PREFACE

Wind energy has been shown to be one of the most viable sources of renewable energy. With current technology, the low cost wind energy is competitive with more conventional sources of energy such as coal. Small wind turbine technology has seen a moderate advancement and a lot of improvement scope is available in this area. There is a strong interest in using these smaller turbines in domestic applications and in remote areas. One of the main cost challenges associated with making of small wind turbines feasible lies with the blades.

The present work is focused on design and development of small size wind turbine blades using NACA profiles. Two blade models namely R21 and R22 are developed by using NACA 63415 and their aerodynamic analysis is done using ANSYS CFD software. Finite element analysis is conducted by changing their material compositions in both static and dynamic conditions. UV hard foam is used to improve the stiffness of the blades, glass fibers reinforced with either polyester / epoxy resins. Totally six different blade models are developed and analysis is carried out.

Experimental investigations are done by conducting load deflection test, cyclic load bench test. Finally power performance test is conducted and corresponding power curves are developed. Based on
the results obtained from the above experiments a better performing blade model is recommended. The thesis is organized with 8 chapters where the chapter-1 describes the basics of wind energy, role of wind turbines in power extraction and small wind turbine technical basics.

Chapter-2 reviews the literature related to the basic theories, wind turbine blade analysis, simulation, experiments and development of power curves for various wind turbine systems.

Chapter-3 describes about the airfoil theory wind turbine blade profile development using NACA profiles and CFD analysis of wind turbine blade model.

Chapter-4 deals with finite element analysis of Small Wind Turbine blade models by performing static analysis. Modal and harmonic analysis are performed to extract vibrational characteristics of Small Wind Turbine blades.

Chapter-5 deals with the fabrication of the small wind turbine blades, materials and preparation of blades for assembly by weight balancing and rotor balancing.

Chapter-6 discusses about the experimentation on wind turbine blades by load deflection test and cyclic load bench test.
Chapter-7 discusses about the turbine assembly, generator specifications, site details, power performance test and development of power curves.

Results are drawn at the end of each chapter. Finally conclusions are drawn from the investigations carried out from aerodynamic analysis, finite element analysis and experimental results from load deflection test, cyclic load bench test and power performance test and are furnished in chapter-8.