DESIGN AND ANALYSIS OF THE DRIVETRAIN SYSTEM FOR FORMULA SAE RACE CAR

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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This dissertation is submitted as partial fulfillment of the requirement for the degree of Bachelor of Mechanical Engineering (Automotive)

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APPROVAL OF SUPERVISOR

"I hereby declared that I have read through this report and I found that it has comply the partial fulfilment for awarding the degree in Bachelor of Mechanical Engineering (Automotive)"

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Dedication

This book is especially dedicated to my loving parents, my supervisor, all respective UTeM staffs and friends for their undivided help and guidance in enabling me to gain experience and knowledge in making my final year project a success.

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ABSTRACT

The drivetrain system is a part in powertrain system that associate together to describe the way the power transmitted from engine to wheel. This project aims is to design and develop the drivetrain system for formula SAE race car and the design that used for the car must fulfill the standard regulation that made by SAE for Formula SAE competition. A research has been conducted with several different types of drivetrain system and components to gain knowledge and understanding required to select an appropriate system for the race car. Then, the different designs of drivetrain system were analyzed for comparison. A design that been choose to be developed for the drivetrain and the detail analysis of the design is conducted. The analysis for the drivetrain is more on determining the final gearing that affects the performance parameter such as torque, acceleration and top speed. Besides that, the load of the axle also been determine to get the maximum torque applied using three different approached that are engine performance, tire friction, and predicted acceleration and cornering force acting on the race car.

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ABSTRAK

Sistem Penghantar adalah sebahagian daripada Sistem Kuasa Kenderaan yang saling berkaitan untuk menggambarkan bagaimana kuasa dapat disalurkan melalui enjin hingga ke roda. Matlamat utama projek adalah untuk mereka bentuk serta membangunkan Sistem Penghantar untuk kereta lumba Formula SAE. Reka bentuk yang akan digunakan mestilah memenuhi peraturan piawaian yang telah ditetapkan oleh SAE untuk pertandingan Formula SAE. Satu kajian telah dijalankan dengan memilih beberapa jenis Sistem Penghantar berserta komponen-komponennya untuk menambah pengetahuan serta memahami keperluan bagi memilih system yang sesuai untuk kereta lumba. Seterusnya, reka bentuk yang berbeza bagi Sistem Penghantar akan dianalisis untuk dijadikan pembandingan. Reka bentuk yang telah dipilih bagi Sistem Penghantar akan dibangunkan dan analisis secara terperinci terhadap reka bentuk itu dijalankan. Analisis terhadap Sistem Penghantar lebih kepada mengenal pasti akhiran gear yang mempengaruhi prestasi kenderaan seperti daya kilas, pecutan dan kelajuan maksimum bagi kenderaaan. Selain daripada itu, bebanan pada gandar juga diambil kira untuk mendapatkan daya kilas maksimum dengan menggunakan tiga pendekatan berbeza iaitu prestasi engine, geseran tayar, dan ramalan pecutan serta daya membelok yang bertindak pada kereta lumba.

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LIST OF SYMBOL

V	=	Velocity, m/s^2
V_f	=	Final Velocity, m/s^2
V_i	=	Initial Velocity, m/s^2
r	=	Radius, m
r_R	=	Radius at Rear, m
r_C	=	Radius of Car Wheel, m
ω	=	Angular Velocity, rad/s
ω_R	=	Angular Velocity at Rear, rad/s
ω_F	=	Angular Velocity at Front, rad/s
ω_C	=	Angular Velocity of a Car, rad/s
T	=	Torque, Nm
F	=	Force, N
F_N	=	Normal Force on Tire, N
F_R	=	Frictional Force, N
m	=	Mass, kg
g	=	Gravitational Acceleration, m/s^2
μ_k	=	Coefficient of Friction

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N	=	Normal Force, N
N_3	=	Normal Force on Outside Rear Tire, N
N_4	=	Normal Force on Inside Rear Tire, N
a	=	Acceleration, m/s^2
t	=	Time, s
M	=	Moment, Nm
2t	=	Rear Wheel Track, m
h_C	=	Height of Center Gravity, m

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CHAPTER 1

INTRODUCTION

1.1 Background

Formula SAE is a student design competition that been organized by the SAE International. This competition was started back in 1978 and was originally called as SAE Mini Indy.

The concept behind this competition is that a frictional manufacturing company has contact a student design team to develop a small Formula-style race car which can be a production item for the non-professional weekend autocross racer. Each student team design will builds and test the prototype of the car based on the rules that purpose to ensure onsite operations and promote clever problem solving.

This competition also promotes careers and excellence in engineering field especially in automotive as it encompasses all aspect of the automotive industry including research, design, manufacturing, testing, developing, marketing, management and finances.

In order to enter the Formula SAE competition, a race car must be developed. There are several vehicle requirements need for race car such as chassis, suspension and powertrain system. This study will focus on the drivetrain development for the car.

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The drivetrain is one of the components in the powertrain system which explains the mechanism of power transmitted from the engine to the rear wheel. The drivetrain includes a gearbox, a power transmission or transfer system such as drive shaft, differential, axles, CV joints, wheels, tires and braking system. There are many of different form of drivetrain that using different component in several of combinations. Thus, it is necessary to analysis the suitable drivetrain layout that suitable for the race car

1.2 Problem Statement

The previous study on the powertrain system only comes out with the design concept without having detail analysis on the system. Thus, to get the detail analysis for the powertrain system a study has been conducted.

This study is conducted to design analysis the powertrain system of Formula SAE race car and it mainly focusing on the drivetrain system. The drivetrain functioning as transmits power from the engine to the drive wheels and also varies the amount of torque.

The drivetrain design must fulfill the standard regulation that made by SAE for the Formula SAE competition. Thus, an analysis of several type of drivetrain has been conducted to select the appropriate design for the car.

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1.3 Objective

a) Develop a design and analysis of the drivetrain system layout for Formula SAE race car that fulfill the standard and regulation rule that made by SAE.

1.4 Scope

There are several of scopes that will be fulfilling in this project such as

i. To study on powertrain system which is mainly focusing on drivetrain system that used in Formula SAE and also fulfill the standard regulation that made by SAE for the Formula SAE competition.

ii. Design and analysis of several drivetrain systems before choosing it as a final design layout.

1.5 Benefit of Study

This study is important due to develop a suitable drivetrain layout for the Formula SAE race car. The analysis of the drivetrain system is important to give maximum performance of the race car and reducing the possibilities of the drivetrain components to be failure during the competition. Based on the analysis made, the simples design layout will be choose and the entire drivetrain component will be a readily available in the market to make sure if anything happen to the drivetrain component there is a new replacement for it.

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1.6 Overall Summary

In chapter one, this study detailing about the overview of the project which is the objective and the scope of study that might be involved in the project development process are started well as project guideline and goal. In this chapter also has been defined clearly about some of the problem statement that occurred in constructing this project.

In chapter two there are literature studies of the project. In this chapter, the appropriate data and information is gain from all the sources including from the internet website surfing, from journal, textbook, and so on. This chapter provides some knowledge to understand the drivetrain system.

In chapter three is the explanations of the project methodology. This chapter will explain the method that been used to complete the study.

Chapter four is about the analysis that made for the drivetrain development. This chapter includes the calculation and explanation of analysis made such as final gearing, engine performance, tire friction and engine performance during accelerating and cornering.

Chapter five is the summary or conclusion for what have been done in this project. In this chapter also will include the suggestion and further work to improve the project in the future.

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