

# TABLE OF CONTENTS

LIST OF TABLES.....	x
LIST OF FIGURES.....	xi
CHAPTER 1: INTRODUCTION.....	1
1.1    Background of Study.....	1
1.2    Problem Statement.....	1
1.3    Significant of Project.....	2
1.4    Objectives.....	2
1.5    Scope of the Project.....	3
1.6    Feasibility of Project.....	3
CHAPTER 2: LITERATURE REVIEW.....	4
2.1    Drag Force.....	4
2.2    Drag Coefficient.....	6
2.3    Lift Force.....	7
2.4    Lift Coefficient.....	8
2.4    Dimensional Similarity.....	9
2.5    Meshing.....	10

CHAPTER 3: METHODOLOGY.....	11
3.1 Literature Review.....	12
3.2 Analysis Wind tunnel Experiment.....	12
3.3 Computer Fluid Dynamic Simulation (CFD).....	12
3.4 Calculation for Drag and Lift Force.....	13
3.5 Comparing CFD Result with Wind Tunnel Result....	13
CHAPTER 4: RESULT AND DISCUSSION.....	14
4.1 Position of Car.....	14
4.2 Boundary Condition.....	15
4.3 Meshing Process.....	15
4.4 Postprocessing.....	17
4.5 Convergence History.....	18
4.6 Single Model.....	20
4.7 Two Models.....	24
4.7.1 Half Width Distance (6.25 cm).....	25
4.7.2 One Width Distance (12.5 cm).....	28
4.7.3 One and Half Width Distance (18.75 cm).....	31
4.7.4 Two Width Distance (25 cm).....	34
4.8 Comparison between CFD Results with Experimental.....	37
4.8.1 Single Model.....	37
4.8.2 Half Width Distance (6.25cm).....	38
4.8.3 One Width Distance (12.5 cm).....	39

4.8.4	One Half Width Distance (18.75 cm).....	40
4.8.5	Two Width Distance (25 cm).....	41
CHAPTER 5: CONCLUSION AND RECOMMENDATION.....		44
5.1	Conclusion.....	44
5.2	Recommendation.....	45
REFERENCES.....		46
APPENDICES.....		47
APPENDIX A: Wind Tunnel.....		48

## LIST OF TABLES

TABLE 4.1: Single Model.....	21
TABLE 4.2: Half Width Distance (6.25 cm).....	25
TABLE 4.3: One Width Distance (12.5 cm).....	28
TABLE 4.4: One and Half Width Distance (18.75 cm).....	31
TABLE 4.5: Two Width Distance (25 cm).....	34

## LIST OF FIGURES

FIGURE 2.1: Flow of the Drag Force.....	5
FIGURE 2.2: Drag Force on Flat Plat.....	5
FIGURE 2.3: Typical Graph of Drag Coefficient vs Reynolds Number.....	6
FIGURE 2.4: Lift Force.....	8
FIGURE 2.5: Typical Portion of Volume Mesh.....	10
FIGURE 2.6: Typical Surface Mesh on Rear of Car Body.....	10
FIGURE 3.1: Flow Chart of the Project.....	11
FIGURE 3.2: CFD Procedure.....	13
FIGURE 4.1: Front View of Wind Tunnel.....	14
FIGURE 4.2: Top View of Wind Tunnel.....	14
FIGURE 4.3: Boundary types.....	15
FIGURE 4.4: Meshing Process for Single Model.....	15
FIGURE 4.5: Meshing Process for Double Model (12.5 cm).....	16
FIGURE 4.6: Meshing on Body of the Car.....	16
FIGURE 4.7: Velocity Vector in Wind Tunnel.....	17
FIGURE 4.8: Velocity Vector in m/s for Single Model.....	17
FIGURE 4.9: Path Line.....	18
FIGURE 4.10: Residual for 10 iterations.....	18
FIGURE 4.11: Convergence History of Drag Force.....	19
FIGURE 4.12: Drag Force versus Velocity.....	22
FIGURE 4.13: Drag Coefficient versus Reynolds number.....	22
FIGURE 4.14: Lift Force versus Velocity.....	23
FIGURE 4.15: Lift Coefficient versus Reynolds number.....	23

FIGURE 4.16: Position of Two Cars.....	24
FIGURE 4.17: Drag Force versus Velocity (0.5 W).....	26
FIGURE 4.18: Drag Coefficient versus Reynolds number (0.5 W).....	26
FIGURE 4.19: Lift Force versus Velocity (0.5 W).....	27
FIGURE 4.20: Lift Coefficient versus Reynolds number (0.5 W).....	27
FIGURE 4.21: Drag Force versus Velocity (1 W).....	29
FIGURE 4.22: Drag Coefficient versus Reynolds number (1 W).....	29
FIGURE 4.23: Lift Force versus Velocity (1 W).....	30
FIGURE 4.24: Lift Coefficient versus Reynolds number (1 W).....	30
FIGURE 4.25: Drag Force versus Velocity (1.5 W).....	32
FIGURE 4.26: Drag Coefficient versus Reynolds number (1.5 W).....	32
FIGURE 4.27: Lift Force versus Velocity (1.5 W).....	33
FIGURE 4.28: Lift Coefficient versus Reynolds number (1.5 W).....	33
FIGURE 4.29: Drag Force versus Velocity (2W).....	35
FIGURE 4.30: Drag Coefficient versus Reynolds number (2 W).....	35
FIGURE 4.31: Lift Force versus Velocity (2W).....	36
FIGURE 4.32: Lift Coefficient versus Reynolds number (2 W).....	36
FIGURE 4.33: Comparison Drag coefficient versus Reynolds Number for single model.....	37
FIGURE 4.34: Comparison Drag force versus Reynolds Number for single model.....	37
FIGURE 4.35: Comparison Drag coefficient versus Reynolds number (0.5W).....	38

FIGURE 4.36: Comparison Drag force versus Reynolds	
Number (0.5W).....	38
FIGURE 4.37: Comparison Drag coefficient versus	
Reynolds number (1W).....	39
FIGURE 4.38: Comparison Drag force versus	
Reynolds number (1W).....	39
FIGURE 4.39: Comparison Drag coefficients versus	
Reynolds number (1.5W).....	40
FIGURE 4.40: Comparison Drag force versus	
Reynolds number (1.5W).....	40
FIGURE 4.41: Comparison Drag coefficient versus	
Reynolds number (2W).....	41
FIGURE 4.42: Comparison Drag force versus	
Reynolds number (2W).....	41
FIGURE 4.43: Drag Force versus Velocity for all cases.....	42
FIGURE 4.44: Drag coefficient versus Reynolds number	
for all cases.....	42
FIGURE A1: Real Wind Tunnel.....	48
FIGURE A2: CFD model.....	48