

# SOUMYABRATA TALUKDER

3<sup>rd</sup> year PhD student ◊ Electrical Engineering ◊ Iowa State University

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## CAREER OBJECTIVE

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A self-motivated spontaneous researcher and team player, intrigued and inclined towards the areas of machine-learning, numerical optimization and formal methods with power systems as application domain, looking for a fellowship and/or internship opportunity.

## EDUCATION

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**Iowa State University, IA, USA**

Doctor of Philosophy (in progress)

Department of Electrical and Computer Engineering

*Aug 2017 - present*

CGPA: 4.00/4.00

**Jadavpur University, Kolkata, India**

Bachelor of Engineering (first class with honors)

Department of Electrical Engineering

*Jun 2005 - Apr 2009*

CGPA: 9.08/10.00

## GRADUATE COURSES TAKEN

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<b>EE-571</b>	Convex Optimization	<b>EE-577</b>	Linear Systems
<b>EE-576</b>	Digital Feedback Control	<b>EE-578</b>	Nonlinear Systems
<b>STAT-554</b>	Stochastic Processes	<b>COMS-507X</b>	Applied Formal Methods
<b>EE-525X</b>	Data Analytics	<b>EE-526X</b>	Deep Learning
<b>ME-592X</b>	Machine Learning for CPS		

## ACCEPTED/SUBMITTED RESEARCH ARTICLES

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1. **S. Talukder**, R. Kumar, *An Enhancement in Sum-of-Squares Optimization based Region of Attraction Estimation for Power Systems* - accepted in IEEE PES General Meeting 2019 ([link](#)).
2. **S. Talukder**, M. Ibrahim, R. Kumar, *Computation of Stability and Performance related Resilience Measures for Power Systems* - submitted in IEEE Transaction on Systems, Man and Cybernetics: Systems in Sep 2019 ([link](#)).

## SKILLS

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<b>Research</b>	Deep neural networks, deep reinforcement learning, partially observed Markov decision processes, learning Gaussian process models, numerical optimization, model predictive control, resilience of complex systems, formal methods, transient stability, differential-algebraic equations, cyber security.
<b>Technical software</b>	Tensor Flow, PyTorch, Keras, Scikit-learn, CVX, Sostools, PSAT, PSSE, PSLF, PSCAD, R, Nuxmv, Spin, Z3, AADL.
<b>Programming language</b>	Python, Java, C, C++, MATLAB.
<b>Operating system</b>	Windows, Linux (both Fedora and Debian distributions).
<b>General tool</b>	MS Office, MS Project, Latex.
<b>Managerial</b>	Managing scope, time, cost and quality of projects, leadership, stakeholder management, progress monitoring and reporting.

## ACADEMIC RESEARCH EXPERIENCE

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Iowa State University, IA, USA

Fall 2018 - present

Research assistant at ESSeNCE lab, supervised by Dr. Ratnesh Kumar

- **Sum-of-squares Optimization:** An algorithmic enhancement of the traditional *sum-of-squares optimization* based *region-of-attraction* (ROA) estimation for power systems is proposed, showing significant reduction in the overall computation time. The approach is further extended to compute the volume of the estimated ROA as a sub-level set of a *Lyapunov* function, which provides a metric to quantify the transient stability of a power system in polynomial time computational complexity.
- **Resilience:** A physical-topology guided notion of resilience for power systems is quantified as a six dimensional normalized vector, which is the probabilistic average of such vectors corresponding to the individual credible fault-sequences. A new way of computing *transient stability margin* and *critical clearance time* using sum-of-squares optimization is proposed. Also a novel approach to compute *relay margin* by solving an iterative *quadratic-constraint-quadratic-program* is introduced.
- **Deep-neural-networks:** A novel *long-short-term-memory* (LSTM) based deep-neural-network (DNN) is proposed for early prediction of *long-term voltage instability*, ensuing a large disturbance in a power-grid. The proposed DNN is capable to utilize both the pre-fault SCADA snapshot and a short-prefix of the post-fault time-series of PMU measurements for prediction, showing substantial improvement in its noise-robustness over a state-of-the-art decision-tree.
- **Deep-reinforcement-learning** (current research area): Recently, wide-area control schemes are proven to be more effective than their local counterparts, under emergency condition of a large power-grid. However, computing real-time centralized control utilizing the wide-area measurements using the conventional optimization-based techniques, may not be practical, especially when the control needs to be enacted within a very short time-window to regain normalcy. This motivates us to explore the possibility to design a deep-reinforcement learning based centralized controller, trained offline from simulation-data generated around the baseline operating condition, for real-time control synthesis using online measurements.
- **Future research plan:** The future research directions include development of an integrated framework for wide-area instability detection and control of power-grid using machine-learning. The objective encompasses detection of anomalous behaviour of measuring instruments to trigger back-up control as needed, identification of optimal islanding-strategy during inter-area oscillations. An efficient approach to verify safety and robustness of a DNN will be developed, using an ensemble method that leverages benefits of interval arithmetic, SMT solver and convex relaxation of input-output constraints and neural-network activations.

## TEACHING EXPERIENCE

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Iowa State University, IA, USA

Fall 2017 - Spr 2018

Teaching assistant for EE-324 (Signals and Systems - II)

- Responsibilities included course-recitation, lab-proctoring and grading.

## INDUSTRIAL EXPERIENCE

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GE Global Research Center, NY, USA

May 2019 - Aug 2019

Fellow Intern

- Worked with the formal methods team for the **Cyber Assured System Engineering** (CASE) project, led by DARPA. Proposed and developed an innovative graphical user interface that provides an intuitive and interactive *wizard* to set the mission-level cyber requirements as well as the cyber relations among the inter-dependent subcomponents involved in the mission.

- Got exposure to the state-of-the-art of cyber-security analysis and verification framework in aviation industry, and also to GE's popular Bayesian Hybrid Modelling tool, which uses a Gaussian process based learning technique for modelling and testing of dynamic input-output systems.

#### **ITC Ltd., Bangalore, India**

*Dec 2012 - Jul 2017*

*Assistant Manager - Projects*

- Led design, procurement and construction of electro-mechanical services for two large-scale building projects, spanning over 9 acres of plot area and 0.6 million sqft. of built-up space.
- Took the role of a key coordinator among the interdependent disciplines (e.g. structural, interior etc.) of the overall project.

#### **GE Grid Solutions, Noida, India**

*Jul 2009 - Nov 2012*

*Project Engineer*

- Led site installation and commissioning of *electrical balance of plant* for a 2 x 600 MW thermal power plant, together with a 400 kV generation switchyard.
- Led engineering, procurement and construction of six new power-transmission substation projects.

### **AWARDS AND HONORS**

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1. Received **Impact Award** from General Electric Global Research Center, USA, in Jul 2019 for developing an innovative graphical user-interface that made usage of a software toolset substantially easier.
2. Received **Certificate of Appreciation** from the CEO of ABD, ITC Limited, India, in Jun 2017 for timely delivery of a constrained project.
3. Received a **Barindra Memorial Medal** from Jadavpur University, India, in Dec 2009 for distinguished academic performance during Bachelor of Engineering program.
4. Received **SEEA scholarship** from West Bengal State Electrical Engineers Association, India, in Aug 2008 for consistent academic excellence during Bachelor of Engineering program.
5. Received **National Merit Scholarship** from Govt. of India in Aug 2005 for academic distinction prior undergraduate program.

### **EXTRA-CURRICULAR ACTIVITY**

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Voluntarily promoting awareness about sustainability, and optimal usage of natural resources. A **certified trainer** of **Green Rating for Integrated Habitat Assessment**.