City University of Hong Kong

Information on a Course
offered by Department of Computer Science
with effect from Semester A in 2012 / 2013

Part I

Course Title: Algorithms and Protocols for Internet Market

Course Code: CS6280

Course Duration: One Semester

Credit Units: 3

Level: P6

Medium of Instruction: English

Prerequisites: CS5222 Computer Networks and Internets or
CS5285 Information Security for eCommerce or
CS5286 Algorithms & Techniques for Web Searching or equivalent

Precursors: Nil

Equivalent Courses: Nil

Exclusive Courses: Nil

Part II

Course Aims

The aim of this course is to introduce students to an emerging and dynamic field in the interface of economics and computer science. Concepts, principles, and applications of market mechanisms are introduced with a special focus on information goods created over the Internet. Knowledge and skills for Internet market design and implementations are covered to provide the know-how in the making of the growing Internet Economics.

Course Intended Learning Outcomes (CILOs)
Upon successful completion of this course, students should be able to:

No.	CILOs	Weighting (if applicable)
1.	describe and critique basic exchange market models, and their economic formulations from a technical perspective;	
2.	describe and apply key principles and protocols in market price determinations;	
3.	characterize special market properties of information goods;	
4.	optimize value of information and knowledge through market mechanism;	
5.	design and analyse Internet market systems.	

Teaching and Learning Activities (TLAs)
(Indicative of likely activities and tasks designed to facilitate students' achievement of the CILOs. Final details will be provided to students in their first week of attendance in this course)

Teaching pattern:
Suggested lecture/tutorial/laboratory mix: 2 hrs. lecture; 1 hr. tutorial.

This course will focus on introducing the fundamental and state-of-the-art techniques in Internet market design, with a focus on markets of information goods.

The topics to be covered will be three major components: 1.) classical results in economic analysis of markets, 2.) digital goods and internet market models, 3.) advanced topics in applications of Internet markets.

The first component is fundamental but the last two parts may vary from year to year, depending on the trend and direction of this emerging field. Instructor will introduce background information, fundamental methodologies and advanced topics. Students are then required to have a comprehensive understanding of the field by learning the fundamentals through completing assignments/quizzes/examinations, gaining insight in the current development by either in the system development part, or writing an essay on important topics together with extensive readings of the literatures.

CILO No.	TLAs	Hours/week (if applicable)
CILO 1 CILO 2 CILO 3	**Written Assignment** – This assignment gives students an opportunity to practice their understandings of the basic market models. This activity supports Course ILOs #1, 2, 3.	
CILO 1	**Quiz** – The quiz reinforces students' understanding	

CILO 2 CILO 3	of the principles, methods, and formulations of the Internet market models. This activity supports Course ILOs #1, 2, 3.	
CILO 4 CILO 5	**Project** – Two different types of projects are formulated that allow students to choose from: an essay based one, and another software programming based one. Software-based assignment gives students an opportunity to show their ability in designing and prototyping Internet market system. In addition, students will be encouraged to propose/invent their own methods/algorithms for a specific market. The assignment will be documented in a report. This activity supports Course ILOs #4, 5.	
CILO 3 CILO 4 CILO 5	**Presentation** – Students will present their project results, in a research essay or an implementation of Internet market models. Through this sharing process, students will learn from each other application values of Internet market models.. This activity supports Course ILOs #3, 4, 5.	
CILO 1 CILO 2 CILO 3 CILO 4	**Examination** – Students will be tested on their overall understanding of the topics covered in CILO 1, 2, 3, 4.	

Assessment Tasks/Activities

(Indicative of likely activities and tasks designed to assess how well the students achieve the CILOs. Final details will be provided to students in their first week of attendance in this course)

CILO No.	Type of Assessment Tasks/Activities	Weighting (if applicable)	Remarks
CILO 1	Describe and critique basic exchange market models, and their economic formulations. **Coursework**: The quality of students' written assignment #1 will be used to assess this ILO. **Exam**: Questions will be included to assess students' understandings on agent incentives in exchange markets.		
CILO 2	Describe and apply key principles and protocols in market price determinations. **Coursework:** Students are required to complete written assignment #2, and the correctness of their answers will be measured against this ILO.		

	Exam: Final exam will include questions to assess the students' understanding on selected pricing models.		
CILO 3	Characterize special market properties of information goods. **Coursework**: The quality of students' written assignment #3 will be used to assess this ILO. **Exam**: Final exam will include questions to assess the students' understanding on this ILO.		
CILO 4	Optimize value of information and knowledge through market mechanism. **Project**: Students can further demonstrate their understandings on this topic in their project, either essay or system. The performance of the algorithms for the testing data set will be the measures of this ILO. **Exam**: Final exam will include questions to test the students' capability in applying market optimal design techniques for market makers and market systems.		
CILO 5	Design and analyze Internet market systems. **Project**: Students are required to complete a project (essay or software programming based) for some chosen topics of Internet markets. In addition to demonstrate the comprehensive understanding of the topic, the creativity and novelty of the project will also be an important measure of this ILO.		

Grading of Student Achievement: Refer to Grading of Courses in the Academic Regulations for Taught Postgraduate Degrees.

Examination duration: 2 hours

Percentage of coursework, examination, etc.:   50% CW; 50% Exam

Grading pattern: Standard (A+AA-…F)

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

A formative assessment will be made on the students' ability to apply tools and knowledge to different situation. The equal weighting of coursework and examination assessment is due to the emphasis on both the practicality and the theory of market design models.

Part III

Keyword Syllabus

Auction protocol, mechanism design, envy-free, incentive compatibility, Nash equilibrium, cooperative games, arbitrage, equilibrium, pricing, sponsored search, pay-per-click, advertisement allocation, generalized second price auction, market clearance, Walrasian equilibrium, cross-market arbitrage, revenue opimtization, buyers, sellers, market makers, advertisers, prediction market, information market, opinion aggregating, outcome forecasting, pari-mutuel, spam, phishing.

Syllabus

1. Introduction (overview of market models)
   Fixed price model, single auction market, market maker model, double auction market (matching model).

2. Principle of game theory and market price determinations
   Incentive compatibility and mechanism design, Vickrey Auction, Truthfulness, VCG auction, Nash equilibrium, non-arbitrage, general equilibrium, cooperative games.

3. Sponsored Search Market: Web search engines, Models for Internet Economics, Generalized Second Price, Pay-per-impression, pay-per-click, pay-per-action Vickrey-Clarke-Groves auction for sponsored search, Generalized First-Price Auctions, Generalized second-price auction.

4. Revenue maximization: Optimal auction design, SNE, LEFN, FLNE, core in GSP, Arbitrage crossing multiple markets.

5. Prediction market models: Wisdom of crowd, opinion aggregation and outcome forecasting, pari-mutuel market, market: value of information and knowledge.

6. Research topic: computation of equilibrium, economic measures for fighting negative information (spam/phishing), value of reputation.

Recommended Reading
Text(s)

Essential Text

Lecture notes.

Supplementary Reading

- **Auction theory,** Krishna, Vijay. San Diego: Academic Press, c2002.
- **An introduction to auction theory** ,Flavio M. Menezes, Paulo K. Monteiro. Oxford ; New York : Oxford University Press, 2005.
- **Algorithmic Game Theory**, Noam Nisan, Tim Roughgarden, Eva Tardos, Vijay V. Vazirani, Cambridge University Press, 2008.
  http://www.cambridge.org/journals/nisan/downloads/Nisan_Non-printable.pdf
- **Mechanism Design Theory**, Scientific background on the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2007. Online version: http://nobelprize.org/nobel_prizes/economics/laureates/2007/ecoadv07.pdf

In addition, a collection of readings from journal literature and conference proceedings will be used

[JM] Bernard J. Jansen and Tracy Mullen, Sponsored search: an overview of the concept, history, and technology, *Int. J. Electronic Business, Vol. 6, No. 2, 2008*

- [Paper] J. Wolfers and E. Zitzewitz. Prediction markets. In Journal of Economic Perspectives,volume 18, pages 107–126, spring 2004.
- [Paper] Arrow. K,J., R. Forsythe, M. Gorham, R. Hahn, R. Hanson, J. O. Ledyard, S. Levmore, R. Litan, P. Milgrom, F. D. Nelson, G. R.Neumann, M. Ottaviani, T. C. Schelling, R.J. Shiller, V. L. Smith, E. Snowberg, C. R.Sunstein, P. C. Tetlock, P. E. Tetlock, H. R.Varian, J. Wolfers, E. Zitzewitz. (2008): "The Promise of Prediction Markets," Science, 320, 877-878.

◆ **Wisdom of crowd:**
  - The wisdom of crowds: why the many are smarter than the few and how collective wisdom shapes business, economies, societies, and nations, James Surowiecki**,** New York : Doubleday, c2004. (City U Library)

◆ **Accuracy**
  - J. Berg, R. Forsythe, F. Nelson, and T. Rietz. Results from a dozen years of election futures markets research. 2001.
  - J.E. Berg and T.A. Rietz. Prediction markets as decision support systems. Inform. Systems Frontier, 5:79-93, 2003.

◆ **Information aggregation problem:**
➢ David M. Pennock and Rahul Sami, P652-654, CHAPTER 26 Computational Aspects of Prediction Markets, in textbook Algorithmic Game Theory.

◆ **Rational Expectations Equilibrium:**
➢ S.J. Grossman. An introduction to the theory of rational expectations under asymmetric information. Rev. Econ. Stud., 48(4):541-559, 1981.
➢ J. Feigenbaum, L. Fortnow, D.M. Pennock and R. Sami. Computation in a distributed information market, Theoretcal Computer Science, 343:114-132, 2005.

Market models with automated market makers:

Market Scoring Rule (MSR):
➢ R. Hanson. Combinatorial information market design. In Information Systems Frontiers, volume 5, pages 107–119(13), January 2003.
➢ R. Hanson. Logarithmic market scoring rules for modular combinatorial information aggregation. In The Journal of Prediction Markets, volume 1, pages 3–15(13), February 2007.

Dynamic Pari-mutuel Market (DPM):
➢ B. Mangold, M. Dooley, G. W. Flake, H. Hoffman, T. Kasturi, D. M. Pennock, and R. Dornfest. The tech buzz game. In Electronic Commerce Research, volume 6, pages 201–221(21), April 2006.
➢ D. M. Pennock. A dynamic pari-mutuel market for hedging, wagering, and information aggregation. In Electronic Commerce, pages 170 – 179, May 2004.

Projection Game:
➢ E. Nikolova and R. Sami. A strategic model for information markets. In The 8th ACM conference on Electronic commerce, pages 316 – 325, 2007.

Sequential Convex Pari-mutuel Mechanism (SCPM):
➢ Mark Peters, Yinyu Ye, Anthony Man-Cho So, Pari-mutuel Markets: Mechanisms and Performance, WINE 07.

Online Resources (Related courses in other universities):
➢ **Topics at the Interface between Computer Science and Economics**
Yiling Chen, Fall 2008 Topic: Social Computing
http://www.eecs.harvard.edu/cs286r/
➢ **Computational Mechanism Design.**
Prof. David C. Parkes
http://www.eecs.harvard.edu/~parkes/cs700/
➢ Noam Nisan's Course on **CS, Game Theory, and Economics**

http://www.cs.huji.ac.il/~noam/econcs/index.html

- Christos Papadimitriou's Course on **Algorithmic Aspects of Game Theory**
  http://www.cs.berkeley.edu/~christos/games/cs294.html
- Joan Feigenbaum's Course on **Economics and Computation**
  http://zoo.cs.yale.edu/classes/cs455/
- Jeff MacKie-Mason's Course on **Information Economics**
  http://www.jeff-mason.com/courses/econ755/econ755-syll.html
- Kate Larson's **Electronic Market Design** Course
  http://www.cs.uwaterloo.ca/~klarson/teaching/F04-886/index.html
- **Computational Game Theory.** Yishay Mansour, school of Computer Science Tel Aviv University
  http://www.math.tau.ac.il/~mansour/course_games/course_games_03_04.htm