MONTGOMERY COLLEGE - Germantown Campus

Mathematics & Statistics Department

Course Syllabus

I. Instructor Information

Professor: Dr. Zhou Dong
Email: Zhou.Dong@MontgomeryCollege.edu
Phone: (240) 567-7810
Office: HT 134
Mail box: HT 314
Office Hours: MWF 11:00 am – 12:00 pm, or by appointment Click here to make a virtual appointment

II. General Course Information

HONR 265 Independent Study-Tutorial in Mathematics/Computer Science

This tutorial emphasizes independent studies in areas not listed among the credit courses in mathematics. Appropriate mathematics/computer science faculty tutor individual students in specific studies, e.g., in computer science, the study and comparison of modern programming languages; in mathematics, topology, complex analysis, abstract algebra, and logic. Students may repeat this course provided that each time it is taken, a different topic is covered.

3 Semester Hours

PREREQUISITE:
Completion of at least 12 college credits, a 3.4 grade point average or higher, a grade of A or B in ENGL 101 or ENGL 101A.

CRN 24633: HONR 265CG Combinatorial Game Theory
The course will introduce students to Combinatorial Game Theory. The course will cover the foundations of the theory and basic techniques for analyzing combinatorial games, including analysis of classic examples such as Nim. Students will choose a game to analyze on their own, document their research, and present their findings.

Math Requirement: Completion of MATH 181
Programming Requirement: Proficiency in Python or Java

Fall 2024
MWF 10:00 am – 10:50 am
HT 104

The professor reserves the right to make changes to this syllabus.

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NOTE: HONR courses do not meet General Education requirements. In addition, the transferability of HONR courses is determined by the transfer institution. It is recommended that students planning to transfer complete a degree audit to verify that this course complies with new Program of Study and Financial Aid Guidelines.

III. Specific Outcomes

HONR 265 - Upon completion of this course, a student will be able to:

- Demonstrate an understanding of the concepts, terminology, and methodologies associated with a given topic in mathematics and/or computer science.
- Demonstrate an understanding of the relevant mathematics or computer science associated with the special topic of the course.
- Conduct research relevant to the selected topic or research a current and relevant topic.
- Communicate concepts effectively in both oral and written presentations.

Combinatorial Game Theory - Upon completion of this course, a student will be able to:

- Explain what is a combinatorial game
- Classify combinatorial games by their properties
- Describe the techniques for analyzing combinatorial games
- Conduct analysis of combinatorial games and present findings

IV. Text and Supplies

Required Text:

- Lessons in Play: An Introduction to Combinatorial Game Theory, Second Edition by Michael H. Albert, Richard J. Nowakowski, David Wolfe
  www.lessonsinplay.com

Other resources:

- Knop's Courses – Introduction to Combinatorial Game Theory
  https://www.youtube.com/watch?v=DbCKHPlMN2c&list=PLxYr6TaF_SDV5r6rmI0LDxuO48FPFb6Rk
- Coursera - Games Without Chance: Combinatorial Game Theory
  https://www.coursera.org/learn/combinatorial-game-theory
- Final Answers – Mathematical Games (2 Players)
  http://www.numericana.com/answer/games.htm
- Erik Demaine's Combinatorial Game Theory webpage
  https://erikdemaine.org/games/
- David Eppstein's Combinatorial Game Theory webpage
  https://www.ics.uci.edu/~eppstein/cgt/
- Jeff Erickson's Combinatorial Game Theory webpage
  http://jeffe.cs.illinois.edu/mathgames.html
- Unsolved Problems in Combinatorial Games
  http://library.msri.org/books/Book42/files/guy.pdf

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V. Grading

A. Requirements

The student is required to

- Attend and participate in all class meetings and workshops
- Complete readings and homework as assigned
- Complete a research project on a combinatorial game
  - Keep research log of a minimum of 10 hours of research activity per week
  - Attend weekly research meetings individually with the professor and in research groups
- Present findings – informally during research group meetings and formally at the end of the semester

B. Course Grade

Attendance and Participation	20%
Homework	20%
Research Project	40%
Presentation	20%

A = 90% – 100%
B = 80% – 90%
C = 70% - 80%
D = 60% - 70%
F < 60%

VI. Student Code of Conduct and Collegewide Policies and Procedures

http://cms.montgomerycollege.edu/mcsyllabus/

VII. Course Schedule

Date	**Combinatorial Game Theory Topic**	**Research Activity**
Week 1 *W 9/4* *F 9/6*	Appendix A 0 Combinatorial Games 0.1 Basic Terminology 1 Basic Techniques 1.1 Greedy 1.2 Symmetry 1.3 Parity 1.4 Give Them Enough Rope! 1.5 Strategy Stealing 1.6 Change the Game! 1.7 Case Study: Long Chains in Dots & Boxes	Introduction to Research Introduction and getting to know research group members
Week 2 *M 9/9* *W 9/11* *F 9/13*	2 Outcome Classes 2.1 Outcome Functions 2.2 Game Positions and Options 2.3 Impartial Games: Minding your P's and N's 2.4 Case Study: Roll the Lawn	Introduction to Nim

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	2.5 Case Study: Timber 2.6 Case Study: Partizan Endnim	
Week 3 *M 9/16* *W 9/18* *F 9/20*	3 Motivational Interlude 3.1 Sums 3.2 Comparisons 3.3 Equality and Identity 3.4 Case Study: Domineering	Understanding classic Nim
Week 4 *M 9/23* *W 9/25* *F 9/27*	4 The Algebra of Games 4.1 The Fundamental Definitions 4.2 Games Form a Group with a Partial Order 4.3 Canonical Form 4.4 Case Study: Cricket Pitch 4.5 Incentives Incentives	Understanding Nim on Graphs
Week 5 *M 9/30* *W 10/2* *F 10/4*	5 Values of Games 5.1 Numbers 5.2 Case Study: Shove 5.3 Stops 5.4 A Few All-Smalls: Up, Down, and Stars 5.5 Switches 5.6 Case Study: Elephants & Rhinos 5.7 Tiny and Miny 5.8 Case Study: Toppling Dominoes 5.9 Proofs of Equivalence of Games and Numbers	Nim on Graphs Game Tree Program Development: • Design the program • Develop program flow chart
Week 6 *M 10/7* *W 10/9* *F 10/11*	6 Values of Games 6.1 Numbers 6.2 Case Study: Shove 6.3 Stops 6.4 A Few All-Smalls: Up, Down, and Stars 6.5 Switches 6.6 Case Study: Elephants & Rhinos 6.7 Tiny and Miny 6.8 Case Study: Toppling Dominoes 6.9 Proofs of Equivalence of Games and Numbers	Nim on Graphs Game Tree Program Development: • Code the program • Debug the program
Week 7 *M 10/14* *W 10/16* *F 10/18*	Nim on Graphs Game Tree Program Development: • Test the program	
Week 8 *M 10/21* *W 10/23* *F 10/25*	Research Nim on Graphs with partners Details TBA	
Week 9 *M 10/28* *W 10/30*	Research Nim on Graphs with partners Details TBA	

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F 11/1	
Week 10 *M 11/4* *W 11/6* *F 11/8*	Research Nim on Graphs with partners Details TBA
Week 11 *M 11/11* *W 11/13* *F 11/15*	Research Nim on Graphs with partners Details TBA
Week 12 *M 11/18* *W 11/20* *F 11/22*	Research Nim on Graphs with partners Details TBA
Week 13 *M 11/25*	Presentation drafting
Week 14 *M 12/2* *W 12/4* *F 12/6*	Presentation drafting
Week 15 *M 12/9* *W 12/11* *F 12/13*	Presentation practice
Final Exam *M 12/16*	Final Presentation