**HIMANSHU JAIN**

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**EDUCATION**

* PhD, Electrical Engineering, Virginia Tech, Blacksburg, VA, USA, 2016, GPA-4.0/4.0

**Advisor:** Dr. Robert Broadwater

**Dissertation Title:** Dynamic Simulation of Power Systems using Three Phase Integrated Transmission and Distribution System Models: Case Study Comparisons with Traditional Analysis Methods

* Master of Science (MS), Electrical Engineering, The University of Texas at Arlington, Arlington, TX, USA, 2010, GPA-4.0/4.0

**Advisor**: Dr. Wei-Jen Lee

**Thesis Title:** Detection and Severity Classification of Rotor Imbalance Faults in Induction Machines

* B. Tech., Electrical Engineering, G. B Pant University of Agriculture and Technology, Pantnagar, India, 2008, GPA-9.0/10.0

**RESEARCH INTERESTS**

* Grid reliability and resilience under very-high variable renewable energy penetration.
* Blackstart of bulk power and distribution systems using inverter-based generation resources.
* Modeling and simulation of utility-scale transmission, distribution, and integrated transmission and distribution systems at multiple timescales.
* Developing software tools to improve the modeling accuracy of power grids under very-high variable renewable energy penetration.
* Using distributed energy resources (DERs) for improving grid reliability and resilience

**PUBLICATIONS & PRESENTATIONS SUMMARY**

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| --- | --- |
| **Attribute** | **Value** |
| **Total Citations** | 220 |
| **Peer Reviewed Journals** | 6 |
| **Peer Reviewed Conferences** | 12 |
| **Trade Publication** | 1 |
| **Paper/Panel/Workshop Presentations** | 10 |

**PAPER REVIEW SUMMARY**

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| --- | --- |
| **Journal/Conference** | **# of Papers Reviewed** |
| **IEEE Power Engineering Letters** | 1 |
| **IEEE Transactions on Power Systems** | 7 |
| **IEEE Transactions on Smart Grid** | 5 |
| **IET Generation, Transmission, and Distribution** | 8 |
| **Journal of Energy Engineering, ASCE** | 9 |
| **Energies** | 2 |
| **IEEE PES General Meeting** | 5 |
| **Total** | **37** |

**AWARDS**

* NREL’s Outstanding Mentor Award, 2020.
* NREL’s President’s Award for efforts in obtaining funding for research in the area of power system stability exceeding **$1 million (INR 7.0 crore)**, 2019.
* Member of the Hierarchical Engine for Large-scale Infrastructure Co-Simulation (HELICS) team, which was a **finalist for the 2019 R&D100 Awards**, 2019.
* 2017 American Society of Civil Engineers (ASCE) **Outstanding Reviewer** award in recognition of outstanding service as a reviewer for the ASCE Journal of Energy Engineering, 2018.
* ICF **Certificate of Recognition** awarded for exemplary contribution to the success of the Energy, Environment, and Transportation Group and ICF International, 2012.
* Vice Chancellor’s gold medal for excellence in academics in the B. Tech degree program, 2009.

**RESEARCH GRANTS**

* PI from NREL for a U.S. Department of Energy (DOE), Solar Energy Technologies Office (SETO) project that aims at obtaining grid services from behind-the-meter distributed energy resources; 2019.
* PI for the “Blackstart Using Inverter-Based Resources” project under NREL’s lab-directed research and development (LDRD) program, 2019.
* Task lead for the power flow and stability analysis task in a project with an electric utility; 2018.

**ADVISING & MENTORING**

* PhD Committee member for a student at the Colorado State University, Fort Collins, CO, USA.
* Mentor for 5 PhD interns - Mentored 2 interns in summer of 2020, mentored 2 interns in summer of 2019, and 1 intern in summer of 2018.

**SOFTWARE PROFICIENCY**

MATLAB/Simulink, Simscape Power Systems, PSLF, PSS/E, DEW, GridLAB-D, Cymdist, ATP, PSCAD, C++, Python, Linux applications on High Performance Computing (HPC) platforms.

**MACHINE LEARNING**

* Sort-term load forecasting using (i) feedforward artificial neural networks (ANNs), (ii) radial basis function networks, and (iii) adaptive neuro fuzzy inference system (ANFIS).
* Sensor fusion to classify the severity of rotor imbalance fault in induction motors using (i) ANFIS, and (ii) Dempster Shafer theory.
* Identifying the dynamics of complex non-linear systems using feed forward ANNs.

**HARDWARE AND SOFTWARE DEVELOPMENT**

* Developed a hardware testbed to emulate rotor imbalance faults in induction motors during my MS research. The set up involved installing vibration, current and voltage sensors on an induction motor, developing a wooden protective box around the motor, and programming LabVIEW-based data acquisition system to acquire sensor data.
* Set up SEL 710 motor protection relay for an undergraduate relay protection laboratory as a graduate teaching assistant.
* Developed the Three-phase Dynamics Analyzer (TPDA) program during my PhD to enable full three-phase integrated transmission and distribution simulations.
* Developed MAFRIT at NREL to enable extended-term dynamic simulations for studying frequency response of the grid under high renewable energy penetration.
* Developed the code to interface two co-simulation platforms – an implementation of the High Level Architecture (HLA) and the HELICS.
* Performed large-scale integrated transmission and distribution co-simulations on NREL’s high performance computer Peregrine using the Integrated Grid Modeling System (IGMS) developed at NREL.

**RESEARCH & PROFESSIONAL EXPERIENCE**

* **Assistant Professor, Hydro and Renewable Energy Department, IIT Roorkee, 2021-Present**

**Research Interests:**

* Reliable and resilient grid integration of renewable energy
* New modeling and simulation approaches for high variable renewable energy power systems
* Stability analysis of utility-scale power systems
* Blackstart of power systems using inverter-based resources (IBRs)
* Grid services from behind-the-meter distributed energy resources
* **Senior Research Engineer, NREL, Golden, CO, USA, 2020-2021**
* Obtain research funding for innovative ideas that advance grid reliability and resilience
* Focus on disseminating research through publications, presentations, and speaking engagements
* Mentor entry level engineers and interns
* Same research focus as under “Research Engineer” below
* **Research Engineer, NREL, Golden, CO, USA, 2017-2020**
* PI for projects and tasks worth **$1.9 million** (**INR 13.3 crore**)
* **Research focus** - Modeling utility-scale transmission, distribution, and integrated transmission and distribution systems over multiple timescales – steady state and quasi-steady state (sec-hour), dynamics (milliseconds), and transients (microseconds) to analyze the impacts of high penetration levels of variable renewable energy resources on the reliability of power systems.
* **Research focus** - Developing new approaches to improve the reliability and resilience of transmission and distribution systems with distributed and bulk power system connected inverter-based generation resources.
* **Summer Intern, NREL, Golden, CO, USA, 2015**
* Developed a software tool called the Multi-Area Frequency Response Integration Tool (MAFRIT) to simulate short and long-term power systems dynamics.
* **Senior Associate, ICF International, Fairfax, VA, USA, 2012-2013**
* Lead the effort to develop new capabilities at ICF to perform distribution feeder modeling and analysis.
* Lead a team of three to perform power systems studies to analyze the impact of transmission projects on the reliability of the electric grid.
* **Associate, ICF International, Fairfax, VA, USA, 2011-2012**
* Performed power systems studies to analyze the impact of transmission projects and DERs on the reliability of the electric grid.
* Reviewed and qualitatively assessed the impact of regulatory orders and electricity market rules on renewable energy development and transmission expansion.

**PUBLICATIONS (Total citations 220; h-index 7; i10 index 5 – Google Scholar)**

**Peer Reviewed Journal Publications (Published)**

* **H. Jain**, B. Bhatti, T. Wu, B. Mather, and R. Broadwater, “Integrated Transmission-and-Distribution System Modeling of Power Systems: State-of-the-Art and Future Research Directions”, in *MDPI Energies*, 2021. **Impact Factor – 2.702**.
* A.K. Jain, K. Horowitz, F. Ding, K.S. Sedzro, B. Palmintier, B. Mather, and **H. Jain**, “Dynamic Hosting Capacity Analysis for Distributed Photovoltaic Resources - Framework and Case Study”, in *Applied Energy*, 2020. **Impact Factor - 8.426.**
* B-MS Hodge, **H Jain**, C Brancucci, et al, “Addressing Technical Challenges in 100% Variable Inverter-Based Renewable Energy Power Systems”, in *Wiley Interdisciplinary Reviews Energy and Environment*, e376, 1-19, 2020. **Impact Factor - 3.297.**
* **H. Jain**, R. P. Broadwater, M. Dilek, J. Bank, “Studying the Impact of Solar PV on Power System Dynamics using Integrated Transmission & Distribution Network Models,” in *Journal of Energy Engineering*, vol. 144, no. 1, 2017. **Impact Factor - 1.131.**
* Tbaileh, **H. Jain**, R. Broadwater, J. Cordova, R. Arghandeh, M. Dilek, “Graph Trace Analysis: An object-oriented power flow, verifications and comparisons”, in *Electric Power Systems Research* 147, 145-153, 2017. **Impact Factor - 3.022.**
* **H. Jain**, A. Parchure, R. P. Broadwater, M. Dilek and J. Woyak, "Three-Phase Dynamic Simulation of Power Systems Using Combined Transmission and Distribution System Models," in *IEEE Transactions on Power Systems*, vol. 31, no. 6, pp. 4517-4524, Nov. 2016. **Impact Factor - 6.807.**

 **Peer Reviewed Conference Publications (Published)**

* **H. Jain**, G. Seo, E. Lockhart, V. Gevorgian, and B. Kroposki, “Black Start of Power Grids with Inverter-based Resources”, in proc., *2020 IEEE Power and Energy Society General Meeting (PESGM),* Virtual Meeting, 2020.
* **H. Jain***, et al.*, “Quantifying Solar PV Variability at Multiple Timescales for Power Systems Studies”, in proc., *47th IEEE Photovoltaic Specialists Conference (PVSC),* Virtual Meeting, 2020*.*
* **H. Jain**, B. Palmintier, D. Krishnamurthy, I. Krad, and E. Hale, “Evaluating the Impact of Price-Responsive Load on Power Systems Using Integrated T&D Simulation,” in proc., *IEEE Innovative Smart Grid Technologies (ISGT) Conference 2019*, Washington DC, 2019.
* R.S. Biswas, J. Tan, **H. Jain**, V. Gevorgian and Y. Zhang, “Equivalent Test Bed in PSCAD and PSLF for Studying Advanced Power Systems Controller Performance”, in proc., *IEEE Innovative Smart Grid Technologies (ISGT) Conference 2019,* Washington DC, 2019.
* **H. Jain**, B. Palmintier, I. Krad, D. Krishnamurthy, “Studying the Impact of Distributed Solar PV on Power Systems using Integrated Transmission and Distribution Models,” in proc. 2018 *IEEE/PES Transmission and Distribution Conference and Exposition Conference and Exposition (T&D)*, Denver, CO, 2018.
* K. Rahimi, **H. Jain** and R. Broadwater, "Application of Distributed Series Reactors in relieving congestion costs," n proc., *2016 IEEE/PES Transmission and Distribution Conference and Exposition (T&D)*, Dallas, TX, 2016.
* **H. Jain**, K. Rahimi, A. Tbaileh, R. P. Broadwater, Akshay Kumar Jain and M. Dilek, "Integrated transmission & distribution system modeling and analysis: Need & advantages," in proc., *2016 IEEE Power and Energy Society General Meeting (PESGM)*, Boston, MA, 2016.
* **H. Jain**, A. Parchure, R. P. Broadwater, M. Dilek and J. Woyak, "Three phase dynamics analyzer: A new program for dynamic simulation using three phase models of power systems," in proc., *2015 IEEE IAS Joint Industrial and Commercial Power Systems / Petroleum and Chemical Industry Conference (ICPSPCIC)*, Hyderabad, 2015.
* K. Rahimi, **H. Jain**, R. Broadwater and J. Hambrick, "Application of Distributed Series Reactors in voltage balancing," in proc, *2015 IEEE Power & Energy Society General Meeting (PESGM)*, Denver, CO, 2015.
* **H. Jain**, K. Kumaraswamy and R. N. Maurya, "Plug-In Electric Vehicles - Distribution system impacts and high level screening methodologies for calculating costs and benefits," in proc., *IEEE Innovative Smart Grid Technologies* (*ISGT) Conference 2014*, Washington, DC, 2014.
* **H. Jain**, S. Korkua, W. Lee and C. Kwan, "Detection and Severity Classification of Rotor Imbalance Faults in Induction Machines,"in proc.*, 2010 IEEE Industry Applications Society Annual Meeting*, Houston, TX, 2010.
* S. Korkua, **H. Jain**, W. Lee and C. Kwan, "Wireless health monitoring system for vibration detection of induction motors," in proc., *2010 IEEE Industrial and Commercial Power Systems Technical Conference*, Tallahassee, FL, 2010.

 **Trade Publication (Published)**

* E. Roseman and **H. Jain**, “Regional Differences in Order 1000 Cost Allocation. What does it mean?” World-generation, 2013 V.24 #5.

 **Dissertation and Thesis**

* **H. Jain**, “Dynamic simulation of power systems using three phase integrated transmission and distribution system models: Case study comparisons with traditional analysis methods”, Ph.D Dissertation, Virginia Tech, Blacksburg, VA, November, 2016.
* **H. Jain**, “Detection and severity classification of rotor imbalance faults in induction machines”, MS Thesis, University of Texas at Arlington, Arlington, TX, August, 2010.

**PRESENTATIONS**

* **Invited speaker at the Northeast Power Coordinating Council (USA) DER Forum, 2021**. The presentation topic was “Blackstart using inverter - based resources”.
* **Paper presentation at the 2020 IEEE PES General Meeting** (Virtual Meeting due to Covid 19 Pandemic), **2020**: Paper presented was titled “Black Start of Power Grids with Inverter-based Resources”.
* **Paper presentation** **at the 47th** **IEEE PVSC Conference,** (Virtual Meeting due to Covid 19 Pandemic)**, 2020:** Paper presented was titled “Quantifying Solar PV Variability at Multiple Timescales for Power Systems Studies”.
* **Puerto Rico Energy Planning Resources Workshop**, **Puerto Rico, USA, 2019**: Presented the MAFRIT tool to various stakeholders in Puerto Rico, including university students, faculty, and industry members as part of a workshop organized under a DOE project to introduce tools that can help improve the reliability and resilience of Puerto Rico’s electric grid. (<https://www.nrel.gov/docs/fy19osti/73839.pdf>).
* **Poster presentation** **at the 2018 IEEE T&D Conference, Denver, CO, USA, 2018**: Poster presented was titled “Studying the Impact of Distributed Solar PV on Power Systems using Integrated Transmission and Distribution Models”
* **Panelist at the 2016 IEEE PES General Meeting, Boston, MA, USA, 2016**: Panel session was titled “Distribution Simulations at Varying Time Scales” and my presentation was titled “Three-Phase Dynamic Analysis of a Hybrid Transmission and Distribution Model: Impact of PV on Dynamics”
* **Paper and poster presentation** **at the 2016 IEEE PES General Meeting, Boston, MA, USA, 2016**: Paper presented was titled “Integrated transmission & distribution system modeling and analysis: Need & advantages”
* **Paper presentation** **at the 2015 IEEE IAS Joint Industrial and Commercial Power Systems / Petroleum and Chemical Industry Conference (ICPSPCIC), Hyderabad,** **India, 2015**: paper presented was titled “Three phase dynamics analyzer: A new program for dynamic simulation using three phase models of power systems”
* **Paper presentation** **at the 2015 IEEE PES General Meeting, Denver, CO, USA, 2015**: Paper presented was titled “Application of Distributed Series Reactors in voltage balancing”
* Presentation on the Distributed Engineering Workstation (DEW) software at the Central Power Research Institute (CPRI), Bangalore, India, 2015

**RELEVANT RESEARCH PROJECTS**

* PI from NREL for a DOE project that aims at obtaining grid reliability services from behind the meter distributed energy resources, 2020-2021
* PIfor“Blackstart Using Inverter-Based Resources” project, 2019-2021
* PI for evaluating the reliability of a utility’s grid under very-high variable energy penetration using power flow and dynamic simulations, task budget, 2018-2021
* Lead the solar PV variability modeling effort in the Multi-timescale Integrated Dynamics and Scheduling for Solar (MIDAS-Solar) project funded by SETO, 2018-2019.
* Lead the technical evaluation of challenges and opportunities of blackstart using solar PV and battery storage in the SETO-funded Solar Energy Innovation Network (SEIN) project, 2018-2019.
* Worked with a U.S. Investor-owned utility to determine the impact of very-high penetration levels of solar PV and battery storage on the stability of the power system. Impact of adding synthetic inertia to solar PV and battery storage on the stability of the power system was also investigated, 2018.
* Worked on a DOE sponsored grid modernization lab consortium (GMLC) project where my primary responsibility was to develop a HELICS-HLA interface. Hierarchical Engine for Large-scale Infrastructure Co-Simulation or HELICS is a co-simulation platform that was developed under this project. High Level Architecture or HLA is another co-simulation architecture that is widely used in the defense community, 2017-2018.
* Performed a study using MATLAB for a utility to calculate the temporary over voltage (TOV) on a section of a distribution feeder with large amount of PV generation. TOV resulted from reversal of power flow when a switch upstream opened to isolate the section of the feeder, 2014.
* Conducted studies in CYMDIST to assess the impact of integrating photovoltaics and electric vehicles on the distribution system. Used the prototype feeders developed by the Pacific Northwest National Laboratory (PNNL) to perform the analysis; prototype feeders were converted into CYMDIST acceptable format using Excel VBA, 2013.

**PROFESSIONAL AFFILIATIONS**

Member, IEEE

Member, IEEE-Power and Energy Society

Tau-Beta-Pi (Treasurer, Texas Eta Chapter, 2009-2010)