RIPHAH International Colleges

A Project of RIPHAH International University

Course Outline

Course Information	Course Title	**Data Structures**		
	Course ID		Course Type	Computing Core
	Credit hours	4 (3+1)	Hours per week(C-L)	(3 + 3) = 6
	Programs	ADP Computing (CS)	Preferred Semester	3rd
Course Description	This course will focus on data structures for manipulating particularly for storing information. Various ADT like lists, stacks, queues, trees and graphs will be covered. Analysis and application of the various ADT to be used as per problem will also be discussed. Different types of searching and sorting techniques will also be introduced and will be compared. Students will carry out a number of programming assignments, which will emphasize various aspects of data organization and manipulation process.			

Course Objectives (CO)

The objective of this course is to enable students to understand;

No.	Objective	Relation with PEO
CO1.	Ability to apply OOP concepts while using ADTs	
CO2.	Knowledge to implement the various abstract data types ADTs	
CO3.	Appropriate use data structure for a particular problem based on requirements, ADT time and space complexity	
CO4.	Analyze algorithms and identify key algorithmic strategies	

Course Learning Outcomes (CLO)

At the end of this course students will be able to;

No.	Outcome	Relation with PLO	BT Level	PLO Level
CLO1.	**Apply** OOP concepts during defining and using ADTs	PLO1	C2	I
CLO2.	**Apply** the various linear and nonlinear data structures and their relevant operations for problem solving	PLO 3,4	C3	I
CLO3.	**Apply** different types of searching and sorting techniques	PLO2	C3	I
CLO4.	**Analyze** time required for the execution of a program, as well as the correctness of a program.	PLO.3,4	C4	I
CLO5.	**Measure** the performance of the various ADTs	PLO 3	C4	A
CLO6.	**Implement** the various linear and nonlinear data structures and their relevant operations for problem solving	PLO 11,12	C4	I

Lecture type	Lectures, Lab sessions
Prerequisites	Object Oriented Programming
Follow up Courses	Distributed Systems, Advanced Operating Systems

Textbook / Reference Books

	Title	Edition	Authors	Publisher	Year	ISBN
Textbook	Data Structures using C and C++	latest Edition	A. M. Tenenbaum	Prentice-Hall		
Reference Books	C++ Plus Data Structures	latest Edition	Nell Dale	Jones and Bartlet, Inc.		
	Data Structures, Algorithms and Applications	latest Edition	Sahni	McGraw Hill		
	Data Structures and Algorithm Analysis in C++	latest Edition	Mark Allen Weiss	Addison Wesley		

Reference Material	Lecture handouts https://drive.google.com/file/d/190f7e9Xw1AjN6iirHYQkJdQpR43PPmXq/view?usp=sharing
Course Software or Tool	Visual Studio

Assessment Criteria (100%)

Assessment	Weight	Used to attain CLO	Assessment	Weight	Used to attain CLO
Assignment	5%	CLO1,2,4,5,6	Quiz	5%	CLO1,2,3,4
Lab	15%	CLO1,3,4,5	Project / Presentation	10%	CLO 3,4,5,6
Mid Term	25%	CLO1,2,3,4,5	Final	40%	CLO1,2,3,4,5

Methods of Evaluation	Quizzes, Assignments, Mid/Final exam, Lab, Project

Notes	Labs are managed and evaluated separately

Week No.	Topic	Lecture No.	Lecture Contents	Relation with CLO	Class Activity	Tasks
W1.	Introduction to data structures	L1.	▪ Introduction to data structures ▪ Difference between data structure and ADT ▪ Linear and nonlinear data structures	CLO 1		
		L2.	▪ Elementary knowledge of Asymptotic behavior ▪ Time complexity (selection statement, loops and nested loops) ▪ Space complexity (selection statement, loops and nested loops)	CLO 1		
W2.	Revision of OOP concepts	L3.	▪ Class, object, structure, data members and functions ▪ Functions (by reference, by value) and function calling ▪ Inter class communication ▪ Operator and function overloading	CLO 1	Out-put practice Questions	
		L4.	▪ Friend function and class ▪ Static functions and classes ▪ Inheritance ▪ Virtual and pure virtual class	CLO 1	Assignment 1	
W3.	Array (based on previous PF and OOP concepts)	L5.	▪ Static vs Dynamic Array ▪ Object Array	CLO 3,4		
		L6.	▪ Pointer to (integer, character and object) array ▪ Passing array by reference ▪ Printing array (loop, pointer addresses) ▪ Time and space complexity	CLO 3,4	Out-put practice Questions	
W4.	Array Data Structure	L7.	▪ Declaration ▪ Insertion & deletion (general algorithm approach) ▪ Time and space complexity	CLO 3,4		
		L8.	▪ Declaring NULL (integer, char and object) array ▪ Searching sub string ▪ Resizing array (increasing and decreasing) ▪ Time and space complexity	CLO 3,4	Quiz 1: Arrays and Pointers	
W5.	Sorting Algorithmic Approaches	L9.	▪ Recursion ▪ Insertion sort, selection and bubble sort (time and space complexity)	CLO 3,4		
		L10.	▪ Merge sort, Quick Sort (time and space complexity)	CLO 3,4		
W6.	Linked List (singly) Data Structure	L11.	▪ Introduction of LL : theoretic concepts ▪ Concept of a node, creating a node ▪ Creating a line between node (internal single pointer)	CLO 3,4	Assignment 2	
		L12.	▪ Theoretical concept/ logic of adding a node to LL	CLO 3,4	Quiz 2: Singly LL+ Sorting	Project Discussion

			▪ Time and space complexity ▪ Operations: ▪ Insertion (add to head, tail)		Algorithms	
W7.	Linked List (singly) Data Structure	L13.	▪ Traversal , displaying nodes of a LL ▪ Time and space complexity	CLO 3,4		
		L14.	– Searching a node – Deletion(first node)			
W8.	Linked List(Singly) Data Structure	L15.	– Deletion(last node, in between nodes) – Time and space complexity			
		L16.	– Sorting Linked Lists – Time and space complexity			
W9.	**Mid Term Exam Week**	L17.				
		L18.				
W10.	Linked List (Double, circular link list) Data Structure	L19.	▪ Introduction to double LL ▪ Operations (add, search, update, remove) ▪ Time and space complexity	CLO 4,5		Project Proposal Submission
		L20.	▪ Introduction to circular LL ▪ Operations (add, search, update, remove) ▪ Time and space complexity	CLO 4,5		
W11.	Stacks Data Structures	L21.	▪ Introduction ▪ Array based Implementation ▪ Creating stack ▪ Operations (Push, Pop, Top, IsEmpty) ▪ Resizing stack ▪ Time and space complexity	CLO ,4,5		Project Deliverable 1
		L22.	▪ Implementation of stacks (pre-fix, in-fix, post-fix) ▪ Time and space complexity	CLO 4,5		
W12.	Queue Data Structure	L23.	▪ Introduction ▪ Queue Operations using Array Enqueue, Dequeue, getFront, getRare ▪ Time and space complexity	CLO 4,5	Assignment 3: Priority queues	
		L24.	▪ Circular Queue ▪ Operations using Array ▪ Time and space complexity	CLO 4,5	Quiz : Stacks & Queues	
W13.	Tree Data Structures	L25.	▪ Introduction(linear and Binary Search) ▪ Introduction (terminologies): root, leaf nodes, non-leaf nodes, height of the tree ▪ Complete tree ▪ Binary Tree (B-Tree) ▪ Insertion Operation	CLO 3,4		
		L26.	▪ Tree Traversing (in-order, Pre-order, Post-order) ▪ Searching node ▪ Finding Maximum and Minimum	CLO 3,4		Project Deliverable 2

W14.	Tree Data Structures	L27.	▪ Heaps (max, min) ▪ Adding a node to a heap	CLO 3,4		
		L28.	▪ Heaps operations (searching, remove)	CLO 3,4	Assignment 4	
W15.	Tree Data Structures	L29.	▪ AVL Trees Introduction ▪ Problem with B-Tree ▪ Cases of Linearity ▪ Tri-Node Restructuring	CLO 3,4	Quiz : Trees	Project deliverable 3
		L30.	▪ Algorithm to Find height balance Property ▪ Tri-Node Restructuring Algorithm	CLO 3,4		
W16.	Hash Tables	L31.	▪ Introduction ▪ Hashing ▪ Problems with hashing	CLO 4,5		
		L32.	▪ Collision Resolution ▪ Separate Chaining ▪ Open Addressing	CLO 3,4		
W17.	Hash Tables	L33.	▪ Project Demonstrations			
		L34.	▪ Project Demonstrations			
W18.	**Final Term Exam**		**Final Term Exam**			

LAB CONTENTS				
Week No.	**Topic**	**Lab Contents / Activity**	**Home Tasks**	**Relation with CLO**
W1.	Revision of OOP concepts	– Single Class, Struct, Object – Function calling – Function overloading		CLO 1,2,3
W2.	Revision of OOP concepts	– Friend function – Inheritance – Polymorphism		CLO 1,2,3
W3.	Arrays & Pointers	– Pointers (declaration and usage) – Pointer arrays		CLO 2,3,4,5
W4.	Array as Data Structures	– Static Arrays – Inserting data – General sorting approach implementation		CLO 2,3,4,5
W5.	Sorting Algorithm	– Insertion, selection, merge and quick sort implementation		CLO 2,3,4,5
W6.	Link List	– Simple single list implementation (add, remove, search, display) – Application of LL (add, remove, search, display)		CLO 3,4,5
W7.	Link List	– Double LL (add, remove, search, display)		CLO 3,4,5
W8.	Link List	– Circular LL (add, remove, search, display)		CLO 3,4,5
W9.	Mid Term Exam Week	▪ Mid Term Examination		CLO 1,2, 3,4
W10.	Stacks	– Basic stack implementation (add, remove, search, display) – Application of stacks (pre-fix, in-fix, post fix)		CLO 3,4,5
W11.	Queues	– Basic queue implementation (add, remove, search, display) – Application of queues		CLO 3,4,5
W12.	Binary Trees	– Basic implementation BT (add, remove, search, display) – Implementation BST (add, remove, search, display)		CLO 3,4,5
W13.	Heaps	– Implementation of heaps (max/min) (add, remove, search, display) – Application of heaps		CLO 3,4,5
W14.	AVL Trees	– Implementation of AVL trees (add, remove, search, display)		CLO 3,4,5
W15.	Hash Tables	– Implementation of Hash Tables (add, remove, search, display) – Collision correction		CLO 3,4,5
W16.	Graphs	– Basic graphs (directed, undirected) (add, remove, search, display) –		CLO 3,4,5
W17.	Project Demonstration	– Project Demonstrations		CLO 2,3,4,5
W18.	Final exam	▪ Final exam		CLO

				2,3,4,5