National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Droop based Decentralized Control Strategies for Accurate Power Sharing and Performance Improvement in Islanded AC Microgrid
Speaker	: Bibhudatta Mishra (Rollno : 519ee1005)
Supervisor	: Monalisa Pattnaik
Venue	: EE-401
Date and Time	: 08 Oct 2025 (05:00 PM)

Abstract

: The growing integration of distributed energy resources (DERs) into modern power networks has accelerated the development of AC microgrids, where multiple inverter-based units operate in parallel. In such systems, decentralized controllers play a crucial role in ensuring reliable operation, as they govern active and reactive power sharing, maintain point of common coupling (PCC) voltage stability, and restore system frequency under varying operating conditions. However, conventional droop-based strategies are often inadequate in the presence of line impedance mismatches, load transients, and renewable generation variability, necessitating advanced control solutions.

This research investigates, develops, and validates a set of improved decentralized control strategies for parallel operating inverters in islanded AC microgrids. Initially, the research is conducted in two different scenarios, first part highlights the simulation and hardware validation of simple droop control for a single inverter, demonstrating effective voltage and frequency restoration. The second part extends to simulate all the conventional droop control (P&ndashf/Q&ndashV), reverse droop (P&ndashV/Q&ndashf) and mixed droop (P&ndashf/Q&ndashV with P&ndashV/Q&ndashf) in Opal-RT OP4510 platform with same line impedance condition for parallel inverter configuration. The comprehensive result highlights the effective performance in accurate power sharing, voltage and frequency regulation. However, the efficacy of these controllers deteriorates in a mismatched line impedance scenario. To address the limitation of the existing control schemes, firstly, an improved conventional droop with virtual impedance control method is introduced for a PV-fed AC microgrid under mismatched line impedance. This enables better impedance matching and reduces circulating currents, which significantly enhances active and reactive power sharing performance. Further, a reverse droop (Q&ndashf/P&ndashV) integrated with the modified virtual impedance loop improves reactive power balancing and provides superior voltage support. Finally, a combined droop strategy augmented with modified virtual impedance is proposed, offering robust performance by combining the advantages of conventional and reverse droop controls.

All control approaches are extensively validated through real-time simulations on the OPAL-RT OP4510 platform. The results confirm that the proposed strategies achieve precise power sharing, enhanced voltage and frequency regulation, improved dynamic response compared to conventional methods. Overall, this research establishes a framework of robust decentralized control strategies that enhance the performance of parallel inverters in AC microgrid, particularly under challenging conditions of line impedance mismatch, load variations, and renewable energy intermittency. This research work can be further extended to grid integrated multiple smart microgrid networks.