

**Instructor:** Robert R. Snapp, email: [snapp@cs.uvm.edu](mailto:snapp@cs.uvm.edu), office: 353 Votey, phone: 656-0735.

**Office Hours:** T 1:30-3:00 PM, W 3:30-4:30 PM, F 9:30-11:00 AM, and by appointment.

**Lectures:** MWF, 11:15 - 12:05 p.m. in 205 Votey.

**Discussion/Lab Sessions:** In room 206 Votey:

Lab	Day	Scheduled Time	Actual Time
A01	Wed	4:40-6:30 PM	4:45-6:00 PM
A02	Thu	3:30-5:20 PM	3:30-4:45 PM
A03	Thu	6:30-8:20 PM	7:00-8:15 PM

**Web Page:** [www.cs.uvm.edu/~snapp/puzzles/](http://www.cs.uvm.edu/~snapp/puzzles/)

**Graduate Teaching Assistant:** Katerina Simonova, [ekaterina.simonova@uvm.edu](mailto:ekaterina.simonova@uvm.edu). Office Hours: *TBA*.

**Description:** An introduction to computer science that explores the history, rules, and strategies for puzzles and games, such as Rubik's Cube, chess, and go. We will introduce both mathematical and computational tools that allow computers to solve puzzles and play games. We will also learn and use the scheme programming language.

This course satisfies the Mathematical Sciences distribution requirement for Bachelor of Arts students enrolled in the College of Arts and Sciences.

**Prerequisites:** None.

**Texts:** Online course notes. Some readings will be assigned during the course of the semester from books and articles placed on reserve in the Bailey-Howe Library.

**Materials:** The following materials are required:

- Five (or more) six sided dice.
- A standard deck of 52 playing cards.
- Fifty to one-hundred counters (e.g., pennies, buttons, poker chips, M&Ms).
- A standard  $3 \times 3 \times 3$  Rubik's cube, available at either Barnes & Noble, or Vermont Toy and Hobby.

**Computer Software:** Dr. Scheme. You may download this for free from the web site <http://www.drscheme.org>, for MS Windows, MacOS X, and Linux.

**Homework:** Homework exercises will be assigned on a regular basis. Some assignments will be graded, other assignments will be recommended.

**Quizzes:** Approximately ten quizzes will be given during the term. Each quiz will consist of one or two short problems similar to the homework. The lowest quiz grade will be dropped. The quiz dates are all on Fridays: 9/8, 9/15, 9/22, 9/29, 10/6, 10/20, 10/27, 11/3, 11/10, and 12/1.

**Field Trip:** On Saturday, **September 30** (rain date: October 14), we will visit and solve a corn maze situated in the Northeast Kingdom that has over two miles of twisty passages. Please bring a sack lunch and something to drink.

The bus will leave UVM from the Royal Tyler Theater at 9:30 AM, and will return around 4:30 PM.

**Midterm Exams:** Two midterm exams will be given in class: the first, on Friday, **October 13**; and the second, on Friday, **November 17**. The material covered on each exam will be announced one week in advance.

**Final Exam:** The final exam for this course is scheduled for 3:30-6:30 PM, Tuesday, **December 12**.

**Grading Policy:** The course grade will be based on

- homework & lab participation (20%),
- field trip participation (5%),
- quizzes (25%, after dropping the lowest quiz),
- two midterm exams (25%), and the
- final exam (25%).

There will be many opportunities for extra credit: motivated students can complete an approved project, lead a discussion in a lab, or lecture session, etc.

Letter grades will be assigned as follows:

Percentage	Grade	Percentage	Grade
98 — 100	A+	78 — 79	C+
92 — 97	A	72 — 77	C
90 — 91	A-	70 — 71	C-
88 — 89	B+	68 — 69	D+
82 — 87	B	62 — 67	D
80 — 81	B-	60 — 61	D-
		0 — 59	F

*Students entitled to special accommodation must notify the instructor by the second week of the semester.*

**Computer Accounts:** Each student will receive an EMCF computer account, which will allow you to use the public computers in the Votey building. *Drscheme* should be installed on the both the Windows and Unix platforms.

**Collaboration:** You are *encouraged* to share your knowledge, discoveries, and ideas with other students outside of class. All work (e.g., ideas, opinions, analyses, algorithms, data, and source code) generated by others should be properly cited.

*Absolutely no collaboration or unauthorized material is allowed during any quiz or exam.* All violations will be forwarded to the University Coordinator of Academic Honesty, following the *new* policy of Academic Integrity posted at

[http://www.uvm.edu/cses/code\\_ai.html](http://www.uvm.edu/cses/code_ai.html)

**Classroom Policies:** We are very lucky to be able to use rooms 205 and 206 for this course. But, because of risk of equipment damage, *absolutely no food or drink may be consumed in these rooms*. Please restrict your eating to either immediately before or after class, outside of the room. Otherwise, please keep all foods and beverages in your backpacks, and off of the desks.

## Topics

The following topics are subject to change. We will try to discuss puzzles and games that pique our interests, so if you have a favorite, please let me know as soon as possible. We will try to describe the history, rules, and strategies for each puzzle and game we study. We will also describe how computers can solve puzzles and play games.

- Introduction to puzzles and games.
- *Homo ludens*: the importance of play
- Word jumbles, card shuffles, & permutations
- Sudoku
- Games of chance, including dice games, poker, blackjack, raffles, and lotteries.
- Introduction to scheme programming: factorials, Pascal's triangle, and Fibonacci numbers.
- The history of labyrinths and mazes.
- Graphs and trees.
- How to thread a real maze without getting lost!
- How computers can solve mazes and puzzles.
- Peg solitaire.
- The Tower of Hanoi and Chinese rings.
- Games of perfect information: Tic-tac-toe, mancala, checkers, chess, go, and hex.
- Nim, kayles, game trees & Sprague-Grundy numbers.
- Sliding block puzzles
- Rubik's cube.

**References:** There are many useful reference books dedicated to puzzles and games. The following is my personal list of favorites, and is certainly not complete. Many of them are in the Bailey-Howe Library. The rest are available through interlibrary loan.

1. Bonnie Averbach and Orin Chein, *Problem Solving Through Recreational Mathematics*, Dover, NY, 2000.
2. W. W. Rouse Ball and H. S. M. Coxeter, *Mathematical Recreations and Essays*, Thirteenth Edition, Dover, New York, 1987.
3. John D. Beasley, *The Mathematics of Games*, Oxford University Press, Oxford, England, 1989.
4. John D. Beasley, *The Ins and Outs of Peg Solitaire*, Oxford University Press, Oxford, England, 1992.
5. Anatole Beck and Michael N. Bleicher and Donald W. Crowe, *Excursions into Mathematics*, Worth Publishers, Inc., New York, 1969.
6. R. C. Bell, *Board and Table Games From Many Civilizations*, Revised Edition, Dover, NY 1979.
7. Elwyn R. Berlekamp, *The Dots and Boxes Game: Sophisticated Child's Play*, A. K. Peters, Ltd., Natick, MA, 2000.
8. Elwyn R. Berlekamp, John H. Conway and Richard K. Guy, *Winning Ways for Your Mathematical Plays*, Second Edition, A. K. Peters, Ltd., Natick, MA Volume 1, 2001; Volume 2, 2003; Volume 3, (2003) & Volume 4, (2004), (*advanced*).
9. Elwyn Berlekamp and Tom Rodgers, *The Mathematician and Pied Puzzler: A Collection in Tribute to Martin Gardner*, A. K. Peters, Ltd., Natick, MA, 1999.

10. Ken Binmore, *Fun and Games: A Text on Game Theory*, D. C. Heath and Co., Lexington, MA, 1992.
11. Cameron Browne, *Hex Strategy: Making the Right Connections*, A. K. Peters, Natick, MA, 2000.
12. Roger Caillois, *Man, Play and Games*, University of Illinois Press, Urbana, IL, 1961.
13. Stewart T. Coffin, *The Puzzling World of Polyhedral Dissections*, Oxford University Press, Oxford, England, 1990.
14. John H. Conway, *On Numbers and Games*, Second Edition, A. K. Peters, Ltd., Natick, MA, 2001 (*advanced*).
15. Charles Cotton, *The Compleat Gamester*, R. Cutler, London, 1674. Reprinted by Cornmarket Reprints, Cambridge, England, 1972.
16. Marcel Danesi, *The Puzzle Instinct: The Meaning of Puzzles in Human Life*, Indiana University Press, Bloomington, IN, 2004.
17. Henry Ernest Dudeney, *Amusements in Mathematics*, Dover, New York, 1970.
18. Henry Ernest Dudeney, *The Canterbury Puzzles*, Dover, New York, 1958.
19. Henry Ernest Dudeney, *536 Puzzles & Curious Problems*, Scribners, New York, 1967.
20. Ross Eckler, *Making the Alphabet Dance*, St. Martin's Press, New York, 1996.
21. Anthony S. Filipiak, *Mathematical Puzzles and Other Brain Teasers*, Bell Publishing Company, New York, 1942.
22. David B. Fogel, *Blondie24: Playing at the Edge of AI*, Morgan Kaufmann, San Francisco, 2001.
23. Martin Gardner, *The Colossal Book of Mathematics*, W. W. Norton, New York, 2001.
24. Martin Gardner, *A Gardner's Workout: Training the Mind and Entertaining the Spirit*, A. K. Peters, Ltd., Natick, MA, 2001.
25. Martin Gardner, *The Unexpected Hanging and Other Mathematical Diversions*, The University of Chicago Press, Chicago, IL, 1991.
26. Martin Gardner, *Hexaflexagons and Other Mathematical Diversions*, The University of Chicago Press, Chicago, IL, 1988.
27. Martin Gardner, *The 2nd Scientific American Book of Mathematical Puzzles & Diversions*, Simon & Schuster, New York, 1961.
28. Martin Gardner, *New Mathematical Diversions from Scientific American*, Simon & Schuster, New York, 1966.
29. Martin Gardner, *Wheels, Life and Other Mathematical Amusements*, W. J. Freeman, San Francisco, CA, 1983.
30. Solomon W. Golomb, *Polyominoes*, Revised Edition, Princeton University Press, Princeton, NJ, 1994.
31. Catherine Perry Hargrave, *A History of Playing Cards*, Dover, NY, 2000.
32. L. E. Hordern, ed., *Hoffmann's Puzzles Old & New*, Cane End House, Reading, England, 1893 (*modern reprint*).

33. L. E. Hordern, *Sliding Piece Puzzles*, Oxford University Press, Oxford, England, 1986.
34. Jean-Marie L'Hôte, *Histoire des Jeux de Société*, Flammarion, Paris, 1994.
35. Johan Huizinga, *Homo Ludens*, Routledge & Kegan Paul, Ltd., London, 1950. Reprinted by The Beacon Press, Boston, 1955.
36. David Joyner, *Adventures in Group Theory: Rubik's Cube, Merlin's Machine & Other Mathematical Toys*, Johns Hopkins University Press, Baltimore, MD, 2002 (*advanced*).
37. Hermann Kern, *Through the Labyrinth: Designs and Meanings over 5000 Years*, Prestal, Munich, Germany, 2000.
38. Janice Kim and Jeong Soo-hyun, *Learn to Play Go*, Volumes 1-4, Good Move Press, Corte Madera, CA, 1997.
39. Boris A. Kordemsky, *The Moscow Puzzles: 359 Mathematical Recreations*, Dover, NY, 1972.
40. Sam Loyd, *Cyclopedia of Puzzles*, Lamb Publishing Company, New York, 1914.
41. Édouard Lucas, *Récréations Mathématiques*, second edition, Gautier-Villars et fils, Paris; vols. 1-4, 1882-94. Reprinted by Blanchard, Paris, 1979.
42. W. H. Matthews, *Mazes and Labyrinths: A General Account of Their History and Developments*, Longmans, Green, and Co., London, 1922 (*available in an inexpensive Dover reprint*).
43. Geoffrey Mott-Smith, *Mathematical Puzzles for Beginners and Enthusiasts*, The Blakiston Company, Philadelphia, PA, 1946.
44. S. Brent Morris, *Magic Tricks, Card Shuffling and Dynamic Computer Memories*, Mathematical Association of America, Washington, D.C., 1998.
45. H. J. R. Murray, *A History of Board-Games Other than Chess*, Oxford University Press, Oxford, 1951.
46. H. J. R. Murray, *A History of Chess*, Oxford University Press, Oxford, 1913.
47. Richard J. Nowakowski, *Games of No Chance*, Cambridge University Press, Cambridge, England, 1998, (*advanced*).
48. Richard J. Nowakowski, *More Games of No Chance*, Cambridge University Press, Cambridge, England, 2002 (*advanced*).
49. T. H. O'Beirne, *Puzzles & Paradoxes*, Oxford University Press, New York, 1965.
50. David Parlett, *The Oxford History of Board Games*, Oxford University Press, London, 1999.
51. William Poundstone, *Fortune's Formula: The Untold Story of the Scientific Betting System that Beat the Casinos and Wall Street*, Hill and Wang, New York, 2005.
52. Ernő Rubik and Tamás Varga and Gerzson Kéri and György Marx and Tamás Vekerdy, *Rubik's Cubic Compendium*, Oxford University Press, Oxford, England, 1987.
53. Stuart Russel and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Second Edition, Prentice Hall, Upper Saddle River, NJ, 2003.
54. Arther M. Sackler Gallery, *Asian Games: The Art of Contest*, Asia Society, New York, 2004.
55. Sid Sackson, *Card Games Around the World*, Dover, NY, 1981.
56. Katie Salen and Eric Zimmerman, *Rules of Play*, MIT Press, Cambridge, MA, 2003.
57. Katie Salen and Eric Zimmerman, ed., *The Game Design Reader*, MIT Press, Cambridge, MA, 2005.
58. John Scarne, *Scarne's Encyclopedia of Card Games*, Harper & Row, New York, 1983.
59. John Scarn, *Scarne on Dice*, Stackpole Books, Harrisburg, PA, 1974.
60. Jonathan Schaeffer, *One Jump Ahead: Challenging Human Supremacy in Checkers*, Springer-Verlag, New York, 1997.
61. Jerry Slocum, *The Tangram Book*, Sterling Publishing, New York, 2003.
62. Jerry Slocum and Jack Botermans, *Puzzles Old & New*, University of Washington Press, Seattle, WA, Fourth Edition, 1994.
63. David Singmaster, *Notes on Rubik's Cube*, Enslow, Hillside, NJ, 1980.
64. Claude E. Shannon, "Programming a computer for playing chess," *Philosophical Magazine*, **41**, 1950, pp. 256-275.
65. Raymond Smullyan, *What is the Name of This Book: The Riddle of Dracula and Other Logical Puzzles*, Prentice-Hall, Englewood Cliffs, NJ, 1978.
66. Edward Snow, *Inside Bruegel: The Play of Images in Children's Games*, North Point Press, New York, 1997.
67. Bernard Suits, *The Grasshopper: Games, Life and Utopia*, University of Toronto Press, Toronto, Canada, 1978.
68. Pieter van Delft and Jack Botermans, *Creative Puzzles of the World*, Abrams, Amsterdam, 1978.
69. John J. Watkins, *Across the Board: The Mathematics of Chessboard Problems*, Princeton University Press, Princeton, NJ, 2004.
70. David Wells, *The Penguin Book of Curious and Interesting Puzzles*, Penguin Books, London, 1992.
71. Peter Winkler, *Mathematical Puzzles: A Connoisseur's Collection*, A. K. Peters, Natick, MA, 2004.
72. David Wolfe and Tom Rodgers, *Puzzler's Tribute: A Feast for the Mind*, A. K. Peters, Ltd., Natick, MA, 2002.