INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

COMPUTER SCIENCE AND ENGINEERING

COURSE DESCRIPTOR

Course Title	**DATA STRUCTURES**				
Course Code	ACSB03				
Programme	B.Tech				
Semester	III	CSE | IT | ECE | CE | ME			
	IV	AE | EEE			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	0	3	3	1.5
Chief Coordinator	Dr. K Suvarchala, Associate Professor				
Course Faculty	Dr. K Suvarchala, Associate Professor Dr. J Sirisha Devi, Associate Professor Mrs. B Padmaja, Associate Professor Mrs. G Geetha Reddy, Assistant Professor				

I. COURSE OVERVIEW:

The course covers some of the general-purpose data structures and algorithms, and software development. Topics covered include managing complexity, analysis, static data structures, dynamic data structures and hashing mechanisms. The main objective of the course is to teach the students how to select and design data structures and algorithms that are appropriate for problems that they might encounter in real life. This course reaches to student by power point presentations, lecture notes, and lab which involve the problem solving in mathematical and engineering areas.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	ACSB01	II	Programming for Problem Solving	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Data Structures	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✔	Mini Project	✔	Videos
✔	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz – Online Examination:

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Assignments/ Laboratory Practices/Quiz
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminar
PO 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.	2	Seminar
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Seminar/ Laboratory Practices
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage independent and life-long learning in the broadest context of technological change.	2	Seminar/Guest Lecture

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of Computer-based systems of varying complexity.	3	Assignments
PSO 2	**Problem-Solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.	3	Assignments/ Laboratory Practices
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.	1	Guest Lecture

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES :

The course should enable the students to:	
I	Learn the basic techniques of algorithm analysis.
II	Demonstrate searching and sorting algorithms and analyze their time complexities.
III	Implement linear data structures viz. stack, queue and linked list.
IV	Demonstrate non-linear data structures viz. tree and graph traversal algorithms.
V	Study and choose appropriate data structure to solve problems in real world.

IX. COURSE OUTCOMES (COs):

Cos	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand the concept of data structures and apply algorithm for solving problems like sorting, searching, insertion and deletion of data.	CLO 1	Understand algorithms and data structures in terms of time and space complexity of basic operations.
		CLO 2	Choose a suitable algorithm to organize the data in ascending or descending order.
		CLO 3	Explore an algorithm to find the location of an element in a given list.
		CLO 4	Compare the time complexities of various searching and sorting algorithms.
CO 2	Understand linear data structures for processing of ordered or unordered data.	CLO 5	Implementation of stack and queues using an underlying array.
		CLO 6	Understand application of stacks in arithmetic expression conversion and evaluation.
		CLO 7	Understand working of circular queues and double ended queue.
CO 3	Explore various operations on dynamic data structures like single linked list, circular	CLO 8	Understand dynamic data structures and their real time applications.
		CLO 9	Understand the basic insertion and deletion operations associated with linked list.

Cos	Course Outcome	CLOs	Course Learning Outcome
	linked list and doubly linked list.	CLO 10	Organize the data in various linked representation format.
CO 4	Explore the concept of non linear data structures such as trees and graphs.	CLO 11	Understand the concept of non-linear data structures viz. trees and graphs.
		CLO 12	Application of trees, graphs and graph traversal techniques.
CO 5	Understand the binary search trees, hash function, and concepts of collision and its resolution methods.	CLO 13	Compare and Contrast the operations of binary search trees and AVL trees.
		CLO 14	Understand the concept of M-way search trees, operations and applications.
		CLO 15	Understand the implementation of hashing using hash table and hash function.
		CLO 16	Describe the concept of collision and its resolving methods in applications.
		CLO 17	Strengthen the knowledge of data structures and algorithms for employability.

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACSB03.01	CLO 1	Understand algorithms and data structures in terms of time and space complexity of basic operations.	PO 1	3
ACSB03.02	CLO 2	Choose a suitable algorithm to organize the data in ascending or descending order.	PO 3,PO4	2
ACSB03.03	CLO 3	Explore an algorithm to find the location of an element in a given list.	PO 2,PO5	2
ACSB03.04	CLO 4	Compare the time complexities of various searching and sorting algorithms.	PO 1	3
ACSB03.05	CLO 5	Implementation of stack and queues using an underlying array.	PO 2, PO 3, PO 5	3
ACSB03.06	CLO 6	Understand application of stacks in arithmetic expression conversion and evaluation.	PO 1,PO2	3
ACSB03.07	CLO 7	Understand working of circular queues and double ended queue.	PO 1,PO5	2
ACSB03.08	CLO 8	Understand dynamic data structures and their real time applications.	PO1,PO 2, PO 5	3
ACSB03.09	CLO 9	Understand the basic insertion and deletion operations associated with linked list.	PO 1,PO 2, PO 5	3
ACSB03.10	CLO 10	Organize the data in various linked representation format.	PO 1,PO 2	3
ACSB03.11	CLO 11	Understand the concept of non-linear data structures viz. trees and graphs.	PO 1,PO 2	2
ACSB03.12	CLO 12	Application of trees, graphs and graph traversal techniques.	PO 1	2
ACSB03.13	CLO 13	Compare and Contrast the operations of binary search trees and AVL trees.	PO 1,PO 2, PO 5	3
ACSB03.14	CLO 14	Understand the concept of M-way search trees, operations and applications.	PO 1,PO 2, PO5	2
ACSB03.15	CLO 15	Understand the implementation of hashing using hash table and hash function.	PO 1,PO 2, PO5	3

ACSB03.16	CLO 16	Describe the concept of collision and its resolving methods in applications.	PO 1,PO 2, PO5, PO 12	2
ACSB03.17	CLO 17	Strengthen the knowledge of data structures and algorithms for employability.	PO 1,PO 2, PO5, PO 12	2

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)							
	PO 1	PO 2	PO 3	PO 5	PO 12	PSO1	PSO2	PSO3
CO 1	3	3	2	2		3	2	
CO 2	3	3	2	2		2		
CO 3	3	3	2	2		2	3	
CO 4	2	3		2		2		
CO 5	3	3		2	3	3	3	1

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3														
CLO 2		3	2										3		
CLO 3		3			2								3		
CLO 4	3														
CLO 5		3	3		2									2	
CLO 6	3	3											3		
CLO 7	3				2								2		
CLO 8	3	3	2										3		
CLO 9	2	3			2								3		
CLO 10	3	3											2		
CLO 11	3	3												3	
CLO 12	3														1
CLO 13	3	3			2								3		
CLO 14	2	3			2								3		
CLO 15	3	3			2								3		

CLO 16	2	3			2							2		3	3
CLO 17	2	3			2							3		3	3

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2, PO 3, PO 5, PO 12, PSO 1, PSO 2, PSO 3	SEE Exams	PO 1, PO 2, PO 3, PO 5, PO 12, PSO 1, PSO 2, PSO 3	Assignments	PO 1, PSO 2 PSO 3	Seminars	PO 1, PO 2, PO 3, PO 5, PO 12, PSO 1, PSO 3
Laboratory Practices	PO 1, PO 5, PSO 2, PSO 3	Student Viva		Mini Project		Certification	
Term Paper							

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

MODULE-I	INTRODUCTION TO DATA STRUCTURES, SEARCHING AND SORTING
Basic concepts: Introduction to data structures, classification of data structures, operations on data structures, abstract data type, algorithms, different approaches to design an algorithm, recursive algorithms; Searching techniques: Linear search, binary search and Fibonacci search; Sorting techniques: Bubble sort, selection sort, insertion sort, quick sort, merge sort, and comparison of sorting algorithms.	
MODULE-II	**LINEAR DATA STRUCTURES**
Stacks: Primitive operations, implementation of stacks using Arrays, applications of stacks arithmetic expression conversion and evaluation; Queues: Primitive operations; Implementation of queues using Arrays, applications of linear queue, circular queue and double ended queue (deque).	
MODULE-III	**LINKED LISTS**
Linked lists: Introduction, singly linked list, representation of a linked list in memory, operations on a single linked list; Applications of linked lists: Polynomial representation and sparse matrix manipulation. Types of linked lists: Circular linked lists, doubly linked lists; Linked list representation and operations of Stack, linked list representation and operations of queue.	
MODULE-IV	**NON LINEAR DATA STRUCTURES**
Trees: Basic concept, binary tree, binary tree representation, array and linked representations, binary tree traversal, binary tree variants, application of trees; Graphs: Basic concept, graph terminology, graph implementation, graph traversals, Application of graphs, Priority Queue.	
MODULE-V	**BINARY TREES AND HASHING**
Binary search trees: Binary search trees, properties and operations; Balanced search trees: AVL trees; Introduction to M-Way search trees, B trees; Hashing and collision: Introduction, hash tables, hash functions, collisions, applications of hashing.	
Text Books:	
1. Rance D. Necaise, "Data Structures and Algorithms using Python", Wiley Student Edition. 2. Benjamin Baka, David Julian, "Python Data Structures and Algorithms", Packt Publishers, 2017.	
Reference Books:	
1. S. Lipschutz, "Data Structures", Tata McGraw Hill Education, 1st Edition, 2008. 2. D. Samanta, "Classic Data Structures", PHI Learning, 2nd Edition, 2004.	

Web References:
1. https://www.tutorialspoint.com/data_structures_algorithms/algorithms_basics.htm 2. https://www.codechef.com/certification/data-structures-and-algorithms/prepare 3. https://www.cs.auckland.ac.nz/software/AlgAnim/dsToC.html 4. https://online-learning.harvard.edu/course/data-structures-and-algorithms

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1 – 2	Basic concepts: Introduction to Data Structures.	CLO 1	T1:1.1.3 R2 : 1.2
3 – 4	Classification of data structures	CLO 2	T1:1.1.3 R2 : 1.4
5 – 6	Operations on data Structures	CLO 2	T1:1.2
7 – 8	Searching techniques: Linear search and binary search	CLO 4	T1:5.1
9 – 10	Sorting techniques: Bubble sort, selection sort	CLO 4	R1:14.5
11 – 14	Insertion sort and comparison of sorting algorithms.	CLO 7	T1:5.2 R2 : 10.2
15 – 16	Stacks: Primitive operations, implementation of stacks using Arrays.	CLO 9	T1:7.1
17 – 20	Applications of stacks arithmetic expression conversion and evaluation.	CLO 9	T1:7.2
21 – 22	Queues: Primitive operations; Implementation of queues using Array.	CLO 11	T1:8.1
23 – 24	Applications of linear queue, circular queue.	CLO 11	T1:8.4
25 – 26	Double ended queue (deque).	CLO 13	R2 : 5.4
27 – 28	Linked lists: Introduction, singly linked list, representation of a linked list in memory.	CLO 11	T1:9.1
29– 30	Operations on a single linked list, Applications of linked lists: Polynomial representation, Circular linked lists, doubly linked lists;	CLO 9	T1:9.2
31 - 32	Sparse matrix manipulation.	CLO 14	T2:9.2
33 – 35	Linked list representation and operations of Stack, Linked list representation and operations of queue.	CLO 14	T1:9
36 – 38	Trees: Basic concept, binary tree, binary tree representation, array and linked representations	CLO 14	T1:13.1-13.2
39 – 40	Binary tree traversal, binary tree variants, application of trees.	CLO 14	T1:13.2.3
41 – 43	Graphs: Basic concept, graph terminology, graph implementation.	CLO 14	R2 : 8.2
44 – 46	Graph traversals, Application of graphs,	CLO 17	T2:6.2
47 – 50	Priority Queue.	CLO 17	T1:6.1 T2:5.6
51 – 52	Binary search trees, properties and operations.	CLO 16	T1:14.1
53 – 55	Balanced search trees: AVL trees, Introduction to M-Way search trees, B trees.	CLO 16	T1:14.3
56 – 58	Hashing and collision: Introduction, hash tables, hash functions,	CLO 15	R2 : 6.4
59 - 60	Collisions, applications of hashing.	CLO 15	R2 : 6.4

XVII.GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Familiarizing different Tree techniques viz, Threaded binary trees, B+ trees	Seminar/NPTEL	PO 3	PSO 1
2	Familiarizing the role of Python language in developing application level programs.	Industrial visits	PO 1,PO 2	PSO 3
3	Solving different problems and Practicing various debugging strategies to become a good programmer	Extra Lab Sessions, Participating in Coding contests.	PO 2	PSO 3

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