

Indian Institute of Technology Kanpur
Department of Economic Sciences
Proposal for a New Course

1. Course No: ECO7XX

2. Course Title: Markets, algorithms, and incentives

3. Per Week Lectures: 3 (L), Tutorial: 0 (T), Laboratory: 0 (P), Additional Hours: 0

Credits: ($3 \times L + T + P + A$): 9 credits

Duration of Course: Full Semester Course

4. Proposing Department: Economic Sciences

Other Departments which may be interested: None

Other faculty members interested in teaching the proposed course: None

5. Proposing instructor: Aditya Vikram

Level of the course: PG (PhD and 2nd-year MSc students of Economics)

6. Course Description:

A) Objectives: The goal of this course is to provide a rigorous, research-level treatment of matching theory, auction theory and allocation problems, with an emphasis on their formulation and solution through linear programming, integer programming and combinatorial optimization, and to expose students to the practical design of real-world marketplaces and to current research frontiers in market design.

B) Contents

S. No.	Broad Title	Topics	No. of Lectures
1.	Introduction	Game theory basics; the economist as engineer; thickness, congestion, safety and simplicity ; repugnant markets ; overview of famous market design cases: residency matching, spectrum auctions, kidney exchange, school choice	4
2.	Matching and assignment	Deferred acceptance and stable matchings ; strategy-proofness; matching with contracts and couples; top trading cycles and house allocation ; random assignment; kidney exchange ; Indian applications: school choice; bureaucratic assignment and quotas, etc.	11
3.	Auctions	Mechanism design basics; Myerson's optimal auction; interdependent values and the linkage principle; Myerson–Satterthwaite theorem; double auctions; robust	12

		mechanism design; VCG and multi-object auctions; clock, combinatorial and core-selecting auctions; spectrum auctions; position auctions	
4.	Allocation and mathematical programming	The assignment game and LP duality ; Walrasian prices as dual variables; stable matching and winner determination as mathematical programs ; complexity and approximation; scheduling, queueing and sequencing; applications include course allocation, refugee resettlement, electricity markets, etc.	7
5.	Miscellaneous	Online mechanisms; posted prices and prophet inequalities; platform design; frequent batch auctions; Mechanism design in artificial intelligence; automated mechanism design	5

*50-minute lecture each, total of 39 lectures

C) Prerequisites: HSO201 or any equivalent probability and statistics course

D) Short summary for including in the Courses of Study Booklet: Market design studies how the rules of a marketplace can be engineered to achieve efficiency, stability, fairness and incentive compatibility. The course provides a research-level treatment of matching theory and auction theory, and develops an optimization perspective in which allocation problems, including scheduling and queueing, are formulated and solved through linear and integer programming. Applications include residency matching, school choice, kidney exchange, spectrum auctions and electricity markets. The course closes with contemporary topics such as online mechanisms, platform design and automated mechanism design, and emphasizes formal results, proofs and the reading of recent research papers.

7) Recommended textbooks

Two-Sided Matching: A Study in Game-Theoretic Modeling and Analysis, Alvin E. Roth and Marilda Sotomayor. Cambridge, U.K.: Cambridge University Press, 1990

Auction Theory, Vijay Krishna, 2nd edition. San Diego, CA: Academic Press, 2010

Putting Auction Theory to Work, Paul Milgrom. Cambridge, U.K.: Cambridge University Press, 2004

Discovering Prices: Auction Design in Markets with Complex Constraints, Paul Milgrom. New York, NY: Columbia University Press, 2017

An Introduction to the Theory of Mechanism Design, Tilman Börgers. Oxford, U.K.: Oxford University Press, 2015

Mechanism Design: A Linear Programming Approach, Rakesh V. Vohra. Cambridge, U.K.: Cambridge University Press, 2011

Market Design: A Linear Programming Approach to Auctions and Matching, Martin Bichler. Cambridge, U.K.: Cambridge University Press, 2017

Algorithmic Game Theory, Noam Nisan, Tim Roughgarden, Éva Tardos and Vijay V. Vazirani (eds.). Cambridge, U.K.: Cambridge University Press, 2007

Market Design: Auctions and Matching, Guillaume Haeringer. Cambridge, MA: MIT Press, 2017

Online and Matching-Based Market Design, Federico Echenique, Nicole Immorlica and Vijay V. Vazirani (eds.). Cambridge, U.K.: Cambridge University Press, 2023

In addition, the course will draw on journal articles, surveys and recent working papers, a reading list of which will be circulated by the instructor. Representative articles include:

Roth, A. E. (2002), “The Economist as Engineer: Game Theory, Experimentation, and Computation as Tools for Design Economics,” *Econometrica*, 70(4), 1341–1378.

Roth, A. E. (2007), “Repugnance as a Constraint on Markets,” *Journal of Economic Perspectives*, 21(3), 37–58.

Edelman, B., M. Ostrovsky and M. Schwarz (2007), “Internet Advertising and the Generalized Second-Price Auction: Selling Billions of Dollars Worth of Keywords,” *American Economic Review*, 97(1), 242–259.

Nisan, N. and A. Ronen (2001), “Algorithmic Mechanism Design,” *Games and Economic Behavior*, 35(1–2), 166–196.

Budish, E., P. Cramton and J. Shim (2015), “The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response,” *Quarterly Journal of Economics*, 130(4), 1547–1621.

8) Any other remarks: None

Dated: _____

Proposer: Aditya Vikram

Dated: _____

DPGC Convener: _____

The course is approved / not approved

Chairman, SPGC

Dated: _____