ECON 8819: Theory and Applications of Mechanism Design

Topics in Axiomatic, Bayesian, and Dynamic Mechanism Design with Applications to Matching, Auctions, and Beyond

Spring 2025

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Office Hours: Thursdays 3:15-4:45 pm or by appointment

Course Objectives: This course covers introductory and advanced materials on the axiomatic theory of mechanism design, Bayesian mechanism design, dynamic mechanism design, and its applications in matching, auctions, and beyond. The course aims to build a solid background for economics Ph.D. students in mechanism design and introduce selected material on its frontiers and other niche areas. Even though it targets graduate students who want to do theoretical work, other students may also benefit.

Teaching Method: The lectures will cover the theoretical material supplemented with examples.

Course Materials:

1. M. Utku Ünver's course notes, slides, and other material on Canvas,
2. Matthew O. Jackson. "Mechanism Theory." (2014), Available at SSRN 2542983,[1]
3. Tilman Börgers. *An Introduction to the Theory of Mechanism Design* (2015), Oxford University Press, USA, (*I recommend for purchase*)
4. Tayfun Sönmez and M. Utku Ünver. "Matching under Non-transferable Utility: Theory," Chapter 1 in Yeon-Koo Che, Pierre-Andre Chiaporri, and Bernard Salanie (eds) *Handbook of the Economics of Matching*, Volume 2 (Elsevier), forthcoming
5. Tayfun Sönmez and M. Utku Ünver. "Matching, Allocation, and Exchange of Discrete Resources." in J. Benhabib, A. Bisin, and M. O. Jackson (eds.), *Handbook of Social Economics* (2011), 1, 781-852, North-Holland, The Netherlands,

[1] An abridged version of this survey appeared in Ulrich Derigs (ed.) *Optimization and Operations Research, The Encyclopedia of Life Support Systems* (2003), EOLSS Publishers, Oxford UK, http://www.eolss.net.

6. Parag A. Pathak, Tayfun Sönmez, and M. Utku Ünver. *Theory and Practice of Matching Markets.* (2021) Unpublished manuscript.

7. Tayfun Sönmez and M. Utku Ünver. "Matching under Non-transferable Utility: Applications," Chapter 3 in Yeon-Koo Che, Pierre-Andre Chiaporri, and Bernard Salanie (eds) *Handbook of the Economics of Matching*, Volume 2 (Elsevier), forthcoming

8. Reading list material cited at the end of each part.

Grades and Requirements: Students are expected to come to each class, read the assigned material, and solve the homework questions as scheduled. Class participation through questions to the instructor and answers to the instructor's questions are expected. Returning in homework assignment sets, preparation of a credible paper outline, and a final paper presentation will be required. A recommended paper list for presentations will be provided later.

Tentative Course Outline:

Part 0: Basics

- Hurwiczian approach to mechanism design, implementation, and the revelation principle (Jackson, 2014 Survey).

Part I: An Axiomatic Approach to Dominant-Strategy Mechanism Design: Efficiency and Beyond (without Transfers) (Jackson, 2014 Survey; Sönmez and Ünver, forthcoming "Theory" Survey).

- Axiomatic approach to design economics (Thomson 2011 Survey)
- Finite and strict universal domain: application voting
  - Non-existence of plausible strategy-proof and efficient mechanisms (Gibbard, 1973, Satterthwaite, 1975, Reny, 2001),
  - * Gibbard's random dictatorship characterization (Gibbard, 1977, Tanaka, 2003).
- Single-peaked domain: voting and allocation of a single divisible good without free disposal
  - Voting (Moulin, 1980),
  - * Divisible good without free disposal (Sprument, 1991).
- Hedonic non-transferable domain (Sönmez and Ünver, 2011 Survey; Sönmez and Ünver, forthcoming "Theory" Survey; Pathak, Sönmez, and Ünver, 2021 Manuscript).
  - House allocation, exchange and hybrid models (Svensson, 1999, Ma, 1994, Sönmez and Ünver, 2010, Papái, 2000, Pycia and Ünver, 2017),
  - * Generalized matching markets and core as a mechanism (Sönmez, 1998),
  - * Two-sided matching via balanced exchange (Dur and Ünver, 2019).

- Hedonic non-transferable domain: Random mechanisms and incentives in large markets. (Pathak, Sönmez, and Ünver, 2021 Manuscript)
  - Random serial dictatorship (Abdulkadiroğlu and Sönmez, 1998),
  - Probabilistic serial (Bogomolnaia and Moulin, 2001, Hashimoto et. al, 2014, Manea and Kojima, 2010),
  - Competitive equilibrium from equal incomes (Hylland and Zeckhauser, 1979, He et al., 2018),
  - Random mechanisms with property rights (Yilmaz, 2009, Sönmez and Ünver, 2005),
  - * Strategy-proofness in the large ((Che and Kojima, 2010, Liu and Pycia, 2016, Azevedo and Budish, 2019).
- Beyond efficiency in the hedonic non-transferable domain: Priority-based assignment and two-sided matching. (Pathak, Sönmez, and Ünver, 2021 Manuscript)
  - Matching with contracts (Hatfield and Milgrom, 2005, Hatfield and Kojima, 2010, Hatfield, Kominers, Westkamp, 2021, Greenberg, Pathak, Sönmez, 2021),
  - * School choice lotteries (Kesten and Ünver, 2015).
  - * Two-sided matching in the large (Immorlica and Mahdian, 2005, Kojima and Pathak, 2009).

Reading List:

- (r) Matthew O. Jackson. "Mechanism theory." (2014), Available at SSRN 2542983.
- (r) William Thomson. "Chapter Twenty-One - Fair Allocation Rules." in K. J. Arrow, A. Sen, and K. Suzumura (eds.), *Handbook of Social Choice and Welfare* (2011), 2, 293-506, Elsevier.
- Allan Gibbard. "Manipulation of Voting Schemes: A General Result." *Econometrica* (1973), 41, 587-601.
- Mark A. Satterthwaite. "Strategy-proofness and Arrow's conditions: Existence and correspondence theorems for voting procedures and social welfare functions." *Journal of Economic Theory* (1975), 10(2), 187-217.
- (r) Philip Reny. "Arrow's theorem and the Gibbard-Satterthwaite theorem: a unified approach." *Economics Letters* (2001), 70: 99-105.
- (r) Hervé Moulin. "On strategy-proofness and single peakedness." *Public Choice* (1980), 35(4), 437-455.
- Yves Sprumont. "The Division Problem with Single-Peaked Preferences: A Characterization of the Uniform Allocation Rule." *Econometrica* (1991), 59(2), 509-519.

- Tayfun Sönmez. "Strategy-proofness and essentially single-valued cores." *Econometrica* (1999), 67(3), 677-689.
- (r) Tayfun Sönmez and M. Utku Ünver. "Matching under Non-transferable Utility: Theory," Chapter 1 in Yeon-Koo Che, Pierre-Andre Chiaporri, and Bernard Salanie (eds) *Handbook of the Economics of Matching*, Volume 2 (Elsevier), forthcoming
- (r) Parag A. Pathak, Tayfun Sönmez, and M. Utku Ünver. *Theory and Practice of Matching Markets.* (2021) Unpublished manuscript.
- (r) Tayfun Sönmez and M. Utku Ünver. "Matching, Allocation, and Exchange of Discrete Resources." in J. Benhabib, A. Bisin, and M. O. Jackson (eds.), *Handbook of Social Economics* (2011), 1, 781-852, Elsevier.
- Jin Peng Ma. "Strategy-proofness and the strict core in a market with indivisibilities." *International Journal of Game Theory* (1994), 23(1), 75-83.
- (r) Lars-Gunnar Svensson. "Strategy-proof allocation of indivisible goods." *Social Choice and Welfare* (1999), 16(4), 557-567.
- Szilvia Papái. "Strategyproof Assignment by Hierarchical Exchange." *Econometrica* (2000), 68(6), 1403-1433.
- (r) Hatfield, John William, and Paul R. Milgrom. "Matching with contracts." *American Economic Review* (2005), 95(4), 913-935.
- Tayfun Sönmez and M. Utku Ünver. "House allocation with existing tenants: A characterization." *Games and Economic Behavior* (2010), 69(2), 425-445.
- (r) Marek Pycia and M. Utku Ünver. "Incentive compatible allocation and exchange of discrete resources." *Theoretical Economics* (2017), 12, 287-329.

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- Allan Gibbard. "Manipulation of schemes that mix voting with chance." *Econometrica* (1977), 665-681.
- (r) Yasuhito Tanaka. "An alternative direct proof of Gibbard's random dictatorship theorem." *Review of Economic Design* (2003), 8, 319-328.
- (r) Marek Pycia and M. Utku Ünver. "Decomposing random mechanisms." *Journal of Mathematical Economics* (2015), 61, 21-33.
- (r) Atila Abdulkadiroğlu and Tayfun Sönmez. "Random serial dictatorship and the core from random endowments in house allocation problems." *Econometrica* (1998), 66(3), 689-701.

- (r) Anna Bogomolnaia and Hervé Moulin. "A New Solution to the Random Assignment Problem." *Journal of Economic Theory* (2001), 100, 295-328.
- (r) Fuhito Kojima and Mihai Manea. "Incentives in the probabilistic serial mechanism." *Journal of Economic Theory* (2010), 145(1), 106-123.
- (r) Tadashi Hashimoto, Daisuke Hirata, Onur Kesten, Morimitsu Kurino, and M. Utku Ünver. "Two Axiomatic Approaches to the Probabilistic Serial Mechanism." *Theoretical Economics* (2014), 9, 253-277.
- (r) Aanund Hylland and Richard Zeckhauser. "The efficient allocation of individuals to positions." *Journal of Political Economy* (1979), 87(2), 293-314.
- Tayfun Sönmez and M. Utku Ünver. "House allocation with existing tenants: An equivalence." *Games and Economic Behavior* (2005), 52(1), 153-185.
- (r) Yilmaz, Özgür. "Random assignment under weak preferences." *Games and Economic Behavior* (2009), 66(1), 546-558.

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- (r) Eduardo Azevedo and Eric Budish. "Strategy-proofness in the Large." *The Review of Economic Studies* (2019), 86(1), 81-116.
- Yeon-Koo Che and Fuhito Kojima. "Asymptotic Equivalence of Probabilistic Serial and Random Priority Mechanisms." *Econometrica* (2010), 78(5), 1625-1672.
- Qingmin Liu and Marek Pycia. "Ordinal Efficiency, Fairness, and Incentives in Large Markets." Working paper (2016).

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- John William Hatfield and Paul R. Milgrom. "Matching with Contracts." *American Economic Review* (2005)m, 95 (4), 913-935.
- John William Hatfield and Fuhito Kojima. "Substitutes and stability for matching with contracts." *Journal of Economic Theory* (2010), 145(5), 1704-1723.
- John William Hatfield, Scott Duke Kominers, and Alexander Westkamp. "Stability, Strategy-Proofness, and Cumulative Offer Mechanisms." *The Review of Economic Studies* (2021), 88, 1457-1502.
- Nicole Immorlica and Mohammad Mahdian. "Marriage, honesty, and stability." *Conference Proceedings of the Sixteenth Annual ACM-SIAM Symposium on Discrete Algorithms* (2005), 53-62.

- Fuhito Kojima and Parag A. Pathak. "Incentives and Stability in Large Two-Sided Matching Markets." *American Economic Review* (2009), 99(3), 608-627.
- Umut Mert Dur and M. Utku Ünver. "Two-sided matching via balanced exchange." *Journal of Political Economy* (2019), 127(3), 1156-1177.
- Onur Kesten and M. Utku Ünver. "A theory of school-choice lotteries." *Theoretical Economics* (2015), 10(2), 543-595.
- Kyle Greenberg, Parag A. Pathak, and Tayfun Sönmez. "Mechanism Design meets Priority Design: Redesigning the US Army's Branching Process." (2024), *American Economic Review*

Part II: (Bayesian) Mechanism Design with Transfers

- Dominant Strategy Mechanisms in Quasi-linear Domain
  - Generalized Vickrey-Clark-Groves mechanisms (Jackson, 2014 Survey).
- Myersonian approach to Bayesian Mechanisms with Transfers (Börgers, 2015 Book, Chapters 2, 3, 5, and 6).
  - Optimal Auctions and Revenue Equivalence (Myerson, 1981),
  - * Public Goods (D'Aspermont and Gerard-Valet, 1979),[2]
  - Bilateral Trade (Myerson and Satterthwaite, 1983),
  - Correlated Types and Full Surplus Extraction (Crémer and McLean, 1988).

Reading List:

- Claude d'Aspremont and Louis-Andre Gerard-Varet. "On Bayesian incentive compatible mechanisms." in J.J. Laffont (ed.), *Aggregation and Revelation Preferences* (1979), 269-288, North-Holland, The Netherlands.
- (r) Roger B. Myerson. "Optimal auction design." *Mathematics of Operations Research* (1981), 6(1), 58-73.[3]
- Roger B. Myerson and Mark A. Satterthwaite. "Efficient mechanisms for bilateral trading." *Journal of Economic Theory* (1983), 29(2), 265-281.
- Jacques Crémer and Richard P. McLean. "Full extraction of the surplus in Bayesian and dominant strategy auctions." *Econometrica* (1988), 1247-1257.
- Vijay Krishna. *Auction Theory*. (2002), Academic Press.
- Matthew O. Jackson. "Mechanism theory." (2014), Available at SSRN 2542983.

[2] * : paper will be covered if time permits.

[3] (r) : the book/paper will be used in the class heavily, so it is an obligatory reading.

- (r) Tilman Börgers. *An Introduction to the Theory of Mechanism Design*. (2015), Oxford University Press, USA (Chapters 2,3,5,6).

Part III: Dynamic Mechanism Design.

- Dynamic ex-post mechanism design (Bergemann and Välimäki, 2019, Pavan, Segal, and Toikka 2014).
- Dynamic matching.
  - Queueing and matching (Ünver, 2010, Che and Tercieux, 2021),
  - Optimal dynamic matching mechanisms (Baccara, Lee, Yariv, 2020),
  - * A theory of stability in dynamic matching markets (Doval, 2022).

Reading List:

- (r) M. Utku Ünver. "Dynamic kidney exchange." *The Review of Economic Studies* (2010), 77(1), 372-414.
- Alessandro Pavan, Ilya Segal, and Juuso Toikka. "Dynamic mechanism design: A Myersonian approach." *Econometrica* (2014), 82(2), 601-653.
- (r) Dirk Bergemann and Juuso Välimäki. "Dynamic mechanism design: An introduction." *Journal of Economic Literature* (2019), 57(2), 235-274.
- Yeon-Koo Che and Olivier Tercieux. "Optimal Queue Design." Working paper (2021).
- (r) Mariagiovanna Baccara, SangMok Lee, and Leeat Yariv. "Optimal dynamic matching." *Theoretical Economics* (2020), 15(3), 1221-1278.
- Laura Doval. "Dynamically stable matching." *Theoretical Economics* (2022), 17(2), 687-724.

Statement on Academic Integrity:

The Graduate School of Arts and Sciences at Boston College expects all students to adhere to the accepted norms of intellectual honesty in their academic work. Any forms of cheating, plagiarism, or dishonesty or collusion in another's dishonesty is a fundamental violation of these norms.

CHEATING is the use or attempted use of unauthorized aids in any exam or other academic exercise submitted for evaluation. This includes data falsification; the fabrication of data; deceitful alteration of collected data included in a report; copying from another student's work; unauthorized cooperation in doing assignments or during an examination; the use of purchased essays, term papers, or preparatory research for such papers; submission of the same written work in more than one course without prior written approval from the instructor(s), involved; and dishonesty in requests for either extensions or papers or make-up examinations.

PLAGIARISM is the deliberate act of taking the words, ideas, data, illustrative material, or statements of someone else, without full and proper acknowledgment, and presenting them as one's own.

COLLUSION is assisting or attempting to assist another student in an act of academic dishonesty.

As part of your scholarly development, you must learn how to work cooperatively in a community of scholars and fruitfully utilize the work of others without violating the norms of intellectual honesty. You have a responsibility to learn the parameters of collaboration and the proper forms for quoting, summarizing and paraphrasing.

Faculty members who detect any form of academic dishonesty have the responsibility to take appropriate action. The faculty member also has the responsibility to report the incident and penalty to the Department Chairperson and the appropriate Class Dean. The report will remain in your student file until you graduate.

If the gravity of the offense seems to warrant it or if the faculty member prefers that another academic authority decide the matter, he or she may refer the case to a Dean. In addition, if the student is unwilling to accept the faculty member's decision, he or she may choose to have the matter adjudicated either by an Associate Dean or by an Administrative Board. The section of the College of Arts and Sciences in the Boston College Undergraduate Catalogue has further details about this process. Academic integrity is a very important matter. If you have any questions in any of your courses about what is allowed or not allowed, please discuss the matter immediately with the instructor.

Disability Statement:

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and the Disability Services Office, Office of the Dean of Students, Phone: 617-552-3470, TTY: 617-552-2548, Email: disabsrv@bc.edu. Also see https://www.bc.edu/offices/dos/subsidiary_offices/disabilityservices.html.