Syllabus

Department	Math & CS	**Credits**	3	**Instructor**	Han-Saem Yun	**Class Room**	5708
Subject	MC322: Discrete Mathematics	**Class hrs/wk**	3	**Lab (e-mail)**		**Attendee**	
				5707			

1 Course Description

Course Objectives

On completion of this course, you'll hopefully be able to:

- Think in the language of mathematics (i.e. set/relation/logic)
  - Throughout this course, you will be trained to be able to think in terms of set/relation/logic fairly freely and comfortably.
- Synthesize (even heavy) mathematical proofs;
- Model/analyze real-world problems and design algorithmic solutions to the problems along with mathematical proofs;
  - using discrete structures and combinatorial methods
- Think computationally/algorithmically;
  - appreciate the importance of algorithms in CS and beyond;
  - understand/appreciate limits of computation.
  - learn/remember some basic tricks, algorithms, problems.

Contents

- Logic, Proofs, Sets, Relations, Algebraic structures
- Graph: Basic notions, Isomorphism, Coloring, Planarity, Connectivity, Independence
- Theory of computation: Turing machines, Undecidability, Intractability, Reductions
- Groups, Modular arithmetic, Cryptology
- Combinatorial analysis
  - Lattice paths, Cayley's formula, Pölya/Burnside methods, Chains & Antichains
- Combinatorial designs
  - Finite Fields, Finite geometries, Latin squares, block designs
- Combinatorial optimizations
  - Graph algorithms: shortest paths, minimum spanning trees, maximum flows
  - Matroids, Algebraic path problems
- Game theory
  - Combinatorial games: Nim, Sparague-Grundy functions, surreal numbers
  - Classical games: Nash equilibrium, solution concepts, mechanism design

2 Text & References

Text: None (slides and handouts)

References:

- "*Discrete and Combinatorial Mathematics*", R. Grimaldi
- "*Extremal Combinatorics*", S. Jukna
- "*Handbook of Discrete and Combinatorial Mathematics*", K. Rosen *et al.*
- "*Introductory Combinatorics*", R. Brualdi
- "*Introduction to Set Theory*", K. Hrbacek and T. Jech
- "*On Numbers and Games*", J. Conway
- "*A Course in Game Theory*", M. Osborne and A. Rubinstein
- "*Graph Theory*", R. Diestel
- "*The Probabilistic Method*", N. Alon and J. Spencer
- "*Introduction to Theory of Computation*", M. Sipser
- "*Cryptography: Theory and Practice*", D. Stinson
- "*Computers and Intractability: A Guide to the Theory of NP-Completeness*", M. Garey *et al.*
- "*Algorithm Design*", J. Kleinberg and E. Tardos
- "*Introduction to Algorithms*", T. Cormen, C. Leiserson, and R. Rivest

Course online:

- http://ebook.ksa.hs.kr ⇒ New VOD ⇒ Log in
  ⇒ 정보과학 ⇒ 윤한샘 ⇒ MC322: Discrete Math

3 Grading

- Grading table

Activities	**Percentages**
Problem Sets	25%
Midterm	15%
Final exam	50%
Attendance	10%

- Absolute evaluation
- 12 problem sets
- Miderm/Final exam: open-book/note, unlimited time
- Late-work policy: -30%/day

4 Lecture Schedule

Lec #	Topics	Assignments	Categories
1	Sets/Logic (basic notions)		Sets/Logic
2	Subgroups, Permutation Groups		Algebraic Structures
3	Group Actions/Homomorphisms	PS #1 due	
4	Groups & Rubik's Cube		
5	Finite Fields		
6	Finite Geometries	PS #2 due	
7	Course Overview	PS #3 due	
8	Order/Equivalence Relations		Relations
9	Operations/Relations on Relations		
10	Graphs (basic notions)	PS #4 due	Graphs
11**	Graphs problems in CS		
12	Trees		
13	Counting	PS #5 due	Combinatorial Analysis
14	Discrete Probability		
15	Cayley's Formula		
16-17	Chains/Antichains	PS #6 due	
18**	Turing Machines & Algorithms		Theory of Computation
19**	Universality & Undecidability	PS #7 due	
20**	Reductions		
21	*Wrap-up for the midterm*		
22**	Divisibility		Cryptography
23-24**	Modular Arithmetic	PS #8 due	
25**	Cryptology (informal overview)		
26**	Public-Key Cryptosystems	PS #9 due	
27	Latin Squares		Combinatorial Design
28	Block Designs		
29*	Shortest Paths (Dijkstra)	PS #10 due	Graph Algorithms (Combinatorial Optimization)
30	Shortest Paths (Floyd-Warshall)		
31	Algebraic Path Problems (Semiring)	PS #11 due	
32*	Minimum Spanning Trees		
33	Matroids & MST		
34*	Max Flows & Bipartite Matching	PS #12 due	
35	Combinatorial Games		Game Theory
36	Games & Mechanism Design		
37*	Polynomial-Time Reductions	PS #13 due	Intractability
38*	NP-Completeness		
39	*Wrap-up for the final exam*	PS #14 due	

*: overlap with MC422

**: overlap with MC221