# DEPARTMENT OF MATHEMATICAL AND COMPUTATIONAL SCIENCES UNIVERSITY OF TORONTO MISSISSAUGA

# MAT406H5F LEC0101 Mathematical Introduction to Game Theory Course Outline - Fall 2019

**Class Location & Time** Tue, 11:00 AM - 01:00 PM DH 4001

Thu, 11:00 AM - 12:00 PM DH 4001

InstructorIlia BinderOffice LocationDH3026Office HoursTu Th 10-11

E-mail Address ilia@math.toronto.edu

Course Web Site <a href="http://www.math.toronto.edu/ilia/Teaching/MAT406.2019/index.html">http://www.math.toronto.edu/ilia/Teaching/MAT406.2019/index.html</a> and https://q.utoronto.

ca

**Teaching Assistant** Eric Ramalheiro

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## **Course Description**

Combinatorial games: Nim and other impartial games; Sprague-Grundy value; existence of a winning strategy in partisan games. Two-player (matrix) games: zero-sum games and Von-Neuman's minimax theorem; general sum-matrix games, prisoner's dilemma, Nash equilibrium, cooperative games, asymmetric information. Multi-player games: coalitions and the Shapley value. Possible additional topics: repeated (stochastic) games; auctions; voting schemes and Arrow's paradox. Mathematical tools that may be introduced include hyperplane separation of convex sets and Brouwer's fixed point theorem. Numerous examples will be analyzed in depth, to offer insight to the mathematical theory and its relation with real life situations. [36L, 12T]

Prerequisite: MAT102H5, MAT223H5/MAT240H5; STA256H5

Exclusion: ECO316H1 (SCI)
Distribution Requirement: SCI

Students who lack a pre/co-requisite can be removed at any time unless they have received an explicit waiver from the department. The waiver form can be downloaded from <a href="here">here</a>.

## **Detailed Course Description**

The course will discuss the mathematical aspects of the Game Theory, an important area of Mathematics/Probability with multiple applications to Economics, Political Science, and Evolutionary Biology, to name a few.

The course will start with the discussion of impartial combinatorial games: subtraction game, Nim, and Chomp. We will also carefully discuss the Sprague-Grundy value. After a brief discussion of partisan combinatorial games, we will talk about the zero-sum games and von Neuman's minimax theorem. We will discuss various methods for solving such games. The next big topic will be the general sum games and Nash equilibrium. Other topics will include the coalition games and Shapley value, applications of Game theory to voting (such as Arrow theorem), auctions, and stochastic games.

#### **Textbooks and Other Materials**

Required Text: Anna R. Karlin and Yuval Peres. Game Theory, Alive. American Mathematical Society, 2017)

#### Online book:

Thomas S. Ferguson. Game Theory. http://www.math.ucla.edu/~tom/Game Theory/Contents.html

#### **Assessment and Deadlines**

Type	Description	<b>Due Date</b>	Weight
Assignment	Homework assignment 1	2019-09-18	3%
Assignment	Homework assignment 2	2019-09-25	3%
Assignment	Homework assignment 3	2019-10-02	3%

		Total	100%
Final Exam	Final Exam	TBA	45%
Term Test	Midterm	2019-10-29	31%
Other	Bonus problems, up to 5%	On-going	0%
Assignment	Homework assignment 8	2019-11-27	3%
Assignment	Homework assignment 7	2019-11-20	3%
Assignment	Homework assignment 6	2019-11-13	3%
Assignment	Homework assignment 5	2019-10-23	3%
Assignment	Homework assignment 4	2019-10-16	3%

#### More Details for Assessment and Deadlines

Homework is due every Wednesday, at the beginning of the tutorial. The assignments will be posted to the course web page the preceding Thursdays (6 days in advance). The assignments can also be submitted through Quercus **before the beginning of the tutorial.** To submit, you can scan or take a photo of your work (or write your work electronically). **Please make sure that the images are clear and easy to read** before you submit them.

There will be one in-class two-hour midterm test on Tuesday, October 29.

#### **Penalties for Lateness**

20% reduction in mark per day of lateness (submission on the day the homework due after the tutorial is considered to be one day late).

#### **Procedures and Rules**

#### Missed Term Work

Extensions for homework deadlines will be considered only for medical reasons. Late assignments will lose 20% per day. Special consideration for late assignments or missed exams must be submitted via e-mail within a week of the original due date. There will be no make-up midterm tests or final. Justifiable absences must be declared on ROSI, undocumented absences will result in zero credit.

#### **Missed Final Exam**

Students who cannot write a final examination due to illness or other serious causes must file an<u>online petition</u> within 72 hours of the missed examination. Original supporting documentation must also be submitted to the Office of the Registrar within 72 hours of the missed exam. Late petitions will NOT be considered. If illness is cited as the reason for a deferred exam request, a U of T Verification of Student Illness or Injury Form must show that you were examined and diagnosed at the time of illness and on the date of the exam, or by the day after at the latest. Students must also record their absence on ACORN on the day of the missed exam or by the day after at the latest. Upon approval of a deferred exam request, a non-refundable fee of \$70 is required for each examination approved.

#### **Academic Integrity**

Honesty and fairness are fundamental to the University of Toronto's mission. Plagiarism is a form of academic fraud and is treated very seriously. The work that you submit must be your own and cannot contain anyone elses work or ideas without proper attribution. You are expected to read the handout How not to plagiarize (<a href="http://www.writing.utoronto.ca/advice/using-sources/how-not-to-plagiarize">http://www.writing.utoronto.ca/advice/using-sources/how-not-to-plagiarize</a>) and to be familiar with the Code of behaviour on academic matters, which is linked from the UTM calendar under the link Codes and policies.

#### **Final Exam Information**

Duration: 2 hours

Aids Permitted: 1 page(s) of single-sided Letter (8-1/2 x 11) sheet

#### Additional Information

The course will discuss the mathematical aspects of the Game Theory, an important area of Mathematics/Probability with multiple

applications to Economics, Political Science, and Evolutionary Biology, to name a few.

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Prerequisites will be checked, and students not meeting them will be removed from the course by the end of the second week of classes. If a student believes that s/he does have the necessary background material and is able to prove it (e.g., has a transfer credit from a different university), then s/he should submit a 'Prerequisite/Corequisite Waiver Request Form', which can be found on the department website, at

http://www.utm.utoronto.ca/math-cs-stats/sites/files/math-cs-stats/public/users/yeyvette/PrereqCoreqForm-20129.pdf or on the course website.

#### E-mail Policy

E-mails must originate from a utoronto.ca address and contain the course code MAT406 in the subject line. Please include your **full name** and **student number** in your e-mail.

Last Date to drop course from Academic Record and GPA is November 7, 2019.