Tanushree Roy

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Research Interest

Theory: Control Theory • Machine Learning • Estimation • Fault Diagnosis • Cybersecurity • Partial Differential Equations • Cyber-Physical-Social Systems
Applications: Smart Cities • Connected and Autonomous Transportation • Energy Storage

Education

The Pennsylvania State University — University Park, PA
PhD in Mechanical Engineering — *Aug. 2020– Aug. 2022*

University of Central Florida — Orlando, FL
Master of Science in Mathematics — *Aug. 2013 – May 2015*

Indian Institute of Engineering Science and Technology (IIEST), Shibpur — India
Master of Engineering in Electrical (Specialization: Control System) — *Jul. 2009 – May 2011*

Haldia Institute of Technology — India
Bachelor of Technology in Applied Electronics and Instrumentation — *Jul. 2005 – May 2009*

Appointments

Assistant Professor — Aug 2022 – Present
Department of Mechanical Engineering, Texas Tech University — *Lubbock, TX*

Graduate Researcher Assistant — Aug 2020 – Aug 2022
Department of Mechanical Engineering, The Pennsylvania State University — *University Park, PA*

Graduate Researcher Assistant — Aug 2019 -July 2020
Department of Electrical Engineering, University of Colorado Denver — *Denver, CO*

Graduate Teaching Assistant — Aug 2013 – July 2019
Department of Mathematics, University of Central Florida — *Orlando, FL*

Research Consultant — May 2011 – July 2013
Department of Electrical Engineering, Indian Institute of Technology, Kharagpur — *India*

Publications and Invited Talks

Google Scholar Citations: 47 Link

Publications Under Review/In Preparation

1. **T. Roy**, S. Sattarzadeh, and S. Dey. Cyber-attack detection in socio-technical transportation systems exploiting redundancies between physical and social data, 2021, *under revision*.
2. **T. Roy** and S. Dey. Route choice-based socio-technical macroscopic traffic model, 2021, *under revision*.

3. **T. Roy** and S. Dey. Security of distributed parameter cyber-physical systems: Cyber-attack detection in linear parabolic pdes, 2021, *under revision*.

4. **T. Roy**, A. Knichel and S. Dey. An Input-to-State Safety Approach to Anomaly-Resilient Parabolic PDEs: Application to Cyber-Physical Battery Modules, *submitted*.

5. **T. Roy**, and S. Dey. Cyber-attack vs Fault: Distinguishability Criteria and Adversarial Knowledge Metric, *in preparation*.

6. **T. Roy**, S. Sattarzadeh, S. D. Vyas, A. Colclasure, K. Smith, and S. Dey. Deep-Regression Learning for Estimation of Unobservable Electrode States in Batteries, *in preparation*.

7. S. D. Vyas, S. K. Padisala, **T. Roy**, and S. Dey. Thermal Fault-Tolerance in Lithium-ion Battery Cells: An Input-to-State Safety Framework, *in preparation*.

Published Journals and Letters

1. S. Sattarzadeh, **T. Roy**, and S. Dey. Thermal fault detection and localization framework for large format batteries. Journal of Power Sources, 512:230400, 2021.

2. S. Sattarzadeh, **T. Roy**, and S. Dey. Real-time estimation of two-dimensional temperature distribution in lithium-ion pouch cells. IEEE Transactions on Transportation Electrification, pages 1–1, 2021.

3. **T. Roy**, A. Tariq, and S. Dey. A socio-technical approach for resilient connected transportation systems in smart cities. IEEE Transactions on Intelligent Transportation Systems, pages 1–10, 2021.

4. **T. Roy** and S. Dey. Fault detectability conditions for linear deterministic heat equations. IEEE Control Systems Letters, 3(1):204–209, 2019.

5. **T. Roy**, S. R. Choudhury, and U. Tanriver. Analytical prediction of homoclinic bifurcations following a supercritical hopf bifurcation. Discontinuity, Nonlinearity, and Complexity, 6(2):209–222, 2017.

Peer-reviewed Conference Publications

1. S. Sattarzadeh, **T. Roy** and S. Dey. Clustering-based Sensor Placement for Thermal Fault Diagnostics in Large-Format Batteries, *accepted for 2021 Modeling, Estimation and Control Conference (MECC)*.

2. **T. Roy** and S. Dey. Secure traffic networks in smart cities: Analysis and design of cyber-attack detection algorithms. In 2020 American Control Conference (ACC), pages 4102–4107, 2020.

3. S. Bag, S. Mukhopadhyay, S. Samanta, R. Sheehan, and **T. Roy**. Frequency compensation and power stage design for buck converters to meet load transient specifications. In 2014 IEEE Applied Power Electronics Conference and Exposition (APEC), pages 1024–1031, 2014.

4. S. Bag, **T. Roy**, S. Mukhopadhyay, S. Samanta, and R. Sheehan. Boost converter control using smith predictor technique to minimize the effect of right half plane zero. In 2013 IEEE International Conference on Control Applications (CCA), pages 983–988, 2013.

Presentations

1. "Resilient Transportation Systems in Smart Cities," *Institute of Pure and Applied Mathematics (IPAM)*, Long Program: Mathematical Challenges and Opportunities for Autonomous Vehicles, Nov 2020.

2. "Secure Traffic Networks in Smart Cities: Cyber-Attack Detection," (Invited Session) *2020 American Control Conference*, Denver, July 2020.

3. "Optimum boarding strategies for Airline and practical implementation recommendations," *Institute for Mathematics and its Applications (IMA)*, July 2018.

Academic Research Experience

Position: Graduate Research Assistant, The Pennsylvania State University [2020 - 2022]

Projects:

- **Attack-resilient transportation system:** Working on designing a attack-resilient transportation system using Barrier functional for Distributed Parameter System (DPS).
- **Distinguishing cyber-attack and faults:** Working on deriving criteria for distinguishability of faults and cyber-attacks and quantifying the level of a cyber-threat.
- **Socio-Technical modeling of traffic as DPS:** Introduced a model for Cumulative Prospect Theory (CPT) based route-choice influenced traffic model under DPS setting. Utilized Mean Field Games (MFG) to obtain limit from individual route choice decisions to global traffic flow forking.
- **Cyber-attack detection in freeway traffic using social data:** Implemented a micro-macro hybrid modeling to design two filters utilizing social and physical data, in order to detect cyber-attack.
- **Cyber-attack detection in V2I network for a platoon using social data:** Developed an algorithm for detecting cyber-attack using physical measurements and social data.
- **Machine Learning Based estimation of unobservable electrode states in Li-ion batteries:** Developing a Long-Short Term Memory (LSTM) based Deep Neural Network to estimate unobservable electrode states in Lithium-ion batteries.
- **Thermal fault detection and localization in large format Li-ion batteries under limited sensor availability:** Implemented a data-driven Evidential C-means (ECM) clustering to determine optimum sensor locations under limited sensor availability and designed a Kalman filtering based detection and localization scheme in large-format batteries.
- **Temperature Filed Re-construction of Lithium-ion Batteries:** 2-Dimensional temperature distribution estimation in pouch type battery cell.

Position: Graduate Research Assistant, University of Colorado Denver [2019 - 2020]

Projects:

- **Stealthy Attack Condition & Traffic Cyber-attack Detection:** Derived stealthy attack condition for a ramp-metered traffic PDE system and designed an detection algorithm using sensor measurements.
- **Distributed Thermal Model for Lithium-ion Batteries:** Identification of 2D distributed thermal model of lithium-ion battery from experimental data obtained from Arbin battery tester system.
- **Lithium-ion battery life-extension using re-lithiation:** (in collaboration with **National Renewable Energy Lab (NREL)**) Implemented and designed (sizing) of a passive re-lithiation circuit using phenomenological model of a Lithium-Silicon battery, incorporating variations arising from temperature and state-of-charge.

Position: Graduate Student, University of Central Florida [2013 - 2019]

Projects:

- **Fault Detectability Conditions for Partial Differential Equations (PDE) Systems:** Proposed intrinsic fault detectability criterion for PDE systems and derived analytical fundamental limitations of Parabolic PDE systems in detecting faults.
- **Analytical Prediction of Homoclinic Bifurcations:** Developed an analytical approach to predict homoclinic bifurcations at a saddle fixed point using method of multiple scales approximations of the stable periodic orbit created at a supercritical Hopf bifurcation of a neighboring fixed point.
- **Semi-classical limit solution for 1-D Nonlinear Schrodinger Equation (NLSE) with box potential:** Derived the semi-classical limit of reflection coefficient by asymptotic expansion of the hypergeometric functions of the second kind at ∞.
- **Large genus limit of soliton solutions of NLSE:** Derived generation equation for the constants of motion for NLSE under large genus thermodynamic limit.

Position: Research Consultant, Indian Institute of Technology, Kharagpur [2011 - 2013]

Projects in collaboration with Texas Instruments:

- **Boost converter control:** Designed a Smith-predictor based (using Sallen-key filter structure) switching control of non-minimum phase power converters in order to improve their time response.

- **Theoretical limit of control bandwidth for converters:** Derived the analytical maximum for control bandwidth in boost converter circuit with Smith Predictor structure.
- **Validation of results using Cadence:** Implemented Smith Predictor structure in Cadence for validation of theoretical maximum of control bandwidths in boost converters.
- **Design of buck converters to meet transient load specifications:** Developed an analytical expression for the peak transient output voltage due to a load step in a buck converter considering bandwidth of its control loop

Position: Graduate Student, IIEST, Shibpur, India [2009 - 2011]

Projects:

- **Chaotic Synchronizers:** Implemented Backstepping and sliding methods to synchronize topologically inequivalent systems.
- **Chaotic Observers:** Designed a nonlinear Luenberger-like observer and Thau's observer for chaotic dynamical systems.
- **Controlling Chaos:** Developed Ott-Grebogi-Yorke (OGY) controllers for chaotic systems to achieve set-point or reference tracking.

Position: Undergraduate Researcher, Haldia Institute of Technology, India [2008 - 2009]

Project:

- **Analysis of Human Electrocardiogram for Authentication:** Developed an algorithm to classify Human Electrocardiogram signal using feature extraction and Principle Component Analysis (PCA) technique.

Awards and Achievements

1. Selected for NYU Tandon School of Engineering Faculty First Look Program, 2022
2. WTS Helene M. Overly Memorial Scholarship Winner, 2021
3. Women in Science and Mathematics Scholarship, University of Central Florida, 2018
4. Nominated for Lee Armstrong Award for Distinguished Teaching, University of Central Florida, 2018
5. Travel grant and stipend to attend IMA Math-to-Industry Bootcamp III, 2018
6. Yvette Kanouff Industrial Mathematics Scholarship, University of Central Florida, 2017
7. NSF grant for attending Summer school at Fields Institute, 2017
8. Student Government International Students Scholarship, Fall 2016, Spring 2018
9. Departmental travel grant to attend AMS sectional meeting, 2016
10. Graduate Aptitude Test in Engineering (Government of India) monthly scholarship, 2009-2011
11. Certificate of Excellence in National Mathematics and Science talent tests (India), 2000, 1999

Teaching Experience

Assistant Professor, Texas Tech University

- ME 3333 Dynamic Systems and Vibrations [Undergraduate], Fall 2022.

Instructor of Record, University of Central Florida

- MAP 2302 Ordinary Differential Equations I [Undergraduate (Math Major)], Summer'19
- MHF 3302 Logic and Proof in Mathematics [Undergraduate], Fall'18, Spring'18, Summer'19

- MAS 3105 Matrix and Linear Algebra [Undergraduate], Spring'18, Summer'18
- MAC 2312 Calculus with Analytic Geometry III [Undergraduate], Fall'17, Summer'16
- MAC 2312 Calculus with Analytic Geometry II [Undergraduate], Spring'19, Fall'16, Summer'15
- MAC2233 Concepts of Calculus [Undergraduate], Fall'18

Graduate Teaching Assistant, The Pennsylvania State University

- ME 450 Modeling of Dynamical Systems [Undergraduate], Fall '21

Graduate Teaching Assistant, University of Central Florida

- MAP 2302 Ordinary Differential Equations I [Undergraduate], Spring'16
- MAC 2312 Calculus with Analytic Geometry I [Undergraduate], Summer 2014, Fall'14-'15, Spring'15
- MAC 1140C Pre-Calculus Algebra [Undergraduate], Fall'13, Spring'14
- MAC 1114C College Trigonometry [Undergraduate], Fall'13, Spring'14
- MAC 1105C College Algebra [Undergraduate], Fall'13, Spring'14
- MAT 1033C Intermediate Algebra [Undergraduate], Fall'13, Spring'14

Graduate Assistant (Lab), IIEST Shibpur

- Computational methods in Electrical Engineering [Graduate], 2011
- Analog Electronics [Undergraduate], 2010
- Microprocessor [Undergraduate], 2010
- Process control [Undergraduate], 2009

Mentoring Experience

- PhD Thesis advisor to Sanchita Ghosh, Texas Tech University at Texas Tech University, 2022.
- Research mentor to Ramona Devi, Masters' Student at The Pennsylvania State University, 2021
- Research mentor to Ruby Al Fawares, Undergraduate Student at The Pennsylvania State University, 2020
- Academic mentor to Mia Wanyo, Undergraduate Student through Penn State Mechanical Engineering Society (PSMES) mentoring program, 2021

Research & Professional Development

Workshop and Meeting

1. Core-participant in "Long Program: Mathematical Challenges and Opportunities for Autonomous Vehicles," at Institute for Pure and Applied Mathematics (IPAM) [Sept-Dec 2020]
2. Participated in IMA (Institute for Mathematics and its Application) Math-to-Industry 6 weeks Bootcamp III [June -July, 2018] with travel grant and stipend

- Worked on an algorithm for decomposition of Quadratic Unconstrained Binary Optimization (QUBO) problems to fit 2000Q D-wave Quantum computer architecture
- Simulated an optimum boarding strategy for Airlines and proposed practical implementation recommendations

3. AMS (American Mathematical Society) Sectional Meeting, University of Central Florida, 2017
4. Focus Program on Nonlinear Dispersive Partial Differential Equations and Inverse Scattering at Fields Institute, Toronto Canada
5. AMS Sectional Meeting, College of Charleston, 2017
6. National Workshop on Nano-Science and Technology, Quantum Computing and its Application, organized by Department of Engineering Science and Department of Computer Science and Informatics of Haldia Institute of Technology, March 2007

Professional Training

1. Excellence in Academic Advising: Under-Resourced Students I (4-weeks course), Penn State, 2021
2. Essentials of Online Teaching for Graduate Students (5-weeks course), Penn State, 2021
3. Safer People Safer Places Foundations workshop, Penn State, 2021 (geared towards foundations of being an ally to the LGBTQ+ community at PSU)
4. Safety and Security training for National Renewable Energy Lab (NREL), 2019
5. UCF's Family Educational Rights and Privacy Act (FERPA) training, 2017
6. Preparing Tomorrow's Faculty Program (12-week Instructor training) at FCTL, University of Central Florida, 2014
7. Intellectual Property Rights Workshop, 2014
8. Industrial Training Program at Indian Oil Corporation Limited (IOCL), Haldia refinery (India), 2008

Professional Service

Journal & Conference Reviewer

- IEEE Transactions on Systems, Man and Cybernetics: Systems
- IEEE Control System Letters, 2021
- American Control Conference (ACC), 2020, 2021
- IEEE Conference on Decision and Conference (CDC), 2020, 2021
- Modeling, Estimation and Control Conference (MECC), 2021
- ASME Dynamic Systems and Control Conference, 2018
- IEEE Students' Technology Symposium (TechSym 2016)

Conference Session Chair

Presided as Chair over Materials and Mechanics Session at College of Engineering Research Symposium (CERS) at Penn State, 2021

Student Recruitment

Volunteered as an interviewer for Penn State Millennium Scholars Program (MSP), 2021 and provided recommendations towards selecting prospective MSP scholars who can lead and increase the diversity in their STEM fields at Penn State

Campus Organization Involvement

- Chair, Professional Development Team for Engineering Graduate Student Council (EGSC), The Pennsylvania State University, 2021-present.
    1. Launched and presided a professional development book-club *(Next Chapter)*
    2. Organized monthly Lecture series *(Engineered to Excel)*
- Co-chair, Graduate Women in Science (GWIS) Science++ , 2021
    1. Collaborated with Zhennovate to launch a career counselling assistance platform for GWIS members.
- Vice President, ITE Penn State Student Chapter, 2021
- Technical Chair, Engineering Graduate Student Council (EGSC), The Pennsylvania State University, 2020
    1. Manager for EGSC LinkedIn page, responsible for all promotions of events via LinkedIn
    2. Organized the largest annual event of EGSC *Engineering Power Hours*, 2020
    3. Event Head for Wellness Day *Reboot and Rejoice* 2021

Professional Affiliations

- Institute of Electrical & Electronics Engineers (IEEE)
- Society for Industrial and Applied Mathematics (SIAM)

Outreach

- Mentoring a math enthusiast, who is under incarceration through *Prison Mathematics Project*, 2021
- Instructor for *UCF Math Circle*, a 7-week program geared towards middle-school children to explore concepts in mathematics and logic and cultivate math appreciation through puzzles and mathematical games, 2018