Mathematics MAT 1855HS Professor Robert McCann www.math.toronto.edu/mccann/1855

MATHEMATICAL PROBLEMS IN ECONOMICS

Lecture Hours: Tuesday 16h10-17h40 BA 6180
Thursday 16h10-17h40 BA 6180
Prof's Office Hours: immediately following each class BA 6124
Except: **neither classes nor office hours on Sept 3-5, Sept 24-26**

This course surveys a number of economic topics of current research interest in which mathematical developments have (and are expected to continue to) contribute crucial advances. These include the theory of matching and pricing, problems of asymmetric information, the principal-agent framework, auction theory, mechanism (and information) design, portfolio optimization and hedging. These topics are partly unified through mathematical techniques such as linear programming (optimal transport and its emerging relevance figure prominently think of trying to pair N workers with N firms so as to maximize the total surplus), nonsmooth analysis, the calculus of variations, and differential equations. We may also consider related topics such as obstacle and free boundary problems, matching with unobservable heterogeneity and/or imperfectly transferable utility, and equilibria involving agents who respond nonlinearly to prices, which go beyond the variational framework. The necessary mathematics (beyond measure theory and integration) will be developed in parallel with the applications, as well as any necessary background in economics.

Grading Scheme: Attendance and participation 10 %
Project (breakdown and deadlines below) 90 %

References:

Basov. Multidimensional Screening. Springer, 2005.

Chiappori. Matching with Transfers: The Economics of Love and Marriage. Princeton, 2017.

Galichon. Optimal Transport Methods in Economics. Princeton, 2016.

Henry-Labordère. Model-free Hedging: A Martingale Optimal Transport Viewpt. CRC 2017.

Mas-Colell, Whinston and Green. Microeconomic Theory. Oxford, 1995.

Sotomayor and Roth. Two-Sided Matching: a Study in Game-Theoretic Modeling and Analysis. Cambridge Press, 1992.

* Santambrogio. Optimal Transport for Applied Mathematicians. Birkhauser 2015.

Vohra. Mechanism Design: A Linear Programming Approach. Cambridge 2011.

My survey on the arXiv also at `www.math.toronto.edu/mccann/publications`

* [47] R McCann & N Guillen (2013) "Five Lectures on Optimal Transport..."

Further sources may also periodically be linked to the course webpage.

INDEPENDENT PROJECT DEADLINES

Identify topic and references (5%): Thursday, Oct. 3
Complete rough draft (25%): Thursday, Nov. 7
Final draft (60%): Thursday, Nov 28
Optional: oral presentation for extra credit.

This project is intended to provide you with an opportunity to independently pursue some topic of interest to you within the framework of the course. Those taking this course for credit will be expected to prepare a written report on your topic (something on the order of 6-12 pages). Students also have the option to volunteer to give an oral presentation on the same topic in the last week of the semester.

By Tuesday Oct. 3 each such student should communicate to me a topic related to themes of the course which you have decided to learn about on your own, and at least two written sources

which you plan to use to research it (these could be articles or books). Your written project should summarized the interest, importance, and key contributions, methods and results which you learn. A complete written draft, in polished form, is due Thursday Nov 7, along with an indication of whether or not you would like to present your topic orally for extra credit. I will provide feedback on this, to be incorporated into your presentations and final draft. The sources listed above include many possible topics; others may be mentioned in class or on the course webpage, and you are certainly welcome to suggest your own proposals to me. In any case you should settle on a topic and format in consultation with me by end of by Oct. 3 at latest.

Projects will be accepted up to 7 days late, at a penalty of 3% per day late (up to a maximum penalty of 21% of the marks earned). After 7 days the grade will be zero. Late penalties will be waived in cases of justified absence documented in writing to the satisfaction the instructor.

INTEGRITY

The University treats cases of academic misconduct very seriously. Academic integrity is a fundamental value of learning and scholarship at the UofT. Participating honestly, respectfully, responsibly, and fairly in this academic community ensures that your UofT degree is valued and respected as a true signifier of your individual academic achievement.

The University of Toronto's Code of Behaviour on Academic Matters outlines the behaviours that constitute academic misconduct, the processes for addressing academic offences, and the penalties that may be imposed. You are expected to be familiar with the contents of this document. Potential offences include, but are not limited to:

Using someone else's ideas or words without appropriate acknowledgement. Obtaining or providing unauthorized assistance on any assignment.

Misrepresentation: Falsifying or altering any documentation required by the University, including (but not limited to) doctor's notes. Falsifying institutional documents or grades. All suspected cases of academic dishonesty will be investigated following the procedures outlined in the Code of Behaviour on Academic Matters. If you have any questions about what is or is not permitted in this course, please do not hesitate to contact me.

DIVERSITY AND ACCOMMODATIONS

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or contact Accessibility Services at (416) 978-8060; accessibility.utoronto.ca

---

COMMUNICATIONS POLICY

Course material will be posted to Quercus or `www.math.toronto.edu/mccann/1855`

Questions concerning the subject matter of the course should be brought to lectures or office hours. Administrative concerns including documentation justifying absences should go by e-mail to `mccann@math.toronto.edu` Please include the course number MAT 1855HS in the subject heading. I will endeavour to respond to emails within 72 hours. Project submissions will be on Quercus, but I would also appreciate receiving a paper copy of your projects in class.