



# Foundations Of Resilient CybEr-physical Systems (FORCES)

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# Education & Outreach

- \* **Overview** – Education and Outreach Goals and Objectives.
- \* **Teaching** - Overview of teaching material developed.
- \* **Outreach** – Broader Impacts.
- \* **Girls in Engineering** – Update and highlights of last summer’s program and plan for this summer’s program.
- \* **Going Forward** - Education/outreach in the coming 6-12 months.

# FORCES Education & Outreach Goals

## \* **Curriculum Development**

- Address the gaps in the EE, CS, and Systems curricula in the area of economic incentives for large-scale cyber physical systems.
- Real-world case studies from transportation, electricity, and information networks.
- Development of k-12 Module on CPS

## \* **Outreach to Community**

- Provide training to the students, researchers and practitioners working in the area of cyber-physical systems.

## \* **Broadening Participation**

- \* Infuse the EE and CS pipeline with (1) more diverse participation in the area and (2) increase the number of women and URMs involved in cyber-physical systems work.

# FORCES Module & Curriculum Development

## \* CPS has attracted attention

- Several courses have arisen that address cyber-physical systems.
  - Cyber Physical Systems (Seshia & Lee):  
<https://www.youtube.com/watch?v=7zSCnnJE1cs>
  - Cyber Physical System Summer School (Sangiovanni)
  - Cyber Physical System Fundamentals (TU Dortmund)  
<https://www.youtube.com/watch?v=8HLJFIncMls>

## \* FORCES Contribution

- Economic incentives and resilient control modules that can be added to existing syllabi or online courses.
- Further development on MIT Course
- K-12 Module for CPS

# FORCES: Online Module Development

## Resilient Infrastructure Networks (MIT/Amin)

- \* (Graduate) Control algorithms and game-theoretic tools to enable resilient operation of large-scale infrastructure networks. Dynamical network flow models, stability analysis, robust predictive control, fault and attack diagnostic tools. Strategic network design, routing games, congestion pricing, demand response, and incentive regulation. Design of operations management strategies for different reliability and security scenarios. Applications to transportation, logistics, electric-power, and water distribution networks.
  - Finished the first cycle of the course
  - In next cycle, make notes available
  - Finalize modules for online

# FORCES Community Engagement Activities

## Conferences & Workshops

- \* ACM/IEEE 6th International Conference on Cyber-Physical Systems (ICCPS): New focus areas on secure and resilient infrastructure CPS (the confluence of cyber-security, privacy, and CPS that impacts the operation of critical infrastructures), April 14-16, 2015. <http://iccps.acm.org/2015/index.html>

### Conference Leadership

- General Co-Chair, Alex Bayen
  - Technical Program Committee Co-Chair, Xenofon Koutsoukos
  - Technical Program Committee Member, Saurabh Amin
  - Session Chairs, Alex Bayen and Xenofon Koutsoukos
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- \* Institute for Pure & Applied Mathematics: FORCES-organized graduate summer school on "Games and Contracts for Cyber-Physical Security" (Galina Schwartz, Saurabh Amin), July 7 - 23, 2015:  
<http://www.ipam.ucla.edu/programs/summer-schools/graduate-summer-school-games-and-contracts-for-cyber-physical-security/>

# FORCES Community Engagement Activities

## Games and Contracts for Cyber-Physical Security, July 7-23

\* *Organizing Committee: Saurabh Amin, Asuman Ozdaglar, Galina Schwartz*

\* **Speakers:**

Saurabh Amin (MIT)  
Itai Ashlagi (MIT)  
Hamsa Balakrishnan (MIT)  
Tamer Basar (UIUC)  
Kostas Bimpikis (Stanford)  
George Cybenko (Dartmouth)  
Ian Hiskens (Michigan)  
Ramesh Johari (Stanford)  
Ehud Kalai (Northwestern)  
Cedric Langbort (UIUC)  
Patrick Loiseau (Institut Eurécom)  
Bud Mishra (NYU)  
John Musacchio (UC Santa Cruz)  
Michael Ostrovsky (Stanford)  
Galina Schwartz (UC Berkeley)

Michael Schwarz (Google Inc.)  
Srinivas Shakkottai (Texas A & M)  
Jeff Shamma (Georgia Institute of Technology)  
Eran Shmaya (Northwestern)  
R. Srikant (UIUC)  
Milind Tambe (USC)  
Hamidou Tembine (New York University)  
Alexander Teytelboym (University of Oxford)  
Mihaela van der Schaar (UCLA)  
Rakesh Vohra (University of Pennsylvania)  
Adam Wierman (California Tech.)  
Stephen Wright (University of Wisconsin)  
Muhamet Yildiz (MIT)  
William Zame (UCLA)



**Graduate Summer School: Games and Contracts for Cyber-Physical Security**  
JULY 7 - 23, 2015

OVERVIEW | SPEAKER LIST | SCHEDULE | APPLICATION | REGISTRATION

### Overview

This summer school will provide an advanced introduction on how the mathematical tools of game theory can be applied to improve the resilience (security and reliability) of cyber-physical systems (CPS) that control critical national infrastructures, such as our electricity, water, and transportation networks. The operations of such CPS are driven by actions of many human decision makers who need to make decisions based on limited information. In addition, these humans frequently have conflicting objectives, which make them reluctant to share even partial information with others. Game-theoretic tools allow analyzing strategic behavior of the entities upon whose choices the CPS operations depend.

The summer school will cover:

- Mathematical tools from game theory
- Economic applications of game theory, such as principal agent theory, dynamic games and contracts, regulation, mechanism design and auctions, and matching and market design.
- Game theory for cyber physical systems, especially security and resilience with applications to various infrastructure domains.

The content will be translated to French available on-line, and modified to cover the associated lecture and exercises.



**Schedule:** <http://www.ipam.ucla.edu/programs/summer-schools/graduate-summer-school-games-and-contracts-for-cyber-physical-security/?tab=schedule>

# FORCES Broadening Participation Activities

## K-12 Outreach

- \* MESA Day: March 7, 2015



## Conferences & Workshops

- \* WiCyS: Sponsorship, Education, Recruiting & Advising, March 27-28, 2015





# FORCES Broadening Participation

## CYBEAR High School Program

- \* Program to develop the skills and STEM readiness of students in transition from high school to college
- \* Dates: June 29<sup>th</sup>-July 24<sup>st</sup>
- \* 24 high school students 9<sup>th</sup>-11<sup>th</sup> grades
- \* Multiple Engineering & Research Based Components
  - \* Provide college preparedness and exposure to career options and multiple STEM Careers
  - \* Inclusion of module focused solely on SCADA
  - \* Inclusion of parents and school support programs



# Berkeley Girls in Engineering

- \* Summer 2014 we ran the “pilot”:
  - \* 60 middle school girls from east bay
  - \* 2 2-week sessions at UC Berkeley
  - \* 3 “modules” a day:
    - \* Bioengineering, robotics, materials, coding, big data...
    - \* What is Engineering?
    - \* Leadership, talks, posters, elevator pitches...
  - \* Week long project (in groups)
  - \* Field trips: LHS, Pixar
  - \* All of the instructors (faculty, graduate students, staff, Pixar engineers) were women



# Berkeley Girls in Engineering

## Summer 2014 Post Surveys

- \* After program, girls stated more likely to take math and science classes at school.
- \* 85% of parents felt their objectives were met:
  - \* Expose child to engineering, science, and technology profession.
  - \* To have their child learn more about engineering.
- \* All parents would recommend the program highly to other parents and students.

Post-Survey Questions (Scale of 1-5)	Mean	Std. Dev.
How would you categorize interest in Engineering before the program?	3.39	1.45
After program, considering a career in Engineering.	4.42	0.72
After Program, would take more science and math classes.	4.25	0.62
Girls felt they learned a lot in Girls in Engineering.	4.42	0.61

# Moving Forward

## Online Module Development

- \* Why We Should Care – Introduction Video
  - \* A series of 2 minute videos as an introduction as to why students should be interested in the problems of cyber physical systems
  - \* 3 topics: Transportation, Energy and Water

## K-12 Module Development

- \* Creation of one module on SCADA and CPS for high school students in development currently.
- \* 2<sup>nd</sup> Cycle of Girls in Engineering this Summer. Exploration of new curriculum modules and new format.

# Moving Forward

## Workshops & Conference

- \* CPSWeek, Resilience Week, IEEE CDC, ACC & WiCyS
  - \* Continued engagement with academics, practitioners and women in the field.