ECE 6500: Convex and Stochastic Network Optimization

Course Description

Convex and stochastic optimization theory and algorithms applied to selected electrical engineering application areas.

Prior Course Number: 7100
Transcript Abbreviation: Convex & Stoch Opt
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Graduate
Student Ranks: Masters, Doctoral
Course Offerings: Spring
Flex Scheduled Course: Never
Course Frequency: Odd Years
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: Prereq: Grad standing.
Exclusions: Not open to students with credit for 7100.
Cross-Listings:

Course Rationale: Existing course 7100 is modified to include new advances in the theory and methods of convex and stochastic optimization with applications from ECE.

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.1001
Subsidy Level: Doctoral Course

Programs

Abbreviation	Description
CpE	Computer Engineering
EE	Electrical Engineering

Course Goals

Discuss convex formulation of problems with stochastic components from diverse ECE domains such as circuit design, communications, signal processing, control, estimation, learning, and/or electromagnetics.
Introduce primal and dual methods for the solutions of convex optimization problems.
Introduce probabilistic and control-theoretic design methods for stochastic operation and analysis.

Design decentralized and low-complexity algorithms and analyze their performance for decentralized operation.

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Modeling of convex optimization problems with applications in electrical and computer engineering, such as communications, networking, signal processing, learning, estimation, and/or electromagnetics.	2.0							
Convex optimization theory - convex sets and functions, optimality conditions for unconstrained/constrained and non-smooth convex optimization;	6.0							
Duality Theory and Methods Geometric Duality, Lagrangian Duality, Strong/Weak Duality, KKT conditions.	6.0							
Convex optimization algorithms - unconstrained methods; dual and primal-dual methods; gradient, sub gradient, Nesterov/Heavy-Ball, Proximal, Mirror-Descent Methods.	11.0							
Stochastic design and analysis techniques - probability and random processes basics: Markov chains; stability theory, Foster-Lyapunov criteria; Lyapunov Drift Minimization; Heavy-traffic analysis; Stochastic GD, Random Gradient Descent, Variance Reduction Methods.	8.0							
Optimization-based network algorithm design - cross-layer controller description; performance analysis: proof of optimality of the cross-layer controller; extensions multi-cast traffic, asynchronous implementation; decentralized and low-complexity algorithms	8.0							

Grades

Aspect	Percent
Midterm	30%
Project	35%
Final	35%

Representative Textbooks and Other Course Materials

Title	Author
notes	Eryilmaz
Convex Optimization, Cambridge University Press (reference)	S. Boyd and L. Vandenberghe
Convex Optimization: Algorithms and Complexity	Sebastian Bubeck
Stochastic network optimization with application to communication and queueing systems	Michael Neely
Convex Optimization Algorithms	Dimitri P. Bertsekas

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
	1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics - pre-2019 EAC SLOs (a) and (e); (k) is implied

Course Contribution		College Outcome
	2	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors - pre-2019 EAC SLO (c); (k) is implied
	3	an ability to communicate effectively with a range of audiences - pre-2019 EAC SLO (g)
	4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts - pre-2019 EAC SLOs (f) (h) and (j)
	5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives - pre-2019 EAC SLO (d)
	6	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions - pre-2019 EAC SLO (b); (k) is implied
	7	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies - pre-2019 EAC SLO (i)

CpE ABET-EAC Criterion 9 Program Criteria Outcomes

Course Contribution		Program Outcome
	1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
	2	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
	3	an ability to communicate effectively with a range of audiences
	4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
	5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
	6	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
	7	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

EE ABET-EAC Criterion 9 Program Criteria Outcomes

Course Contribution		Program Outcome
	1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
	2	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
	3	an ability to communicate effectively with a range of audiences
	4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
	5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
	6	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
	7	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Additional Notes or Comments

Updated abbreviation, prereqs, exclusions, goals and topics to conform to university format 3/29/12

Delted text Control Techniques for Complex Networks, Cambridge University Press by meyn, added notes. 3/30/12

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