

The Superior University Lahore
Faculty of Computer Science & Information Technology
Course Outline

Course Information	Course Title	Data Structure & Algorithm (Python)		
	Course ID	CPR601220	Course Type	Computing Core
	Credit hours	3 + 1	Hours per week (C-L)	3 + 1
	Programs	BS (AI), BS (DS)	Preferred Semester	3
	Date	2024-08-19	Version	1.0
	Instructor	Hafiz Muhammad Tayyab Khushi	TA / Lab Engineer	Philemon
Course Description	<p>The purpose of this course is to provide the students with solid foundations in the basic concepts of programming: data structures and algorithms. 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. This course is also about showing the correctness of algorithms and studying their computational complexities. This course offers the students a mixture of theoretical knowledge and practical experience.</p> <p>The study of data structures and algorithms is carried out within an object-oriented framework. When implementations are considered, the Python programming language is used.</p> <p>The course focuses on basic and essential topics in data structures, including array-based lists, linked lists Introduction to Data Structures and Algorithms, Complexity Analysis, Arrays, Sorting Algorithms: Insertion Sort, Selection Sort, Bubble Sort, Shell Sort, Heap Sort, Quick Sort, Merge Sort, Radix Sort, Bucket Sort, Linked Lists: Singly Linked Lists, Doubly Linked Lists, Circular List, Stacks, Queues, and Priority Queue, Recursion: Function call and Recursion Implementation, Tail Recursion, Non-tail Recursion, Indirect Recursion, Nested Recursion, Backtracking, Trees: Binary Trees, Binary Heap, Binary Search. Tree Traversal, Insertion, Deletion, and Balancing a Tree, Heap, B-Tree, Spanning Tree, Splay Trees, Graphs: Representation, Traversal, Shortest Path, and Cycle Detection, Isomorphic Graphs; Graph Traversal Algorithms, Hashing, Memory Management and Garbage Collection.</p>			
Course Objectives	The objective of this course is to enable students;			
	No.	Objective	Relation with Program Objectives	
	1.	To impart the basic concepts of data structures and algorithms.	POL 1,2,3	
	2.	To understand concepts about searching and sorting techniques	POL 4	
	3.	To Understand basic concepts about stacks, queues, lists, trees and graphs.	POL 1-4	
	4.	To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures	POL 1-4	
Course Learning Outcomes (CLO)	At the end of this course students will be able to demonstrate;			
	No.	Outcome	Relation with PLO/PLO	
	1.	Explain the need for efficiency in data structures and algorithms.	PLO 1	
	2.	Apply methods to analyze running time of essential data structures and estimate efficiency of the algorithms and implementations.	PLO 2	

	3.	Understand and apply the concept of abstract data type to represent and implement heterogeneous data structures.					PLO 2
	4.	Write programs using array-based lists, write programs using linked lists, write programs that use skiplists. write code for hash tables, and compare and contrast various collision detection and avoidance techniques.					PLO 3
	5.	Demonstrate skills in tracing, analyzing, and designing recursive algorithms and recursive methods.					PLO 3
	6.	Write programs using binary trees and variations.					PLO 1-3
	7.	Analyze and implement different types of sorting algorithms.					PLO 1-3
	8.	Implement data structures for graphs and approaches for searching graphs using breadth-first, depth-first, best-first search, etc.					PLO 1-4
Lecture type							
Prerequisites	Object Oriented Programming						
Follow up Courses	Design & Analysis of Algorithm						
Course Software or Tool	PyCharm (Recommended), Jupyter Notebook, Anaconda, Spyder, Visual Studio Code						
Textbook	Title		Edition	Authors	Publisher	Year	ISBN
	Data Structures and Algorithms in Python,		Anu	Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser	Wily	2014	978-0-13-284737-7
	Data Structures and Algorithms using Python		4th	Rance D Necaie	Wily	2016	1-133-60842-6
Assessment Criteria (100%)	Assessment	Weight	Used to attain CLO	Assessment		Weight	Used to attain CLO
	Assignment	0%		Quiz		0%	
	Lab	30%		Project / Presentation		30%	
	Attendance	0%		Participation		0%	
	Mid Term	0%		Final		40%	
Methods of Evaluation	Quizzes, Assignments, Mid Term, Final Term, and Semester Project.						
Notes							

Week No.	Topic	Lecture No.	Lecture Contents	Relation with CLO
W1.	Introduction to Data structures and algorithms (DSA)	L1.	<ul style="list-style-type: none">• Introduction to data structures and algorithms• Why do we need data structures and algorithms?• Course module and book discussion	CLO1
		L2.	<ul style="list-style-type: none">• Discussion on different data structures• Discussion on different algorithms	CLO1
W2.	Stack & Queue Python Implementation	L3.	<ul style="list-style-type: none">• Stack	CLO1
		L4.	<ul style="list-style-type: none">• Queue	
W3.	Recursions & Sorting Algorithms Python Implementations	L5.	<ul style="list-style-type: none">• Concept of recursion• Insertion Sort• Selection Sort• Shell Sort Heap Sort• Bubble Sort• Quick Sort• Merge Sort• Radix Sort• Bucket Sort	CLO 1,2,3
L6.				
W4.		L7.		
		L8.		
W5.	Linked List (Implementation using python list)	L9.	<ul style="list-style-type: none">• Singly Linked List• Insertion<ul style="list-style-type: none">◦ Beginning of List.◦ End of List.• Before / After any number / Location• Deletion<ul style="list-style-type: none">◦ Beginning of List.◦ End of List.◦ Before / After any number / Location	CLO2
		L10.	<ul style="list-style-type: none">• Searching<ul style="list-style-type: none">◦ Beginning of List.◦ End of List.	

			○ Before / After any number / Location	
W6.	Double & Circular Linked List	L11.	• Double & Circular Linked (Insertion)	
		L12.	• Double & Circular Linked List (Deletion & Searching)	
W7.	NUMPY ARRAYS Data Structure	L13.	• Difference between python list and numpy • Mathematical operations • Martix operations • N Dimentionla Array Opearations	
		L14.	• All sorting algorithmes using the NUMPY arrays and measuring the and time and space complexity using the Python functions	
W8.	Python PANDAS Data Structures – 1	L15.	• Difference between the python list and Pandas Series & Pandas Data Frames • Difference between NUMPY List and Pandas data frames	
		L16.	• Revision	
W9.	Mid Term	L17.	• Mid Term Week	
		L18.		
W10.	Python PANDAS Data Structures- 2	L19.	• Reading the Large data sets and csv files using the pandas data frames	CLO 1,2,3
		L20.	• Row / column / matrix and n-dimensional operations using the combinations of pandas data structure and NumPy operations	
W11.	Tree with NUMPY Arrays, Pandas and Normal python Lists	L21.	• Trees with python list	CLO 1,2,3,4
		L22.	• Tree with numpy arrays and pandas series	
W12.		L23.	• Tree & its Terminology	CLO 1,2,3,4
		L24.	• Binary Tree • Binary Search Tree • AVL Tree • Tree Balancing	
W13.	Tree	L25.	• Implementation of Binary Tree	CLO 1,2,3,4

	Implementation	L26.	<ul style="list-style-type: none">Tree Traversing	
W14.	Graphs (Python Implementations) with NUMPY Arrays & Normal Lists	L27.	<ul style="list-style-type: none">Introduction of Graphs	CLO 1,2,3,4
		L28.	<ul style="list-style-type: none">Graph Types	
W15.		L29.	<ul style="list-style-type: none">Graph Traversing	
		L30.		
W16.		Hashing	L31.	
	L32.		<ul style="list-style-type: none">Garbage Collection	
W17.	Final Exam		<ul style="list-style-type: none">Final Exam	