

# Tanmay Mishra

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## Education

- Aug 2016 – Feb 2023    ■ **PhD, Indian Institute of Science (IISc) Bangalore, Karnataka, India.**  
Major: *Power Electronics applications in Power Systems*, CGPA: (8.3/10)  
Thesis title: *Development of Generalized Synchronous Machine Emulation Platform*
- Aug 2014 – July 2016    ■ **M.Tech., Delhi Technological University (formerly Delhi College of Engineering), India.**  
Major: *Control and Instrumentation*, CGPA: (8.48/10)  
Thesis title: *Design and Analysis of Hysteresis Current Control and SVPWM on Fuzzy Logic based Vector-Controlled Induction Motor Drive*
- Aug 2009 – May 2013    ■ **B.Tech., National Institute of Technology (NIT) Hamirpur, Himachal Pradesh, India.**  
Major: *Electrical and Electronics Engineering*, CGPA: (7.65/10)

## Work Experience

- Feb 2024- Present    ■ **Research Associate**, Department of Electrical and Biomedical Engineering, University of Vermont, Burlington, VT.
- Mar 2023- Jan 2024    ■ **Post Doctoral Associate**, Department of Electrical and Biomedical Engineering, University of Vermont, Burlington, VT.

## Skills and Expertise

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| Power System         | ■ Modeling of Power System Network, Time-domain Simulations in C, Design and Tuning of Excitation System and PSS, Modelling of Turbine-Governors, Time Constant Regulation of Synchronous Generator, Design of Limiters for Synchronous Generator as per IEEE standard, State Estimation, Unit Commitment, Economic Load Dispatch, Optimal Power Flow. |
| Optimization and AI  | ■ Convex and non-convex optimization, Linear and non-linear programming, Linear and Logistic regression.   |
| Electric Drive       | ■ Modeling and Closed-loop control of DC and AC Drives.  |
| Controller Design    | ■ Design of Linear & Non-linear controller for Power Converters, Implementation of the Digital controller on TI Micro-controller for: DC-DC Power Converters, Voltage Source Inverters, Three-phase Controlled Rectifiers, DC Bus.   |
| Control Systems      | ■ Design of Linear control, Non-linear system modeling and analysis, Linearization, Design of Non-linear controller.   |
| Real time simulation | ■ Miniature Model of Full Spectrum Simulator (FSS MINI) developed by CDAC, IISc and IIT-Bomaby   |
| Tools and Utilities  | ■ MATLAB (Scripting, Custom functions, Simulink), Code Composer Studio (CCS), EMTP-RV, PSCAD, LaTeX.   |
| Programming          | ■ C, Embedded C, Python (Scripting, Libraries: numpy, pandas, matplotlib), Julia.  |
| Mentoring            | ■ Teaching Assistant (TA) for two courses- 'Power Systems Dynamics and Control' and 'Power Electronics Lab.' Training course students in time domain simulation for transient studies in power systems, Hands-on exercises on designing power electronics circuits and its closed-loop control.  |

### ■ **Holistic techno-economic analysis of hybrid energy systems (HESs) in cold weather climates**

(Postdoctoral Advisor : Dr. Mads R. Almassalkhi, University of Vermont)

(2023-present)

- Developed an electro-thermal model for hybrid energy systems to enable predictive optimization. Evaluated scheduling algorithms (NLP, MILP, Homotopy) for battery charging and discharging under diverse ambient conditions and C-ratings. Compared with a temperature-agnostic model to highlight the advantages of temperature dependency.
- Working on electro-thermal parameter estimation of battery model using the real world data.
- Setting up an Accelerated Testing Laboratory (ATL) to facilitate hardware testing of HES components, including batteries undergoing various charge and discharge cycles, as well as assessing inverter grid-following and forming capabilities

### ■ **Design and Development of Generalized Source Emulation Platform for Experimental Power Grid**

(Ph.D Thesis Guide: Dr. Gurunath Gurralla, Indian Institute of Science, Bangalore)

(2016-2022)

#### • **Design and Development of Excitation System:**

- A buck converter excitation system using Semicron power converters is developed for a 3 kVA micro alternator.
- The design involves the selection of the converter switch ratings, the DC bus ratings, associated filter design, gate driver selection, analog and digital sensor card development using Analog-Digital converter ICs.
- A closed loop PID controller for automatic voltage regulation, under excitation, overexcitation and V/Hz protective limiters are designed for excitation system using analytical techniques and bode plots. Implemented on TMS320F28377S Micro-controllers in embedded C.
- Implemented serial communication in embedded C on TMS320F28377S.

#### • **Emulation of Industrial Excitation Systems :**

- Developed control algorithms for automatic voltage regulation, Time Constant Regulation for a vendor-supplied H-Bridge converter on a TMS320F28335 microcontroller.
- Developed a control architecture for emulating the behaviour of industrial excitation systems on 5 kVA custom-built micro-alternator.
- Validated the performance of the emulation approach on experimental single machine infinite bus (SMIB) test system under small and large disturbances
- To establish the SMIB test system in laboratory, generalized substation model has been configured and operated.

#### • **Emulation of Turbine-Governor on DC Motor:**

- A droop speed control algorithm has been developed for 11 kW DC motor coupled with 5 kVA micro-alternator.
- The development involves designing and incorporating sensors, converting vendor-given assembly codes to embedded c and adding the control algorithms on top of it.
- Further, using the current control approach, emulated steam (single and double reheat) turbines and hydro turbines with mechanical, electro-hydraulic and hydraulic speed governors.
- The performance has been tested under various loading conditions, step change in speed and set point.

#### • **Development of Re-configurable Synchronous Generator:**

- Proposed an approach to emulate the dynamics of large synchronous generators (100s of MVA) on the laboratory's 5 kVA micro-alternator.
- The frame work consists of detail modelling of synchronous generator, network, turbine-governor models and different excitation systems.
- A dynamic inversion-based non-linear controller has been designed to track the terminal characteristics of large machines.
- A complete reconfiguration source emulation platform has been developed to emulate the behaviour of any hydro/thermal power plant. The approach is validated experimentally on SMIB test system under various disturbances (step change and fault cases).
- Impact of variation of inertia constant (H) on the frequency of oscillations has been studied.

## Research Work (continued)

### ■ Development of Source Emulation approach for Multi-machine Systems:

- Developed a time domain model of 3 machine 9 bus system with a Hydro and 2 thermal generators with suitable excitation systems and governor turbine models in MATLAB/SIMULINK platform.
- Proposed the scaling approach to WSCC 3 machine 9 bus system to a laboratory power level.
- Extended the dynamic inversion-based synchronous machine emulation approach for 3 Machine 9 Bus system.

### ■ Emulation of Composite load Characteristics using Grid-tied Back to Back Power Converter

(PI: Dr. Gurunath Gurralla, Indian Institute of Science, Bangalore)

(2019)

- An experimental load emulation platform using a back-to-back converter (A Voltage source inverter fed by 3-phase front-end converter has been developed. Static load (ZIP), Dynamic load (Induction motor), and Composite load have been emulated as per WSCC guidelines.
- A synchronous reference phase lock loop (SR-PLL) has been used to estimate the phase and angle, which is essential to transform the voltage/currents in abc frame to dq frame.
- Closed loop PI controllers for inner current control for VSI and DC bus of FEC have been designed.
- These controls and load models are Implemented on TMS320F28377S Micro-controllers in embedded C.

### ■ Design and Analysis of Hysteresis Current Control and SVPWM on Fuzzy Logicbased Vector-Controlled Induction Motor Drive

(M.Tech Thesis Guide: Dr. Narendra Kumar, Delhi Technological University, India)

(2014-2016)

Modeled an induction motor fed by a 3-phase voltage source inverter for vector control, developed fuzzy logic and hysteresis current controllers for speed control, and validated the system under speed change, speed reversal, and load change scenarios

### ■ Comparative Study of Face Recognition

(Guided by: Dr. Amit Kaul, National Institute Technology, Hamirpur)

(2013)

Feature extraction from the captured images and compare two face recognition algorithm: Principal component analysis (PCA) and Linear discriminant analysis (LDA) using MATLAB.

## Selected Awards and Honors

- 2019 ■ **RBCCPS Research Grant for CPS-Projects** Research grant from the Robert Bosch Centre for Cyber-Physical Systems (RBCCPS) at IISc.
- 2016 ■ **MHRD PhD Fellowship** by Ministry of Human Resource Development, Government of India.
- **Graduate Aptitude Test in Engineering (GATE) Examination**, National level entrance exam for postgraduate courses. Secured the rank of 376 (out of 150 thousand candidates) and scored 792/1000 (99.75 percentile)

## Research Publications

### Journal Articles

- [1] T. Mishra, D. Kalke, G. Gurralla and R. Padhi, 'A Re-configurable Synchronous Machine Emulation Platform Using Laboratory Micro Alternator,' *IEEE Trans. on Energy Conversion* (\*under review), 2024.
- [2] T. Mishra, A. Pandey and M. Almassalkhi, 'Predictive Optimization of Hybrid Energy Systems with Temperature Dependency,' *Electric Power Systems Research* (accepted for PSCC), 2024.
- [3] T. Mishra and G. Gurralla, 'Emulation of IEEE STD 421.5/Industrial Excitation Systems Using a Micro-Alternator's Exciter,' *IEEE Trans. on Energy Conversion*, vol. 38, no. 3, pp. 1881–1892, 2023.

### Conference Proceedings

- [4] T. Mishra and G. Gurralla, 'Design of Limiters for Buck Converter Based Static Excitation System for Micro-Alternator,' in (accepted) *2nd International Conference on Electrical, Computer and Energy Technologies (ICECET)*, 2023.
- [5] T. Mishra, 'Generalized Source Emulation Approach on Laboratory Micro-Alternator,' in *EECS Research Symposium, IISc Bangalore*, 2021.
- [6] T. Mishra and G. Gurralla, 'Emulation of IEEE excitation system models using micro-alternator's excitation system,' in *2020 IEEE 29th International Symposium on Industrial Electronics (ISIE)*, 2020, pp. 845–850.

- [7] —, ‘Design and implementation of igbt based static excitation system with buck converter,’ in *2018 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, 2018, pp. 1–6.
- [8] **T. Mishra**, A. Devanshu, N. Kumar and A. R. Kulkarni, ‘Comparative analysis of hysteresis current control and svpwm on fuzzy logic based vector controlled induction motor drive,’ in *2016 IEEE 1st International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES)*, 2016, pp. 1–6.

## Technical Committees & Organizations

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- 2022    **■ Founding Vice-Chair**, IEEE IISc PES Student Branch
- 2020    **■ Student Member**,, in *Organizing Committee* of IEEE International Conference on Power System Technology POWERCON 2020.
- 2017-2018    **■ Secretary**, IEEE IISc Student Branch
- 2009–13    **■ Managing Editor**, SRIJAN, Annual College magazine, NIT Hamirpur.