

**Syllabus: ECON 212 – Introduction to Game Theory
Winter 2023**

Class meeting times:

MW 10:00-11:20am in DWE 3522

Instructor:

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Description:

Game Theory is the study of strategic interactions between agents where the outcome for an agent depends not only on her choice of action but also on the actions of other players. This course is an introduction to Game Theory. We will develop game theoretic tools that can be used to analyze all sorts of situations including a game of poker, negotiations, auctions, military strategy, or the inability of the world community to curb carbon emissions. We will develop methods for determining best strategies for the different players and for determining the equilibrium outcomes of games.

The course will also have an important hands-on component. You will put the theory into action by playing games against fellow students. These games will teach you to think strategically. But beware, theory and practice don't always line up!

Learning Outcomes:

- Learn the key concepts of Game Theory
- Apply concepts to solve (new) problems
- Identify real-world situations where Game Theory is applicable and model the situation using Game Theory
- Effectively play games: putting theory (and intuition) into practice

Required Readings:

- Martin J. Osborne. *An introduction to Game Theory*, Oxford University Press, 2004.
 - Partial solutions to the exercises are available at:
<http://www.economics.utoronto.ca/osborne/igt/index.html>

Prerequisites:

You will be expected to know algebra well enough to solve systems of equations. Some calculus is strongly recommended but not absolutely necessary.

My Expectations:

- You will stay on top of the material
- You will participate fully in the games and submit them on time
- You will complete the assigned problems from the book

Method of Evaluation:

Games:	35% of final grade
Midterm Examination:	20% of final grade (March 1 st)
Final Examination:	45% of final grade (Date TBD)

Important Notes:

Students who write the midterm exam but do better on the final exam will have half of the weight of the midterm shifted to the final. Thus, your final mark would be 35% Games, 10% midterm, and 55% final.

While the games are nominally worth 35% of the final mark, **it is possible to score above 100% or below 0% in a given game!!** A negative grade on a game implies that not only do you get 0 on that game, you also lose grades from other games! On the other hand, since you can get above 100% in a given game, games could in principle contribute more than 35% to your final mark.

Collusion in games: Collusion in games is not allowed and is a breach of academic integrity. You are allowed, even encouraged, to discuss the game and broad strategies with your classmates, with friends, with family, etc. But you cannot coordinate your strategies in any way. The games are designed so that there are limited opportunities for collusion anyway, and moreover, any attempt at collusion is likely to raise suspicion and a follow up from me. Please engage with the games in good faith. And have fun!

Late Submission of Strategies for Games:

Because of the nature of the games (each student submission plays against all others), late submissions will not be accepted and will earn a grade of 0. Failure to submit will also earn a grade of 0 for that game.

Absence from Exams:

Failure to write an exam results in a grade of zero. Exceptions will only be made under the most extreme circumstances, with a written note, and according to the policies of the department of economics and faculty of Arts.

If you miss the midterm due to illness or other excused absence, the 20% weight will be shifted to the final examination.

If you miss the final exam it is your responsibility to petition the department of economics as per the regulations for the opportunity to write a make-up exam.

Course Outline:

The following is a tentative course schedule/outline and could be updated as we proceed through the course. The course content will primarily be delivered in class, but I may on occasion upload a lecture (slides with voiceover) to make more time in class to discuss games.

Note: Solutions to the problems can be found at:

<https://www.economics.utoronto.ca/osborne/igt/igtSolutions.pdf>

I encourage you to do the problems first, then to look at the solutions, as that will better prepare you for the midterm and exam.

Week 1: Introduction, Strategic Games

Chapter 1 and Sections 2.1-2.5

Problems:

- 16.1 Working on a joint project
- 17.1 Games equivalent to the Prisoner's Dilemma
- 20.1 Games without conflict

Game 1: Choose 2/3 of the Average is due (3%)

Week 2: Nash Equilibrium, Best Response Functions, Dominated Actions

Sections 2.6-2.9

Problems:

- 27.2 Selfish and altruistic social behaviour
- 33.1 Contributing to a public good
- 34.2 Voter participation
- 37.1 Finding NE using best response functions
- 38.1 Constructing best response functions
- 38.2 Dividing money
- 42.1 Finding NE using best response functions
- 42.2 A joint project
- 47.1 Strict equilibria and dominated actions
- 47.2 NE and weakly dominated actions
- 48.1 Voting

Game 2: Take II: Choose 2/3 of the Average is due (1%)

Week 3: Cournot, Bertrand, Electoral Competition

Sections 3.1-3.3

Problems:

- 52.2 Equilibrium for pairwise interactions in a single population
- 58.1 Cournot game with linear inverse demand and different unit costs
- 60.2 NE of Cournot game and collusive outcomes
- 61.1 Cournot game with many firms
- 63.1 Interaction among resource users
- 67.1 Bertrand game with constant unit cost
- 68.1 Bertrand oligopoly game
- 68.2 Bertrand duopoly game with different unit costs
- 73.1 Electoral competition with asymmetric voters' preferences
- 74.1 Electoral competition with three candidates
- 76.1 Competition in product characteristics

Game 3: Bidding for a dollar is due (4%)

Week 4: Auctions

Section 3.5

Problems:

- 84.1 Nash equilibrium of 2nd price sealed bid auction
- 85.1 Second price sealed bid auction with two bidders
- 86.1 Auctioning the right to choose
- 86.2 Nash equilibrium of 1st price sealed bid auction
- 87.1 First price sealed bid auction
- 88.1 Third price auction

Game 4: Bidding for a jar of pennies is due (2%)

Week 5: Mixed Strategy Equilibrium

Sections 4.1-4.5

Read Section 4.10

Problems:

- 106.2 Extensions of BoS with vNM preferences
- 110.1 Expected payoffs
- 111.1 Best responses
- 114.2 Games with mixed strategy equilibria
- 114.3 A coordination game
- 117.2 Choosing numbers
- 118.2 Voter participation
- 120.2 Strictly dominating mixed strategies
- 120.3 Strict domination for mixed strategies
- 121.2 Eliminating dominated actions when finding equilibria

Game 5: All-pay auction is due (4%)

Week 6: Illustrations of Mixed Strategy Equilibrium

Sections 4.6, 4.8

Problems

- 127.2 Incompetent experts
- 128.1 Choosing a seller
- 132.2 Reporting a crime when the witnesses are heterogeneous
- 132.3 Contributing to a public good

No game this week due to midterm

Midterm Exam: Monday March 1st 10:00-11:20am (room assignments to follow)

Week 7 & 8: Extensive Games with Perfect Information

Sections 5.1-5.4

Read Section 5.5

Problems

- 156.2 Examples of extensive games with perfect information
- 161.1 Strategies in extensive games
- 163.1 Nash equilibria of extensive games
- 163.2 Voting by alternating veto
- 164.2 Subgames
- 168.1 Checking for subgame perfect equilibria
- 173.2 Finding subgame perfect equilibria
- 173.3 Voting by alternating veto
- 177.1 Firm-union bargaining
- 177.3 Comparing simultaneous and sequential games

Game 6: Collecting bills is due (4%)

Game 7: "Tyler vs. Kroetsch" is due (4%)

Week 9: Illustrations of Extensive Games with Perfect Information

Sections 6.1-6.2

Problems

- 183.1 Nash equilibria of the ultimatum game
- 183.2 Subgame perfect equilibria of the ultimatum game with indivisible units
- 183.3 Dictator game and impunity game
- 186.1 Holdup game
- 189.1 Stackelberg's duopoly game with quadratic costs
- 192.1 Sequential variant of Bertrand duopoly game

Game 8: "Eating Cookies" is due (6%)

Week 10: Bargaining

Section 16.1, 16.3

Problems:

- 468.1 Two-period bargaining with constant cost of delay
- 468.2 Three-period bargaining with constant cost of delay

- 473.1 One-sided offers
- 473.2 Alternating offer bargaining with constant cost of delay

Game 9: "Dividing grades" is due (4%)

Week 11 & 12: Repeated Prisoner's Dilemma

Sections 14.1 – 14.8

Problems:

- 429.1 Grim trigger strategies in a general Prisoner's Dilemma
- 430.1 Limited punishment strategies in an infinitely repeated Prisoner's Dilemma
- 431.1 Tit-for-tat in an infinitely repeated Prisoner's Dilemma
- 431.2 Nash equilibria of an infinitely repeated Prisoner's Dilemma

Game 10: "Repeated Prisoner's Dilemma" is due (3%)

Economics Department Deferred Final Exam Policy

Deferred Final Exam Policy found at <https://uwaterloo.ca/economics/undergraduate/resources-and-policies/deferred-final-exam-policy>

Cross-listed course

Please note that a cross-listed course will count in all respective averages no matter under which rubric it has been taken. For example, a PHIL/PSCI cross-list will count in a Philosophy major average, even if the course was taken under the Political Science rubric.

Academic Integrity

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo are expected to promote honesty, trust, fairness, respect and responsibility. See the [UWaterloo Academic Integrity](#) webpage and the [Arts Academic Integrity](#) webpage for more information.

Discipline: A student is expected to know what constitutes academic integrity, to avoid committing academic offences, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 – Student Discipline. For information on categories of offenses and types of penalties, students should refer to [Policy 71 - Student Discipline](#). For typical penalties check [Guidelines for the Assessment of Penalties](#).

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. [Read Policy 70 - Student Petitions and Grievances](#), Section 4. When in doubt, please be certain to contact the department’s administrative assistant who will provide further assistance.

Appeals: A decision made or penalty imposed under Policy 70 - Student Petitions and Grievances (other than a petition) or Policy 71 - Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to [Policy 72 - Student Appeals](#).

Accommodation for Students with Disabilities

Note for students with disabilities: [The AccessAbility Services office](#), located on the first floor of the Needles Hall extension (1401), collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the AS office at the beginning of each academic term.