

# ZIXIAO MA

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## EDUCATION

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### Iowa State University

Ph.D., Electrical Engineering

Advisor: Prof. Zhaoyu Wang

Ames, IA, USA

*May 2017 - May 2023*

### Northeastern University

M.S., Control Theory and Control Engineering

Advisor: Prof. Tianyou Chai

Shenyang, Liaoning, China

*Sep. 2014 - Jan. 2017*

### Northeastern University

B.S., Automation

Shenyang, Liaoning, China

*Sep. 2010 - Jun. 2014*

## PROFESSIONAL EMPLOYMENT

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### State University of New York at Binghamton

Assistant Professor

Department of Electrical and Computer Engineering

Binghamton, NY, USA

*Starting Aug. 2024*

### University of Washington

Distinguished Postdoctoral Fellow in Clean Energy Institute

Hosted by Prof. Baosen Zhang

Seattle, WA, USA

*Jun. 2023-Present*

## PUBLICATION

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### Journal Paper

- [J15] L. Liu, N. Shi, D. Wang, **Z. Ma**, Z. Wang, M. J. Reno, and J. A. Azzolini, "Voltage Calculations in Secondary Distribution Networks via Physics-Inspired Neural Network Using Smart Meter Data," IEEE Transactions on Smart Grid, early access, 2024.
- [J14] **Z. Ma**, Z. Wang, Y. Yuan and T. Hong, "Singular Perturbation-based Large-Signal Order Reduction of Microgrids for Stability and Accuracy Synthesis with Control," IEEE Transactions on Smart Grid, early access, 2024.
- [J13] **Z. Ma**, Q. Zhang and Z. Wang, "Safe and Stable Secondary Voltage Control of Microgrids based on Explicit Neural Networks," IEEE Transactions on Smart Grid, vol. 14, no. 5, pp. 3375-3387, 2023.
- [J12] **Z. Ma**, Z. Wang and Rui Cheng, "Analytical Large-Signal Modeling of Inverter-based Microgrids with Koopman Operator Theory for Autonomous Control," IEEE Transactions on Smart Grid, early access, 2023.
- [J11] **Z. Ma**, Y. Xiang and Z. Wang, "Robust Conservation Voltage Reduction Evaluation using Soft Constrained Gradient Analysis," IEEE Transactions on Power Systems, vol. 37, no. 6, pp. 4485-4496, 2022.
- [J10] **Z. Ma**, B. Cui, Z. Wang and D. Zhao, "Parameter Reduction of Composite Load Model using Active Subspace Method," IEEE Transactions on Power Systems, vol. 36, no. 6, pp. 5441-5452, Nov. 2021.
- [J9] **Z. Ma**, Z. Wang, Y. Guo, Y. Yuan and H. Chen, "Nonlinear Multiple Models Adaptive Secondary Voltage Control of Microgrids," IEEE Transactions on Smart Grid, vol. 12, no. 1, pp. 227-238, 2021.
- [J8] J. Fu, **Z. Ma**, Y. Fu, T. Chai, "Hybrid Adaptive Control of Nonlinear Systems with Non-Lipschitz Nonlinearities," Systems & Control Letters, vol. 156, no. 105012, 2021.

- [J7] J. Xie, **Z. Ma**, K. Dehghanpour, Z. Wang, Y. Wang, R. Diao and D. Shi, “Imitation and Transfer Q-Learning-based parameter identification for composite load modeling,” *IEEE Transactions on Smart Grid*, vol. 12, no. 2, pp. 1674-1684, 2021.
- [J6] Q. Zhang, **Z. Ma**, Y. Zhu and Z. Wang, “A Two-Level Simulation-Assisted Sequential Distribution System Restoration Model With Frequency Dynamics Constraints,” *IEEE Transactions on Smart Grid*, vol. 12, no. 5, pp. 3835-3846, 2021.
- [J5] F. Bu, **Z. Ma**, Y. Yuan and Z. Wang, “WECC Composite Load Model Parameter Identification using Evolutionary Deep Reinforcement Learning,” *IEEE Transactions on Smart Grid*, vol. 11, no. 6, pp. 5407-5417, 2020.
- [J4] **Z. Ma**, Z. Wang, D. Zhao and B. Cui, “High-Fidelity Large-signal Order Reduction Approach for Composite Load Model,” *IET Generation, Transmission & Distribution*, vol. 14, no. 21, pp. 4888-4897, 2020.
- [J3] **Z. Ma**, Z. Wang, Y. Wang, R. Diao and D. Shi, “Mathematical Representation of WECC Composite Load Model,” *Journal of Modern Power Systems and Clean Energy*, vol. 8, no. 5, pp. 1015-1023, 2020.
- [J2] J. Li, **Z. Ma** and J. Fu, “Exponential Stabilization of Switched Discrete-Time Systems with All Unstable Modes,” *Asian Journal of Control*, vol. 20, no. 1, pp. 608-612, 2018.
- [J1] T. Li, J. Fu and **Z. Ma**, “Improved Event-Triggered Control for a Class of Continuous-Time Switched Linear Systems,” *IET Control Theory & Application*, vol. 12, no. 7, pp. 1000-1005, 2018.

#### Conference Paper

- [C2] **Z. Ma**, N. Shi, Z. Wang and W. Fan, “Time-Varying Conservation Voltage Reduction Evaluation with Ground Truth Validation,” accepted by 2024 IEEE Power & Energy Society General Meeting, Seattle, WA, USA.
- [C1] **Z. Ma** and B. Zhang, “Controlling Grid-Connected Inverters under Time-Varying Voltage Constraints,” accepted by 2024 IEEE Power & Energy Society General Meeting, Seattle, WA, USA.

#### Working Paper

- [J3] **Z. Ma** and B. Zhang, “Static Voltage Control of Grid-Connected Inverters under Time-Varying Power Quality Constraints,” *IEEE Transactions on Power Systems*, under preparation.
- [J2] R. Cheng, N. Shi, Z. Wang and **Z. Ma**, “Optimal Power Flow for Integrated Primary-Secondary Distribution Networks with Service Transformers,” *IEEE Transactions on Power Systems*, under review.
- [J1] N. Shi, R. Cheng, **Z. Ma** and Z. Wang, “Hierarchical Voltage Control for Integrated Primary-Secondary Distribution Systems: A Leader-Follower Game”, *IEEE Transactions on Smart Grid*, under review.

#### Dissertation

**Z. Ma**, “Composite load modeling for power systems: Model reduction, identification, and application to conservation voltage reduction,” Ph.D. dissertation, Iowa State University, Ames, IA, 2023.

### SUMMARY OF RESEARCH INTERESTS AND WORKS

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#### Microgrid modeling, order reduction and control:

- Proposed a transient-safety-critical secondary voltage control method for microgrids based on explicit neural networks. The proposed method utilizes the learning feature of neural networks to transfer the computational burden of stability and safety constrained optimization to the offline training phase, such that the controller is fast enough to be implemented online to govern the transient performance.

- Proposed a model-free nonlinear secondary voltage control method for microgrids using multiple models adaptive control and neural networks, which guarantees the bounded-input-bounded-output stability of the nonlinear microgrid system.
- Developed a singular perturbation based model order reduction method for nonlinear inverter-dominated microgrids to reduce the computational cost and complexity of stability analysis

#### **Data-driven and machine learning based composite load modeling:**

- Developed the mathematical representation of the WECC composite load model. A singular perturbation based large-signal order reduction approach is tailored for the model to reduce the simulation time.
- Proposed an active subspace method based parameter reduction approach for the WECC composite load model to reduce the dimension of its parameter space, in order to improve the accuracy of parameter identification and lower the computational cost.
- Proposed an evolutionary deep reinforcement learning based parameter identification algorithm for the WECC composite load model. This algorithm is designed to deal with the high non-convexity and high dimension of parameter space of the WECC composite load model.
- Proposed an imitation and transfer-Q-learning based parameter identification approach for the classical ZIP+induction motor composite load model. The main innovation of the proposed method is that the information of historical identification tasks can be utilized to accelerate and aid the new task by leveraging transfer learning.

#### **Conservation voltage reduction factor evaluation methodology:**

- Proposed a time-varying conservation voltage reduction factor evaluation approach based on time-varying load modeling and soft constrained gradient analysis.

### **TEACHING**

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#### **EE 653, Power Distribution System Modeling, Optimization and Simulation**

*Teaching Assistant*

**Iowa State University**

*Fall 2019*

**Areas Prepared to Teach:** Power Systems, Dynamical Systems, Control Theory, Signal and Systems, Optimization, Data Analytics, Machine Learning

### **AWARDS**

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- 2024 Rising Stars in Cyber-Physical Systems, University of Virginia
- 2023 Distinguished Postdoctoral Fellowship, University of Washington
- 2023 Research Excellent Award, Iowa State University
- 2021 Outstanding Reviewer, IEEE Transactions on Power Systems

### **SERVICES**

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#### **Technical Committee Officers**

- Section Co-Lead of Methodologies Selection of IEEE Standard P3102, IEEE Conservation Voltage Reduction (CVR) Task Force, 2020 - present

#### **Peer Reviewer**

- *Journals:* IEEE Transactions on Power Systems; IEEE Transaction on Smart Grid; IEEE Transaction on Sustainable Energy; IEEE Transactions on Power Delivery; IEEE Transaction on Energy Conversion; IEEE Transactions on Circuits and Systems II: Express Briefs; IEEE Transactions on Systems, Man, and Cybernetics: Systems; Applied Energy; IET Generation, Transmission & Distribution; IEEE Journal on Emerging and Selected Topics in Circuits and Systems, Systems & Control Letters

- *Conferences*: 2023 Power & Energy Society General Meeting (PESGM), 2022 Power & Energy Society General Meeting (PESGM), 2022 IEEE Innovative Smart Grid Technology Conference, 2021 Power & Energy Society General Meeting (PESGM), 2021 IEEE Innovative Smart Grid Technology Conference, 2020 Power & Energy Society General Meeting (PESGM)

## INVITED TALKS

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- Advancing reliable inverter-based power systems for future generations, University of Washington CEI Distinguished postdoc seminar, April 18, 2024.
- Control and optimization of renewable energy systems, Montana State University, March 25, 2024.
- Towards next generation reliable inverter-based power systems, Binghamton University, March 15, 2024.
- Towards next generation reliable inverter-based power systems, University of Maine, March 4, 2024.
- Towards next generation reliable inverter-based power systems, Southern Illinois University, Carbondale, February 15, 2024.
- Creating Ground Truth for Validation of CVR Assessment, Commonwealth Edison, May 19, 2023.
- Energy Savings via Conservation Voltage Reduction: Measurement and Verification Methodologies and Field Results, University of Washington Clean Energy Institute Seminar, February 9, 2023.
- WECC Modeling and Validation Subcommittee Meeting (virtual), *Python-PSSE based tool to identify composite model parameters*, November 30, 2021.
- NERC Load Modeling Working Group Meeting (virtual), *Python-PSSE based WECC composite load identification tool*, July 27, 2021.
- Webinar to American Electric Power, *WECC Composite Load Model Identification using Python-PSSE*, May 18, 2021.
- Western Electricity Coordinating Council (Salt Lake City, Utah), *Mathematical Representation and Dynamic Order Reduction of WECC Composite Load Model*, April 3, 2019.
- GEIRI North America (San Jose, CA), *Mathematical Modeling of WECC Composite Load Models*, December 4, 2018.