Description of Course CSE 207

PART A: General Information

1	**Course Title**	: DATA STRUCTURES AND ALGORITHMS II
2	**Type of Course**	: THEORY
3	**Offered to**	: DEPARTMENT OF CSE
4	**Pre-requisite Course(s)**	: N/A

PART B: Course Details

1. Course Content (As approved by the Academic Council)

Graph algorithms: minimum spanning tree algorithms, shortest path algorithms, maximum flow and maximum bipartite matching; Advanced data Structures: balanced binary search trees (AVL trees, red-black trees, splay trees), skip list, advanced heaps (Fibonacci heaps, binomial heaps); Hashing; NP-completeness; NP-hard and NP-complete problems; Coping with hardness: backtracking, branch and bound, approximation algorithms.

2. Course Objectives

The students are expected to:

i. understand and analyze performance of algorithms in terms of time and space, and evaluate the correctness of algorithms,
ii. formulate various algorithmic problems and design efficient algorithms to solve those problems,
iii. solve real world problems using various data structures and algorithms,
iv. utilize advanced data structures for efficient implementations of algorithms,
v. understand various complexity classes of algorithmic problems and compare between them, and
vi. design backtracking, branch and bound and efficient approximation algorithms to cope with hard combinatorial problems.

3. Knowledge required

Technical

- Programming language

Mathematics

- Discrete mathematics

4. Course Outcomes (COs)

CO No.	**CO Statement** After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	**Understand and analyze** performance of algorithms in terms of time and space and **evaluate** the correctness of algorithms	PO1, PO2, PO4	C4, A5	Lecture, problem solving, coding and development	Assignments or Projects, Viva, Quiz
CO2	**Formulate** various algorithmic problems and **utilize** efficient data structures and algorithms to solve real world problems	PO2, PO3, PO5, PO6, PO12	C5, A2, P5	Lecture, problem solving, coding and development	Assignments or Projects, Viva, Quiz
CO3	**Understand** various complexity classes of algorithmic problems and **compare** between them	PO4, PO9, PO12	C4, A3, P3	Lecture, problem solving, and hands-on	Assignments or Projects, Viva, Quiz

***Program Outcomes (POs)**

PO1: Engineering knowledge; PO2: Problem analysis; PO3: Design/development of solutions; PO4: Investigation; PO5: Modern tool usage; PO6: The engineer and society; PO7: Environment and sustainability; PO8: Ethics; PO9: Individual work and teamwork; PO10: Communication; PO11: Project management and finance; PO12: Life-long learning.

**Domains

C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

5. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1		√	√		√			√	√			√			√					
CO2		√			√	√	√		√		√			√	√			√	√	√
CO3		√	√	√				√	√			√						√		

K-Knowledge Profile:

K1: A systematic, theory-based understanding of the natural sciences applicable to the discipline; **K2:** Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline; **K3:** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline; **K4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline; **K5:** Knowledge that supports engineering design in a practice area; **K6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline; **K7:** Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability; **K8:** Engagement with selected knowledge in the research literature of the discipline

P-Range of Complex Engineering Problem Solving:

P1: Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach; **P2:** Involve wide-ranging or conflicting technical, engineering and other issues; **P3:** Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models; **P4:** Involve infrequently encountered issues; **P5:** Are outside problems encompassed by standards and codes of practice for professional engineering; **P6:** Involve diverse groups of stakeholders with widely varying needs; **P7:** Are high level problems including many component parts or sub-problems

A-Range of Complex Engineering Activities:

A1: Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies); **A2:** Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues; **A3:** Involve creative use of engineering principles and research-based knowledge in novel ways; **A4:** Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation; **A5:** Can extend beyond previous experiences by applying principles-based approaches

6. Lecture/ Activity Plan

Week	Topics	Corresponding CO(s)
Week 1	Introduction, Basic Graph Algorithms	CO1
Week 2	Shortest path algorithms, Minimum Spanning Tree	CO1, CO2
Week 3	Minimum Spanning Tree, All Pair shortest Path	CO1, CO2
Week 4	Maximum Flow and Maximum Bipartite Matching	CO1, CO2
Week 5	Advanced heaps (Fibonacci heaps, binomial heaps)	CO1, CO2
Week 6	AVL tree, Skip list	CO1, CO2
Week 7	Red-black tree	CO1, CO2
Week 8	Splay tree	CO1, CO2
Week 9	Hashing	CO1, CO2
Week 10	NP-completeness;	CO1, CO2, CO3
Week 11	NP-completeness; NP-hard and NP complete problems	CO1, CO2, CO3
Week 12	Coping with hardness: Backtracking, branch and bound	CO1, CO2
Week 13	Approximation algorithms	CO1, CO2

7. Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

8. Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

9. Textbook/ Reference

a. Algorithm Design, by Michael T. Goodrich and Roberto Tamassia, John Wiley & Sons, Inc.
b. Algorithms, by Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani.
c. Introduction to Algorithms, by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and, Clifford Stein, MIT Press.
d. Algorithm Design, by Jon Kleinberg and Eva Tardos, Pearsons Publishers.
e. Introduction to the Design & Analysis of Algorithms, by Anany Levitin.
f. Algorithm Design Manual, by Steven S. Skiena.

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