
2) Data Structures using C and C++ by Langsam, Tenenbaum, PHI publications
3) Data Structures using C by ReemaThareja,OXFORD publications


**REFERENCE BOOKS:**


1) "Fundamentals of Data Structures of C" by Ellis Horowitz, SartajSahni, Susan Anderson-freed

2) Data structures through C language by Samiran Chattopadhy

## COURSE DELIVERY PLAN:

| Week | Sess. No. | CO | Topic (s) | **Book No [CH No][Page No]** | Teaching-Learning Methods | Planned Date | Execution Date |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | Data, Information,<br>Concepts of data structures, Classifications of data structure, Algorithm-Characteristics | [1][1.1-1.2] | T: Chalk & Talk<br>L: Observes understands | 18/07/2022 | 18/07/2022 |
| | 2 | | **Linear Data Structure: Array-** Insertion, Deletion, Traversing | [1] [4.1-4.9]] | T:Chalk & Talk<br>L: Observes understands | 19/07/2022 | 19/07/2022 |
| | 3 | | 2-D array, Row Major, Column Major<br>**Singly Linked List-**Definitions, Structures | Handnotes | T:Questioning /Discussion<br>L: Answering questions, Participates | 20/07/2022 | 20/07/2022 |
| 2 | 4 | 2 | **Singly Linked List-**Operations-Create, Traverse, Insertions, Deletions | Handnotes | T:Questioning /Discussion<br>L: Answering questions, Participates | 25/07/2022 | 25/07/2022 |
| | 5 | 2 | **Singly Linked List-**<br>Reverse, Sorting, Searching | Handnotes | T: Lecturing<br>L: Observes understands | 26/07/2022 | 26/07/2022 |
| | 6 | 2 | **Linear Data Structure: Stack-** Definitions, operations (push, pop, traverse using array) | Handnotes | **T:** Chalk & Talk<br>L: Observes understands | 27/07/2022 | 27/07/2022 |
| 3 | 4 | 3 | Implementations stack using linked list<br>Polish notations Conversion - infix to postfix | [1][6.1-6.8] | T: Lecturing<br>L: Observes understands | 01/08/2022 | 02/08/2022 |
| | 5 | 3 | Polish notations Conversion - infix to postfix, Evaluation of postfix | [1][6.14-6.56] | T: demonstration,<br>L: Practice by doing | 02/08/2022 | 03/08/2022 |
| | 6 | 3 | Algorithms and programs, basic idea of pseudo-code. Algorithm efficiency and analysis, time and space analysis of algorithms – order notations. | [2][2.1-2.18] | T: Lecturing<br>L: Observes understands<br>Video synthesis | 03/08/2022 | 05/08/2022 |

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|---|---|---|---|---|---|---|---|
| 4 | 7 | 3 | **Linear queue** -(Definition, implementation using array | [1][6.48-6.66] | **T:** Chalk & Talk L: Observes understands | 08/08/2022 | 08/08/2022 |
| | 8 | 3 | **Linear Queue** -Implementation using Linked List<br>**Circular queue** -(Definition, implementation using array | [1][6.48-6.66] | T: demonstration, L: Practice by doing | 10/08/2022 | 10/08/2022 |
| | 9 | | **Circular queue** - (Implementation using Linked List),<br>Priority Queue | [1][6.74]] | T: Lecturing L: Observes understands | 16/08/2022 | 16/08/2022 |
| 5 | 10 | 4 | **Principles of recursion** – use of stack, differences between recursion and iteration, tail recursion, Applications - The Tower of Hanoi | | T: Questioning /Discussion, L: PBL | 17/08/2022 | 17/08/2022 |
| | 11 | | **Nonlinear Data structures Trees -**<br>Basic terminologies, forest, tree representation (using array, using linked list). | [1][7.1-7.4] | T: Lecturing L: Observes understands | 22/08/2022 | |
| | 12 | | Binary trees –Definitions, binary tree traversal (pre-order, in-order, post- order) | [1][7.1-7.8] | T: Lecturing L: Observes understands | 23/08/2022 | |
| 6 | 13 | 4 | Expression tree, Binary search tree- operations (creation, insertion, deletion) | [1][7.27-7.38 | T: demonstration, L: Practice by doing | 24/08/2022 | |
| | 14 | | Deletion and Searching in BST | [1][7.27-7.38 | T: demonstration, L: Practice by doing | 29/08/2022 | |
| | 15 | | Threaded binary tree (left, right, full) - non-recursive traversal algorithms using threaded binary tree | Handnotes | T: demonstration, L: Practice by doing | 30/08/2022 | |
| 7 | 16 | 4 | Height balanced binary tree – AVL tree (insertion with examples only) | [1][7.59-7.64] | T: demonistration, L: Practice by doing | 31/08/2022 | |
| | 17 | | Deletions in AVL tree,<br>B- Trees – operations (insertion with examples only) | [1][7.70-7.73] | T: demonstration, L: Practice by doing | 05/09/2022 | |

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|---|---|---|---|---|---|---|---|
| | 18 | | B-tree Deletion, B+ Tree | [1][7.87] | T: Lecturing<br>L: Observes understands | 06/09/2022 | |
| 08 | 19 | 5 | **Sorting Algorithms :** Bubble sort and its optimizations | Hand notes | **T:** Chalk & Talk<br>L: Observes understands | 07/09/2022 | |
| | 20 | | Insertion sort and selection sort time complexity analysis | Hand notes | T: Lecturing<br>L: Observes understands | 12/09/2022 | |
| | 21 | | Merge Sort and time complexity analysis | Hand notes | T: Lecturing<br>L: Observes understands | 13/09/2022 | |
| 10 | 25 | 5 | Quick Sort and time complexity analysis | Hand notes | **T:** Chalk & Talk<br>L: Observes understands, Problem solving | 14/09/2022 | |
| | 26 | | Heap sort (concept of max heap) and analysis of time complexity,Performance and Comparison among all the methods | Hand notes | T: Lecturing<br>L: Observes understands | 19/09/2022 | |
| | 27 | | Linear Search, Binary Search and Time Complexity analysis | [1][4.18-4.21] | T: Lecturing<br>L: Observes understands | 20/09/2022 | |
| 11 | 28 | 5 | Double Linked List and its operations | Handnotes | **T:** Chalk & Talk<br>L: Observes understands | 21/08/2022 | |
| | 29 | | Circular Linked List and its operations | Hand notes | **T:** Chalk & Talk<br>L: Observes understands | 26/09/2022 | |
| | 30 | | Polynomial and Applications using array and linked list, Abstract data type | Hand notes | **T:** Chalk & Talk<br>L: Observes understands | 27/09/2022 | |
| 12 | *15* | 5 | **Non-linear Data structure: Graphs-** definitions and concepts (directed/undirected graph, weighted/un-weighted edges, sub-graph, degree, cut-vertex/articulation point, pendant node, clique, and complete graph,strongly connected component, weakly connected component, path, connected components shortest path, isomorphism) | [1][8.1-8.5] | T: Lecturing<br>L: Observes understands | 28/09/2022 | |
| | 16 | | **Graphs:** Definitions (Graph representations storage implementations – adjacency matrix, adjacency list, adjacency multi-list., connectivity | [1][8.1-8.5] | T: Lecturing<br>L: Observes understands | 10/10/2022 | |
| | 17 | | Breadth-first search (BFS) – concepts of edges used in BFS, algorithms | [1][8.20-8.30] | T: Lecturing<br>L: Observes understands | 11/10/2022 | |

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|---|---|---|---|---|---|---|---|
| 13 | 18 | 2 | Depth-first search (DFS)- Concepts, algorithms | [1][8.20-8.30] | T: Lecturing L: Observes understands | 12/10/2022 | |
| | 19 | 2 | Minimal spanning tree – Prim's algorithm (basic idea of greedy methods) | Handnotes | **T:** Chalk & Talk L: Observes understands | 17/10/2022 | |
| | 20 | | **Hashing :** Hashing –Definitions, functions | [1][9.39] | **T:** Chalk & Talk L: Observes understands | 18/10/2022 | |
| 14 | 21 | | Collision resolution techniques in Hashing | Handnotes | T: Lecturing L: Observes understands | 19/10/2022 | |
| | 22 | | Revision Lesson | | | 01/11/2022 | |
| | 23 | | Discussion on Previous Question Paper on MAKAUT | | | 02/11/2022 | |

**LIST OF TUTORIALS:OPTIONAL**

| Tutorial session no | Topics | CO-Mapping |
|---|---|---|
| | NA | |

**WEEKLY HOMEWORK ASSIGNMENTS/ PROBLEM SETS/OPEN ENDEDED PROBLEM-SOLVING EXERCISES etc.**

| Week | Assignment/Quiz | Topic | Details | CO |
|---|---|---|---|---|
| 2 | A01 | QUIZ 1 | | Pre requisite,CO1,CO2 |
| 4 | A02 | | | CO1 |
| 6 | A03 | QUIZ 2 | | CO2,CO3 |
| 9 | A04 | | | CO3 |
| 12 | A05 | | | CO4 |

**COURSE TIME TABLE (THEORY):**

| Day | Tuesday [L] | Wednesday[L] | Thursday [L] |
|---|---|---|---|
| Timing | 10:00 am-10:50 am | 10:00 am-10:50 am | 11:40 am-12:30 pm |

**COURSE TIME TABLE (PRACTICAL):**

| Day | Friday |
|---|---|
| Timing | 1:20 pm-04:40 pm |

**REMEDIAL CLASSES:**

**Supplement course handout,** which may perhaps include special lectures and discussions that would be planned, and schedule notified accordingly.

## DELIVERY DETAILS OF CONTENT BEYOND SYLLABUS:

Content beyond syllabus covered (if any) should be delivered to all students that would be planned, and schedule notified accordingly.

| S.No | Advanced Topics, Additional Reading, Research papers and any | CO | POs & PSOs | ALM | References/MOOCS |
|---|---|---|---|---|---|
| 1 | | CO1 | PO1 & PSO 1 | Quiz | |
| 2 | | CO1 | PO1 & PSO1 | PPT | |
| 3 | | CO2 | PO2 & PSO2 | Videos | |
| 4 | | CO3 | PO1 & PSO1 | PPT | |

## EVALUATION: AS PER MAKAUT GUIDELINES

## Schedule for Continuous Assessment (CA):

| CA | Assessment By | Schedule |
|---|---|---|
| CA-I | Presentation, Quiz, Group Discussion | As per Academic Calendar |
| CA-II | Report writing | |
| CA-III | Class test in pen and paper mode to be conducted at the College Level | |
| CA-IV | Centralized online test to be arranged by theUniversity | |
| PCA1 | Rubrics based Evaluation and Viva -Voce | |
| PCA2 | Rubrics based Evaluation and Viva -Voce | |

## ATTENDANCE POLICY

Every student is expected to be responsible for regularity of his/her attendance in class rooms and laboratories, to appear in scheduled tests and examinations and fulfil all other tasks assigned to him/her in every course. For Promotion, a Minimum of 50% of internal marks must be obtained. In every course, student has to maintain a minimum of 75% attendance to be eligible for appearing in Semester end examination of the course, for cases of medical issues and other unavoidable circumstances the students will be condoned if their attendance is between 60% to 75% in every course, subjected to submission of medical certificates, medical case file and other needful documental proof to the concerned departments.

## DETENTION POLICY

In any course, a student has to maintain a minimum of75% attendance and must secure a minimum of 50% marks in In-Semester Examinations to be eligible for appearing to the Semester End Examination, failing to fulfill these conditions will deem such student to have been detained in that course.

## PLAGIARISM POLICY

Use of unfair means in any of the evaluation components will be dealt with strictly, and the case will be reported to the examination committee.

**COURSE TEAM MEMBERS, CHAMBER CONSULTATION HOURS AND CHAMBER VENUE DETAILS:**

Each instructor will specify his / her chamber consultation hours during which the student can contact him / her in his / her chamber for consultation.

| S.No. | Name of Faculty | Chamber Consultation Day (s) | Chamber Consultation Timings for each day | Chamber Consultation Room No: | Signature of Course faculty |
|---|---|---|---|---|---|
| 1 | Sathi Ball | | As per prior Appointment | | |

**GENERAL INSTRUCTIONS**

Students should come prepared for classes and carry the text book(s) or material(s) as prescribed by the Course Faculty to the class.

**NOTICES**

All notices will be communicated through the institution email.
All notices concerning the course will be displayed on the respective Notice Boards.

**Signature of COURSE COORDINATOR:** Sathi Ball

16/8/22

**HEAD OF DEPARTMENT:**

29/8/22

**Approval from: Head of the Institutions**
**(Sign with Office Seal)**

Principal
Siliguri Institute of Technology