

**Syllabus: ECON 412 –Game Theory
Winter 2016**

Instructor:

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Office Hours: TBD or by appointment

Teaching Assistant:

TBD

Objectives:

Game Theory is the study of strategic interactions between individuals where the outcome for an individual depends not only on his 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 the optimal strategies for the different players and for determining the equilibrium outcomes of games.

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

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 use algebra and calculus including taking derivatives. If you think this will pose problems for you please come and see me.

My Expectations:

- You will come to class and you will participate
- You will stay on top of the material
- You will participate fully in the out of class exercises and submit them on time
- You will complete the assigned problems from the book

Method of Evaluation:

Participation: 5% of final grade
Games (5): 15% of final grade (ex1: 3%, ex2: 4%, ex3: 1%, ex4: 4%, ex5: 3%)
Midterm Examination: Thu Feb 18th (in TBD) - 30% of final grade
Final Examination: Date TBD - 50% of final grade

NOTE: 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 5% participation, 15% problem sets, 15% midterm, and 65% final.

Note: While the games are nominally worth 15% of the final mark, it is possible to score above 100% or below 0% in a given exercise. Thus, they could effectively be worth more than 15% of the final mark.

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 30% 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:

Some of the major topics covered include: strictly and weakly dominated strategies; static games of complete information (Nash equilibrium and mixed strategy equilibrium); dynamic games of complete information (subgame perfect equilibrium); static games of incomplete information (Bayesian games); and repeated games with complete information.

The following is a tentative course schedule/outline and will be updated as we proceed through the course.

Note: Problems marked with an asterisk do not have publicly available solutions.

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 Thursday night

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

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
- 59.2* Cournot game with linear inverse demand and a fixed cost
- 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 2: Bidding for a dollar is due Thursday night

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 3: Bidding for a jar of pennies is due after the first lecture

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
- 114.4* Swimming with sharks
- 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

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

Week 7: Midterm Feb 18th (in TBD)

Week 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

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
- 191.1* Stackelberg's duopoly game with fixed costs
- 192.1* Sequential variant of Bertrand duopoly game

Game 4: "Eating Cookies" is due

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

Week 11: Bayesian Games

Sections 9.1 – 9.4

Problems:

- 276.1 Equilibria of a variant of BoS with imperfect information
- 277.1 Expected payoffs in a variant of BoS with imperfect information

- 282.1* Fighting an opponent of unknown strength
- 282.2 An exchange game
- 282.3* Adverse selection
- 284.1* Infection
- 287.1 Cournot's duopoly game with imperfect information
- 288.1 Cournot's duopoly game with imperfect information - this one is optional

Game 5: "Repeated Prisoner's Dilemma" is due

Week 12: Repeated Prisoner's Dilemma

Sections 14.1 – 14.7

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

Economics Department Deferred Final Exam Policy

Deferred Final Exam Policy found at <https://uwaterloo.ca/economics/current-undergraduates/policies-and-resources/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 \(https://uwaterloo.ca/academic-integrity/\)](https://uwaterloo.ca/academic-integrity/) and the [Arts Academic Integrity Office Webpage \(http://arts.uwaterloo.ca/current-undergraduates/academic-responsibility\)](http://arts.uwaterloo.ca/current-undergraduates/academic-responsibility) for more information.

Discipline: A student is expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (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, **including writing exams in a section that you are not registered in**, 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 found at <http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm>.

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](#). In addition, read [the Student Grievance Process](#) for the Faculty of Arts found at <https://uwaterloo.ca/arts/current-undergraduates/student-support/student-grievances-faculty-arts-processes>.

Appeals: A student may appeal the finding and/or penalty in a decision made under Policy 70 - Student Petitions and Grievances (other than regarding a petition) or Policy 71 - Student Discipline if a ground for an appeal can be established. Read [Policy 72 - Student Appeals](#).

Other sources of information for students

[Academic integrity \(Arts\) Academic Integrity Office \(uWaterloo\)](#)

Accommodation for Students with Disabilities

Note for students with disabilities: The [AccessAbility Services office](#), located on the first floor of the new Needles Hall extension (NH 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.