TO: The Faculty of the College of Engineering

FROM: Elmore Family School of Electrical and Computer Engineering of the College of Engineering

RE: ECE 64700 Changes in Course Title, Description, and Requisites

The faculty of the School of Electrical and Computer Engineering has approved the following changes in ECE 64700. This action is now submitted to the Engineering Faculty with a recommendation for approval.

From: **ECE64700 -- Performance Modeling of Computer Communications Networks**
Sem. 2. Class 3, cr. 3. (Offered in alternative years.)
Prerequisite: ECE 60000. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

The mathematical background needed for the performance and stability analysis of computer communication networks is developed. Point processes, Markov processes, and queuing processes are used in the modeling and analysis of queues, interconnected queues such as ARPANET, and random multiple access networks such as Xerox's ETHERNET. Distributed control of random access networks and centralized control of queuing networks is considered. The techniques developed are useful in the design of computer systems as well as computer networks.

To: **ECE 64700 – Convex and Stochastic Optimization and Applications**
Sem. 2. Class 3, cr. 3.
Prerequisite: Graduate Student Standing.

Convex optimization and dynamic programming with application to various disciplines in ECE, including wireless and wireline communications, networks, electrical systems, and machine learning. The goal is to model a research problem as an optimization problem, and use the insights from the optimization algorithms to design implementable protocols and solutions that are tailored to the needs of the applications (e.g., operating in decentralized settings and under stochastic uncertainty). The instructor may tailor the content to reflect current trends and goals of research. Examples of relevant topics are: convex sets and functions, convex program, Lagrange duality, primal and dual decomposition, proximal optimizations, stochastic approximation, Markov decision processes, dynamic programming and approximate dynamic programming. The exposition of the theory will be connected to various ECE applications, such as congestion control, wireless power control and opportunistic scheduling, cross-layer design, demand response, renewable integration, spectrum sharing and cognitive radio, machine learning, optimization of UAV (unmanned aerial vehicles) aided communications.

Reason: Changes have been made to the title, description, and prerequisites to reflect the updated content of the course. To be offered in odd numbered years.

Mithuna Thottethodi, Associate Head for Teaching and Learning
School of Electrical and Computer Engineering

ECE 647 – Performance Modeling of Computer Communication Networks

Purdue University, School of Electrical and Computer Engineering

Graduate Area: Communications, Networking, Signal & Image Processing

Credits: 3

Time and Room: MWF 12:30-1:20pm, EE 224

Office Hour: WF 1:30pm-2:30pm, or by appointment

Recommended Background: ECE 600. ECE 547 is NOT required. Talk to the instructor if you have any questions. Some basic understanding of communication and/or electrical systems will be beneficial but not required.

Course Description:

We plan to cover two main topics:

- Convex optimization
- Optimization under uncertainty (Dynamic programming)

We will take an application-driven approach of learning: each sub-topic of the theory will come with illustrative ECE applications, e.g., wireless and wireline communications, networks, electrical systems.

- **Theory**: Lagrange duality, primal and dual decomposition, proximal optimizations, stochastic approximation, Markov decision processes, dynamic programming and approximate dynamic programming
- **Applications**: Congestion control, wireless power control and opportunistic scheduling, cross-layer design, demand response, renewable integration, spectrum sharing and cognitive radio, UAV (unmanned aerial vehicles) communications.

Course Objectives: At the end of the course, students are expected to be equipped with the basic theory of convex optimization, Markov decision processes, (approximate) dynamic algorithms, and to be able to apply these tools to research problems.

Course Outline:

- *Week 1:* Introduction. Affine and convex sets.
- *Week 2:* Convex functions.
- *Week 3:* Convex optimization problems.
- *Week 4:* Formulations of convex optimization problems in applications.
- *Week 5-6:* Lagrange duality and applications
- *Week 7-8:* Optimization algorithms
- *Week 9:* Asynchronous algorithms, stochastic optimization, proximal algorithms
- *Week 10:* Cross-layer control in wireless networks
- *Week 11-12:* Optimization under uncertainty, Markov Decision Processes and Dynamic Programming Algorithm
- *Week 13:* The curse of dimensionality and approximate Dynamic Programming
- *Week 14-15:* Operating in unknown environments: reinforcement learning

References:

1. S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press 2004. (Available online at http://www.stanford.edu/ boyd/cvxbook/)

2. D. Bertsekas and J. N. Tsitsikalis, Parallel and Distributed Computation: Numerical Methods, Athena Scientific, 1997. (Available online at http://web.mit.edu/dimitrib/www/pdc.html)

3. D. Bertsekas, "Dynamic Programming and Optimal Control: Approximate Dynamic Programming," 4th Edition, Vol. II, Available on Amazon.com

4. R.S. Sutton, A.G. Barto, "Reinforcement Learning: an Introduction," (Available online at http://incompleteideas.net/book/bookdraft2017nov5.pdf) (with an introduction also to MDPs)

5. Notes and papers distributed in class.

Additional references:

5. D. Bertsekas and S. Shreve, Stochastic Optimal Control: The Discrete-Time Case, Athena Scientific, 1996. (Available http://web.mit.edu/dimitrib/www/soc.html)

Grades:

Homeworks: 20%

Midterm Exam (1): 40%; Midterm presentation TBA, end of March

Projects: One paper summary (15%), and one final project (25%). See project handout for the instructions.

All homeworks, the project and the midterm exam must be completed with LaTex, using the template provided.