

LIST OF FIGURES

FIG. NO.	TITLE OF FIGURE	PAGE NO.
1.1	Weight Energy Density vs. Volume Energy Density for each technology	5
1.2	Efficiency & Lifetime at 80% DoD for each technology	6
1.3	Discharge Time vs. Power Ratings for each storage technology	6
1.4	Capital Cost for each technology	7
1.5	Cost per cycle for each technology	7
1.6	Power Train Structure of EV	11
1.7	Power & Energy Management System	14
2.1	IET / IEEE publication on Electric Vehicles – Extracted from IEEE Xplore	16
2.2	Power Split between two energy sources	18
2.3	Evolution of the EDLC Technology	21
2.4	Ragone Chart	23
2.5	Battery- Supercapacitor Supplying a Constant Power Load	24
2.6	Battery-Supercapacitor Systems, Passive and Active Configuration	25
2.7	Connection Configuration of Supercapacitor to an EV propulsion system	26
2.8	Battery-Supercapacitor System with a Buck-Boost Converter	27
2.9	Proposed Scheme Diagram	28
2.10	Low Constant Speed Operation Energy Flow	29
2.11	High Constant Speed Operation Energy Flow	30

2.12	Acceleration Mode Phase I Energy Flow	30
2.13	Acceleration Mode Phase II Energy Flow	31
2.14	Regenerative Braking Phase I Energy Flow { $V_{uc} < V_{uc_tgt}$ }	31
2.15	Regenerative Braking Phase I Energy Flow when { $V_{uc} \geq V_{uc_tgt}$ }	32
2.16	Regenerative Braking Phase II Energy Flow	32
3.1	Force Model for a Vehicle	34
3.2	Drive Train of an Electrical Vehicle	38
3.3	Braunschweig City Driving Cycle	42
3.4	FTP – 75 Test Driving Cycle established by EPA	42
3.5	Manhattan Bus Cycle	43
4.1	Operating Principle of a Secondary Type Battery Cell	51
4.2	Battery Basic Equivalent Circuit and Voltage Characteristics	51
4.3	Basic Cell Construction of a Supercapacitor	58
4.4	Classical Equivalent Circuit of a Supercapacitor	60
4.5	Branch Representation of Supercapacitor model	61
4.6	Supercapacitor Model through Impedance Spectroscopy	62
4.7	Battery Model	64
4.8	Optocoupler Circuit	75
5.1	The Brushed Direct Current Setup	77
5.2	Brushed DC Output for SC at 24 Volt	79
5.3	Brushed DC output when SC Voltage is 0 Volt	80
5.4	HSS for Battery Life Enhancement (Schematic)	81

5.5	Output When Battery Voltage is Below 9 Volt	82
5.6	The Speed Result of Motor [Case – 1]	83
5.7	Voltage Reading for SC When Battery is Below 9 Volt	84
5.8	Output When Battery Above 9 Volt	85
5.9	The Charging of SC When Battery Above 9 Volt	86
5.10	Main Simulation Circuit	88
5.11	The Hybrid Storage System + BLDC	90
5.12	Control Circuit for HSS	91
5.13	Dynamic Vehicle Drive System	92
5.14	Scope in Main Simulation Circuit	93
5.15	Scope in the Control Circuit	95
5.16	HSS + BLDC Circuit Scope	96
6.1	Motor charge supply system (HSS) with DST programmer	113
6.2	Flow Chart of Charge Management process by DST Programmer	116
6.3	Standard driving cycle	118
6.4	City suburban cycle	118
6.5	Speed-time curve	122
6.6	Simplified speed time curve	124
6.7	Quadrilateral speed time curve	124
6.8	Top view of BRTS bus	127
6.9	Bus structure- nomenclatures	128
6.10	BRTS route of study	129

6.11	Driving cycles for the BRTS rout path	130
6.12	3-D model of city bus with (chases + body) by AutoCAD	132
6.13	Different views of 3-D model of city bus	133
6.14	Centre of gravity for bus body with chases by AutoCAD	134