NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

ANALYTIC RESEARCH FOUNDATIONS FOR THE NEXT GENERATION ELECTRIC GRID

A National Research Council Workshop

BOARD ON MATHEMATICAL SCIENCES AND THEIR APPLICATIONS
COMMITTEE ON ANALYTIC RESEARCH FOUNDATIONS FOR THE NEXT GENERATION ELECTRIC GRID

FEBRUARY 11-12, 2015

BECKMAN CENTER
IRVINE, CALIFORNIA

Meeting objective

To involve participants from specific fields of mathematics, computation, and engineering to help identify areas of inquiry where inroads by mathematicians would significantly advance electric power engineering problem solving ability

Day 1: Tuesday, February 11th

7:30 am Coffee and light breakfast available

8:00 am	**Welcome, Introductions, and Overview**

Welcome, framing of the meeting and agenda overview

Opening remarks and meeting overview
Robert J. Thomas, Professor of Electrical and Computer Engineering Cornell University, Workshop Planning Committee Chair

John Guckenheimer, Professor of Mathematics, Cornell University, Committee Co-Chair
Thomas Overbye, Professor of Electrical and Computer Engineering, University of Illinois Champange-Urbana, Committee Co-Chair

8:30 am	**Keynote: Setting the Stage**

Steven Chu, Professor of Physics and Molecular & Cellular Physiology, Stanford University

9:30 am	**Session 1: Data and Data Analytics**

This session will bring together leaders in the field of Data and Data Analytics, to determine what the latest research in these areas are and how they might need to change in order to best serve the smart grid.

Session Co chairs chair: Cynthia Rudin, Associate Professor of Statistics, Massachusetts Institute of Technology, Marija Ilic, Professor of Electrical & Computer Engineering and Engineering & Public Policy, Carnegie Mellon University

- **Session format**
  - **Dr. David Sun,** (45 minutes)

10:15 am	**Break**
10:30	**Data and Data Analytics - continued**

- **Prof. Louis Wehenkel – University of Liege, Belgium** (45 minutes)
- **Dr. Mathew Gardner – Dominion Virginia Power** (45 minutes)

12:00 noon	**Breakout session. There are three rooms available. One speaker will be present in each of the rooms. Participants are asked to choose a room of**

	interest and to proceed to that room for an hour of discussion and Q&A. The discussions will be recorded and the information will be digested by the committee for use in its final report.

- **Background papers for the session**:
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- **Session questions:**
  - How do visionaries in industrial settings envision that analytics will be used for the smart grid?
  - How have they made a difference already and what can we do better to support it as academics?
  - How are innovative analytics being used to support power systems?
  - What are key mathematical areas that are needed for this to succeed?
  - How should we alter our current mathematical research to adapt to new needs?
  - What are the latest mathematical techniques that fuse data with power systems?
  - How do we take data from the power grid and use it to estimate parameters of a dynamical system?

1:00 pm	**Lunch**

2:00 pm	**Session 2:** Optimization and Control Methods for a Robust and Resilient Power Grid

The nature of electricity demand is undergoing a significant shift across the world, and power grids are facing new and unanticipated operating conditions. In order to address these challenges, there is a need for a unified mathematical framework with robust and resilient tools for control and optimization of time-critical operations in complex multicomponent and multiscaled networks. Controlling and optimizing the power grid is particularly challenging due to the significant and unavoidable amount of uncertainty in modeling the dynamics of the grid. Robust control is here understood as control laws that guarantee grid performance in the face of such uncertainties as well as major weather phenomena modeled as large scale disturbances. Further, the control and optimizing approaches should be capable of making the power grid less sensitive to unexpected events of any type. Resilient control is here understood as control laws that enable the control system to detect unexpected events, automatically recover from such events, and perform at least to a set of minimal requirements until the system has fully recovered. In this session, presentations will focus on presenting recent results in the area of robust and resilient control with applications to the power grid as well as describing scientific problems that still remain open challenges in this area.

Session Chair: Jeff Dagle, PE, Chief Electrical Engineer, Pacific Northwest National Laboratory

- **Session format**
  - **Prof. Pravin Varaiya, University of California, Berkeley** (45 minutes)
  - **Prof. Sean Meyn, University of Florida** (45 minutes)

3:30 pm	**Break**

3:45 pm	Optimization and Control Methods for a Robust and Resilient Power Grid - continued

  - **Dr. Robert Bixby, Gurobi** (45 minutes)

4:30 pm	**Breakout session. There are three rooms available. One speaker will be present in each of the rooms. Participants are asked to choose a room of interest and to proceed to that room for an hour of discussion and Q&A. The discussions will be recorded and the information will be digested by the committee for use in its final report.**

- **Background papers for session**:
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- **Session questions:**
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5:30 pm	**Adjourn Day 1**

6:30 pm	**Reception and Dinner**

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Day 2: Wednesday, February 12th

7:30 am Coffee and light breakfast available

8:00 am	**Uncertainty quantification and Validation**

Session chair: Juan Meza, Dean, School of Natural Sciences, University of California, Merced

- **Session format**
  - **Dr. Miriam Goldberg, Kema** (45 minutes)
  - **Prof. Vincent Kaminski, Rice University** (45 minutes)

10:30 pm	**Break**

10:45 pm	**Uncertainty quantification and Validation** - continued

  - **Prof. Gert de Cooman, Gent University, Belgium** (45 minutes)

11:30 pm	**Breakout session. There are three rooms available. One speaker will be present in each of the rooms. Participants are asked to choose a room of interest and to proceed to that room for an hour of discussion and Q&A. The discussions will be recorded and the information will be digested by the committee for use in its final report.**

- **Background papers for session**:
- Introduction to Imprecise Probabilities, Thomas Augustin, Frank Coolen, Gert de Cooman, and Matthias Troffaes.

- **Session questions:**
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12:30 am	**5 Minutes of fame**

Members of the audience who were not speakers can give a 5 minute talk on anything related to the workshop they feel will enhance the outcome. Speakers must register with the Workshop Chair before the end of the first day of the workshop

1:00 pm	**Lunch and Adjourn**

Planning Committee

Chair

Robert J. Thomas, Cornell University

Members

Cynthia Rudin, Massachusetts Institute of Technology
Jeff Dagle, Pacific Northwest National Laboratory
Juan Meza, University of California, Merced
Marija Ilic, Carnegie Mellon University

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