COURSE DESCRIPTION FORM: CS-2009: Design and Analysis of Algorithms

INSTITUTION FAST School of Computing, National University of Computer and Emerging Sciences, Islamabad Campus

PROGRAM TO BE EVALUATED BS-CS: **Spring-2024**

Course Description

Course Code	CS-2009
Course Title	Design and Analysis of Algorithms
Credit Hours	3
Course Instructors	Dr. Kashif Munir, Mr. Owais Idrees, Ms. Amna Irum, Ms. Nirmal Tariq
Grading Policy	Absolute grading
Policy about missed assessment items in the course	Retake of missed assessment items (other than sessional/ final exam) will not be held. Student who misses an assessment item (other than sessional / final exam) is awarded zero marks in that assessment item i.e. late submission will not be accepted. For missed sessional/ final exam, exam retake/ pretake application along with necessary evidence are required to be submitted to the department secretary. The examination assessment and retake committee decides the exam retake/ pretake cases.
Course Plagiarism Policy	Plagiarism in project or sessional/ final exam will result in F grade in the course. Plagiarism in an assignment/ quiz will result in zero marks in the whole assignments/ quizzes category.
Prerequisites by Course(s) or Topics	Data Structures
Assessment Instruments with Weights (homeworks, quizzes, sessional exams, final exam, assignments, etc.)	Assessment with the weight.

Assessment Type	**Weight (%)**
Assignments (3)	5
Quizzes	10
Project	10
Sessional Exams (2); 15% each	30
Final Exam	45

Course Coordinator	Mr. Owais Idrees, Ms. Amna Irum
URL (if any)	
Course Catalog Description	Introduction; role of algorithms in computing, Analysis on nature of input and size of input Asymptotic notations; Big-O, Big Ω, Θ, little-o, little-ω, Sorting Algorithm analysis, loop invariants, Recursion and recurrence relations; Algorithm Design Techniques, Brute Force Approach, Divide-and-conquer approach; Merge, Quick Sort, Greedy approach; Dynamic

	programming; Elements of Dynamic Programming, Search trees; Heaps; Hashing; Graph algorithms, shortest paths, sparse graphs, String matching, Amortized Analysis
Textbook	Thomas H. Cormen et al. "Introduction to Algorithms" 4th Edition.
Reference Material	Anany Levitin "Introduction to the design and analysis of algorithms" 3rd Edition.
Course Goals	

A. Course Learning Outcomes (CLOs)

After course completion, the students shall be able to:

CLO	PLO Mapping
1. **Design** algorithms using different algorithms design techniques i.e. Brute Force, Divide and Conquer, Dynamic Programming, Greedy Algorithms and apply them to solve problems in the domain of the program	1
2. Analyze the time and space complexity of different algorithms by using standard asymptotic notations for recursive and non-recursive algorithms	2
3. **Evaluate** the correctness of algorithms by using theorem proving or executing test cases	4
4. I**mplement** the algorithms, compare the implementations empirically, and apply fundamental algorithms knowledge to solve practical problems related to the program	5

B. Program Learning Outcomes (PLOs)

PLO 1	Computing Knowledge	Apply knowledge of mathematics, natural sciences, computing fundamentals, and computing specialization to the solution of complex computing problems.
PLO 2	Problem Analysis	Identify, formulate, research literature, and analyze complex computational problems, reaching substantiated conclusions using first principles of mathematics, natural sciences, and computing sciences.
PLO 3	Design/ Develop Solutions	Design solutions for complex computing problems and design systems, components, and processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PLO 4	Investigation & Experimentation	Conduct investigation of complex computing problems using research based knowledge and research based methods

	PLO 5	Modern Tool Usage	Create, select, and apply appropriate techniques, resources and modern computing tools, including prediction and modelling for complex computing problems.
	PLO 6	Society Responsibility	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues relevant to context of complex computing problems.
	PLO 7	Environment and Sustainability	Understand and evaluate sustainability and impact of professional computing work in the solution of complex computing problems.
	PLO 8	Ethics	Apply ethical principles and commit to professional ethics, responsibilities, and norms of computing practice.
	PLO 9	Individual and Team Work	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
	PLO 10	Communication	Communicate effectively on complex computing activities with the computing community and with society at large.
	PLO 11	Project Management and Finance	Demonstrate knowledge and understanding of management principles and economic decision making and apply these to one's own work as a member or a team.
	PLO 12	Life Long Learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological changes.

Topics covered in the course
(assume 15-week instruction and 3 contact hours per week)

1. Topics to be covered:

List of Topics	No. of Weeks	Contact Hours	CLO(s)
Basics of Algorithms, Mathematical Foundation, Growth of Function, Asymptotic Notations.	**2**	**6**	**2,3**
Divide and Conquer, Recurrences, Iteration/ algebraic method, Recurrence-Tree Method, Master's Method.	**2**	**6**	**2,3**
Sorting (Merge, Insertion, Quick, Heap, Counting, Radix), Heaps	**2**	**6**	**1,2,3,4**
String Matching Algorithms	**2**	**6**	**2,4,5**

	Greedy Algorithms (Graph Terminology, Representation of Graphs, BFS & DFS, Kruskal's Algorithm, Prim's Algorithm, Dijkstra's Algorithm)	**1.5**	**4.5**	**2, 4**	
	Dynamic Programming	**4.5**	**13.5**	**1,2**	
	Hashing	**0.5**	**1.5**	**1,4,6**	
	Amortized Analysis	**0.5**	**1.5**	**1,4,6**	
	Total	**15**	**45**		

Programming Language for Assignments	C++			
Class Time Spent (in percentage)	**Theory**	**Problem Analysis**	**Solution Design**	**Social and Ethical Issues**
	55	20	20	5
Oral and Written Communications	Every student is required to submit __4___ written reports of typically ___6____ pages each.			