**Abstract of Ph.D. Thesis**
**"Design and Development of Light Electric Vehicle Chargers"**
**Mr. Jitendra Gupta (2017EEZ8178), Research Scholar**

## Abstract

This work deals with the design and development of high performance chargers for the light electric vehicles (LEVs), i.e., electric two wheelers (E2Ws) and electric three wheelers (E3Ws). Several desirable performance features of LEVs chargers from consumers, manufacturers, and power suppliers' perspectives are identified and correspondingly, novel LEV chargers have been designed, analyzed, and implemented in this work. A comprehensive classification of LEV chargers based on the direction of power flow (unidirectional or bidirectional), number of power conversion stages (single or double stages), and need for isolation (nonisolated or isolated) is made in this work. Notably, a wide range of supply and battery voltage conditions are considered when designing and implementing all charger topologies to ensure a general purpose/single charging solution for different classes of LEVs. In this work, the pros and cons of transformers are comprehensively analyzed, and accordingly, different novel nonisolated charging solutions are proposed for the LEV applications. In the proposed nonisolated LEV charging solutions, the applicability of the transformerless gain adjustment techniques, is comprehensively analyzed to achieve desired performance objectives under wide AC and DC side operating conditions. Further, the impact of input-output current ripples on the filter size is explored in these charger topologies, and some novel LEV chargers with continuous input-output current characteristics and low filters size are proposed in this work.

Further, the feasibility of the bidirectional charging system for the LEVs is comprehensively assessed in this work. Correspondingly, various novel bidirectional LEV chargers with grid-to-vehicle (G2V), vehicle-to-grid (V2G), and vehicle-to-home (V2H) modes operational capabilities are proposed for ensuring greater benefits to the LEVs consumers and power suppliers. Further, the seamless mode transfer capability of proposed bidirectional LEV chargers under grid disconnection and reconnection events, is critically analyzed, and correspondingly, a simple yet robust control framework is formulated to achieve desired performance characteristics under normal/abnormal operating conditions.

Notably, all the proposed unidirectional and bidirectional charger configurations are designed and developed to realize improved power quality performance at the supply side and strictly comply with set national/international standards while operating under defined operating conditions. Each charger configuration's operational analysis, design, and control are analyzed comprehensively, considering wide operating conditions. Further, the overall performance of the proposed LEV chargers is validated through software simulation and hardware implementation, and the obtained results are discussed in detail. Notably, the design, control, and overall performance objectives of the proposed unidirectional LEV chargers are validated under various steady state and dynamic operating conditions. Likewise, the bidirectional LEV chargers' performance is analyzed under G2V, V2G, and V2H mode conditions during normal/abnormal grid conditions and grid disconnection/reconnection events. Finally, the AC and DC side performance of the proposed unidirectional and bidirectional chargers are matched with set national/international standards to justify their compliance as high-performance LEV charging systems.