

General Course Information:

ELEN E6767x or y: INTERNET ECONOMICS, ENGINEERING AND THE IMPLICATIONS FOR SOCIETY

Instructor Information

Debasis Mitra

Senior Research Scientist and Adjunct Professor

Department of Electrical Engineering

<http://www.ee.columbia.edu/debasis-mitra>

email: debasismitra@columbia.edu

Prerequisites

Recommended preparation: CSEE W4119 or E6761, ability to comprehend and track the development of sophisticated mathematical models and analyses of economic and network interdependencies in the Internet and industry. Knowledge of basic microeconomics and communication network engineering, including models, their analyses and optimizations. Interest in the economics of markets, application of economic principles in policy and regulations, the environment and industry, and the societal impact of the Internet.

Course Description

The Internet has become an integral part of modern life. The goal of the course is to provide fundamental understanding of the workings of the Internet and its societal impact, and this requires combining elements of economics, engineering, and the theory of organizations. Course topics include various models of the communications industry, market structures in which subscribers, ISPs and content providers are players, network engineering, and regulation. Mathematical models and analyses are basic tools used extensively in the course. Future research directions and open problems are highlighted.

The course starts with basic microeconomics of pricing, market structures, i.e., competitive, oligopoly and monopoly, social welfare maximization and the theory underlying regulations of large firms with special attention to the Internet. This is followed by game theory concepts, revenue allocations in network coalitions, ISP settlements, and network externalities, which lead up to the role of the Internet in two-sided markets, i.e., platform economics, that are ubiquitous today. Also covered are economic principles in networking and network design, which includes decentralized vs. centralized resource allocation, “price of anarchy”, and the “tragedy of the commons”. Models are developed and analyzed to understand organizational inter-working in Content Delivery Networks, environment protection and the deregulated electric power industry. Students do projects researching and applying concepts learnt in the course to topical issues, such as the regulation of Big Tech, privacy protection and the societal impact of automation. A review of approaches taken by governments and regulators around the world concludes the course.

Course requirements: Two papers; project with oral presentation; homework

Approximate schedule:

Weeks 1-3: Basic Economics, including Pricing, Fairness, Efficiency, and Stability; Market Models; Natural Monopoly and Regulation

Weeks 4 - 6: Internet - Fundamental Models, Relations and Structures: Network Externalities; Two-Sided (Platform) Market Economics

Weeks 7-8: Applications of Economic Principles in Networking (e.g., Coalitions, Core of the Game, Shapley Value, Network Control), Environmental Policy, Deregulation in Electric Power Industry

Week 9-10: Students' presentations on projects

Week 11: Topics in Economic Principles in Internet Engineering (e.g., Content Delivery)

Week 12: Societal, Industry and Network Issues in Net Neutrality

Week 13: Approaches to Internet Governance from around the world

Grading policy:

10% active participation

20% homework

20% mid-term paper

25% project and oral presentation

25% final exam paper

For CVN students, the "active participation" component is eliminated, and its percentage is distributed equally over the remaining components.

Reading:**Basic Communication Network Economics, Pricing & Regulation**

Hal Varian, "Intermediate Microeconomics, A Modern Approach", Eighth Edition, W.W. Norton
Review of basic economic concepts: utility, demand, consumer's surplus, social welfare, monopoly behavior, price discrimination

R. Braeutigam, "Optimal Policies for Natural Monopolies", chapter in "Handbook for Industrial Organizations", Vol. 2, Ed. R. Schmalensee and R. Willig, North-Holland, 2007

Impact of Monopolies and Regulations

E.E. Zajac, "Sustainability or Stability of Regulated Prices", Chapter 7 in "Fairness or Efficiency: An Introduction to Public Utility Pricing", Ballinger, 1978

H. Averch and L.L. Johnson, "Behavior of the firm under regulatory constraint", American Economic Review, 52, 1962, 1053-1069

R.J. Gilbert and D.M.G. Newbery, "Preemptive Patenting and the Persistence of Monopolies", The American Economic Review, June 1982

K. Arrow, "Economic Welfare and the Allocation of Resources for Invention", RAND Corp, 1962

Network Coalitions, Cooperation and Revenue-Sharing Concepts from Game Theory

M.O. Jackson, "Allocating the Value", Sec 12.1.2 in "Social and Economic Networks", Princeton University Press

P. Linhart, R. Radner, K.G. Ramakrishnan and R. Steinberg, "The Allocation of Value for Jointly Provided Service", Telecommunication Systems, 4 (1995), 151-175

R.J. Gibbens, F.P. Kelly, G.A. Cope and M.J. Whitehead, "Coalitions in the International Market", Proc. ITC-13, 1991, 93-98

R.T.B. Ma, D.M. Chiu, J.C.S. Liu, V. Mishra and D. Rubenstein, "Internet Economics: The Use of Shapley Value for ISP Settlement", IEEE/ACM Trans. Networking, 18 (3), June 2010, 775-787

Internet Models: Network Externalities, Two-Sided Markets

J. Rohlfs, "A Theory of Interdependent Demand for a Communications Service", Bell J. Economics, 5(1), 16-37, Spring 1974

A. Gersho and D. Mitra, "A Simple Growth Model for the Diffusion of a New Communication Service", IEEE Trans. Systems, Man and Cybernetics, SMC-5 (2), March 1975, 209-216

M. Armstrong, "Competition in Two-Sided Markets", May 2005

J.-C. Rochet and J. Tirole, "Two-Sided Markets: An Overview", March 12, 2004

D.S. Evans and R. Schmalensee, "The Industrial Organization of Markets with Two-Sided Platforms", Competition Policy International, 3(1), Spring 2007

Economic Principles in Networking, Environmental Policy, Power Industry, the Internet

R.A. Berry and R. Johari, "Economic Modeling in Networking": Chapter 2, "Welfare"; Chapter 3, "Static Games", "Nash Equilibrium", "Efficiency Loss"; Sec. 5.2, "Pigovian Taxes"

D. Autor, "Externalities, the Coase Theorem and Market Remedies", MIT, 2010

E.E. Sauma and S.S. Oren, "Alternative Economic Criteria and Proactive Planning for Transmission Investment in Deregulated Power System", in "Economic Market Design and Planning for Electric Power Systems", IEEE & Wiley, 2010

D. Mitra and A. Sridhar, "Consortiums of ISP-Content Providers Formed by Nash Bargaining for Internet Content Delivery", Proc. IEEE INFOCOM 2019

Projects Concerning Society and the Internet

(i) Is wealth inequality a grave social problem, and, if so, what remedial actions should be taken?

(ii) Is the impact on society and the workforce of automation and AI going to be severe, and, if so, what action should be taken in the short and long terms?

- (iii) Should the balance of environment protection be tilted more towards market-based mechanisms or by rules and regulations set by Congress and government agencies?
- (iv) Do anti-trust laws and regulations need to be updated to address societal interests with the growth of Big Tech?
- (v) Do the nation's laws governing social media require updating?
- (vi) As AI and Big Data become more prevalent in society, should the ethics of AI theory and practice be examined more closely, and, if so, where should the priorities lie?

Societal, Industry and Network Issues in Network Neutrality

R.S. Lee and T. Wu, "Subsidizing Creativity through Network Design: Zero-Pricing and Net Neutrality", J. Economic Perspectives, Vol. 23, No. 3, Summer 2009, pp. 61-76

C.S. Hemphill, "Network Neutrality and the False Promise of Zero-Price Regulation", The Social Science Research Network Electronic Paper Collection, The Center for Law and Economic Studies, Columbia University School of Law, Working Paper No. 331, 2008

S. Greenstein, M. Peltz and T. Valletti, "Net Neutrality: A Fast Lane to Understanding the Trade-Offs", J. Economic Perspectives, Vol. 30, No. 2, Sept. 2016, pp. 127-149

D. Mitra and Q. Wang, "Preservation of Best-Effort Service on the Internet in the Presence of Managed Services and Usage-Generated Applications" Proc. TPRC43, Research Conference on Communications, Information and Internet Policy, Washington, Sept. 2015.

Essential background: FCC, Report and Order: In the matter of preserving the open internet broadband industry practices, FCC 10-201, 2010. Retrieved from http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-10-201A1.pdf

FCC, Report and Order: Restoring Internet Freedom, January 4, 2018
<https://www.fcc.gov/document/fcc-releases-restoring-internet-freedom-order>

Industry Structure, Approaches from Around the World

"Next Generation Connectivity: A review of broadband Internet transitions and policy from around the world", Berkman Center, Harvard University, Feb 2010

Stokab, "Stockholm IT-Infrastructure", 2012

Singapore: IDA Fact Sheet Next Generation Nationwide Broadband Network (June 2012)
<http://www.ida.gov.sg/images/content/Infrastructure/nbn/images/pdf/NextGenNBNFACTSHEET.pdf>

R. Tucker, "Rise and Fall of Australia's \$44 Billion Broadband Project", IEEE Spectrum, 2013