1.1 PREAMBLE

In many industrial applications, it is required to convert a fixed-voltage DC source into a variable-voltage DC source. A DC-DC converter converts directly from DC to DC and is simply known as a DC converter. A DC converter can be considered as a DC equivalent of an AC transformer with a continuously variable turns ratio. Like a transformer, it can be used to step down or step up a DC voltage source.

DC converters are widely used for traction motor control in electric automobiles, trolley cars, marine hoists, forklift trucks, and mine haulers. They provide smooth acceleration control, high efficiency, and fast dynamic response. DC converters can be used in regenerative braking of DC motors to return energy back into the supply, and this feature results in energy saving for transportation systems with frequent stops. DC converters are used in DC voltage regulators and are also used in conjunction with an inductor, to generate a DC current source, especially for the current source inverter.

1.2 DC TO DC CONVERTER

All DC to DC switch mode converters are based on one of three basic types of converters, namely, the buck, the boost, and the inverting (or buck-boost) converter. Each of these converters contains in its simplest form,
just four components: a capacitor, an inductor, a diode, and an unidirectional semiconductor switch (Mohammed 2003). The switch must have the capability to be turned on and off (ie, to be closed or opened) at will.

1.2.1 Buck Converter

A buck converter, is formed by connecting the switch to the DC input supply, the inductor to the load (ie, the DC output) and the diode is placed between the two and connected to the ground. The capacitor is connected in parallel across the load so as to maintain a low ripple DC output voltage, as the current is pumped into it from the rest of the converter. This is shown in Figure 1.1

![Figure 1.1 General Circuit Diagram of Buck Converter](image)

For the circuit shown in Figure 1.1, by incorporating suitable control mechanism, the power semiconductor switch is turned on and off. When the switch is turned on, the diode D is in the reverse biased condition and the current flows from the supply to the load. When the switch is turned off the load current continues to flow through the freewheeling diode D and the output voltage would remain more or less constant. In this the voltage across the load (V<sub>a</sub>) will be less than the input voltage (V<sub>s</sub>).
Figure 1.2 Waveform of Voltage across the Diode

Figure 1.2 shows the output voltage waveform of the buck converter without the output filter. Neglecting the voltage drops across devices, the average output voltage is given by the equations

\[ V_a = \frac{1}{T} \int_0^T v_d \, dt = \frac{T_1}{T} V_s = DV_s \quad (1.1) \]

\[ V_a = DV_s \quad (1.2) \]

Equation 1.2 shows that by varying the duty ratio \( D \), the turn on and turn off time of the switch can be varied so that the output voltage can be maintained constant.

1.2.2 Boost Converter

The Boost converter, also known as the step-up converter, is another switching converter that has the same components as the buck converter, but this converter produces an output voltage greater than that of the source. The ideal boost converter has five basic components, namely, a
power semiconductor switch, a diode, an inductor, a capacitor and a PWM controller. The placement of the inductor, the switch and the diode in the boost converter is different from that of the buck converter. The basic circuit of the boost converter is shown in Figure 1.3.

![Figure 1.3 General Circuit Diagram of Boost Converter](image)

The essential control mechanism of the circuit in Figure 1.3 is, turning the power semiconductor switch on and off. When the switch is on, the current through the inductor increases as shown in Figure 1.4 and the energy stored in the inductor builds up. When the switch is off, current through the inductor continues to flow via the diode D, the RC network and back to the source. The inductor is discharging its energy and the polarity of the inductor voltage is such, that its terminal connected to the diode is positive with respect to its other terminal connected to the source. It can be seen then, that the capacitor voltage has to be higher than the source voltage and hence this converter is known as the boost converter. It can be seen that the inductor acts like a pump, receiving energy when the switch is closed and transferring it to the RC network when the switch is open. When the switch is closed, the diode does not conduct and the capacitor sustains the output voltage. As long
as the RC time constant is very much larger than the on-period of the switch, the output voltage would remain more or less constant.

Figure 1.4 Voltage Waveform of Voltage across the Switch and Current Through the Inductor

When the switch is turned on, the voltage across the inductor is

\[ V_s = L \frac{\Delta I}{t_1}, \quad \Delta I = I_2 - I_1 \]  \hspace{1cm} (1.3)

\[ \Delta I = \frac{V}{L} t_1 \]  \hspace{1cm} (1.4)

When the switch is turned off the instantaneous output voltage is

\[ V_s = V_s + L \frac{\Delta I}{t_2} \]  \hspace{1cm} (1.5)

\[ V_s = V_s + \frac{L}{t_2} \frac{V}{L} t_1 \left[ \therefore \Delta I = \frac{V}{L} t_1 \right] \]  \hspace{1cm} (1.6)

\[ V_s = V_s \left[ 1 + \frac{t_1}{t_2} \right] \]  \hspace{1cm} (1.7)
Sub. \( t_1 = DT \), \( t_2 = (1-D) \) T,

\[
v_a = V_i \left[ \frac{1}{1-D} \right]
\]  

(1.8)

Equation 1.8 shows that by varying the duty ratio D the turning of the switch can be varied, so that the output voltage can be maintained constant.

1.3 CONTROLLER DESIGN

Conventional control has provided numerous methods for constructing controllers for dynamic systems. Some of these are listed below:

- Proportional-integral-derivative (PID) control: Over 90% of the controllers in operation today are PID controllers (or at least some form of PID controller like a P or PI Controller). This approach is often viewed as simple, reliable and easy to understand. Often, like fuzzy controllers, heuristics are used to tune PID controllers (e.g., the Zeigler-Nichols tuning rules).
- Classical control: Lead-lag compensation, Bode and Nyquist methods, root-locus design, and so on.
- State-space methods: State feedback, observers, and so on.
- Optimal control: Lead-lag compensation, Bode and Nyquist methods, root-locus design, and so on.
- Robust control: H2 or H-methods, quantitative feedback theory, loop shaping, and so on.
- Nonlinear methods: Feedback linearization, Lyapunov redesign, sliding mode control, back stepping, and so on.
Adaptive control: Model reference adaptive control, self-tuning regulators, nonlinear adaptive control, and so on.

Stochastic control: Minimum variance control, Linear Quadratic Gaussian (LQG) control, stochastic adaptive control, and so on.

Discrete even systems: Petri nets, supervisory control, infinitesimal perturbation analysis, and so on.

1.4 LITERATURE REVIEW

The background information regarding the implementation of PI, fuzzy, neuro-fuzzy and digital controllers for buck and boost converters is explained below.

1.4.1 PI Control

Several researchers have contributed in evolving PI controllers for buck and boost converters. Middlebrook and Cuk (1976) designed a PI-Type controller for switching power converters that are tuned on the basis of a linearised average model. Guanrong Chen and Hao Ying (1993) analyzed the stability of nonlinear fuzzy PI (proportional-integral) control systems. In this investigation, the fuzzy PI controller involved is actually a nonlinear adaptive PI controller whose gains change continuously with the output of the processes under control. They employed the “small gain theorem” to obtain a simple sufficient condition for the global asymptotic stability of nonlinear fuzzy PI control systems. In addition, they proved that in a conventional PI control system, if the linear PI controller is replaced by the nonlinear fuzzy PI controller, then the stability of the resulting control system remains unchanged, in the sense that the resulting control system will be (locally)
asymptotically stable if the original conventional PI control system is (locally) asymptotically stable.

Shahruz (1994) proposed a linear time-invariant single-input single-output (SISO) system that is stabilizable by proportional and integral (PI) compensators. Francesco Parasiliti et al (1996) developed a new on-line self-tuning of PI controller and implemented the controller for a permanent magnet synchronous motor. Hwi-Beom Shin (1998) developed a new antiwindup PI controller to improve the control performance when the windup phenomenon appears and results in performance degradation for the proportional-integral (PI) controller, and when output is saturated. Ya-Gang Wang and Hui-He Shao (1999) proposed auto-tuning of an optimal PI controller and the simulation result shows the effectiveness of the controller. They also suggested that autotuning of optimal PI controllers can be easily adopted by the industry. Ramon Caceres et al (2000) proposed the design of a robust PID controller for a four quadrant DC to AC switched mode inverter, using a buck-boost DC to an AC switched mode inverter, using a buck-boost DC to DC converter. The designed controller is based on a classical two degree of freedom approach. The controller performance was tested by computer simulations.

A novel control configuration was proposed by Jose Alvarez-Ramirez et al (2001) for a stable design of PI control for DC-DC converters with an RHS zero. Birgitta Kristiansson and Bengt Lennartson (2001) proposed cases for PI and PID controllers augmented by a smith predictor structure which are compared to ordinary PI and PID controllers, for plants with medium and great time delays. The comparison was based on a systematic evaluation method, where both robustness and performance aspects in different frequency regions were taken into account. A different non-parametric method, developed by Crowe and Johnson (2001) was the
phase locked loop (PLL) approach. In their work it is shown, how the PLL module can be used to drive an automated PI controller-tuning algorithm to achieve classical performance specifications. The new algorithm yields a PI controller achieving specified maximum sensitivity and phase margin values. The algorithm was one of a family of constructive routines able to automate PI design for a combination of classical performance specification and implemented the algorithm by using matlab/simulink.

Suzana uran and Miro Milanovic (2003) designed an approach with an outer PI controller in addition to the internal state space controller and disturbance observer-based control approach for a buck converter. Jones and Tham (2004) compared the two simple PID design methods, IMC and GPM, that use robustness as their main design criterion, as opposed to performance, and applied to a multi-loop PI control configuration which was being used to control a multivariable process model against load disturbances. Marcelo Perez et al (2004) explored the possibility of direct designing PI controllers using passivity principles for switched power converters.

1.4.2 Fuzzy Control

Fuzzy logic has its roots in the work of renegade mathematicians who saw the value of a multivalent logic system. The credit for fuzzy logic’s application to the areas of control and in engineering, belonged solely to Lotfi Zadeh. Zadeh (1965) formalized the fuzzy set theory and brought it into the context of control systems (Zadeh 1973). According to Lotfi Zadeh, fuzzy logic brings to control systems a “higher machine intelligence quotient”. Siler and Ying (1989) attempted to linearize the same type of fuzzy controller, but in this case described by nine rules, and expressed by five compact rules. For the fuzzy controller to achieve exact linearity, different conjunction and disjunction operators have to be used depending on which rule is fired. Chuen
Chien Lee (1990) explained the general methodology for constructing a fuzzy logic controller and assessing its performance. Ying et al (1990) studied the smallest possible mamdani type fuzzy controller consisting of two inputs, one output, and four fuzzy control rules.

Matia et al (1992) determined how to set up the distribution of the membership functions for a nine rules fuzzy controller to fit a PI controller with known gains. Hoon Kang and George Vachtsevanos (1992) developed two fuzzy control algorithms. The first one is called a fuzzy identification-learning algorithm and the second is a fuzzy control-inferencing algorithm. The fuzzy identification-learning algorithm updates the membership functions on the action side of the rules and the fuzzy control-inferencing algorithm calculates fuzzy control data. This approach guarantees stability, convergence and robustness of the closed-loop feedback system.

An analysis of the nonlinear dynamics of one-dimensional fuzzy controllers was made by Tarn and Kuo (1993). Wong (1993) showed that a fuzzy controller with an arbitrary number of additive rules can be precisely equivalent to a nonlinear controller. A simplified fuzzy reasoning method and mixed fuzzy logics were both considered. Li-Xin Wang (1995) suggested that the fuzzy identifiers can approximate the chaotic system at a reasonable speed and accuracy without using any linguistic information, and by incorporating some fuzzy linguistic IF-THEN rules about the behavior of the system into the fuzzy identifiers, the speed and accuracy of the fuzzy identifiers are greatly improved. Sylvie Galichet and Laurent Foulloy (1995) explained that fuzzy controllers are capable of approximating any real continuous control function on a compact set to arbitrary accuracy. In particular, any given linear control can be achieved with a fuzzy controller for a given accuracy.
Nader Vadiee et al (1996) proposed a flexible structure introduced for fuzzy reasoning paradigms, called a “soft fuzzy reasoning paradigm”, which provides the methodology for the implementation of all the known parameterized fuzzy reasoning paradigms. Ching-Hsue Cheng (1999) constructed a general and easy fuzzy group decision-making method, and illustrated an example of a manufacturing company. Hao Ying et al (1999) found that TS fuzzy systems can be more economical in the number of input fuzzy sets and fuzzy rules than the general mamdani fuzzy systems if nontrapezoidal/ nontriangular input fuzzy sets are used. Their new findings are valuable in designing more compact fuzzy systems, such as fuzzy controllers and models which are two most popular and successful applications of the fuzzy approximators.

Tao and Taur (1998) proposed the nested design approach with a partial fuzzy if-then rule base, to reduce the complexity of the fuzzy controllers. In the design procedure, the fuzzy controllers were first constructed with basic if-then rules. When the performance requirements of the fuzzy control system are not satisfied, the fuzzy controller is adjusted accordingly. Simulations were carried out to show the effectiveness of the fuzzy controllers with nested fuzzy if-then rules.

Rajani and Nikhil (1999) proposed a self-tuning mechanism that was applied to both PI and PID type FLCs for simulation experiments with various types of linear as well as non-linear processes that are generally encountered in process industries. Hao Ying (2002) established the conditions under which the nonlinearity of a general class of mamdani fuzzy controllers can be determined. These fuzzy controllers can use input fuzzy sets of any types, arbitrary fuzzy rules, arbitrary singleton output fuzzy sets, arbitrary inference methods, Zadeh fuzzy logic AND operator, and the centroid defuzzifier. In the present work it has been proved that the fuzzy controllers
using Zadeh AND operator are always nonlinear, regardless of the choice of the other components.

Laurent Foulloy and Sylvie Galichet (2003) were concerned with the use of fuzzy inputs in fuzzy logic controllers. A precise representation of fuzzy logic controllers by means of mappings is used to introduce different ways of dealing with fuzzy inputs. Two types of fuzzy inputs are presented and their potential use in fuzzy control is discussed. The proposed concepts are applied to control a first order process with a PI controller. Kai-Yuan Cai and Lei Zhang (2008) proposed that the fuzzy rule base and the fuzzy reasoning method constituted a control system that may be open loop or closed loop, depending on the underlying reasoning goals/constraints. The fuzzy rule base, the fuzzy reasoning method, and the corresponding reasoning goals/constraints define the three distinct ingredients of fuzzy reasoning. While various existing fuzzy reasoning methods are essentially a static mapping from the universe of single fuzzy premises to the universe of single fuzzy consequences, the new fuzzy reasoning method maps sequences of fuzzy premises to sequences of fuzzy consequences, and is a function of the underlying reasoning goals/constraints. The Monte Carlo simulation shows that the new fuzzy reasoning method is much more robust than the optimal fuzzy reasoning method.

Bor-Ren Lin and Chihchiang Hua (1993) made a fuzzy controller for the buck/boost d.c to d.c converter and simulated the result. The simulation results showed that the performance of the fuzzy control in the buck/boost converter was somewhat better than that of the controls based on the state space and sliding mode method. Fang Hsien Wang and Lee (1995) designed a fuzzy controller for a basic DC/DC converter and then compared the computer simulation results with those of the current mode control in buck, boost and buck boost converters, with respect to the start-up transient
response and load regulations. Raviraj and Sen (1997) presented a comparative evaluation of the proportional-integral, sliding mode and fuzzy logic controllers for application to power converters. They also demonstrated certain similarities of both the fuzzy logic controllers to apply voltage and load disturbances, which were studied.

Paolo Mattavelli et al (1997) developed a general – purpose fuzzy controller for DC-DC converters. Based on a qualitative description of the system to be controlled, fuzzy controllers are capable of good performances, even for those systems where linear control techniques fail and the same concept is also explained by Rahim et al (1997). Smyej and Cheriti (1999) described in detail, a power converter control using fuzzy logic. The converter consisted of the buck topology. The advantage of this approach was its simplicity, as no linearized models of the power converter were required. The buck topology was tested and its output voltage was regulated using fuzzy logic. Simulation was held in the matlab/simulink environment and an EPROM-based-digital-circuit was used for experiments.

Seigo Sasaki and Tadashi Inoue (2000) explained a nonlinear state feedback controller which was systematically derived to achieve an output voltage control of the input voltage and resistance load and simulated the result by matlab/simulink. Viswanathan et al (2002) developed a universal fuzzy controller for a nonlinear power electric converter, and it had more advantages over conventional linear PI controllers for such a converter. The modern fuzzy controllers can be adapted to varying operating conditions for applications in such nonlinear systems. Wang and Li (2005) presented the robust asymptotic stabilization of a class of nonlinear uncertain singularly perturbed systems, by using nonlinear PI control techniques for the fuzzy control of DC-DC switching converters for their stability and robustness analysis.
1.4.3 Neuro- Fuzzy Control

Recently, a combination of neural networks and fuzzy logic has received attention. The idea is to lose the disadvantages of the two and gain the advantages of both. Neural networks bring into this union the ability to learn. Fuzzy logic brings into this union a model of the system based on membership functions and a rule base. Guez et al (1988) proposed an architecture for a neural network control that can serve as an adaptive control system. Nauck et al (1993) proposed the fusion of neural networks and fuzzy systems. Jyh – Shing Roger Jang, and Chuen – Tsai Sun (1995) introduced the design methods for an Adaptive – Network –based Fuzzy Inference systems (ANFIS) in both modeling and control applications. The transformation of an expert’s knowledge to control rules in a fuzzy logic controller has not been formalized, and arbitrary choices for example, concerning the shape of membership functions, have to be made. The quality of a fuzzy controller can be drastically affected by the choice of membership functions. Thus, methods for tuning fuzzy logic controllers are needed and the same was also explained by Culliere et al (1995) and Hollatz (1995).

Jana et al (1996) developed a generalised network based fuzzy inference system by combining the good features from neural networks and fuzzy inferencing systems, and this was applied to the problem of controlling a higher order nonlinear dynamic system. Arafah (1996) suggested that the concept of fuzzy logic has been incorporated into the neural network so as to enable a system to deal with cognitive uncertainties in a manner more like humans. This integration yields the neuro-fuzzy system, that captures the benefits of fuzzy logic as well as the neural network tools into a single approach. Lin (1997) analysed the neural and fuzzy for power electronics control for reducing the voltage drop and Total harmonics distortion. Gurpreet and Kuldip (1997) designed an architecture where the learning algorithms
were presented for a general neuro-fuzzy controller. From this general neuro-fuzzy controller, a scheme for a proportional neuro-fuzzy controller was derived.

A neuro-fuzzy method to learn fuzzy classification rules from data was suggested by Nauck (1997). Kuldip and Gurpreet (1999) suggested that neural networks and fuzzy logic are combined to solve the problem of tuning fuzzy logic controllers. The neuro-fuzzy controller used the neural network learning techniques to tune the membership functions while keeping intact the semantics for the fuzzy logic controller. Both the architecture and the learning algorithm were presented for a general neuro fuzzy controller. From this, procedures to design proportional and proportional plus derivative neuro fuzzy controllers were obtained. Ajoy Kumar Palit and Robert Babuska (2001) described an algorithm that can be used to train the Takagi-Sugeno (TS) type neuro-fuzzy network very efficiently. The above-training algorithm was tested on neuro-fuzzy modeling and prediction applications of time series and nonlinear plants and the same things were also explained by Jonas et al (2000).

Cleber Zanchettin et al (2005) performed a statistical analysis to verify the interactions and interrelations between parameters in the design of Neuro-Fuzzy systems. De Carvalho et al (2005) analysed the learning models by using the arithmetic operations applied in a Neuro-Fuzzy System (NFS). The research integrated the concepts between an Artificial Neural Network (ANN) and the Fuzzy Sets Theory (FST).

1.4.4 Digital Control

The digital control method emerges as a better solution than the analog one, as the cost of a digital circuit is very low. Digital control in power
electronics, is treated now as a hot topic area. Harold Klee and Joe Dumas (1994) explained the basic design of digital control and verified the results using simulation. Watanabe et al (1995) implemented and tested the Buck and boost DC-DC converter using nMOSFETs. Dancy and Chandrakasan (1997) designed an ultra low power control circuit for PWM converters. Boudreaux et al (1997) designed and simulated the DC-DC converter controlled by an 8-bit micro controller. Tarun Gupta (1997) implemented a fuzzy controller for DC-DC converters using an inexpensive 8-bit micro-controller and it regulated the output voltage of buck and boost converters to a desired value without steady-state oscillations, despite a change in load or input voltage.

Milan and Yungtaek Jang (1999) designed an active snubber for the boost converter to improve its performance by reducing the reverse-recovery-related losses in the boost converter with a minimum number of components. Aleksandar Prodic et al (2001) explained the complete design and implementation of a digital PWM controller for a buck converter operating at a switching frequency of 1 MHz. Lam et al (2001) presented the fuzzy control of a PWM (pulse width modulation) boost DC-DC switching converter based on the Takagi-Sugeno (TS) fuzzy modeling approach.

So et al (1995) implemented a digital controller using a fixed point signal processor and also presented the experimental results which demonstrated the capability of the fuzzy controller in regulating high speed switching converters. Patella et al (2003) designed a high frequency digital PWM controlled IC for the DC to DC converter. Vidal-Idiarte et al (2004) implemented the Fuzzy control mechanism by PI Controller using an 8-bit microcontroller for the boost converter. Kanakasabai Viswanathan et al (2004) had shown that the rule table of most of the two-input FLCs used with power converters can be approximated into a single non-linearity. This
allowed the controller to be easily realized, using simple, fast and inexpensive analog circuits. Peter Ljusev and Michael (2004) described the simple implementation of a PID control algorithm for a boost converter, using a fixed point 8-bit microcontroller for the boost converter with a PC interface data acquisition.


Li Peng et al (2007) developed the double pulse width-modulation techniques which overcome the problem with microprocessor-based high-frequency (PWM) converters, this had the modulating resolution limitation caused by limited-time resolution of hardware timers. Philip (2007) explained the three generations of digital control; First-generation digital control: Digital processing outside a control loop, in a management or supervisory role. Second-generation digital control: digital processing inside a control loop. The ultimate formulation included digital loop designs and real-time control processes. Third-generation digital control: digital processing
was responsible for the moment-by-moment direct action of active switching devices in a converter. The ultimate formulation was a digital switch with built-in computational capability that functions in real time as the device operates. He also explained that the third generation control methods optimize the losses and take advantage of non linear control methods for power converters.

Jerry and James (2007) made a survey of digital signal processing. Jianhua Geng (2007) presented the sliding mode control theory and its application on the buck converter, and also brought forward a novel method of designing the sliding mode controller. The new method considered the system and designed the controller in three-dimensional space. This method considered the informations of all elements in the buck circuit adequately. Mariko Shirazi et al (2008) demonstrated the feasibility of incorporating the fully automated frequency response measurement capabilities in digital PWM controllers at a relatively low additional cost.

1.5 OVERVIEW OF LITERATURE SURVEY

In the review of literature it was found that most of the research works have been in PI and fuzzy areas. In this work also, PI and fuzzy controllers were simulated and a neuro - fuzzy controller was designed for a buck and boost converters, which was simulated using MATLAB 7.1 for input voltage and load disturbances for reducing the overshoot and settling time at the instant of parameter variations. In the review of literature it is also found that most of the prototyping of the buck and boost converters was analog and microcontroller. The overshoot and the settling time at the moment of load and input voltage variations will be very high. In the present research, the prototyping models for the buck and boost converters were designed with a controller implemented using the DSP, FPGA, and PI
algorithm for producing very low overshoot and quick settling time at the moment of load and input voltage variations.

1.6 TRENDS IN DIGITAL CONTROLLERS

Technology opportunities in the field of digital electronics underwent a significant evolution over the last few years, consequently creating many innovative openings for the implementation of more and more complex control systems for industrial applications.

The advent of microprocessors made the vector control increasingly acceptable from the 1980s followed by DSP based solutions for the implementation of digital control laws. However, hardware solutions such as Field Programmable Gate Arrays (FPGAs) have recently received special attention, mainly because of their ability to allow designers to build efficient dedicated hardware architectures by means of flexible software. Therefore, FPGAs can now be considered as an appropriate solution to boost the performances of controllers, by enabling the implementation of new control methods and/or designing concurrent architectures.

The fast progress of very large scale integration technology and Electronic Design Automation (EDA) techniques in recent years have created the opportunity for the development of complex and compact high-performance controllers for industrial systems. Nowadays, the design engineer uses modern EDA tools to create, simulate and verify a design and without committing to hardware, can quickly evaluate complex systems and ideas with very high confidence in the “right first time” correct operation of the final product. The advances in Computer Aided Design (CAD) methodologies/languages have brought the functional description of design and hardware implementation closer to each other.
The IEEE Industrial Electronics Society (IES) has encouraged and approved the formation of a new Technical Committee on Electronic Systems on Chip in March 2005. This committee aims to promote professional activities in the area of low-power electronics used in the modern industry with an important focus on the design, development, simulation, verification, and testing of electronic circuits integrated as Systems on Programmable Chips (SoPCs), targeting field programmable gate arrays/ Application-Specific Integrated Circuits (ASICs) or implementation and including the use of Hardware Description Languages (HDLs) or high-level programming language hardware compilers.

The formation of the new technical committee is justified in the context of technological developments and their applications in industry. In the last few years, it became obvious that the number of papers presented at conferences and targeted for journal publication reflected a significant increase in the interest paid to the use of FPGAs in a wide range of electronic systems, due to their obvious advantages of flexibility of design/implementation approach, reprogrammability, parallelism, speed of signal propagation, reliability, customized in-house design/development/implementation and hardware platform reuse.

1.7 OBJECTIVES OF THE THESIS

- To develop a PI and fuzzy controller for buck and boost converters and analyse the result for input voltage and load variations.

- To develop a neuro-fuzzy controller for buck and boost converters to maintain constant output voltage and analyse the result with respect to input voltage and load variations. To
compare and analyse the results using PI, fuzzy, neuro – fuzzy controllers by simulation with respect to overshoot and settling time at the instant of input voltage and load variations.

- To develop a controller for buck and boost converters using DSP and analyse the result for input voltage and load variations.
- To develop a controller for buck and boost converters using FPGA and analyse the result for input voltage and load variations, and also to compare and analyse the experimental results using the controller implemented by using DSP and FPGA with respect to overshoot and settling time at the instant of input voltage and load variations.

1.8 THESIS ORGANISATION

The full thesis work has been organized in eight chapters.

Chapter one discusses the general introduction of the buck and boost converter and the literature works carried out in this area are highlighted. It concludes with a statement of the main objectives and outline of the thesis.

In the second chapter the mathematical model is derived both for the buck and the boost converters using state space average techniques.

The third chapter describes the PI controller and its implementation for the buck and boost converters. It also explains the simulation of the PI controller for buck and boost converters using MATLAB 7.1 for input voltage and load variations, and gives an analysis of the results.
The fourth chapter begins with the design of the fuzzy controller and its implementation for the buck and boost converters. It also describes the simulation of the fuzzy controller for buck and boost converters using MATLAB 7.1 for input voltage and load variations. The results of this implementation are compared with those of the PI controller.

The fifth chapter explains about the neuro-fuzzy controller and the implementation for the buck and boost converters. It also describes the simulation of the neuro-fuzzy controller for buck and boost Converters using MATLAB 7.1 for input voltage and load variations. The results of this implementation are compared with those of the PI and fuzzy with respect to overshoot and settling time at the instant of load and input voltage variations.

The sixth chapter discusses the TMS320LF2407A DSP and the prototyping of the buck and boost converters with a controller implemented by using DSP to maintain constant output voltage irrespective of input voltage and load variations. It also discusses the experimental results obtained with respect to overshoot and settling time.

The seventh chapter explains about the FPGA and the prototyping of the buck and boost converter with a controller implemented by using FPGA to maintain constant output voltage irrespective of input voltage and load variations. It also discusses the experimental results obtained with respect to the DSP controller both for overshoot and settling time.

The eighth chapter gives the conclusions from this research work and also provides a scenario for future works in this area.