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ABSTRACT

Design and fabricating the rear wheel drive differential simulation rig is a conceptual understanding of automotive engineering which is not provided in daily lectures room due to the fact that it is advance knowledge in this field. The project gives awareness of what is going on inside a differential by showing it to people using a rig As such, it is vital to attain this basic knowledge through this project. The purpose of this project is to design, fabricate a rear wheel drive differential simulation rig. The design is purely new and the idea is generated by other types of simulation rig. Material that is strong and could withstand the weight and the vibration of moving parts of the rig. Tests have been done to ensure the rig has meet the objective stated. The progress of this project needs documenting, as it can be a good reference for the next student who involve in this project as well as for a research related to the differential simulation rig. This report describes the project development of the first prototype of UMP rear wheel drive differential simulation rig.

ABSTRAK

Tujuan utama projek ini adalah untuk merekabentuk dan membina sebuah rig pameran differential pacuan roda belakang. Konsep projek ini adalah amat sukar difahami, dan jarang diberi perhatian ketika dalam kuliah maka projek ini member ilmu yang lebih mendalam tentang projek ini. Idea-idea yang dipraktikkan dalam projek ini adalah baru dan adalah hasil kerja saya dan supervisor projek ini. Bahan-bahan yang digunakan adalah bahan yang tahan lasak dan mampu menampung berat seluruh sistem yang menggerakkan differential tersebut. Projek ini memerlukan dokumentasi yang baik kerana ia boleh menjadi panduan kepada pelajar-pelajar selepas ini dan juga kajian berkaitan dengan tajuk ini. Laporan ini menunjukkan projek pertama UMP berkaitan dengan ‘Rear Wheel Drive Differential Simulation Rig’

TABLE OF CONTENTS

	Page
SUPERVISOR'S DECLARATION	**ii**
STUDENT'S DECLARATION	**iii**
DEDICATION	**iv**
ACKNOWLEDGEMENTS	**v**
ABSTRACT	**vi**
ABSTRAK	**vii**
TABLE OF CONTENTS	**viii-xi**
LIST OF TABLES	**xii**
LIST OF FIGURES	**xiii-xiv**
LIST OF SYMBOLS	**xv**
LIST OF APPENDICES	**xiv**

Chapter **Page**

CHAPTER 1 INTRODUCTION

1.1 Project Synopsis 1
1.1.1 Specific Project Synopsis 2
1.2 Objective of Final Year Project 2
1.3 Scope of work 2
1.4 Project Planning 3
1.5 Flow Chart Description 4
1.5.1 Process Flowchart 5
1.6 Gantt Chart 6

CHAPTER 2 REVIEW OF RELEVANT LITERATURE

2.1 Differential Definition 7-8
2.1.1 Types of Differential 8
2.1.1.1 Open Differential 8
2.1.1.2 Limited Slip Differential 9
2.1.1.3 Locking Differential 9
2.1.1.4 Epicyclic Differential 9
2.1.1.5 Differential Operation 12
2.1.1.6 Differential Operation Simplified 13-14

2.2 Electric Motor 14
2.2.1 Introduction 14
2.2.2 Alternating Current(AC) Motors 14-15
2.2.2.1 Three Phase AC Motor 15-16
2.3 Welding 16
2.3.1 Arc Welding 16
2.3.2 MIG Welding 16-17

CHAPTER 3 METHODOLOGY

3.1	Project Methodology	18
	3.1.1 Stage One: Study	19
	3.1.2 Stage Two: Designing	19
	3.1.3 Stage Three: Purchasing	19
	3.1.4 Stage Four: Material Selection	20
	3.1.5 Stage Five: Fabrication and Modification	20
	3.1.6 Stage Six: Assembly	20
3.2	Introduction to Fabrication Work	21
3.3	Steps by Step Fabrication Process	21
	3.3.1 Differential rig	22
	3.3.2 Differential	23
	3.3.3 Motor Wiring	26
	3.3.4 Coupling, Shafts and Universal Joints	27
	3.3.5 Assembly	28
	3.3.6 Testing	29

CHAPTER 4 RESULT AND DISCUSSION

4.1	RPM of 3 Phase Motor	33
4.2	Differential Rig Design Calculations	33
4.3	Differential Rig Factor of Safety	35
4.4	Results	36
	4.4.1 Power Flow	37
4.5	Design Specifications	38
4.6	Discussions	39
	4.6.1 Defects	39
4.7	Problems during Progress	39
	4.7.1 Designing Problems	39
	4.7.2 Fabrication Problems	40

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

5.1 Introduction 41
5.2 Conclusion 41
5.3 Recommendations 42

REFERENCES 43

LIST OF TABLE

Table No.		Page
4.0	Design Specification	38

LIST OF FIGURES

Figure No.		Page
1.0	Flow Chart	5
1.1	Gantt Chart	6
2.0	Differential (cut model)	8
2.1	Open Differential	10
2.2	Epicyclic Differential	10
2.3	Limited Slip Differential	11
2.4	Locking Differential	11
2.5	Straight Line Explanation	13
2.6	Turning Explanation	13
2.7	Arc Welding	17
2.8	MIG Welding	17
3.0	Differential Simulation Rig	21
3.1	Welding of Differential Rig	22
3.2	Drilled Holes to Hold Gearbox	23
3.3	Differential and Housing	24
3.4	Oxy Cutting Differential	24
3.5	Exposed Differential	25
3.6	Fixed Axles	25
3.7	Fixed Axles	25
3.8	Motor	26
3.9	Isolator	26
3.10	5 Pins Plug	26
3.11	Complete Wiring	26
3.12	Universal Joint	27
3.13	25mm Shaft	27
3.14	Welded Shaft and Universal Joint to Coupling	28
3.15	Fully Assembled Rig	29
3.16	Straight Line Simulation	30

3.17	Left Turn Simulation	31
3.18	Right Turn Simulation	32
4.0	Rig Load Deformation	34
4.1	Rig Safety Factor	35
4.2	Differential Rig	36
4.3	Differential Completed Assembly	37
4.4	Power Flow Mechanism	38

LIST OF SYMBOLS

Symbol	Name
RPM	Revolution per Minute
kN	Kilo Newton
˚C	Degrees Celsius
%	Percentage

LIST OF APPENDICES

Appendix		Page
A	Rig Top View	44
B	Rig Front View	45
C	Rig Right View	46
D	Rig Isometric View	47

CHAPTER 1

INTRODUCTION

As a mechanical engineering student of Universiti Malaysia Pahang (UMP) the final year project gives student a chance to practice all the knowledge and skills that they gain along the academic session in solving problems through a project in order to be an efficient and a good assistant engineer.

1.1 Project Synopsis

This project involves designing and fabricating a rear wheel drive simulation rig. As the Diploma final year project allocates the duration of 1 semester, this project requires significant number of machining processes such as welding, metal cutting and grinding. Basically main process involved in the entire rear wheel differential simulation rig are fabrication of a 4 legged support rig, assembly of shafts, speed reducer gearbox and motor system which is driven by a 3 phase motor.

The project will be funded by the UMP Faculty of Mechanical Engineering, The project supervisor and by myself.

1.1.1 Specific Project Synopsis

My project is to Design and Fabricate a Rear wheel Drive Differential Simulation Rig. The project involves the analysis of the Differential rig developed with the concern regarding strength, durability and the function of the system of a display rig. The project prerequisites are good designing skills and 'trial and error' method. Overall will acquire the skills of designing, fabricating, analysis and testing.

1.2 Objective of Final Year Project

Design and Fabricate a working Rear Wheel Drive Differential Simulation Display rig

1.3 Scope of Work

Fabrication of the Differential Simulation Rig needs special coordinated scope of work. As this is a new project, special scope of work is yet to be determined so that the main objective and goal can be achieved

These scopes help me to be focused and know about my job. The scopes are:

a) Literature review on rear wheel drive differential and motors
b) Design rear wheel drive differential rig using CAD software/ Solid Works
c) Fabricate the rear wheel drive differential simulation rig
d) Assemble the differential with exposed housing and 3 phase motor.
e) Test the differential in 3 condition:
    i. Straight
    ii. Left turn
    iii. Right turn

It is time where the soft skill e.g. punctuality, self discipline, time management and problem solving have been practiced because the project highly depend on the effectiveness of all the skill as much as the knowledge we have learnt.

1.4 Project Planning

This project begun with a research and literature review made via internet, books, supervisor and other relevant academic material related to the title, this literature review takes about two weeks and continues along the way of the project as there is much to learn

At the same week, some schedule management of this project which included scheduled management for the project. This is done by using Microsoft Excel using Gantt Chart method.

Supervisor gave briefing about the introduction of the project and the function of a differential as well as its workings.

The sketching of the model design took about 2 weeks to be done. The sketching is done using manual sketched on A4 size paper and the engineering drawing is done using solid works software. The design sketching is deeply discussed and the best design is selected. The design must be suitable for assembly of motors and gears as well as shafts.

The next task is preparation of progress presentation of the project. In this particular week, the student receives aids from the supervisor about the presentation. The preparation of the presentation requires comments and corrections from the supervisor.

The next week is fabrication week where the project is started to be fabricated. The base, shafts and other parts according to the design.

Next come the assembly, testing, correction, and finishing of the model. This task scheduled to take time about four weeks.

Next task is the final report writing and final presentation preparation. This take about one week to accomplished. The report is done with the supervisor's guidance. Due to all problems, the project the management has agreed to extend the time to submit the report and the presentation. All the task is scheduled to take about sixteen weeks overall.

1.5 Flow Chart Description

At the early stage of the flow chart, the project's objectives, problem and the scopes of the project. This process is quit significant because the main goal, that is the objective, have to be understood carefully. As this is a new project, a few changes required, so the scopes and the problem occurred have to be determined.

After determining the objectives, scopes and the problems, research or literature reviews have to be done. This is to collect information about the differential and motors

Brain storming session will be held, to gather some ideas for the design and early stage sketching. The ideas will be transferred into papers as rough sketching. A few designs were made and the supervisor will choose the best design that suits the project objectives and scopes. The design then designed in SOLIDWORKS software and by using the Cosmos Xpress function, every part's strength and load spread can be determined.

After designing stage, the fabricating process will begin. Before any parts are fabricated, the items purchase list will be done. After this list is created, then the fabrication process will be beginning.

The installation process will be beginning after the fabrication process. After assembling all the parts, the trial session, that is the test run session will beginning. If the parts assembled suits the differential, then this stage is successful, if not the part that is not suitable will be modified and assembled again.

Finally, the report preparation session will be beginning. The final report will be finished before week 16.

1.5.1 Process Flowchart

In fabrication of the rear wheel drive differential simulation rig, there is the overall progress to assure the project can be finished on time.

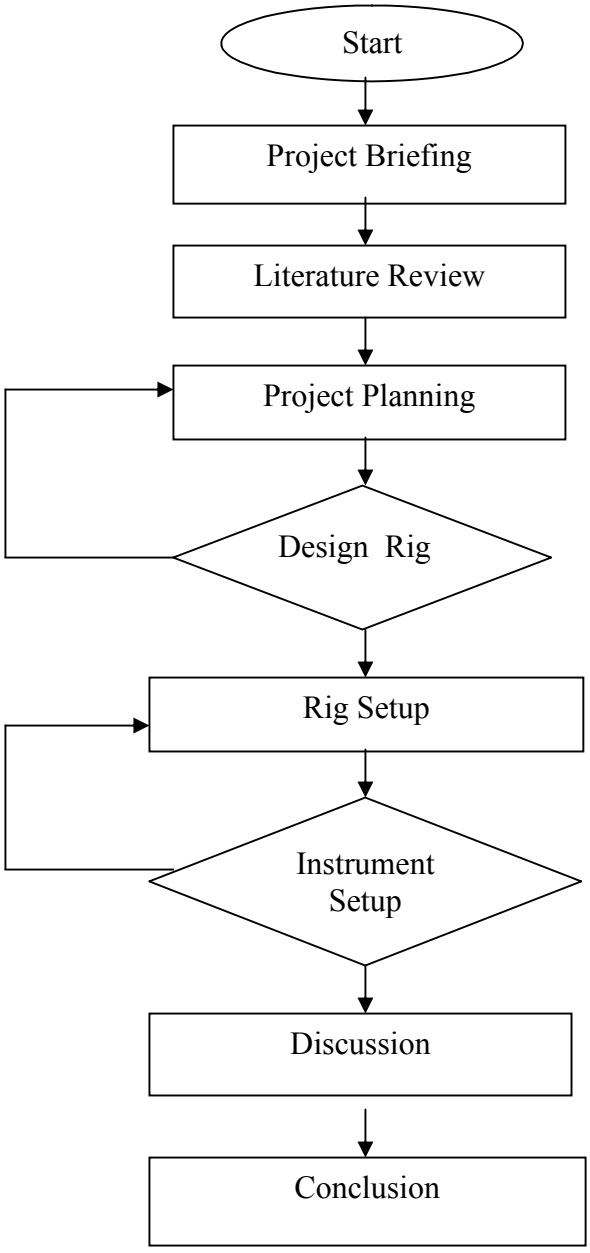

Figure 1.0: Flow Chart

1.6 Gantt Chart

	Week / Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Literature Review	■	■	■											
2	Design Stage			■	■										
3	Design correction				■	■									
4	Parts purchasing and Fabrication				■	■	■	■	■	■	■				
5	Assemble									■	■	■	■	■	■
6	Testing & Modify													■	■
7	Final Report Preparation										■	■	■	■	■

Figure 1.1: Gantt Chart of Differential Rig Project

CHAPTER 2

REVIEW OF RELEVANT LITERATURE

2.1 Differential Definition

Differentials are a variety of gearbox, almost always used in one of two ways. In one of these, it receives one input and provides two outputs; this is found in every automobile. In the other, less commonly encountered, it combines two inputs to create an output that is the sum (or difference) of the inputs. In an automobile and other wheeled vehicles, the differential allows each of the driving wheels to rotate at different speeds, while supplying equal torque to each of them. A vehicle's wheels rotate at different speeds, especially when turning corners. The differential is designed to drive a pair of wheels with equal force, while allowing them to rotate at different speeds. In vehicles without a differential, such as karts, both driving wheels are forced to rotate at the same speed, usually on a common axle driven by a simple chain-drive mechanism. When cornering, the inner wheel travels a shorter distance than the outer wheel, resulting in the inner wheel spinning and/or the outer wheel dragging. This results in difficult and unpredictable handling, damage to tires and roads, and strain on (or possible failure of) the entire drive train.

The differential has three jobs:

- To aim the engine power at the wheels
- To act as the final gear reduction in the vehicle, slowing the rotational speed of the transmission one final time before it hits the wheels
- To transmit the power to the wheels while allowing them to rotate at different speeds

Figure 2.0: Differential (cut model)

2.1.1 Types of Differential

2.1.1.1 Open Differential

The simplest type of differential, It consists of ring gear, side gear, pinion gear, input pinion, pinion shaft, and axle shaft. The open differential have one undesirable effect, it will lower the overall torque. It is found in most of old design cars or trucks.

2.1.1.2 Limited Slip Differential

A limited slip differential (LSD) is a modified or derived type of differential gear arrangement that allows for some difference in rotational velocity of the output shafts, but does not allow the difference in speed to increase beyond a preset amount. In an automobile, such limited slip differentials are sometimes used in place of a standard differential, where they convey certain dynamic advantages, at the expense of greater complexity

2.1.1.3 Locking Differential

A locking differential or locker is a variation on the standard automotive differential. A locking differential may provide increased traction compared to a standard, or "open" differential by restricting each of the two wheels on an axle to the same rotational speed without regard to available traction or differences in resistance seen at each wheel. A locking differential is designed to overcome the chief limitation of a standard open differential by essentially "locking" both wheels on an axle together as if on a common shaft. This forces both wheels to turn in unison, regardless of the traction (or lack thereof) available to either wheel individually. Locking medium can be air.

2.1.1.4 Epicyclic Differential

An epicyclic differential uses epicyclic gears to split torque asymmetrically between the front and rear axles. It has the advantage of being relatively compact along the length of its axis (that is, the sun gear shaft). Epicyclic gears are also called planetary gears because the axes of the planet gears revolve around the common axis of the sun and ring gears that they mesh with and roll between. In figure 2.2, the yellow shaft carries the sun gear which is almost hidden. The blue gears are called planet gears and the pink gear is the ring gear or annulus.

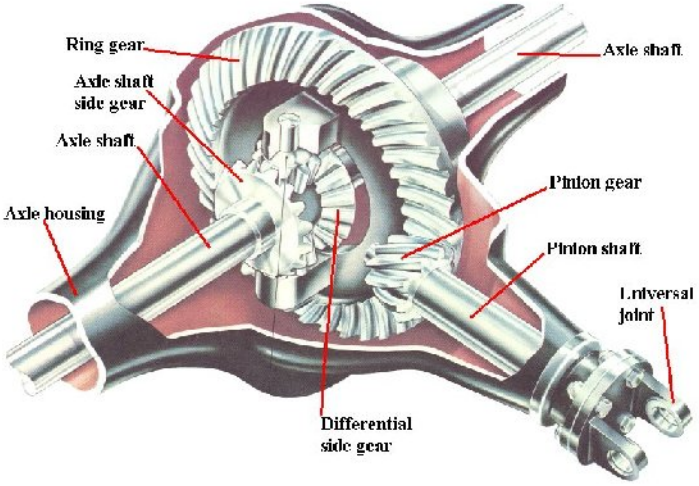

Figure 2.1: Open Differential

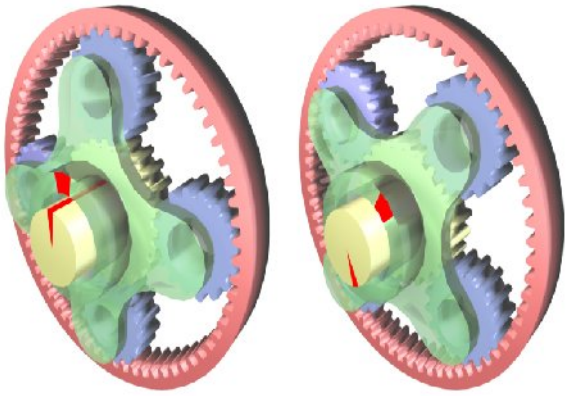

Figure 2.2: Epicyclic Differential

Figure 2.3: Limited Slip Differential

Figure2.4: Locking Differential

2.1.1.5 Differential Operation

Power is supplied from the engine, via the transmission or gearbox, to a drive shaft which runs to the differential. A spiral bevel pinion gear at the end of the propeller shaft is encased within the differential itself, and it meshes with the large spiral bevel *ring* gear (British term: crown wheel). The ring gear is attached to a *carrier*, which holds what is sometimes called a spider, a cluster of four bevel gears in a rectangle, so each bevel gear meshes with two neighbors and rotates counter to the third, that it faces and does not mesh with. Two of these spider gears are aligned on the same axis as the ring gear and drive the half shafts connected to the vehicle's driven wheels. These are called the side gears. The other two spider gears are aligned on a perpendicular axis which changes orientation with the ring gear's rotation. These two gears are just called pinion gears, not to be confused with the main pinion gear. As the carrier rotates, the changing axis orientation of the pinion gears imparts the motion of the ring gear to the motion of the side gears by pushing on them rather than turning against them (that is, the same teeth stay in contact), but because the spider gears are not restricted from turning against each other, *within* that motion the side gears can counter-rotate relative to the ring gear and to each other under the same force. Thus, for example, if the car is making a turn to the right, the main ring gear may make 10 full rotations. During that time, the left wheel will make more rotations because it has further to travel, and the right wheel will make fewer rotations as it has less distance to travel. The side gears will rotate in opposite directions relative to the ring gear by, say, 2 full turns each (4 full turns relative to each other), resulting in the left wheel making 12 rotations, and the right wheel making 8 rotations. The rotation of the ring gear is always the average of the rotations of the side gears. This is why if the wheels are lifted off the ground with the engine off, and the drive shaft is held (preventing the ring gear from turning inside the differential), manually rotating one wheel causes the other to rotate in the opposite direction by the same amount. When the vehicle is traveling in a straight line, there will be no differential movement of the planetary system of gears other than the minute movements necessary to compensate for slight differences in wheel diameter, undulations in the road (which make for a longer or shorter wheel path).