Defence Seminar

Seminar Title	: DEVELOPMENT OF HIERARCHICAL CONTROL FRAMEWORK FOR STAND- ALONE MICROGRID WITH NETWORKING CAPABILITY TO ENSURE LONG TERM SUSTAINABILITY
Speaker	: Sourav Chakraborty (Rollno : 520ee1009)
Supervisor	: Dr. Susmita Kar
Venue	: Department of Electrical Engineering, Room No.-EE402
Date and Time	: 11 Nov 2024 (9:30 am)

Abstract : Integration of Renewable Energy Source (RES) provides several benefits such as onsite generation, zero carbon emission, and improved local supply reliability through the formation of microgrids. The stand-alone operation of microgrids faces several abnormalities with the variation of generation and demand. Further, stand-alone microgrid also faces many challenges in maintaining the voltage and frequency because of the intermittent nature of RES and uneven/sudden load switching. The changing load dynamics may pose a severe threat to the microgrid stability due to its low inertia. Thus, a proper control mechanism is mandatory.
During off-peak hours or sufficient generation conditions, the generation end (inverter control) control can maintain voltage and frequency to its nominal value adhering to IEEE 1547.1.
However, during peak hour or deficit generation conditions, generation end control is unable to maintain the system&rsquos nominal values. Thus, in such a scenario microgrid may collapse due to the large voltage and frequency deviations. Further, a high RoCoF caused due to load switching may degrade the power quality and inverter operation. Therefore, voltage control combined with an inertia-based frequency control mechanism is essential to enhance power flow continuity and alleviate brownouts caused by significant load switching. Furthermore, the heterogeneous switching of loads among the phases also decreases the power quality and increases the Voltage Unbalance Factor (%VUF) and circulation current in a stand-alone microgrid.
The dissertation proposes Positive Negative and Zero sequence (PNZS) compensation control on the generation side to mitigate the abnormalities caused due to uneven switching of loads.
Additionally, virtual inertia-based frequency control is implemented to address frequency transients caused by sudden load switching. A thorough small signal stability analysis is conducted to demonstrate the effectiveness of the proposed controller under various system dynamics. The sequence component-based inverter control strategy can mitigate abnormalities during sufficient generation conditions and fails during deficit generation. Thus, load-end control through load management is employed to maintain power quality during peak hours/ deficit generation. Further, manual load management is challenging and unreliable. Thus, intelligent load aggregation and management are carried out. However, the resilience of the stand-alone microgrid is degraded during adverse conditions while inverter control and load end control fails to mitigate the abnormalities. In such a scenario, the demand for critical loads can be met through power sharing from possible neighboring microgrids. To realize power sharing between microgrids, networking is done with Interlinking Converter. Thus, the dissertation presents a priority-based Interlinking Converter Control (ILC) strategy to enable power-sharing in network microgrids (NM). Further, a network reconfiguration algorithm is required to restore the supply after a High Impact Low Probability (HILP) event. Thus, a hierarchical control mechanism is mandatory to improve stability and enhance microgrid resilience during adverse conditions (HILP events), peak hours, and off-peak hours.
The proposed hierarchical control mechanism is validated under various system dynamics using MATLAB/Simulink and the Digsilent PowerFactory environment. Additionally, the OPAL-RT platform is utilized to assess the real-time performance of the proposed strategy.