The University of Queensland - IIT Delhi Academy of Research Joint PhD Project

Project title	**Analysis and Design of robust control system for grid connected inverters in weak grids involving multi-inverter interactions**
Project code	**UQIDAR 00153**
Project description	Aims: The project aims to develop new robust control methods for smart inverter technologies. Ability of inverters to support power networks in the case of high renewable penetration can be severely compromised if they are subject to uncertain impedance conditions from the power network end. This project aims to address this significant emerging issue through the development of advanced robust control methods that will equip inverter control systems with ability to preserve stability and performance in all types of network conditions and locations. Methodology: Task 1 - Development of control-oriented model of grid connected inverters: This task will involve development of control-oriented mathematical models of inverters whereby the uncertain conditions will be modelled as polytopic set bounded system and parametric uncertainties. The uncertainties will include grid impedance variations from the nominal values and effects of interactions with multiple inverters connected to the same network. Consistent with the current residential rooftop photovoltaic installations, single phase inverters will be considered in this project. Task 2 - Robust control design for grid connected inverters: Using the control-oriented models developed in Task 1, robust controllers will be designed for grid connected inverters to provide stability and performance guarantees despite variations in grid conditions including effects of multiple inverters that are in close proximity on the same networks (e.g. same low voltage distribution network feeder). Here, linear matrix inequality (LMI) and Riccati equation theoretical concepts will be used. Task 3 – Experimental validation of new robust controllers: The robust controllers will be experimentally tested in UQ's power electronic lab. Single phase inverters of ratings 1 kW and 5 kW will be used to evaluated controllers on a diverse range of inverters seen in distribution networks. For control implementation, dSPACE DS1105 equipment will be used that is available in UQ ITEE/PES.
Project outcomes	The proposed project will advance robust and reliable grid connected inverter technologies by delivering the following outcomes: -Inverter control algorithms capable of providing robustness to grid connected inverters to deliver stability, performance and power quality guarantees regardless of the network type in Australia and abroad. -Develop tools to efficiently design robust controllers for single phase grid connected inverters and present sample practical case studies. -Provide guidelines for inverter manufacturers and network operators for designing and tuning control parameters to achieve optimum stability and performance.
Advisory team	**UQ Principal Supervisor** **Dr Rahul Sharma** Information Technology and Electrical Engineering

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Type of student	Applications are open to: i-students who meet eligibility criteria.
Discipline background of student	Ideally, this project requires students with a background in: Electrical Engineering, Mathematical Control Theory, Power Electronics, Power Engineering
Ideal candidate	**Essential Capabilities:** -Strong electrical engineering fundamentals including circuit analysis, electronic concepts and control engineering basics -Ability to proficiently perform simulations in MATLAB/Simulink and ability to implement/program control algorithms in user-defined functions (e.g. in MATLAB functions, C or python). -Strong mathematical and analytical skills. **Desirable Capabilities:** -Prior experience with electrical and electronic hardware to perform hardware-in-the-loop experiments will be desirable. **Expected qualifications (Courses/Degrees etc.):** -Master's in electrical engineering or equivalent with a thesis/research component. -Coursework must have related to mathematical control theory, power electronics and power engineering components.
Application process	Apply online by the due date: https://www.uqidar.org/students/how-to-apply/