

Combinatorial Games and Puzzles
Math 1038
Winter Term 2008
Course Description

January 17, 2008

Instructor: John Schmitt

Warner 311, Ext. 5952

jschmitt@middlebury.edu

Office Hours: Monday 9-10:30am, Wednesday 1-2:30 pm, or by arrangement.

Course web-page: <http://www.middlebury.edu/~jschmitt/>

Meeting Times:

Monday, Tuesday, Wednesday, Thursday, Friday 10:30am-12:30pm, Warner 507

First day: Thursday, January 3rd

Last day: Wednesday, January 30th

Textbooks:

Elwyn Berlekamp, *The Dots and Boxes Game: Sophisticated Child's Play*, (Natick, Mass: AK Peters 2000).

Jörg Bewersdorff (translated by David Kramer), *Luck , Logic and White Lies*, (Wellesley, MA: AK Peters 2005).

Michael Albert, Richard Nowakowski, David Wolfe *Lessons in Play*, (Wellesley, MA: AK Peters 2007)/. The webpage for this text is:

<http://homepages.gac.edu/~wolfe/lessonsinplay/>.

(Please bring the texts to class on a daily basis.)

Attendance: Due to the nature of this course your attendance is of the utmost importance. Only one absence is permitted (none is preferred.) For each additional unexcused absence 5 percentage points will be deducted from your final grade. It is your responsibility to sign the attendance sheet each day.

Materials:

Many of the games that we'll want to play need a modicum of materials to play. Some basic suggested materials to have at your disposal:

- Pens/pencils of several different colors.
- 50 counters of one color, 50 of another (can use beans, coins, skittles)
- Dominos
- Blank white paper
- Straightedge/ruler

Special Needs: If you require special arrangements for class or during tests/exams please talk to me as soon as possible to make such arrangements.

Honor Code: The Honor Code will be observed throughout this class and for all examinations. If you have a question about how the Honor Code applies to this class please ask.

Paper on a Combinatorial Game or Puzzle (30 Percent of Grade)

Approval of topic (including references) date: January 10th (Submit a short description, which includes a game description, and preliminary bibliography.)

Due Date: January 23rd

Goal of Paper: Identify a combinatorial game and conduct research and write an expository paper about this game. The choice of the game is up to you, but must meet with my approval by the date indicated above.

Points that **MUST** be addressed in the paper include:

- Conduct a MathSciNet search about the game (go to www.ams.org/mathscinet).
- Discuss rules of game and how to play - conciseness and accuracy are important.
- Show that the game satisfies the definition of a *combinatorial game*.
- Discuss the order and size of game graph.
- Discuss opening strategy and end strategy.
- Discuss how mathematics informs play.
- Discuss attributes of an evaluation function.
- Include relevant diagrams, figures and calculations.
- Include open problems/questions (if appropriate.)
- You must have **AT LEAST** two mathematical sources.
- Minimum of 5 pages (excluding diagrams). Maximum of 10 pages (excluding diagrams).
- Please submit the paper in duplicate.

The level of mathematical sophistication will contribute to the grade.

Create a set of original problems (15 percent of grade)

Due Date: January 30th (with presentation on 28th and 29th)

Goal: Create a set of *original* problems and their solutions in the combinatorial game you have chosen to research. The problems (game positions) should illustrate the inherent nature of a “good” combinatorial game. The solution might illustrate a useful technique or strategy in the game.

- A minimum of three and a maximum of five problems and their “solutions” must be given.
- Explain why the problems you create are interesting.
- A solution must be given concisely and must be correct.
- A presentation of 10-15 minutes will accompany the written submission which discusses the rules of the game and at least one of your problems (and its solution).
- An indication of an “amateur” move for each problem should be given. You will obtain these “amateur” moves by playing your class-mates and keeping a record of their moves.

Homework (15 percent of grade): These will be given on a daily basis. Some will be in-class, some to solve on your own outside of class time. You may consult with classmates, but the **write-up of these problems must be done on your own!** These will be derived from reading, class discussion and the skills you develop in your playing.

Tournament play and in-class participation (20 percent of Grade):

The content of this course is best learned by *PLAYING*. You will be judged upon your participation in games, class discussion, presentations given, questions given, answers offered, competitions held and your **win/loss record in tournament play**. I **require you to play with classmates** and with others outside of class time in order to develop your skills and understanding of combinatorial games and puzzles.

Exam (20 percent of grade)

Date of Exam: January 30th

Goal: A final exam will cover all reading assignments, lectures, films and games covered.

Grading Percentages:

Homework	15
Paper on a Combinatorial Games	30
Set of problems on a Game	15
Tournament Play and In-class Participation	20
Final Exam	20

Assignment of Grades:

The assignment of grades will follow the scheme below.

90 and above	A
80 - 89	B
70 - 79	C
60 -69	D
below 60	F

Plus and minus will be assigned at my discretion. Any person(s) proving a conjecture or providing a solution to an unsolved problem given in a published mathematical article/text will automatically receive an A for the course. Any person finding a (typographical) error in LiP will receive an additional one percentage point to the final average.

References on Reserve in Library:

1. Michael Albert, Richard Nowakowski, David Wolfe *Lessons in Play*, (Wellesley, MA: AK Peters 2007).
 2. Elwyn Berlekamp, *The Dots and Boxes Game: Sophisticated Child's Play*, (Natick, Mass: AK Peters 2000).
 3. Elwyn R. Berlekamp, John H. Conway and Richard K. Guy, *Winning Ways for Your Mathematical Plays*, Second Edition, A.K. Peters, Natick MA, Volume 1, 2001; Volume 2: 2003; Volume 3: 2003; Volume 4: 2004.
 4. Jörg Bewersdorff (translated by David Kramer), *Luck , Logic and White Lies*, (Wellesley, MA: AK Peters 2005).
 5. Cameron Browne, *Hex Strategy: Making the Right Connections*, A.K. Peters, Natick, MA, 2000.
 6. Cameron Browne, *Connection Games: Variations on a Theme*. A.K. Peters, Wellesley, MA, 2005.
 7. John H. Conway, *On Numbers and Games*, Academic Press, London, 1976.
 8. Imma Curiel, *Cooperative Game Theory and Applications: Cooperative Games Arising from Combinatorial Optimization Problems*, Kluwer Academic Publishers, Dordrecht, Netherlands, 1997.
 9. Martin Gardner, *Mathematical Puzzle Tales*, Mathematical Association of America, Washington, DC, 2000.
 10. Richard J. Nowakowski, *Games of No Chance*, Cambridge University Press, Cambridge, England, 1998.
 11. Richard K. Guy (editor), *Combinatorial Games*, American Mathematical Society, 1991.
 12. Richard J. Nowakowski, *More Games of No Chance*, Cambridge University Press, Cambridge, England, 2002.
 13. Jonathan Schaeffer, *One jump ahead: challenging human supremacy in checkers*, Springer, NY, 1997.
- Film:**
14. Śatarnja ke khilari (The Chess Players) produced by Suresh Jindal ; screenplay, music/direction, Satyajit Ray, New York : Kino on Video, [2006].

Online Resources:

Journals and texts:

1. *Integers: Electronic Journal of Combinatorial Number Theory*, www.integers-ejcnt.org
(See the games section of the journal.)
2. <http://www.msri.org/publications/books/Book29/contents.html>. Most of the contents of *Games of No Chance* is available here.
3. <http://www.msri.org/communications/books/Book42/contents.html>. Most of the contents of *More Games of No Chance* is available here.

Games to play (there are countless more):

4. www.mazeworks.com/hex7.htm. This is a 7×7 version of hex.
5. <http://home.earthlink.net/~vanshel/>. Play Hex against a computer program.
6. <http://www.cs.ualberta.ca/~chinook/>. THE website for computer checkers program.

Gamers:

7. <http://www.mscs.dal.ca/~Erjn/>. The home-page of Richard Nowakowski, an avid combinatorial game theorist.
8. <http://www.wisdom.weizmann.ac.il/~Efraenkel/>. The home-page of A. Fraenkel, an avid combinatorial game theorist.
9. <http://math.berkeley.edu/~berlek/index.html>. The home-page of Elwyn Berlekamp, an avid combinatorial game theorist.
10. <http://www.ics.uci.edu/~eppstein/cgt/>. The home-page of David Eppstein, an avid combinatorial game theorist.
11. <http://compgeom.cs.uiuc.edu/~jeffe/mathgames.html>. The home-page of Jeff Erickson, an avid combinatorial game theorist.
12. Homepage of Robert R. Snapp, U. Vermont, www.cs.uvm.edu/~snapp (Click on CS32)

Table 1: Below is a tentative set of reading assignments. This page WILL be updated as we proceed. You are expected to complete reading prior to next class meeting. Note that reading a page of mathematical arguments can take MUCH longer than reading a page of a novel. LLWL is *Luck, Logic and White Lies*, DB is *Dots and Boxes: Sophisticated Child's Play*, LiP is *Lessons in Play*.

	Monday	Tuesday	Wednesday	Thursday	Friday
December 31				Fraenkel's <i>Combinatorial Games</i> , LLWL: Preface, Chapters 18 and 19, LiP Chapter 0, Appendix D and Pages 219-221	LLWL Chapters 21 and 22, LiP Chapter 1 and Mackenzie handouts
January 7		LiP Chapter 1 (again), DB Preface and Chapters 1-3	LLWL Chapters 23 and 26	LiP Chapter 2, DB Chapter 3,4	DB Chapter 5, Hex handouts

Table 2: Below is a tentative schedule for some class events. These may change if need be.

	Monday	Tuesday	Wednesday	Thursday	Friday
December 31				Introduction	Class
January 7	No Class	Guest Lecturer: Colin Mackenzie	Film: "WarGames"		Class
January 14				Film: The Go Masters - in Warner Hemicycle at 7:30pm	Dots and Boxes Tournament
January 21	Hex Presentations	on Campbell's article	Hex Tournament, Paper Due	Film: "The Chess Players"	No Class
January 28	Presentations	Presentations	Exam		

Table 3: Below is a set of homework assignments. The list will be added to as the semester progresses.

	Monday	Tuesday	Wednesday	Thursday	Friday
December 31				LiP Page 7 - no. 1, 2	See handout
January 7		Written summary of lecture (due Thurs.)	Reaction of film (due Fri.)	Two short problems, and Presentation of Ch 3 puzzle for tomorrow	Presentation of Ch 5 puzzle for Monday
January 14					Analysis of Hex Game due
January 21	Hex Puzzles due, Film (Go Masters) Reaction due		Paper Due	The Chess Players - reaction due Monday	
January 28	Project presentations	and continued			