CONTENTS

	Page No.
Certificate	i
Acknowledgement	ii
Abstract	iii
Contents	vii
List of Figures	ix
List of Tables	xiii
Nomenclature	xiv
Abbreviations	xvii
Chapter 1: Introduction	1
1.1 Supersonic Aircraft	3
1.2 Flow Behaviour at Supersonic Speeds	6
1.3 Shock Expansion theory	12
1.4 Shock Interactions and Reflections	22
1.5 Shock wave-boundary layer interactions	24
1.6 Wave Elimination: Biplane concept	31
1.7 Wave Cancellation effect	33
1.8 Start/Un-start condition of Busemann biplane	34
1.9 Supersonic Airfoil Development	35
Organization of the Thesis	37
Chapter 2: Literature Review	38
Chapter 3: Motivation and Objective	51
3.1 Motivation	51
3.2 Objectives of the research	52
Chapter 4: Methodology	54

4.1 Introduction to CFD 54
4.2 Governing equations 57
4.3 Navier-Stokes Equation: Vector-variable form 60
4.4 Turbulence and transitional models 61
4.4.1 Turbulence Equations 62
4.4.2 Reynolds Averaging 63
4.4.3 Favre (Mass) – Average 65
4.4.4 Favre and Reynolds Averaged Navier-Stokes Equations 65
4.5 Turbulent Modelling 67
4.6 Geometric Modelling and Grid Generation 69
4.6.1 Geometric Modelling 69
4.6.2 Grid Generation 69
4.7 Discretization 76
4.7.1 Temporal Discretization 76
4.7.2 Spatial Discretization 78
4.8 Initial and boundary condition 82
4.8.1 Wall Boundary Condition 83
4.8.2 Far-field Boundary Condition 83
4.9 Grid independent Study 84
4.10 Flow Solver Validation 85
4.10.1 Original Diamond and Busemann type biplane 85
Chapter 5: Results and Discussion 93
5.1 Busemann biplane with Stagger Configuration at $\alpha = 0°$ 93
5.2 Effect of stagger at non-zero angles of attack 103
5.3 Effect of Leading and Trailing Edge radii on Busemann biplane 117
5.4 Effect of Leading and Trailing Edge radii on Stagger biplane 125
Chapter 6: Conclusion and Future Work 131
References 135
Appendix – A : Pressure Contours 143
Appendix – B : Research Publications 167