First Semester 2015-2016

Course Handout Part II

Date: 03/08/2015

In addition to the 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: Dr. Tathagata Ray

1. Scope and Objective:

The objective of this course is to enable each individual student to pursue some of these activities:

- explore advanced topics in algorithmic and complexity theory;
- engage in analysis and design of complex algorithms for real-world problems in current application domains;
- learn and evaluate advanced / novel algorithm design strategies and techniques; and
- understand sturdy / open problems in algorithmic or complexity theory by analyzing known approaches and their limitations.

The scope of this course includes (i) algorithm design strategies such as Randomization and Approximation as well as specific techniques therein (ii) NP-hard problems and approaches to handle them and (iii) problem/application domains such as online social networks, Internet and the Web, number theory and cryptography, and distributed computing.

While algorithm analysis is included in the scope wherever applicable the emphasis of the course is on algorithm design as such and specific analysis techniques are not emphasized. While the student is exposed to various problem/application domains from an algorithmic perspective the focus is not on the domains but on specific problems and approaches to solving those problems. Of course, the student is encouraged – if interested – to pursue a specific domain for a project during the course and – occasionally, if the student is tenacious enough – beyond the course.

2. Text Book:

T1. "Randomized Algorithms", by "Motwani, Rajiv & P. Raghavan", CUP, 1995.

T2. "Combinatorial Optim.: Algo. & Complexity", by "Papadimitnou, C.H. & Kenneth Steiglitz", PHI, 1982

3. **Reference Books:**

R1. Approximation Algorithms. Vijay Vazirani. Springer.

R2. Complexity and Approximation, G. Auseiello, et.al. Springer.

R3. Algorithm Design. Kleinberg and Tardos. Pearson Education.

AR. Additional reading assigned by the Instructor

4. **Course Plan**

No. of Lectures	Objectives	Topic	Reference
1	Importance of randomized algorithms and complexity classes	Introduction & Motivation – Advanced Algorithms & Complexity	-
2 – 4	Review of probability theory	Review of Design Techniques, Complexity Classes and necessary basics in Probability	-
5 – 8	Understanding the classification of randomized algorithms	Randomized Algorithms : Las Vegas & Monte Carlo Techniques,	T1 – Ch 1
9-12	Understanding the success rate of the	Chebyshev Inequality, Tail Inequalities	T1-Ch3,

	randomized algorithm		Ch4
13-16	Understanding how randomization helps in creating some advanced data structures	Data Structures for randomized algorithms - Skip Lists and Hash Tables	T1-Ch8
17-19	Understanding how randomization has helped to obtain algorithms better than deterministic counter parts.	Randomized graph algorithms	T1 – Ch 10
20-22	Understanding the Minimax theorem and its implication in game theory.	Game Theoretic Techniques	T1 – Ch 4
23-25	Understanding role of randomization in parallel algorithms.	Parallel and Distributed Algorithms; PRAM model, Maximal independent sets, Byzantine Agreement	T1-Ch12
26-30	Basic Number theoretic algorithms.	Basic Number-Theoretic Algorithms – Euclid's Algorithm, Computing Euler's phi function and Quadratic Residues.	T1 - Ch 14
31-33	Understanding of basics of online algorithms	Online Algorithms	T1 - Ch 13
34-38	Understanding of complexity classes and their definitions. How to prove a problem is NP-Complete?	Optimization Problems and Hardness – NP-complete Optimization problems	T2 – Ch1, Ch2 & Ch 3, R2-Ch1, Ch2, Ch3
39 – 42	Introduction to approximation algorithm and their	Introduction to Approximation Algorithms – Examples. Design Techniques and Complexity Classes	R2- Ch1, Ch2, Ch3

	complexity classes.		

5. Evaluation Scheme:

Sr. No.	Component	Duration	Weightage (%)	Date & Time	Remarks
1.	Test 1	60 min.	15 %	5/10 4:00 - 5:30 PM	OB
2.	Test 2	60 min.	15%		OB
3.	Term Project - Literature survey & Problem statement - Problem Scoping and Analysis, Mid-Term Progress & Report - Seminar - Conclusion, Viva and Report		40 %		
4.	Compre Exam	3 hrs.	30 %	2/12 AN	CB + OB

6. Chamber Consultation hours: To be announced in the class.

7. Make-up Policy:

Prior Permission of the Instructor-in-Charge is usually required to take a make-up for a test.

A make-up test shall be granted only in genuine cases on justifiable grounds.

8. Notices: Notice regarding the course will be displayed on the CMS and CS & IS group notice board.

Instructor-in-charge

CS G526.