FIRST SEMESTER, 2026–2027
Course Handout Part II

Date: 30th July 2026

In addition to part I (General Handout for all courses appended to the Timetable), this portion gives further specific details regarding the course.

Course No : CS G526
Course Title : Advanced Algorithms & Complexity
Instructor-in-Charge : Tulasimohan Molli (TA: Hans Krupakar)
Instructors : Tulasimohan Molli

1. Course Description:

This course explores advanced paradigms in algorithm design and analysis beyond the core curriculum, coupled with a serious study of complexity theory. It covers randomized algorithms, approximation algorithms, online algorithms, and a focused introduction to two-player matrix games (von Neumann's minimax theorem and the multiplicative weights update), alongside parallel & distributed algorithms. Complexity theory is treated in depth—NP-completeness and reductions, the polynomial hierarchy, counting (#P), and interactive & zero-knowledge proofs—showing both what is computationally hard and what can still be achieved for hard problems.

2. Scope & Objective of the Course:

The course equips students with the mathematical tools and algorithmic techniques needed to reason about computationally hard problems and to design efficient algorithms under uncertainty. Emphasis is placed on both rigorous theoretical analysis and practical algorithm engineering.

3. Textbooks:

T1. *Randomized Algorithms*, R. Motwani & P. Raghavan, CUP, 1995.

T2. *Combinatorial Optimization: Algorithms and Complexity*, C. H. Papadimitriou & K. Steiglitz, PHI, 1982.

T3. *Computational Complexity: A Modern Approach*, S. Arora & B. Barak, Cambridge University Press.

References:

R1. *The Design of Approximation Algorithms*, D. Williamson & D. Shmoys, Cambridge University Press.

R2. *Design and Analysis of Randomized Algorithms*, J. Hromkovic, Springer.

R3. *Approximation Algorithms*, V. Vazirani, Springer.

R4. *Complexity and Approximation*, G. Ausiello, P. Crescenzi, G. Gambosi, V. Kann, A. Marchetti-Spaccamela, M. Protasi, Springer.

R5. *Algorithm Design*, J. Kleinberg & E. Tardos, Pearson Education.

R6. Additional reading assigned by the Instructor.

4. Course Plan:

Weekly plan for 14 weeks with 3 lectures per week

Week no.	Module No.	Description	Reference
1.	M1	Introduction — Advanced Algorithms & Complexity; Review of Probability & Complexity Classes	T1 C1
2.	M1	Las Vegas & Monte Carlo, Freivalds, Min-Cut; PIT, Schwartz–Zippel	T1 C1
3.	M2	Tail Inequalities, Chebyshev, Chernoff Bounds and Applications	T1 C3–4
4.	M3	Skip Lists, Hash Tables, Cuckoo Hashing	T1 C8
5.	M3	Randomized Graph Algorithms: MST, Shortest Paths, Matching	T1 C10
6.	M4	Two-Player Matrix Games; von Neumann's Minimax Theorem; Multiplicative Weights Update	T1 C4
7.	M5	Competitive Ratio, Ski Rental, Paging, Secretary Problem	T1 C13
8.	M6	Euclid, Euler's phi, Primality Testing	T1 C14
9.	M7	PRAM, Prefix, MIS; Byzantine Agreement, Consensus	T1 C12
10.	M8	NP-Completeness & Reductions: Decision Problems, Cook–Levin, Polynomial Hierarchy	T3 C2–4
11.	M9	Greedy, LP Rounding, Primal-Dual, Local Search; Set Cover, TSP	R1, R3
12.	M9/M10	Approximation Schemes: PTAS, APX; Inapproximability, Gap Technique; Interactive Proofs	R4, T3 C8, 11
13.	M10	Interactive & Zero-Knowledge Proofs; #P & Counting; Algebraic Counting Methods	T3 C8–9, T1 C1
14.	M11	Student Project Proposal Presentations	—

5. Evaluation Scheme:

Component	Wt (%)	Duration	Date & Time	Comments
Class participation	10	in class	throughout	Open Book
Term Project	20	during sem	throughout	proposal + final presentation + report, Open Book
Lab participation	10	weekly	Wed/Fri	Weekly problem solving exercises, Open Book
Mid-Semester	25	90 mins.	06/10	Closed Book
Comprehensive Examination	35	180 mins.	04/12 AN	Closed Book

NC Criterion: 30% of the average of the top three performers or 40% of median, whichever is lower, or a suitable modification at the discretion of the IC with the concurrence of the Department.

6. Office Consultation Hour:

Monday 3:00–4:00 PM, H-134. Also, feel free to email me to seek a prior appointment.

7. Make-up Policy:

Make-up tests will be given only to genuine cases with the prior permission of the Instructor-in-Charge, following the regulations set by the AGSRD office. No make-up will be given for the tutorial tests.

8. Academic Honesty and Integrity Policy:

Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

9. Disclaimer:

Any kind of unfair means in exams and assignments will be strictly dealt.

Instructor-in-charge
CS G526: Advanced Algorithms & Complexity