ENME 722
Equilibrium Programming in Engineering

Course Syllabus

Course Description

Provide motivation and introduction to equilibrium models involving economics and engineering. We will concentrate on models involving markets (Nash-Cournot, etc.), those wherein the activities are spatially diverse, and those involving energy activities or traffic flow. Areas that will be covered include:

- Review of relevant optimization theory
- Module 1:
  -Presentation of the mixed complementarity problem (MCP) and variational inequality problem (VIP) formats to solve equilibrium problems as well as introduction to existence and uniqueness results
  - Review of relevant game theory notions
  - Presentation of specific models for market, spatial, energy, and traffic equilibrium problems
  - Presentations for algorithms to solve these equilibrium problems
- Module 2:
  - Presentation of mixed integer nonlinear programming (MINLP) problems in engineering
  -Two-level optimization problems (mathematical programs with equilibrium constraints) as a special case
  -More general MINLP
  -Algorithms to solve MINLP

Suggested course textbooks:

- S.A. Gabriel, A.J. Conejo, B.F. Hobbs, J.D. Fuller, C. Ruiz, *Complementarity Modeling in Energy Markets*, 2013, Springer. (Module 1: MCP/VI portion)
- C.A. Floudas, *Nonlinear and Mixed-Integer Optimization Fundamentals and Applications*, 1995,Oxford University Press. (Module 2: MINLP portion)

Suggested other supplemental textbooks:

- R. W. Cottle, J. S. Pang, and R. E. Stone, *The Linear Complementarity Problem*, Academic Press, Inc., San Diego, 1992, ISBN 0-12-192350-9.
- F. Facchinei and J.-S. Pang, *Finite-Dimensional Variational Inequalities and Complementarity Problems*, Vol. 1, 2003, Springer.
- P. T. Harker, *Lectures on Computation of Equilibria with Equation-Based Methods*, CORE Lecture Series, Université catholique de Louvain, Louvain-la-Neuve, Belgium, 1993.

Course Objectives:

- Provide understanding for studying problems that involve equilibrium concepts or MINLPs in settings that involve engineering and economics
- Learn about various equilibrium/MINLP formulations relevant to engineering and economic settings
- Present theory for solutions to such problems
- Present algorithms to solve these problems

Instructor:

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Grading:

Grading is based on comprehension and mastery of the material.

- Major topic homeworks (1/3 of course grade)
- Exam #1 (take-home) (1/3 of course grade)
- Exam #2 (in-class) #2 (1/3 of course grade)

Course Policies:

Students are encouraged to attend all lectures since the take-home exam and the homeworks will be closely related to material discussed in lectures. In addition, class participation is taken into account as part of the homework grade.

It is assumed that students will complete the homeworks and exams by themselves.

The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. The course is subject to this Code of Academic Integrity which sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit the website.

The University has a legal obligation to provide appropriate accommodations for students with disabilities. Please inform Dr. Gabriel of any accommodations needed relative to disabilities. Also, University of Maryland policy states that students should not be penalized due to observances of their religious beliefs. Please inform Dr. Gabriel of such instances well in advance so that appropriate steps can be taken.

Short Bio on Dr. Gabriel

Webpage: www.eng.umd.edu/~sgabriel

Academic Experience: Besides teaching at University of Maryland, Dr. Gabriel has held appointments in the Mathematical Sciences Department at The Johns Hopkins University, and in the Engineering Management and Systems Engineering Department at The George Washington University. In addition, he has served as a postdoctoral researcher in the Mathematics and Computer Science Division at Argonne National Laboratory.

Industry Experience: Dr. Gabriel has over 20 years of industry experience involving mathematical modeling of engineering-economic systems with applications in energy, transportation, service performance, and operations management. His specialties include optimization/equilibrium modeling, econometrics, decision support systems, and software development. His most recent industry experience includes 5 years as a Project Manager at ICF Consulting involving projects with their oil and gas group, as well as their electrical power group.