MAT 564 Syllabus

Semester:	Fall 2020
Course title:	Combinatorial Game Theory
Instructor:	Professor Matt Klassen
Email:	mklassen@digipen.edu
Phone:	(425) 895-4423
Office hours:	M,W 10:30-12:00, T,Th 3:00-4:00 or by appointment
Course Web Page:	http://azrael.digipen.edu/MAT364
Time/Place:	M,W 9:00-10:20, online in Teams

WEB PAGES AND MOODLE:

The Moodle page for MAT564 will have a link to the course web page. The web page is the central repository for all course documents, including homework assignments. Updates to homework will be posted on the web page. Scores for quizzes, homework, exams, and projects, will be posted through perl scripts on the course web page.

MATERIALS:

Text: Lessons in Play, An Introduction to Combinatorial Game Theory, Second Edition, by Albert, Nowakowski, and Wolfe. AK Peters, 2019. ISBN 13: 978-1-4822-4303-1.

Other reference materials: The Dots and Boxes Game, by Elwin Berlekamp, AK Peters, 2000. Mathematical Go - Chilling Gets the Last Point, by Berlekamp and Wolfe, AK Peters, 1994. Winning Ways for Your Mathematical Plays (Volumes 1-4), by Berlekamp, Conway, and Guy, AK Peters, 2001. On Numbers and Games, by John Conway, second edition, AK Peters 2001.

BACKGROUND MATHEMATICS:

Discrete Mathematics, especially logic, graphs and trees.

COURSE DESCRIPTION:

Combinatorial Game Theory studies finite, two-player games in which there are no ties. Techniques from logic, combinatorics and set theory are used to prove various properties of such games. Typical games include Domineering, Hackenbush, and Nim. The analysis of such games can also be used to study other more complex games like Dots and Boxes, and Go. Topics covered in this course include Conways theory of numbers as games, impartial and partizan games, winning strategies, outcome classes and algebra of games.

COURSE OBJECTIVES AND OUTCOMES:

Students will learn to compute with the basic combinatorial objects relating to finite games and their structure. These computations will give the student some facility in the strategies and analysis of games, and also provide the student with tools that can be applied to artificial intelligence and the analysis of algorithms in computer science. Students will also gain experience in a project that implements a combinatorial game.

The above objectives will be measured through quizzes and exams and homework assignments.

QUIZZES AND EXAMS:

Quizzes will be given periodically to test comprehension of lecture material. There are no make up quizzes, but the lowest two quiz scores will be dropped. The quizzes will last for approximately twenty minutes.

For multiplie choice quizzes and exams, please follow these procedures: Work out the quiz problems and circle your answers on the question sheet. When you are finished, transfer the answers to the answer sheet. Go to a web browser and enter the answers online. Under no circumstances are you allowed to discuss the quiz questions with any other student during the quiz or the data entry process. Your scores will be posted online by your student ID.

For written format quizzes there will be a Moodle submission box, where you should submit your written answers at the end of the quiz.

There will be a midterm exam given during regular class hours, and a final exam. There are *NO* make up exams unless you have a *compelling and well documented reason* for missing a test.

Calculators are allowed on quizzes and exams.

GRADING:

Homework	20%
Quizzes	20%
Project	20%
Class Participation	20%
Midterm Exam	10%
Final Exam	10%

Grades will be determined based on total course percentage. Percentage scores will determine letter grades according to the scale: (in the worst case)

A: $93 - 100$, A-: $90 - 92.9$, B+: $87 - 89.9$, B: $83 - 86.9$, B-: $80 - 82.9$,

C+: $77 - 79.9$, C: $73 - 76.9$, C-: $70 - 72.9$, D: $60 - 69.9$, F: < 60

PROJECTS:

There are several types of projects in this class, including a default project. Any student not wanting to do the default project should write a proposal, due by Friday, October 16. The proposal should outline the scope of the project, goals and deliverables. A project may be completely code-based, or can be research into theory, or almost anything in between but still relevant to combinatorial game theory. If a proposal is not submitted, it will be assumed that the student is doing the default project, which is to write code for the game Amazons (see project description).

Some types of projects:

1. write a combinatorial game ruleset implementation and test this ruleset with a probabilistic analysis of game positions.
2. write a client for a specific combinatorial game which implements a nontrivial level of game play (to be agreed upon with instructor)
3. GUI development for a combinatorial game

Final project due date is Friday, Dec 4

HOMEWORK ASSIGNMENTS:

Homework will be assigned and posted on the web page. You are responsible for checking the web page and noting the assignments and the due date. You may work on homework together, as well as consult the tutors and the instructor. However, the final work that you turn in or present must be your own work. Homework problems may also be worked out in class by students, at the request of the instructor. Selected problems will be graded from each written homework assignment, and these scores will be combined with an overall completeness score, to form the assignment grade.

GRADUATE STUDENTS:

Graduate students will be required to do a class presentation or report which will be factored in as part of their homework grade. The subject matter will involve an in depth analysis of a particular problem, or an application, and will require some synthesis of current work and contributions in the field. This will form part of the graduate student exposure to research methods in course work.

CLASS PARTICIPATION:

Class participation is an important part of the course, so it is assigned a weight of 20%. Class participation credit will be given for the following types of activities: volunteering to answer a question posed by the instructor, asking a relevant question during lecture, participating in a combinatorial game demo, volunteering to work out a homework problem for the class, or other types as they come up in class. Basic credit is one point for a brief but relevant participation. More substantial participation is two points. Working out a detailed homework problem can be worth more points. 10 points is full credit for the semester. Participation grades will be posted weekly.

ACADEMIC INTEGRITY:

Academic dishonesty in any form will not be tolerated in this course. Cheating, copying, plagiarizing, or any other form of academic dishonesty (including doing someone elses individual assignments) will result in, at the extreme minimum, a zero on the assignment in question, and could result in a failing grade in the course or even expulsion from DigiPen.

All students are asked to help in promoting a culture of academic integrity by discouraging cheating in all forms.

DISABILITY SUPPORT SERVICES:

If students have disabilities and will need formal accommodations in order to fully participate or effectively demonstrate learning in this class, they should contact the Disability Support Services Office at (425)629-5015 or dss[at]digipen[dot]edu. The DSS Office welcomes the opportunity to meet with students to discuss how the accommodations will be implemented. Also, if you may need assistance in the event of an evacuation, please let the instructor know.

RELIGIOUS ACCOMMODATION:

DigiPen Institute of Technology provides reasonable accommodations to students who may be absent from activities or incur significant hardship due to religious holidays or observances. These holidays or observances must be part of a religious denomination, church, or religious organization, and the course instructor must be notified in writing during the first two weeks of the course. The institutes policy for grievances is published in the course catalog.

TENTATIVE WEEKLY TOPICS:

Week	Dates	Topics
1	Aug 31 - Sep 2	Combinatorial Games, Domineering, Nim, Amazons
2	Sep 7 - 11	Basic Techniques and Strategies: Symmetry, Parity, Strategy Stealing
3	Sep 14 - 18	Outcome classes, options, and impartial games
4	Sep 21 - 25	Sums of games, equality and identity
5	Sep 28 - Oct 2	The algebra of games, partial order, canonical form
6	Oct 5 - 9	Values of games and positions: Up, Down, Star, Tiny, Miny
7	Oct 12 - 16	Midterm Exam, more values of games
8	Oct 19 - 23	Structure of games, counting games
9	Oct 26 - Oct 30	Impartial games, Nim, and Nimbers
10	Nov 2 - 6	Games and Numbers, Conway Theory
11	Nov 9 - 13	Hot, Cold, and Tepid Games, Strategies
12	Nov 16 - 20	Norton Products
13	Nov 23 - 25	Transfinite Games
14	Nov 30 - Dec 4	projects, review
15	Dec 7 - 11	Final Exams