

## CS5234 : Combinatorial and Graph Algorithms

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Fall 2007 (Aug-Dec 2007)

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**Web-Site:** <http://www.comp.nus.edu.sg/~cs5234/2007-08/>

#### Objectives:

This course presents *advanced* material on the design and analysis of combinatorial algorithms with emphasis on efficient algorithms and data structures. It also provides practical experience of re-using a C++ library of advanced data structures and algorithms in software development. This course is meant for students who intend to do (i) research work in computer science in general, and algorithm design in particular, or (ii) advanced application/software development in other areas of computer science.

**Target Students:** Advanced Undergraduate students;  
Beginning graduate students;  
Those doing research in algorithm design;

**Pre-requisites:** CS3230 Design and Analysis of Algorithms  
(See more pre-req. info on this on course web-site)

#### Main TextBook:

[CLRS] *Introduction to Algorithms, (2<sup>nd</sup> edition)*  
Cormen, Leiserson, Rivest, and Stein MIT Press, (2001)

#### References:

- [Tar83] *Data Structures and Network Algorithms*,  
Robert E. Tarjan, SIAM Press, (1983).
- [RND77] *Combinatorial Algorithms: Theory & Practice*,  
Reingold, Nievergelt & Deo, Prentice-Hall, (1977)
- [SKD83] *Discrete Optimization Algorithms*,  
Syslo, Kowalik & Deo, Prentice-Hall, (1983)
- [PS82] *Combinatorial Optimization: Alg & Complexity*  
Papadimitriou & Steiglitz, Prentice-Hall, (1982)
- [PS85] *Computational Geometry: An Introduction*,  
Preparata & Shamos, Springer-Verlag, (1985)

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## Tentative Course Outline (Fall 2007)

### A. ADVANCED DATA STRUCTURES AND ALGORITHMS

*Quick Review: Design and Analysis of Algorithms*

Heaps and Fast Graph Algorithms

Amortized Analysis

Binomial and Fibonacci Heaps

Disjoint Sets

LEDA Software Library

### B. ADVANCED COMBINATORIAL AND GRAPH ALGORITHMS

Network Flows

Bipartite Matching, Independent Sets and Vertex Covers

Case Study: Graph Partitioning and the Berth Allocation Problem

### C. NP-COMPLETENESS

Introduction to NP-completeness, Cook's Theorem

Proving NP-Completeness

Approximation Algorithms

Local Search Methods

### D. STUDENT PRESENTATION

Various Topics (chosen by the students)

**Assessment:** (30%) Homework  
(30%) Programming Project -- using C++ and LEDA  
(40%) Final Exam [Open Book]

### Homework: (30%)

There will be 4-5 homework sets in the course (roughly one every 2-3 weeks). Homework is a very important part of this course – they force you to learn the material. Please read the important “Remarks on Homework” on course web-site.

### Project Work:

For project work, each student is expected to do C++ programming exercises using LEDA (*Library of Efficient Data Structures and Algorithms*), and also for solving an algorithmic problem (to be decided later). More details will be released later.