20MCA105	ADVANCED DATA STRUCTURES	CATEGORY	L	T	P	CREDIT
		GENERAL	3	1	0	4

Preamble: A graduate course in Computer Applications should give due exposure to the recent developments. Since Data structures is a central pillar of any program on Computer Science/ Applications, this course is designed to build upon the knowledge acquired at the undergraduate level and familiarise students with a bunch of modern data structures which are quite useful to solve, in the most effective manner, the modern, real life problems.

Prerequisite: Basic Data Structures

Course Outcomes: After the completion of the course the student will be able to

CO 1	Remember the Basic Data Structures and understand the Set Data Structure and its implementation.
CO 2	Understand Advanced Tree Structures for the design of efficient algorithms
CO 3	Understand Advanced Heap Structures suitable for solving Computational problems involving Optimisation and analysing these data structures using amortised analysis.
CO 4	Understand Advanced Graph algorithms suitable for solving advanced computational problems
CO 5	Understand the basic operation of Blockchaining along with the data structures used in it and the challenges in Blockchain data.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2		1							
CO 2	2	2	3	2	1		1					
CO 3	2	3	3	2	1		1					
CO 4	3	3	2	1	2		1					
CO 5	3	2	2	2	3		1					

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 8 marks
Continuous Assessment Test (2 numbers) : 20 marks
Assignment/Quiz/Course project : 12 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 compulsory short answer questions, 2 from each module. Each question carries 3 marks. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 6 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

(a) Review the basic data structures such as array, linked list, stack, queue etc.
(b) Understand the set data structure and its implementation
(c) Understand the Disjoint set data structure
(d) Learn the basics of Amortised Analysis and its important types

Course Outcome 2 (CO2)

(a) Understand Balanced Binary Search Trees and the idea of Rotations
(b) Understand Red Blak Trees and their operations
(c) Understand B Trees and operations
(d) Obtain a basic awareness of Splay Trees and Suffix Trees.

Course Outcome 3(CO3):

(a) Understand the concepts of Mergeable Heaps and their operations.
(b) Understand the Binomial Heaps and its operations along with their amortised analysis
(c) Understand the Fibonacci Heaps and its operations along with their amortised analysis

Course Outcome 4 (CO4):

(a) Understand Graphs traversal techniques and topological sorting using these
(b) Understand the algorithms for finding the strongly connected components and biconnected components in a graph.
(c) Understand the Prim's and Krusksl's algorithms and their implementation
(d) Understand the Dijikstra's Single Source Shortest path algorithm and implementing it using Advanced Heap Structures.

Course Outcome 5 (CO5):

(a) Understand a basic overview of the Blockchain system architecture.
(b) Understand the Blockchain Data Structures and Data Types.
(c) Understand the problems and challenges in Blockchain data.

Model Question paper

Reg No.:_____		Name:_____ _	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER M.C.A.DEGREE EXAMINATION, MODEL QUESTION PAPER			
Course Code: 20MCA105			
Course Name: ADVANCED DATA STRUCTURES			
Max. Marks: 60			Duration: 3 Hours
PART A			

		Answer all questions, each carries 3 marks.	Marks
1		What is meant by Hashing ?	(3)
2		How does Amortised Analysis differ from Average Case Analysis?	(3)
3		What is meant by Balanced Binary Search Tree? Give an example for a balanced binary search tree and an unbalanced one.	(3)
4		What is meant by Suffix Tree?	(3)
5		Give a valid Binomial heap with nodes 3,5,7,10,12,15.	(3)
6		Explain how fibonacci heaps are implemented?	(3)
7		What do you mean by Minimum Costs Spanning Tree?	(3)
8		What is meant by Strongly Connected Components? Illustrate with an example	(3)
9		What is meant by Block Chaining?	(3)
10		What is Contract Data ?	(3)
		PART B	
		Answer any one question from each module. Each question carries 6 marks.	
		Module I	
11		How do you perform Amortised Analysis using Accounting method? Illustrate with Multipop Stack example.	(6)
		OR	
12		Explain any three Hashing functions.	(6)
		Module II	
13		What is meant by Red Black Tree? Explain how insertion is done in a Red Black Tree.	(6)
		OR	
14		Give notes on B-Trees and Splay Trees.	(6)
		Module III	
15		Explain how the Decrease-Key operation is performed on Binomial Heaps. What is the Amortised Cost of this operation?	(6)
		OR	
16		Describe how the Delete-Key operation is performed in a Fibonacci heap? Illustrate with an example.	(6)
		Module IV	
17		Explain the Breadth First Search algorithm with a suitable example.	(6)
		OR	
18		Explain the Prim's algorithm with an example.	(6)

Module V			
19		Explain the Blockchain architecture in detail.	(6)
OR			
20		Explain the problems to be solved in Blockchain Data Analysis.	(6)
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Syllabus

Module 1 [12 hrs]

Review of basic data structures- Array, linked list and its variants, Stack ,Queue and Trees
Set Data Structure:- Representation of sets, Set implementation using bit string.
Hashing :- SImple hash functions, Collision and Collision Resolution techniques
Amortised Analysis - Aggregate, Accounting and Potential Methods (using the examples Multipop Stack and Incrementing Binary Counter only)
Disjoint sets- representations, Union, Find algorithms

Module 2 [10 hrs]

Advanced Tree Structures:- Balanced Binary Search trees, Red-Black trees- Properties of Red Black trees, Rotations, Insertion, Deletion. B-Trees- Basic operations on B-Trees – Insertion and Deletion, Introduction to Splay Trees and Suffix Trees

Module 3 [10 hrs]

Advanced Heap Structures:- Mergeable Heaps and operations on Mergeable Heaps. Binomial Heaps, Binomial Heap operations and Analysis, Fibonacci Heaps, Fibonacci Heap operations and Analysis**.**

Module 4 [14 hrs]

Advanced Graph Structures : Representation of graphs, Depth First and Breadth First Traversals, Topological Sorting, Strongly connected Components and Biconnected Components Minimum Cost Spanning Tree algorithms- Prim's Algorithm, Kruskal' Algorithm,. Shortest Path Finding algorithms – Dijikstra's single source shortest paths algorithm

Module 5[8 hrs]

Blockchain Data Structure:- Blockchain Architecture, Blockchain Data Structures and Data types, Contract Data, Problems to be solved in Blockchain data analysis

Text Books

1. Cormen T.H., Leiserson C.E, Rivest R.L. and Stein C, ***Introduction to Algorithms***, Prentice Hall India, New Delhi, 2004 [Modules 1 to 4]

2. Yang, Xiaojing, Jinshan Liu, and Xiaohe Li. "***Research and Analysis of Blockchain Data." Journal of Physics: Conference Series. Vol. 1237***. No. 2. IOP Publishing, 2019.

Reference Books

1. Kleinberg, Jon, and Eva Tardos. ***Algorithm design***. Pearson Education India, 2006.

2. Aho A.V., Hopcroft J.E., and Ullman J.D., ***Data Structures and Algorithms***, Pearson Education, New Delhi, 1983.

3. Sahni S., ***Data Structures, Algorithms, and Applications in C++,*** Mc Graw Hill, Singapore, 1998.

Course Contents and Lecture Schedule

No	Topic	No. of Lecture Hours
1	**Review of basic data structures**	**10Hrs**
1.1	Array, Stack and Queue	
1.2	Linked list and its variants	
1.3	Representation of sets, Set implementation using bit string.	
1.4	Hashing – SImple hash functions	
1.5	Collision and Collision Resolution techniques	
1.6	Amortised Analysis	
1.7	Aggregate Method (Multipop Stack and Incrementing Binary Counter)	
1.8	Accounting Method (Multipop Stack and Incrementing Binary Counter)	
1.9	Potential Method (Multipop Stack and Incrementing Binary Counter)	
1.10	Disjoint sets- representations	
1.11	Union, Find algorithms	
2	**Advanced Tree Structures**	**10Hrs**
2.1	Balanced Binary Search trees	
2.2	Red-Black trees	
2.3	Properties of Red Black trees	
2.4	Rotations	
2.5	Insertion	

2.6	Deletion	
2.7	B-Trees	
2.8	Insertion and Deletion	
2.9	Splay Trees	
2.10	Suffix Trees	
3	**Advanced Heap Structures**	**8Hrs**
3.1	Mergeable Heaps	
3.2	Operations on Mergeable Heaps	
3.3	Binomial Heaps	
3.4	Binomial Heaps operations and Analysis	
3.5	Fibonacci Heaps	
3.6	Fibonacci Heap operations and Analysis.	
4	**Advanced Graph Structures**	**12Hrs**
4.1	Representation of graphs	
4.2	Depth First and Breadth First Traversals	
4.3	Topological Sorting	
4.4	Strongly connected Components	
4.5	Biconnected Components	
4.6	Minimum Cost Spanning Tree	
4.7	Prim's Algorithm	
4.8	Kruskal's Algorithm	
4.9	Dijikstra's single source shortest paths algorithm	
5	**Blockchain Data Structure**	**8Hrs**
5.1	Blockchain Architecture	
5.2	Blockchain Data Structures	
5.3	Blockchain Data types	
5.4	Contract Data	
5.5	Problems to be solved in Blockchain data analysis	