COMSATS University Islamabad, Lahore Campus

Defence Road, Off Raiwind Road, Lahore

COURSE HANDBOOK

1.	**Course Title**	Design and Analysis of Algorithms
2.	**Course Code**	CSC 301
3.	**Credit Hours**	3(3,0)
4.	**Semester**	Semester 5
5.	**Pre-Requisite**	CSC211
6.	**Resource Person**	Dr. Muhammad Hasan Jamal
7.	**Resource Person Contact**	mhjamal@cuilahore.edu.pk
8.	**Contact Hours (Theory)**	3 hours per week
9.	**Contact Hours (Lab)**	Not Applicable
10.	**Office Hours**	TBD

11. Course Introduction

This course is designed to enable students to understand the design, complexity and efficiency issues related to different algorithms. It is an introductory course to the design and analysis of algorithms. It covers mainly asymptotic analysis of time complexity, Proofs of correctness, algorithms, and advanced data structures for searching and sorting lists, and graph algorithms. Some advance topics like greedy algorithms, approximation algorithms, heuristics, and dynamic programming with their applications are also introduced.

12. Course Objectives

- To develop an ability to analyse the asymptotic performance of algorithms.
- To discuss rigorous correctness proofs for algorithms.
- To explain the major algorithms and data structures
- To apply important algorithmic design paradigms and methods of analysis.
- To highlight the significance of NP complete problems;

13. Course Contents

Problem solving: using Loop Invariants to show algorithms correctness; Asymptotic Notations: Worst, Best and Average case behaviour of algorithms; Big O notation; Complexity classes i.e. constant, linear, quadratic; Empirical measurements of performance; time and space trade-offs in algorithms; Recurrence Algorithms; Analysis of iterative and recurrence relations; Master Theorem; Divide and Conquer; Recursive Backtracking; lower/upper bounds on the complexity of various sorting and searching algorithms; Graph algorithms; Brute Force algorithms; Greedy algorithms; Approximation algorithms; Dynamic Programming; Branch-and-Bound Techniques; Heuristics; Reductions; Transform and Conquer; Basic Computability: The complexity classes P and NP; introduction to NP complete problems.

14. Lecture Schedule

Weeks	**Topic of Lecture**	**Reading Assignment**
Week 1	***Introduction to Algorithms:*** Definition of Algorithm and its role in computing, its implementation domain, data structure & techniques. Introduction to Algorithm analysis and its importance, RAM model, methods for analysing algorithms, algorithm efficiency, complexity and order of growth, and some other case studies, benchmarks for analysis, complexity classes, Big – Oh Notation.	

Week 2 & 3	***Growth of Functions:*** Asymptotic notations, ***O,*** **Θ** and **Ω** notations, asymptotic notation in equations and inequalities, comparison of functions, standard notations & common function. Association of asymptotic notation to complexity classes. ***Quiz 01, Assignment 01***	
Week 4 & 5	***Design and analysis of sorting algorithms:*** Sorting and order statistics, structure of data, why sorting is used? Incremental approach for sorting; description and analysis of insertion, selection and bubble sort, best, worst & average case analysis; loop invariants and their correctness. Divide and conquer approach for sorting; description and analysis of merge, quick and heap sort (maintaining heap property, building a heap); worst, average & best-case analysis. Lower bounds for sorting, decision–tree model; sorting in linear time; description and analysis of counting, radix & bucket sorting algorithms; worst, average & best-case analysis. Revision of Course for **First Sessional**	
Week 6	***Sessional – I, Paper Checking and discussion about the solution of the paper***	
Week 7 & 8	***Recurrences & Recurrence Relations:*** Recursion technicalities, mathematical modelling of recursive equations; examples of recursive algorithms e.g., Fibonacci series and Towers of Hanoi problem; the recursion–tree method and its various cases; the Master method, the Master theorem & its use. ***Quiz 02, Assignment 02***	
Week 9	***Hash Table & Hashing:*** Designing a universal class of hash functions; collision handling using separate chaining method and its analysis; collision handling using open addressing method and its analysis linear probing, quadratic probing, and double Hashing. ***Quiz 03, Assignment 03***	
Week 10	**Graphs:** representation of graphs, Depth First and Breadth First Traversal; Minimum Spanning Trees, Prims Algorithm, Kruskal Algorithm, Djikstras Shortest path Algorithm	
Week 11	Brute Force Algorithms; branch and bound techniques; heuristics; reductions; transform and conquer method. Revision of Course for **Second Sessional**	
Week 12	***Sessional – II, Paper Checking and discussion about the solution of the paper***	
Week 13	***Greedy Algorithms:*** Elements of the greedy strategy, greedy choice property, optimal substructure, greedy versus dynamic programming. Huffman Coding construction and Correctness; Bin Packing algorithm; graph colouring algorithm. ***Quiz 04, Assignment 04***	
Week 14	***Dynamic Programming:*** Assembly-line scheduling, fastest way through the factory, recursive solution, computation of the fastest time, construction of fastest way, Matrix–chain Multiplication, 0-1 Knapsack Problem, recursive solution, optimal cost calculation, construction of optimal solution.	
Week 15 & 16	***Complexity Classes:*** P and NP complexity classes; introduction to NP complete problems. Approximation algorithms. **Revision of course**	

15.	Course Assessment

The assessment of this module shall have following breakdown structure

First Sessional Test	10%
Second Sessional Test	15%
Quizzes/Assignments	25%
Terminal Examination	50%

The minimum pass marks for each course shall be 50%. Students obtaining less than 50% marks in any course shall be deemed to have failed in that course. The correspondence between letter grades, credit points, and percentage marks at CIIT shall be as follows:

Grades	Letter Grade	Credit Points	Percentage Marks
A	(Excellent)	4.0	90and above
A-		3.7	85-89
B+		3.3	80-84
B	(Good)	3.0	75-79
B-		2.7	70-74
C+		2.3	65-69
C	(Average)	2.0	60-64
C-		1.7	55-59
D	(Minimum passing)	1.3	50-54
F	(Failing)	0.0	Less than 50

Note: The marks to be assigned to students shall be in whole numbers and are not same as followed in the annual system of Lancaster University.

16.	Assessment Schedule	
	Week 3	***Quiz 01, Assignment 01***
	Week 6	***Sessional-I***
	Week 8	***Quiz 02, Assignment 02***
	Week 10	***Quiz 03, Assignment 03***
	Week 12	***Sessional-II***
	Week 15	***Quiz 04. Assignment 04***
	Week 17-18	***Terminal Examination***

17. Format of Assignment

This course indoctrinates the following format for all its assignments:

1. Paper Size: A4
2. Left Margin: 2 Inches
3. Right Margin: 1 Inch
4. Top Margin: 0.5 Inch
5. Bottom Margin: 0.5 Inch
6. Font: Times New Roman
7. Font Size:
    a. Main Heading 14
    b. Sub Heading 12
    c. Text 12
    d. Titles 16
8. Font Color: Black
9. Line Spacing: 1.5
10. Diagrams & Charts: Need not be colored
11. Title page must be designed as guided by resource person in class
12. Number of Pages: No Limit
13. Reference Style: APA (If applicable)

18.	**Textbook**	T. H. Cormen, C. E. Leiserson, and R. L. Rivest (2009), *Introduction to Algorithms,* (3rd Ed.) MIT Press, McGraw-Hill, New York.
19.	**Reference Books**	R. Sedgewick and Flajolet, P., (2012), *An Introduction to the Analysis of Algorithms*, Addison-Wesley.

20. Plagiarism

Plagiarism involves the unacknowledged use of someone else's work, usually in coursework, and passing it off as if it were one's own. Many students who submit apparently plagiarised work probably do so inadvertently without realising it because of poorly developed study skills, including note taking, referencing and citations; this is poor academic practice rather than malpractice. Some students, particularly those from different cultures and educational systems, find UK academic referencing/acknowledgement systems and conventions awkward, and proof-reading is not always easy for dyslexic students and some visually impaired students. Study skills education within programmes of study should minimise the number of students submitting poorly referenced work. However, some students plagiarise deliberately, with the intent to deceive. This intentional malpractice is a conscious, pre-mediated form of cheating and is regarded as a particularly serious breach of the core values of academic integrity. C**OMSATS University Islamabad has zero tolerance for intentional plagiarism.**

Plagiarism can include the following:

1. collusion, where a piece of work prepared by a group is represented as if it were the student's own.
2. commission or use of work by the student which is not his/her own and representing it as if it were, e.g.:
    a. purchase of a paper from a commercial service, including internet sites, whether pre-written or specially prepared for the student concerned
    b. submission of a paper written by another person, either by a fellow student or a person who is not a member of the university.
3. duplication (of one's own work) of the same or almost identical work for more than one module.
4. the act of copying or paraphrasing a paper from a source text, whether in manuscript, printed or electronic form, without appropriate acknowledgement (this includes quoting directly from another source with a reference but without quotation marks);
5. submission of another student's work, whether with or without that student's knowledge or consent.
6. Directly quoting from model solutions/answers made available in previous years.
7. cheating in class tests, e.g.
    a. when a candidate communicates, or attempts to communicate, with a fellow candidate or individual who is neither an invigilator nor member of staff
    b. copies, or attempts to copy from a fellow candidate
    c. attempts to introduce or consult during the examination any unauthorised printed or written material, or electronic calculating, information storage device, mobile phones or other communication device
    d. personates or allows himself or herself to be impersonated.
8. Fabrication of results occurs when a student claims to have carried out tests, experiments or observations that have not taken place or presents results not supported by the evidence with the object of obtaining an unfair advantage.

These definitions apply to work in whatever format it is presented, including written work, online submissions, groupwork and oral presentations.

21. Attendance Policy

Every student **must attend 80%** of the lectures/seminars delivered in this course and 80% of the practical/laboratory work prescribed for the respective courses. The students falling short of required percentage of attendance of lectures/seminars/practical/laboratory work, etc., shall not be allowed to appear in the terminal examination of this course and shall be treated as having failed this course.