DESIGN AND FABRICATE OF SPEED REDUCER GEARBOX

MOHD ARIF BIN MOHD ARIFFIN

A report submitted in partial fulfilment of the requirements
for the award of the degree of
Diploma of Mechanical Engineering

Faculty of Mechanical Engineering
Universiti Malaysia Pahang

JUNE 2008

DESIGN AND FABRICATION OF SPEED REDUCER GEARBOX

MOHD ARIF BIN MOHD ARIFFIN

UNIVERSITI MALAYSIA PAHANG

FAKULTI KEJURUTERAAN MEKANIKAL

UNIVERSITI MALAYSIA PAHANG

LEBUHRAYA TUN RAZAK, 25000, GAMBANG

KUANTAN PAHANG DARUL MAKMUR.

THESIS TITLE	: DESIGN AND FABRICATE A SPUR GEAR SPEED REDUCER GEARBOX FOR REAR WHEEL DRIVE DIFFERENTIAL SIMULATION RIG
PROGRAMME	: DIPLOMA KEJURUTERAAN MEKANIKAL
FACULTY	: FACULTY OF MECHANICAL ENGINEERING
SESSION	: 2006/2009

SUPERVISOR'S DECLARATION

"I declare that I have read this thesis and in my opinion, this thesis is enough to fulfill the purpose for the award for the Diploma of Mechanical Engineering from the aspects of scope and quality."

Signature : ……

Supervisor : Muhamad Imran Bin Mohmad Sairaji

Position : Vocational Traning Officer

Date :

DECLARATION

I declare that this report entitled *"Design and Fabricate a Spur Gearbox for Real Wheel Drive Differential Simulation rig"* is the result of my own research except as cited in the references. The report has not been accepted for any diploma and is not concurrently submitted in candidature of any other diploma.

Signature : ……

Name : MOHD ARIF BIN MOHD ARIFFIN

ID Number : MB06049

Date :

ACKNOWLEDGEMENTS

Alhamdulillah, I would like to express my thankfulness to Allah s.w.t to giving me all the strength in fulfilling and completely this final year project. All the praise and blessing be upon Prophet Muhammad s.a.w. I would like to thank to those who had been involved whether directly or in directly in helping me to complete my final year project. It could not have been written and produced without the help of many people.

Special appreciation is goes to my lovely parents, Mr. Mohd Ariffin bin Ali and Mrs. Jamilah binti Jusoh. Not forgotten to my family who gave support at all times . My appreciated is also extended to Mr. Muhamad Imran Bin Mohmad Sairaji who acts as my supervisor. Thank for supervision and encouragements. I also would like to thank all my friend who always been listening my problems during the period to finish this dissertation. All your kindness is very much appreciated.

ABSTRACT

The idea to create and build a **Speed reducer gearbox** is come from supervisor that gives me this title and task for this project. The purpose to design and fabricated this speed reducer for reduce speed from motor and transfer to differential at suitable speed. First, get an idea from reference book, internet and other from available data. Form there the information and idea to design and fabricated can be created.

Whole project involves various methods such as collecting data, concept design and fabrication process. The whole project involved various method and process that usually use in engineering such as concept design, analysis process and lastly fabrication process.

This final year project takes one semester to complete. This project is individual project and must be done within this semester. In this project, students must able apply all knowledge during their studies in this Diploma of Mechanical Engineering course. Overall from this project, time management and discipline is important to make sure this project goes smooth as plan and done at correct time.

ABSTRAK

Idea untuk menghasilkan dan membina **speed reducer gearbox** ini datang daripada penyelia yang memberi saya tajuk dan tugasan untuk projek ini. Tujuan merekabentuk dan pembinaan speed reducer gearbox, ialah untuk merendahkkan kelajuan motor untuk dipindahkan kepada differential pada kelajuan tertentu.Langkah pertama, dapatkan maklumat daripada buku rujukan ,internet, dan daripada sumber yang lain.

Keseluruhan projek melibatkan pelbagai cara atau kaedah seperti mengumpulan data, rekabentuk konsep dan proses membina. Kaedah yang selalu yang digunakan dalam kejuruteraan seperti proses analisis juga digunakan.

Projek akhir tahun ini mengambil satu semester untuk disiapkan. Projek ini adalah projrk individu dan mesti disiapkan dalam semester ini. Didalam projek ini, pelajar mesti berupaya menggunakan segala pengetahuan yang mereka perolehi semasa pembelajaran mereka di dalam kursus Diploma Kejuruteraan Mekanika ini. Secara keseluruhan daripada projek ini, pengurusan masa dan disiplin adalah penting dalam memastikan projek berjalan lancar dan siap tepat pada waktunya.

TABLE OF CONTENTS

	TITLE	PAGE
	SUPERVISOR DECLARATION	**ii**
	STUDENT DECLARATION	**iii**
	ACKNOWLEDGEMENTS	**iv**
	ABSTRACT	**v**
	ABSTRAK	**vi**
	TABLE OF CONTENT	**vii**
	LIST OF TABLES	**xi**
	LIST OF FIGURES	**xii**
	LIST OF APPENDICES	**xiv**
CHAPTER 1	**INTRODUCTION**	
	1.1 Introduction	1
	1.1.1 Specific Project	1
	1.2 Problem Statement	2
	1.3 Project Objective	2
	1.3.1 General Objective	2
	1.3.2 Specific Project Objective	2
	1.4 Scope of Work	3
	1.5 Project Planning	4

	1.6	Project Flow Chart	6
CHAPTER 2	**LITERATURE REVIEW**		
	2.1	Introduction	8
	2.2	Spur Gear	8
		2.2.1 Profile	8
		2.2.2 Nomenclature	9
	2.3	Cnc Milling Machine	11
	2.4	Lathe /Cnc turning Center	12
	2.5	Gas Metal Arc Welding	13
	2.6	Drilling Machine	15
	2.7	Hand grinders	17
	2.8	Bandsaw	18
CHAPTER 3	**METHODOLOGY**		
	3.1	Introduction	19
	3.2	Design	20
	3.3	Drawing	20
	3.4	Design in Solidwork Software	21
	3.5	Fabrication Process	23
		3.5.1 Cutting	24
		3.5.2 Welding	25
		3.5.3 milling/ Drilling	26

3.5.4 Etching 27

3.5.5 Turning Process 28

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Torque of the Power Motor 29

4.2 New Spur Gear Calculation 30

4.3 New Force and Stress Calculation 31

4.3.1 Camnetics Gear Trex 2003 31

4.3.2 Spur Gear Module and Parameters 32

4.4 Result 33

4.4.1 Assembly with Differential 35

4.5 Product Specification 36

4.6 Discussion 36

4.6.1 Defect 37

4.7 Problem in Progress 38

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5.0 Introduction 39

5.1 Calculation 39

5.2 Recommendation 40

REFERENCES 42

APPENDICES A-D

LIST OF TABLES

TABLE NO.	TITLE	PAGE
1.1	Gantt Chart	5
4.3	Spur Gears Parameters Final Selection	31
4.5.1	Product Specification	35

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
2.1	Spur Gear	9
2.2	Nomenclature of spur gear teeth	10
2.3	CNC milling machine	11
2.4	CNC lathe machine	12
2.5	Gas Metal Arc Welding (GMAW)	13
2.6	Basic structure of MIG nozzle	14
2.7	Drilling Machine	15
2.8	Hand grinders	17

2.9	Band saw	18
3.1	Bearing Plate	21
3.2	Follower gear	21
3.3	Gear assemble	22
3.4	Housing	22
3.5	Fabrication process	23
3.6	Cutting process	24
3.7	Cutting plate metal	24
3.8	MIG welding	25
3.9	Gearbox housing	25
3.10	Milling process	26
3.11	Bearing housing	26
3.12	EDM wire cut machine	27
3.13	Gears after cut	27
3.14	Gears	27
3.15	Driven shaft	28
3.16	Follower shaft	28
4.2	Gear Trex 2003 Software	30
4.3	Isometric view	32
4.4	Front view	32
4.5	Side view (right)	32
4.6	Assembly with differential and motor	34

4.7	Bead at the chassis	36
4.8	Gap between two materials	37

LIST OF APPENDICES

APPENDIX	TITLE
A	Design Parts
B	Part of Assembly
C	Orthographic View
D	Completed Product

CHAPTER 1

INTRODUCTION

As a mechanical engineering student of University 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 Speed Reducer Gearbox. As the Diploma final year project allocates the duration of 1 semester, this project requires significant number of machining processes such as welding, turning, milling, metal cutting and grinding. In this project, it needs lot of skills and information and also knowledge such as Computer Aided Design software (AutoCad), Solid works software, using EDM wire cut machine, cnc milling machine, lathe machine, band saw, bench work and welding process.

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

1.1.1 Specific Project Synopsis

My project is to Design and Fabricate a spur gear speed reducer gear box for Rear wheel drive differential simulation rig. This will help the motor to running at optimal speed while output shaft will run at low required speed.

1.2 Problem Statement

Not all system run at the same rpm, if the input only need less rpm than the motor supplies, a gear system is needed to reduce the rotation, thus this project is to fabricate a speed reducer gear.

1.3 Project Objectives

1.3.1 General Objective

Diploma final year project objectives is to practices the knowledge and skill of the student that have been gathered before solving problem using academic research, to born an engineer that have enough knowledge and skill.

This project also must complete the subject on this semester. The student also can be explore the advanced machine before involves in industries,

The project otherwise will be produce and train student capable of doing work with minimal supervisory and more independent in searching, detailing and expanding the knowledge and experiences.

The project also will generate student that have capability to make a good research report in thesis form technical writing.

1.3.2 Specific Project Objective

Design and fabricate a working to design & fabricate a spur gear speed reducer gear box for Rear wheel drive differential simulation rig.

1.4 Scope of Work

In order to finish this project require precise scope of work and proper plan need to be followed because this project must through various process before it would be produce. Beside that this project title is new idea which is come from instructor engineer in lab and as the knowledge isn't entirely covered in classes or lab. So it give us advantages to learn new process to produce this product and absolutely we could find lot of advantages neither we are realized or not. These are scope of work in this project,

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

a) Literature review on speed reducer gearbox and gear
b) Design speed reducer gearbox using CAD software/ Solid Works
c) Fabricate the design using material that been selected
d) Test the design in demonstration

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.

1.5 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 speed reducer gearbox 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 wheel drive differential simulation rig.

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 is gear, 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.

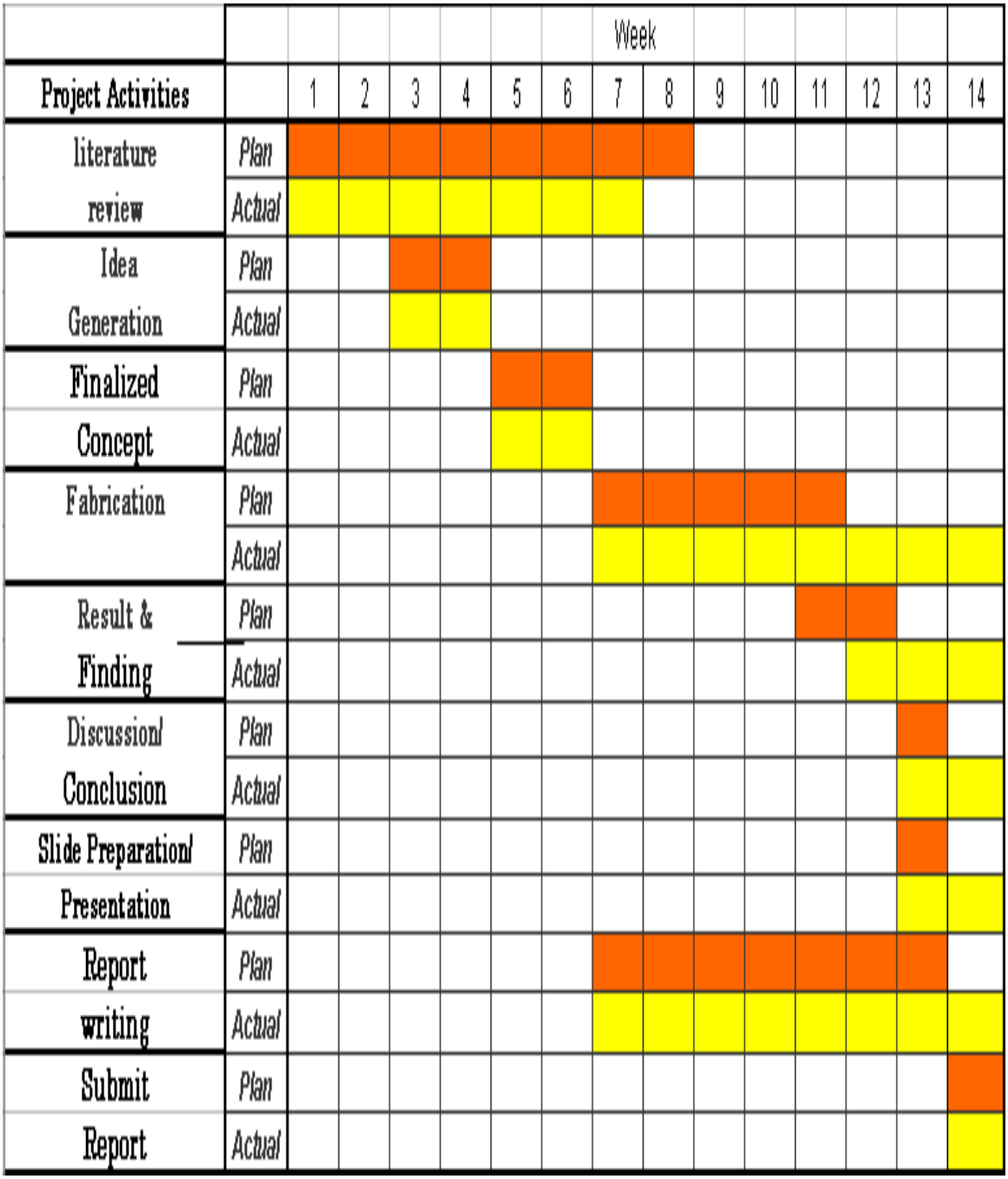


Figure 1.1: Gantt chart

1.6 Project Flow Chart

From the flow diagram on figure 1.2, this project started with discussion with supervisor about title after got from lecturer. This discussion covering project overview supervisor and throw out opinion that related about title and supervisor instruct to proposed a certain design and concept before go up to next step.

Then go to literature review about the title. The most important in these manner is a determined the project scope, objective and project planning so that we could easy get a clear overview. Then study and gather information related to the design and these entire task been done through study from internet, journal and other source.

After gather and collect all related information and obtain new idea and knowledge about the title, the project would continue with the design process. In this stage, the knowledge and idea should throw out in sketching process. After several design sketched, the best design would be choose among previous design so that we could carry on designing process. Then the selected design would be transfer to engineering drawing using SolidWork software in order to improve it capability and for analysis process.

After that material preparation which is has been confirm initially. Purpose of this process is a to determine the suitable and strength material follow the product and design requirement. This process covering purchased material, measuring material and cutting off based on requirement. Here, this process is important because the material would determine whether our product in way to failure or otherwise.

After all the drawing and material preparation done the next process is a fabrication process. This process based on dimension has been determined from drawing.During this process, all the manufacturing process which is suitable could be used such as drilling process using CNC Machine, welding process, turning process and cutting material using handsaw machine.

After all process above done on schedule without any problem such as product malfunction or product brittleness, all material for report writing is gathered. The report writing process covering and including all manners from week 2 until finished. This process also included the presentation for final presentation of the project.

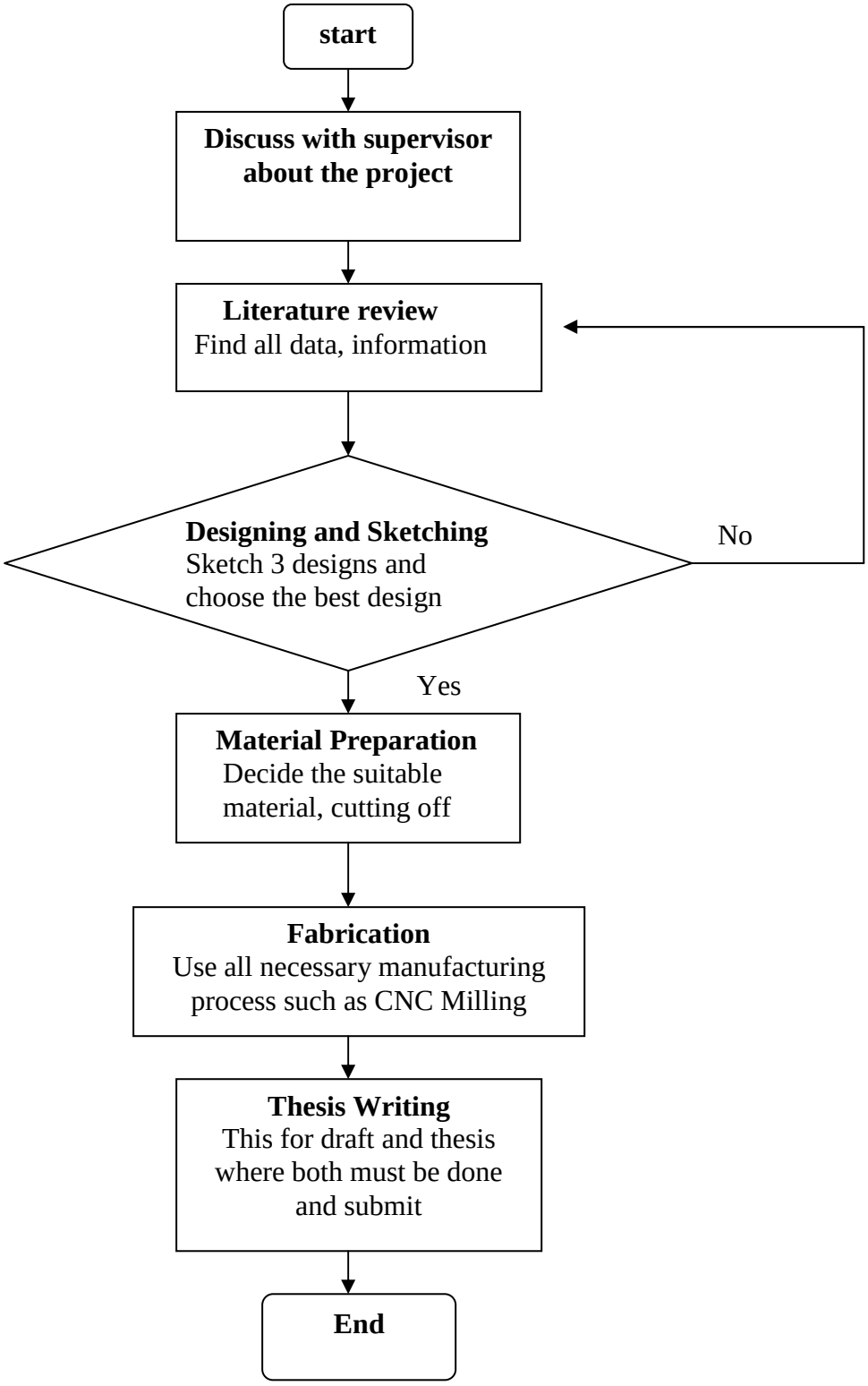


Figure 1.2: Project Flow Chart

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is present about literature review of fabrication process such as milling, turning, cutting, grinding, welding, drilling and other else. Before fabrication process, the material selection is crucial. The selection of joining process is also important to get a product with better strength and durability. Literature review about machine is also important. It is include guide to setup the machine, type of machine suitable for fabrication process and advantages using this machine.

2.2 Spur Gear

2.2.1 Profile

Spur gear illustrated in figure 2.1, have teeth parallel to the axis of rotation and are used to transmit motion from one shaft to another, parallel , shaft .Of all type the spur gear is the simplest and for this reason ,will be used to develop the primary kinetic relationships of the tooth form.

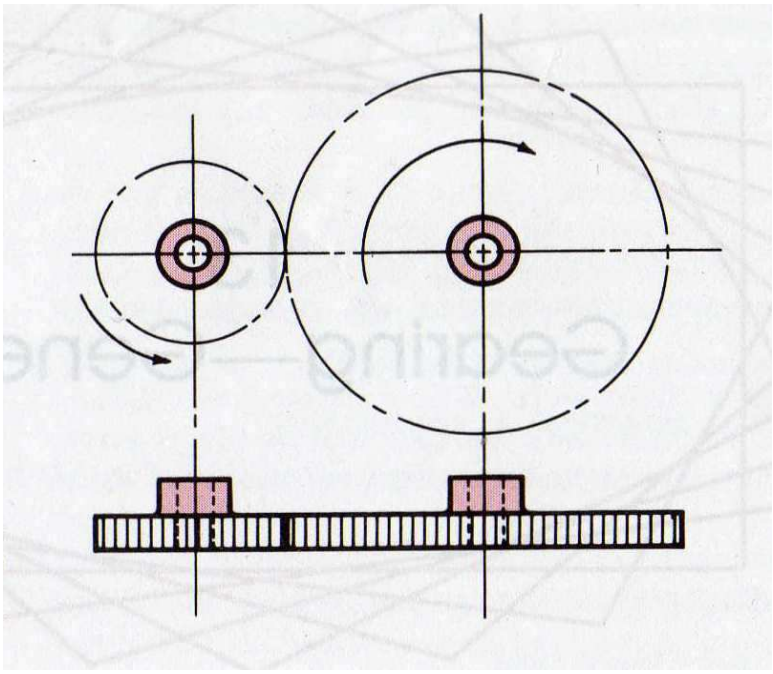


Figure 2.1: Spur gears are used to transmit rotary motion between parallel shafts.

2.2.2 Nomenclature

The terminology of spur gear is illustrated in figure 2.2.The pitch circle is a theoretical Circle upon which all calculations are usually based; its diameter is the pitch diameter .The pitch circles of a pair of mating gear are tangent to each other. A pinion is the smaller of two mating gears. The larger is often called the gear.

The circular pitch P is the distance, measured on the pitch circle, from a point one tooth to a corresponding point on an adjacent tooth. Thus the circular pitch is equal to the sum of the tooth thickness and the width of space.

The module m is the ratio of the pitch diameter to the number of teeth. The customary unit of length used is the millimeter. The module is the index of tooth size in SI. The diameter pitch P is the ratio of the number of teeth on the gear to the pitch diameter.

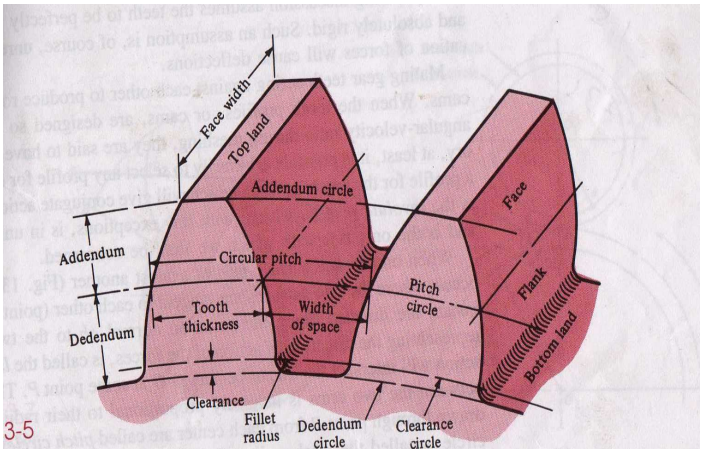


Figure 2.2: Nomenclature of spur gear teeth

The addendum is the radial distance between the top land and the pitch circle. The dedendum b is the radial distance from the bottom land to the pitch circle. The whole depth h is the sum of the addendum and dedendum.

The clearance circle is a circle that is tangent to the addendum circle of the mating gear. The clearance c is the amount by which the dedendum in a given gear exceeds the addendum of it is mating gear. The backlash is the amount by which the width of a tooth space exceeds the thickness of engaging tooth measured on the pitch circles.

P =N/d

Where P = diameter pitch, teeth per inch
N = number of teeth
d = pitch diameter, in

m = d/N

Where m = module, mm
d = pitch diameter, mm

p = μd/N =μm

Where p = circular pitch

pP = μ

2.3 CNC Milling Machine

Figure 2.3: CNC milling machine

A milling machine is a machine tool used for the shaping of metal and other solid materials. Its basic form is that of a rotating cutter which rotates about the spindle axis (similar to a drill), and a table to which the workpiece is affixed. In contrast to drilling, where the drill is moved exclusively along its axis, the milling operation involves movement of the rotating cutter sideways as well as 'in and out'. The cutter and workpiece move relative to each other, generating a toolpath along which material is removed. The movement is precisely controlled, usually with slides and leads crews or analogous technology. Often the movement is achieved by moving the table while the cutter rotates in one place, but regardless of how the parts of the machine slide, the result that matters is the relative motion between cutter and workpiece.

Milling machines may be manually operated, mechanically automated, or digitally automated via CNC (computer numerical control).Milling machines can perform a vast number of operations, some of them with quite complex toolpaths, such as slot cutting, planing, drilling, diesinking, rebating, routing, etc.

The Toolroom Mills combine the power of CNC with the ease of manual control. Haas CNC verticals have travels ranging from 406 x 305 x 254mm (xyz) on the Mini Mill and Super Mini Mill to 3048 x 1016 x 762mm on the monstrous VF-11. Workpiece sizes run the gamut, too, with tables available from 305 x 914mm all the way up to 711 x 3048mm.

The range of possible applications is as varied as the capacities: 7.5 hp Mini Mill, 15 hp Super Mini Mill, 20 and 30 horsepower motors for the VF line; speeds ranging from 0 to 7500 rpm, with options for 10,000, 15,000 and 30,000 rpm; and torque ratings up to 450 ft-lb. These machines are flexible enough for both high-torque, heavy-duty cutting as well as your finest high-speed machining operations.

2.4 lathe / CNC turning center

Figure 2.4: CNC lathe machine

CNC lathes are rapidly replacing the older production lathes (multispindle, etc) due to their ease of setting and operation. They are designed to use modern carbide tooling and fully utilize modern processes. The part may be designed by the Computer-aided manufacturing (CAM) process, the resulting file uploaded to the machine, and once set and trialled the machine will continue to turn out parts under the occasional supervision of an operator. The machine is controlled electronically

via a computer menu style interface, the program may be modified and displayed at the machine, along with a simulated view of the process. The setter/operator needs a high level of skill to perform the process, however the knowledge base is broader compared to the older production machines where intimate knowledge of each machine was considered essential. These machines are often set and operated by the same person, where the operator will supervise a small number of machines (cell).

With the advent of cheap computers, free operating systems such as Linux, and open source NC software, the entry price of CNC machines has plummeted. For example, Sherline makes a desktop CNC lathe that is affordable by hobbyists.

2.5 Gas Metal Arc Welding (GMAW)

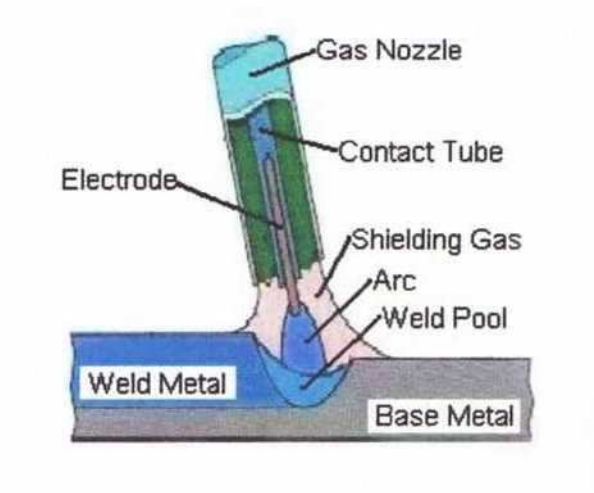


Figure 2.5: Gas Metal Arc Welding (GMAW)

Welding is a fabrication process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material that cools to become a strong joint. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the workpieces to form a bond between them, without melting the workpieces.

The method joining that able to fabricate and assembled the ball store is Metal Inert Gas (MIG) welding. The equipment used in GMAW is a welding gun, a wire feed unit, an electrode wire and a shielding gas supply. When the control switch is turned on the wire feed, electrical power and gas flow are initiated. This

causes an electric arc to be struck. The gas nozzle is used to direct the welding gas evenly into the welding zone.

The figure 2.6 below shows the basic structure of MIG nozzle

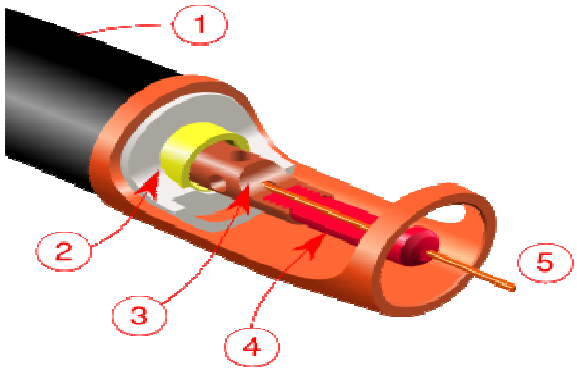


Figure 2.6: (1) Torch Handle (2) Molded phenolic dielectric (3) sheilding gas nozzle (4)

Contact tip (5) Nozzle output fac

To perform gas metal arc welding, the basic necessary equipment is a welding gun, a wire feed unit, a welding power supply, an electrode wire, and a shielding gas supply.

2.6 Drilling Machine

Figure 2.7: Drilling Machine

A **drill** (from Dutch *Drillen*) is a tool with a rotating drill bit used for drilling holes in various materials. Drills are commonly used in woodworking, metalworking, construction and DIY.

The drill bit is gripped by a chuck at one end of the drill, and is pressed against the target material and rotated. The tip of the drill bit does the work of cutting into the target material, either slicing off thin shavings (twist drills or auger bits), grinding off small particles (oil drilling), or crushing and removing pieces of the workpiece (SDS masonry drill).

Types drill

There are many types of drills: some powered manually, others using electricity or compressed air as the motive power, and a minority driven by an internal combustion engine (for example, earth drilling augers). Drills with a percussive action (such as hammer drills, jackhammers or pneumatic drills) are usually used in hard materials such as masonry (brick, concrete and stone) or rock. Drilling rigs are used to bore holes in the earth to obtain water or oil. An oil well, water well, or holes for geothermal heating are created with large drill rigs up to a hundred feet high. Some types of hand-held drills are also used to drive screws. Some small appliances may be drill-powered, such as small pumps, grinders, etc.

2.7 Hand grinders

Figure 2.8: Hand grinders

Angle grinders may be used both for removing excess material off a piece or simply cutting into a piece. There are myriad different kinds of discs that are used for various materials and tasks, such as cut-off discs (diamond blade), abrasive grinding discs, sanding discs, wire brush wheels and polishing pads. The angle grinder has large bearings to counter side forces generated during cutting, unlike a power drill, where the force is axial.

Angle grinders are widely used in metalworking and construction, as well as in emergency rescues.

They are commonly found in workshops, service garages and auto body repair shops. There is a large variety of angle grinders to choose from when trying to find the right one for the job. The most important factors in choosing the right grinder are the disc size and how powerful the motor is. Other factors include power source (pneumatic or electric), rpm's, and arbor size.

Generally disc size and power increase together. Disc size is usually measured in inches. Common disc sizes for angle grinders include 4, 4.5, 5, 6, and 7 inches. Discs for pneumatic grinders also come much smaller. Pneumatic grinders are generally used for lighter duty jobs where more precision is required. This is likely because pneumatic grinders can be small yet remain powerful, while it is harder for an electric grinder to maintain adequate power with smaller size. Electric grinders are more commonly used for larger, heavy duty jobs. There are also small electric grinders and large pneumatic grinders.

2.8 Band saw

Figure 2.9: band saw

A band saw uses a blade consisting of a band of toothed metal, and may be powered by wind, water, steam, electrical motor or animal power. The band rides on two wheels rotating in the same plane. Band saws can be used for woodworking, metal working, or for cutting a variety of other materials, and are particularly useful for cutting irregular shapes. The radius of a curve that can be cut on a particular saw is determined by the width of the band and its lateral flexibility.

When cutting metals or timber, a constant flow of liquid over the blade facilitates cutting by lubricating to keep the blade cool as well as preventing encrustation or smearing on the blade, prolonging blade life and making for greater cutting accuracy. Brushes or brush wheels are sometimes used to remove chips and encrustation from the blade as it exits the material. These units range from manually operated machines to fully automatic machines. Band speeds range from 40 feet per minute to 5000 feet per minute.

Machine shop bandsaws may also be horizontal or vertical. Small bandsaws may employ a gravity-fed blade or the rate of descent may be controlled by a hydraulic cylinder bleeding through an adjustable valve. When the cut is complete, a switch is tripped and the saw automatically turns off.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Project methodology is a body of practices, procedures and rules used by those who work in a set of working methods. This chapter will discuss about methods and machining process that will be use to make the speed reducer gearbox. All the methods that will be explain in this chapter are very important procedure to ensure it follow the entire project schedule so that it will move smoothly. Effective methods will give clear view on how to do this project. These methods will guidance in so that the project will be finish at the right time as planning.

3.2 Design

The design and fabrication of mechanical speed reducer gearbox must be compliance to several aspects. The design consideration must be done carefully in order that design can be fabricated and all parts are functioning. The aspects must be considered in designing the speed reducer gearbox such as the gearbox housing strength. The housing needs to have certain strength to ensure that it can load the gearbox and shaft. The second thing is material. Usually use the available material is one of aspects that have been considered. The materials used depend on their purpose and their function. Then another factor must be consider is cost. The cost of whole system must be not exceeding from budget and reasonable. It should reduce the cost to the minimum. Besides that the ergonomic factors also need to be considered.

3.3 Drawing

The drawings are divided into two categories, which are:

i. Sketching – all the ideas for the speed reducer fabrication are sketched on the paper first to ensure that idea selection can be produce.
ii. Solidworks software – the selected design or concept sketched is transfer to solid modeling and engineering drawing using Solidworks software.

3.4 Design in SolidWork software

After the best design has been selected including all dimension, the next step is a design the drawing that been sketch initially into SolidWork Software. The design modeling created according to the dimension done before and then converted into orthographic view to get its engineering drawing detail.

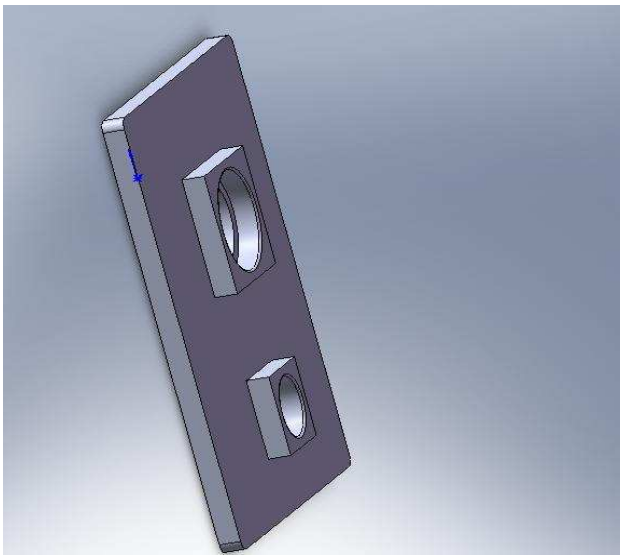


Figure 3.1: Bearing plate

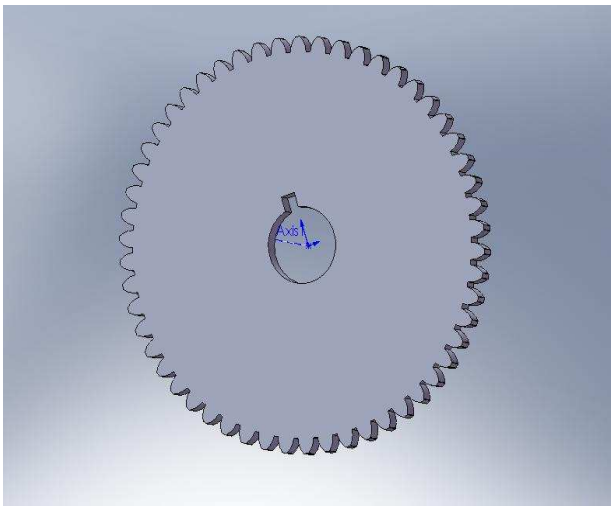


Figure 3.2: Follower gear

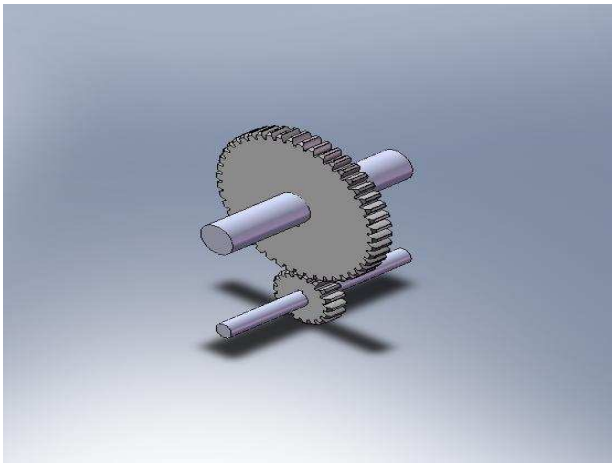


Figure 3.3: Gear assemble

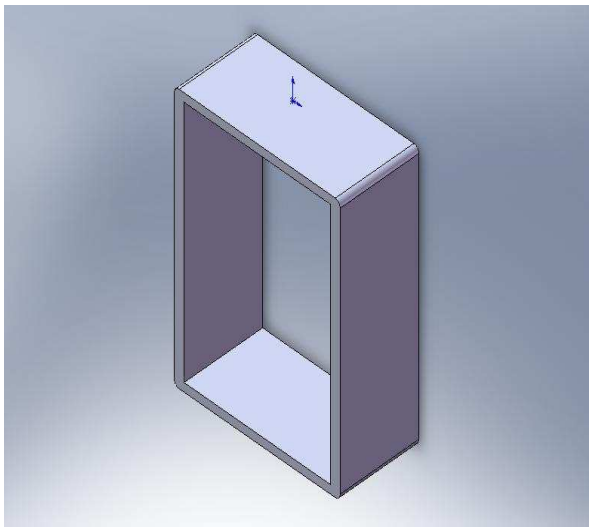


Figure 3.4: Housing

3.5 FABRICATION PROCESS

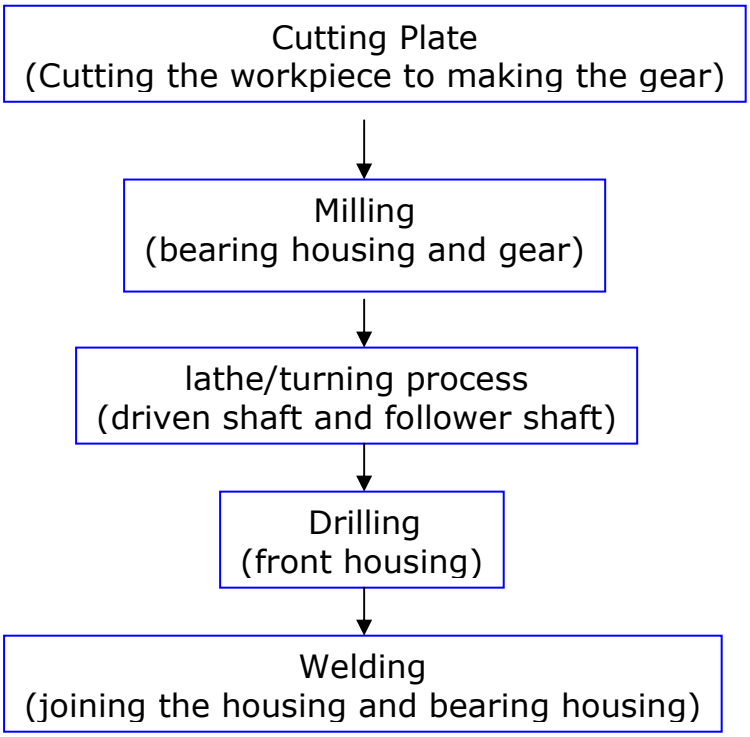


Figure 3.5: Fabrication process flow chart

3.5.1 Cutting

After material preparation step has been done the fabrication process start with the sheet metal cutting of by Band saw machine for two set plate metal with size 100mmx180mmx9mm, 100mmx180mmx9mm each one.

Figure 3.6: Cutting process with bandsaw

Figure 3.7: Cutting plate metal

3.5.2 Welding

This is a process to fabricate a housing of the gearbox .MIG welding (metal inert gas) has been used to joint this part. Safety when using this machine is important to avoidance from injury. These processes using MIG weld with Volt and wire speed has been determined depend on situation. The reason why using this type of welding because the sheet metal that used only 1.5mm thickness and it more proper if using MIG welding than Arc welding as well. Beside that there has no much in using this welding because the place that want to be weld is only 15mm-25mm and it required skill to weld it because as we know before it would getting difficult to weld a small place or part than a big part.

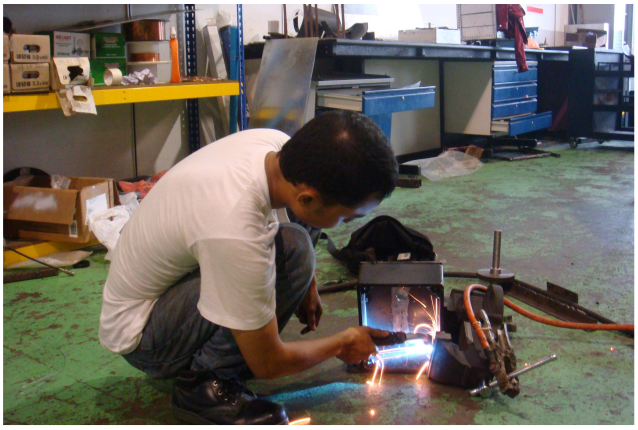


Figure 3.8: MIG welding

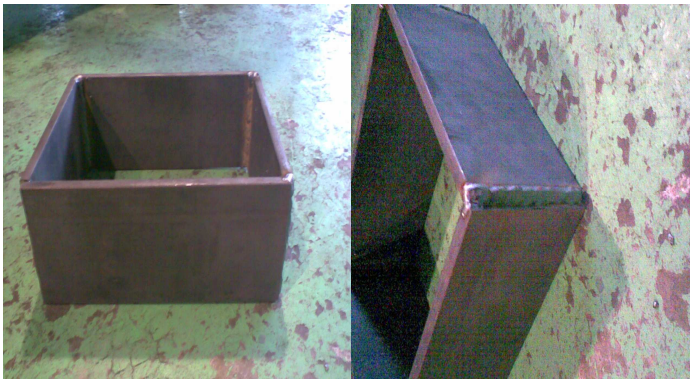


Figure 3.9: Gearbox housing

3.5.3 Milling/drilling

Next step in this fabrication process is a make a hole at sheet metal that been shear before. It using CNC Milling machine where basic form is that of a rotating cutter which rotates about the spindle axis (similar to a drill), and a table to which the workpiece is affixed. Milling machines can perform a vast number of operations, some of them with quite complex toolpaths, such as slot cutting, planing, drilling, diesinking, rebating and routing. We have to draw a design using MasterCam software and then would be transfer into CNC program before machine center at CNC Milling machine read it. After that the machine would run and operate automatically until the desire shape done.

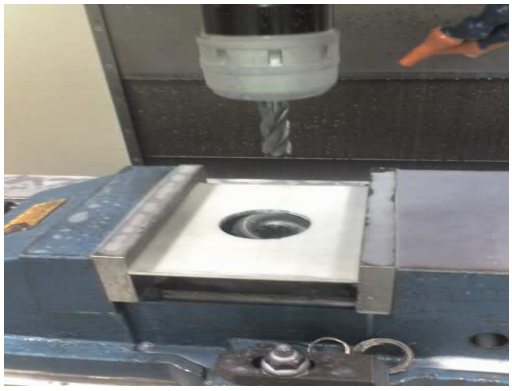


Figure 3.10: Milling process

Figure 3.11: Bearing housing

3.5.4 Etching

After cutting the metal 16mmx150mmx250mm with bandsaw, the work piece must be cutter with EDM wire cut machine to produce the gear. Only (dxf) format can be read in this machine. After finish draw the Follower and Driven gear in the solidwork software, it must converted with (dxf) format.

Figure 3.12: EDM wire cut machine

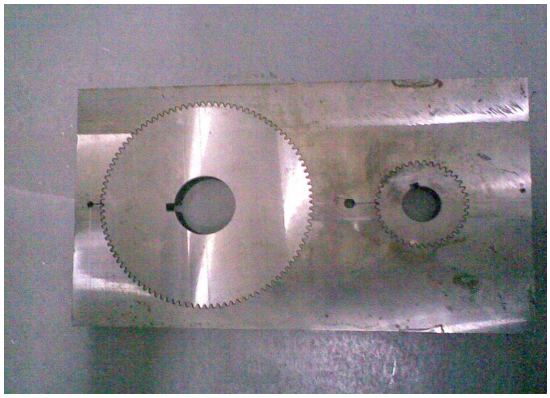


Figure 3.13: Gears after cut

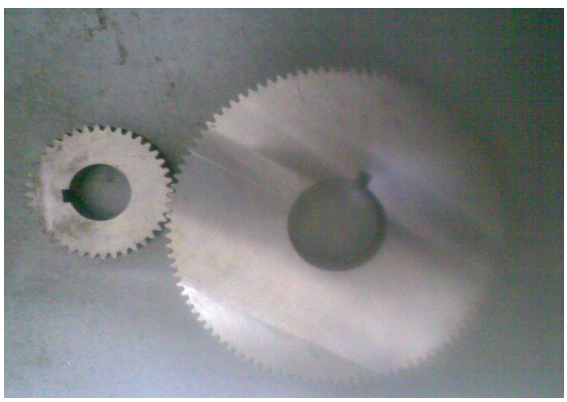


Figure 3.14: Gears

3.5.5 Turning process

In the turning process, the driven shaft and the follower shaft is fabricated by using conventional lathe machine.

Figure 3.15: Driven shaft

Figure 3.16: Follower shaft

CHAPTER 4

RESULT AND DISCUSSION

4.1 Torque of the power motor

The torque of the power motor has been calculated using theorem 4.1 using power and revolution per minute as the variables.

$$P = T \times 2\pi \times RPM \times 1/60$$

*P=Power (W) = 384 W

RPM = 1000 revolution per minute

Equation 4.1: Torque by Power

After measurement with 1000 revolutions per minute and power of 384 W we get the torque of the power motor value as 3.6 Nm.

4.2 New spur gear calculation

This final year project has proposed to make a new calculation to get the suitable condition of forces and stress for the chosen material Carbon steel. From chapter 3, there are many type of material to be considered. After some discussion and consideration of the cost, this project has use carbon steel is chosen as the selected material to replace Mild Steel as the main material. The Mild Steel has lower tensile strength compared to the old material carbon steel. To be a new spur gear material, the main properties to be considered are:

1) Density
2) Tensile Strength
3) Hardness

To obtain the suitable dimension of spur gear, the tensile strength properties have be the main variable or properties. All the reverse engineering calculation is based on the tensile strength. The spur gear arrangement has been calculated suitable to achieve the power motor torque that is 3.6 Nm.

4.3 New force and stress calculation

For new set of spur gear, there are new forces and stress at the spur gear teeth is applied. All the calculation has been calculated from the camnetics gear trex data. For the force calculation, the torque theorem (Equation 4.2) has been used to determine the force value. The stress at the spur gear teeth has been calculated from the stress theorem (Equation 4.2.).

4.3.1 Camnetics Gear Trex 2003

All the spur gear data has been collected from the gear trex 2003 software. Figure 4.2 shows the Camnetics Gear Trex 2003 software.

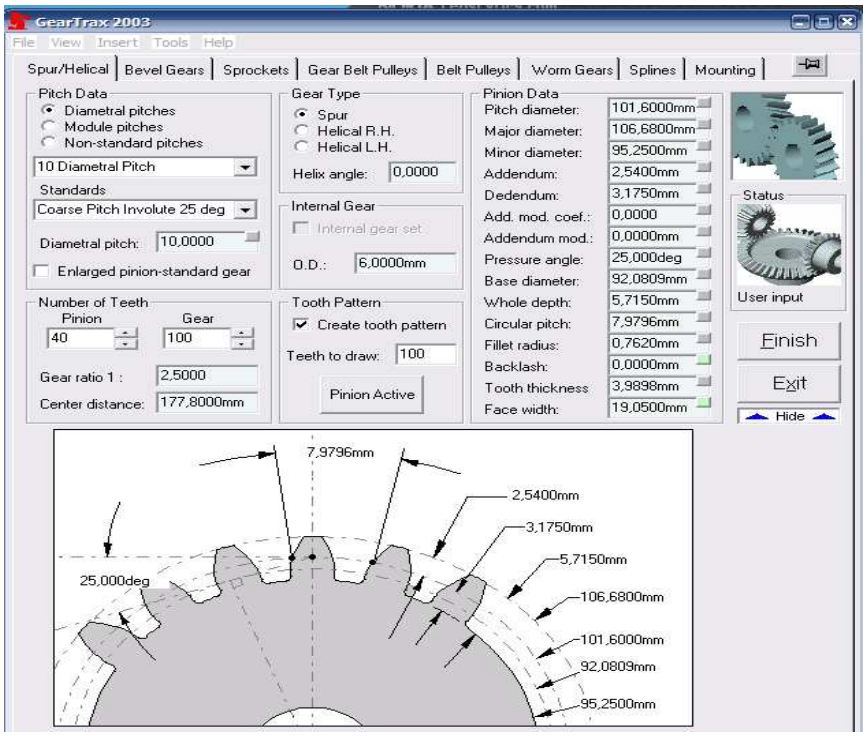


Figure 4.2: Gear Trex 2003 Software

4.3.2 Spur Gear Module and Parameters

The objective of this project is to make compact the product in a suitable size that is demanded for customer product. For the 5th level, the spur gears are in 2.75 modules to achieve the 114 pitch circle diameter (PCD). The other 4 levels have used the 2.25 module to make the design compact and smaller area. Table 4.3 shoes the parameters of the spur gears that calculated with the Camnetics Gear Trex software.

Table 4.3: Spur Gears Parameters Final Selection

Module	Gears teeth	Pitch Diameter, Pd(mm)	Outside Diameter, OD(mm)
2.25	100	225.0000	229.5
	40	90.0000	94.5

The pitch diameter, Pd has been used to calculate the force exerted at the spur gears teeth. From equation 4.2, the radius, r is half of the Pd. The outside diameter, OD data is not get by the Camnetics Gear Trex software because there is some error with the actual spur gears machining. The OD has been calculated with Equation 4.3.2.1, module theorem.

$$\mathbf{M = OD / (N + 2)}$$

*M = module, OD = outside diameter, N = number of teeth

4.4 Final assembly

After finish fabrication process, all information about this product is collected and gathered. It is important to classify the product before it can use. The complete fabrication like below.

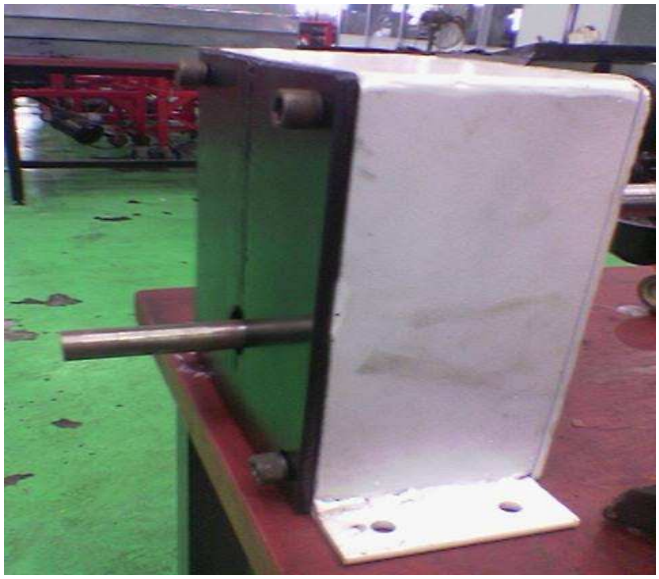


Figure 4.4: Isometric view

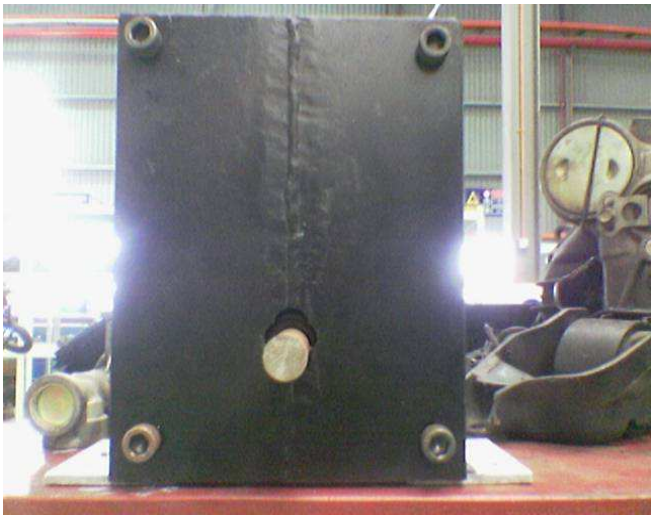


Figure 4.5: Front view

Figure 4.6: Side view (right)

4.4.1 Assembly with differential and motor

This picture figure 4.7 shows the complete assembly of the speed reducer gearbox with the motor and the differential. The whole system is mounted on the steel rig. The power flow is from the motor then it transfers to the speed reducer gearbox where the speed is reduced to a ratio of 5:2 then the power flows to the output shaft which is connected to the differential.

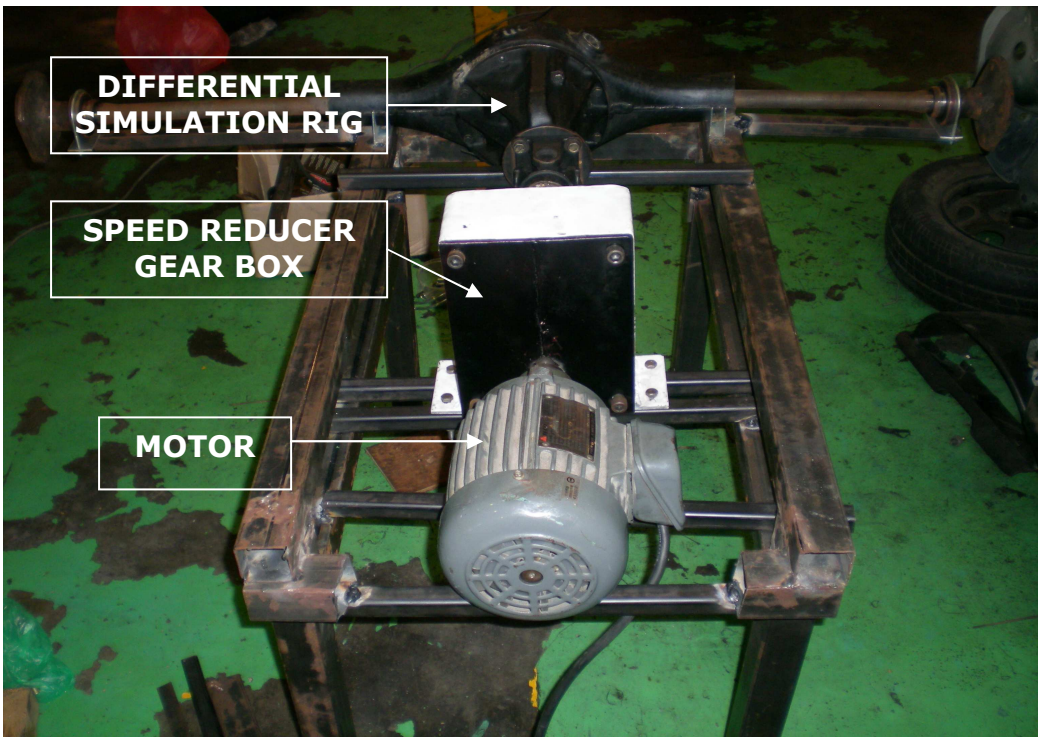


Figure 4.7: Assembly with differential and motor

4.5 Product specification

This is another example of analysis process. The product is classify to several category such as weight, colour, wide, height and other else. The product specification is like below.

Table 4.5.1: Table of product specification

Category	Result
Weight	10 kg
Colour	white and black
Wide	12.5 cm
Height	25.0cm

4.6 Discussion

Discussion is diving by two parts. Firstly is discussion about type of defect on the final product .Second, is about the problem in progress start with literature review until fabricate and finish this product.

4.6.1 Types of Defect

After finish fabrication process, many types of defects are exist. It happens from fabrication process and the weakness using several machine and tool. At the same time, this event can give someone more experience and knowledge. Type of defects is like below.

i. Bead

Figure 4.8 is an example for a defect in chassis. The bead is not trim from welding process. The voltage when welding process is not suitable for this material. Insufficient experience to handle this machine also cause of the defected.

Figure 4.8: Bead at the chassis

ii. Gap

Figure 4.9 is shown a defect in part .It is occurring after using arc welding. This defect happens cause by the chassis not has flat surface and careless in measuring process.

Figure 4.9: Gap between two materials

4.7 Problem in Progress

Many problems occur in progress to design and fabrication of this speed reducer such as gather raw data and literature review, design and fabrication. The problem in progress just like below.

i. Design Problem

The problem also occurs at this step. The problem came during decision making to design that suitable with available machine in UMP mechanical lab .During this period many concept design have been find out when to choose one design that have all criteria needed by specification is can proceed and running machine. After a design is selected, another problem encountered is detail dimensioning; the dimension should suitable with scope of the project and after consider all part and material use the dimensional was suitable with project scope.

ii. Fabrication Problem

Problem during this stage is very critical that make the actual progress not follow project planning schedule. First, the problem is to find material that suitable for the title of the project .The suggestion material to produce wall of speed reducer housing for this speed reducer is not available such as mild steel plate metal was finish. After consider all problems about material available design for the project was change follow material available.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.0 Introduction

For the final chapter it present about conclusion and recommendation for the project. The important things for this chapter are about the problems encountered during the whole project carried out. The problem are included the process planning that have been done. These project problems also make the student to think more creative to solve the problem. This chapter also discuss about the conclusion of the project that is concluding all the process involved. Beside that, this chapter also contains recommendation about project. This is very important to make some improvement about the project for future work.

5.1 Conclusion

This project had achieves its entire objective successfully to design & fabricate a spur gear speed reducer gear box for Rear wheel drive differential simulation rig. Besides that the most important is to make a detail drawing so that the fabrication can run smoothly. From this project also teaches how to understand so many things especially learned how to design a product that is beneficial and learned this subject practically. This project was done around fourteen week included almost all steps of the report such as literature review, design, fabrication process and others.

5.2 Recommendation

Precise planning of the work progress will make sure that the project can be done in a shorter time. Having a good time management can guaranty that any of student tasks to complete in a good ways and also give more time to focus on other subject. But several recommendations to improvement for me and faculty for future final year project are still need.

The speed reducer gearbox can be incorporated with helical gear so that the whole system will be quieter than spur gears when running.

The process of manufacturing the spur gears by using wire cut is not suitable compared to Hobbing process where the cutting by wire cut will not be smooth.

At the last all machines and equipments at FKM LAB always should be in good condition. This situation can help student to complete their project on time.

REFFERENCES

1. Henry,D (1950), *The Industrial Designer and The Businessan*, Havard Business Review, University of H avard

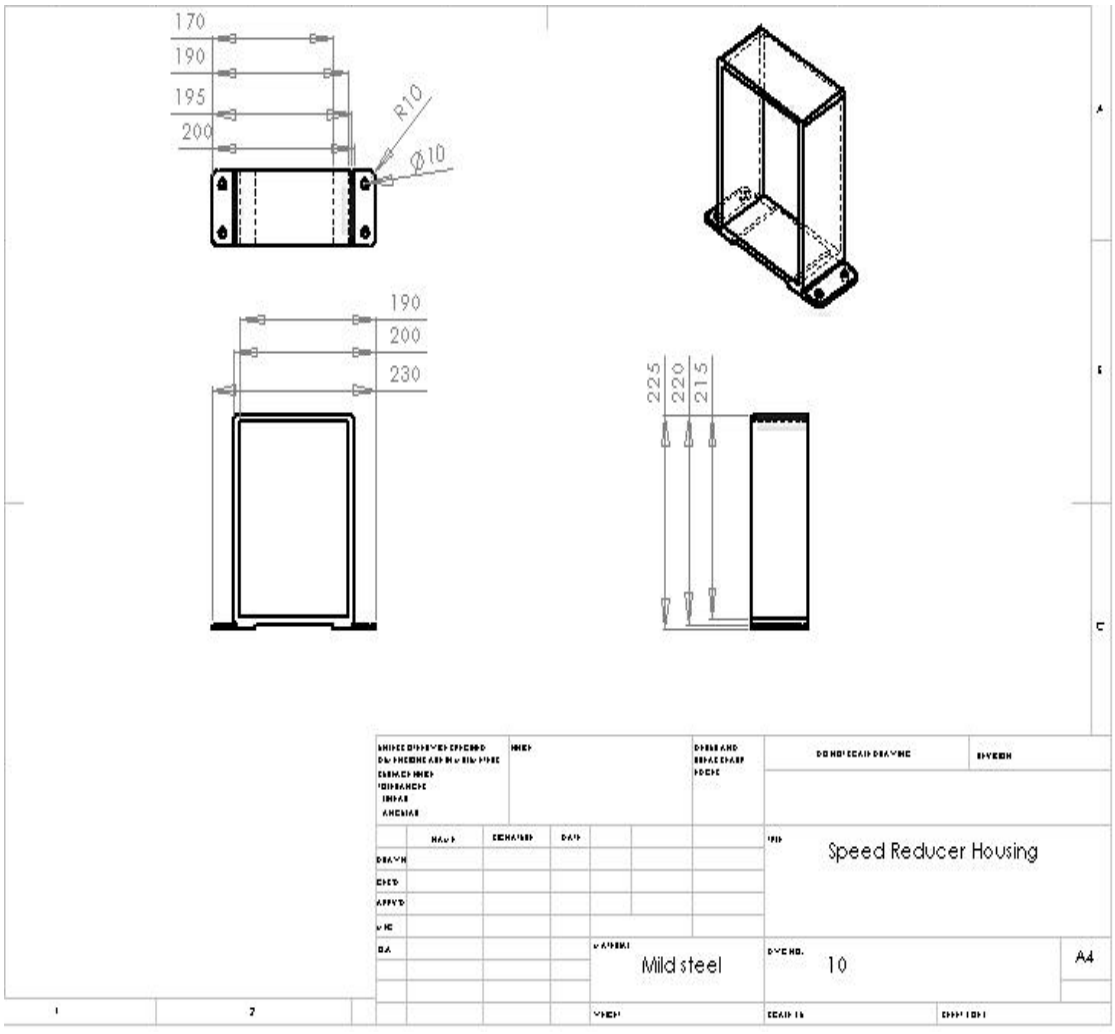
2. Ulrich T. and. Eppinger Steven D, *Product Design and Developmen*, Newcastle, United Kingdom

3. John Joseph Uicker, Gordon R. Pennock, Joseph Edward Shigley. 2003. Theory of Machines and Mechanisms

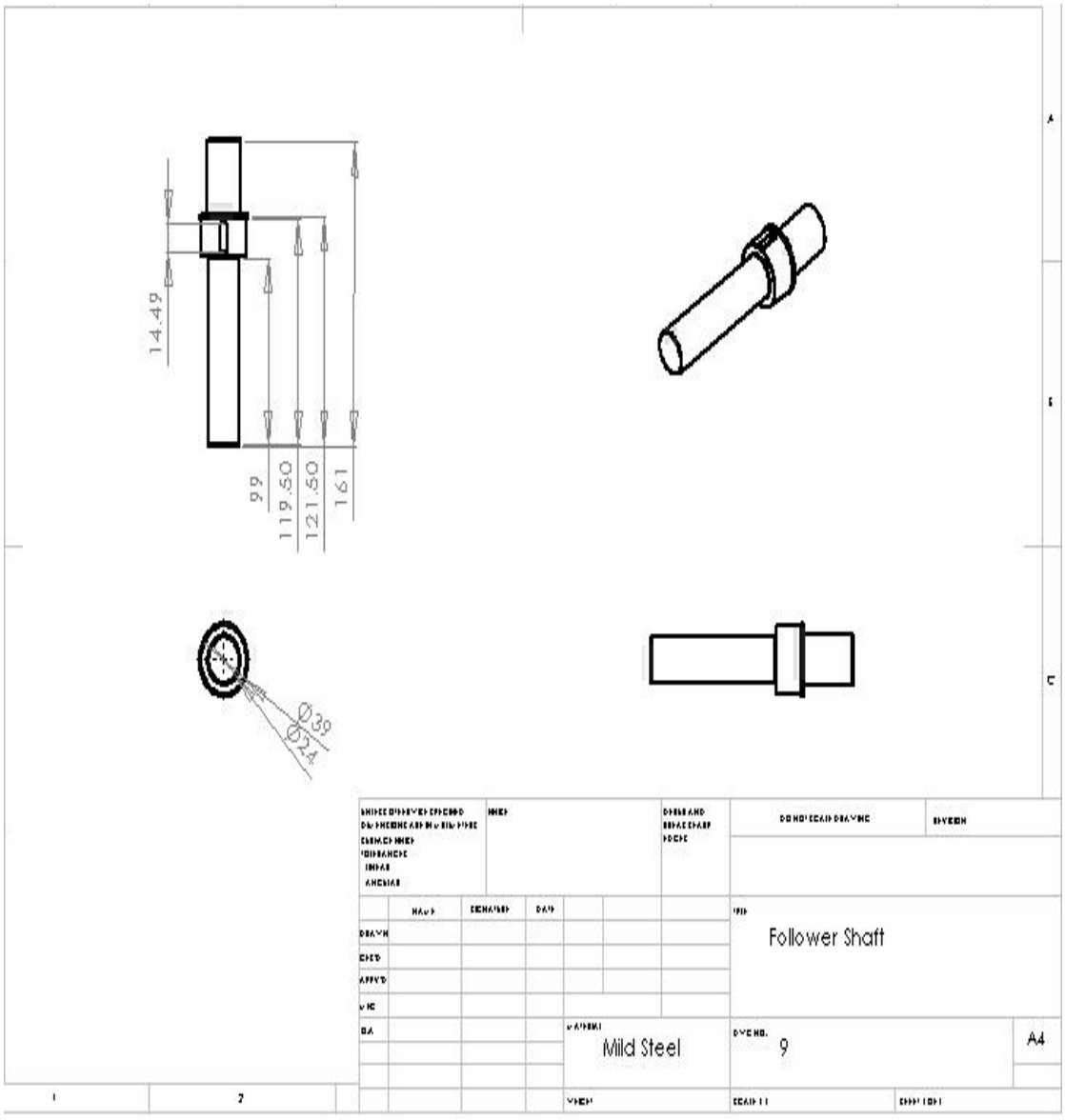
4. Crouse, William Harry and Donald L. Anglin (1993)-10th edition Automotive Mechanics

APPENDIX A

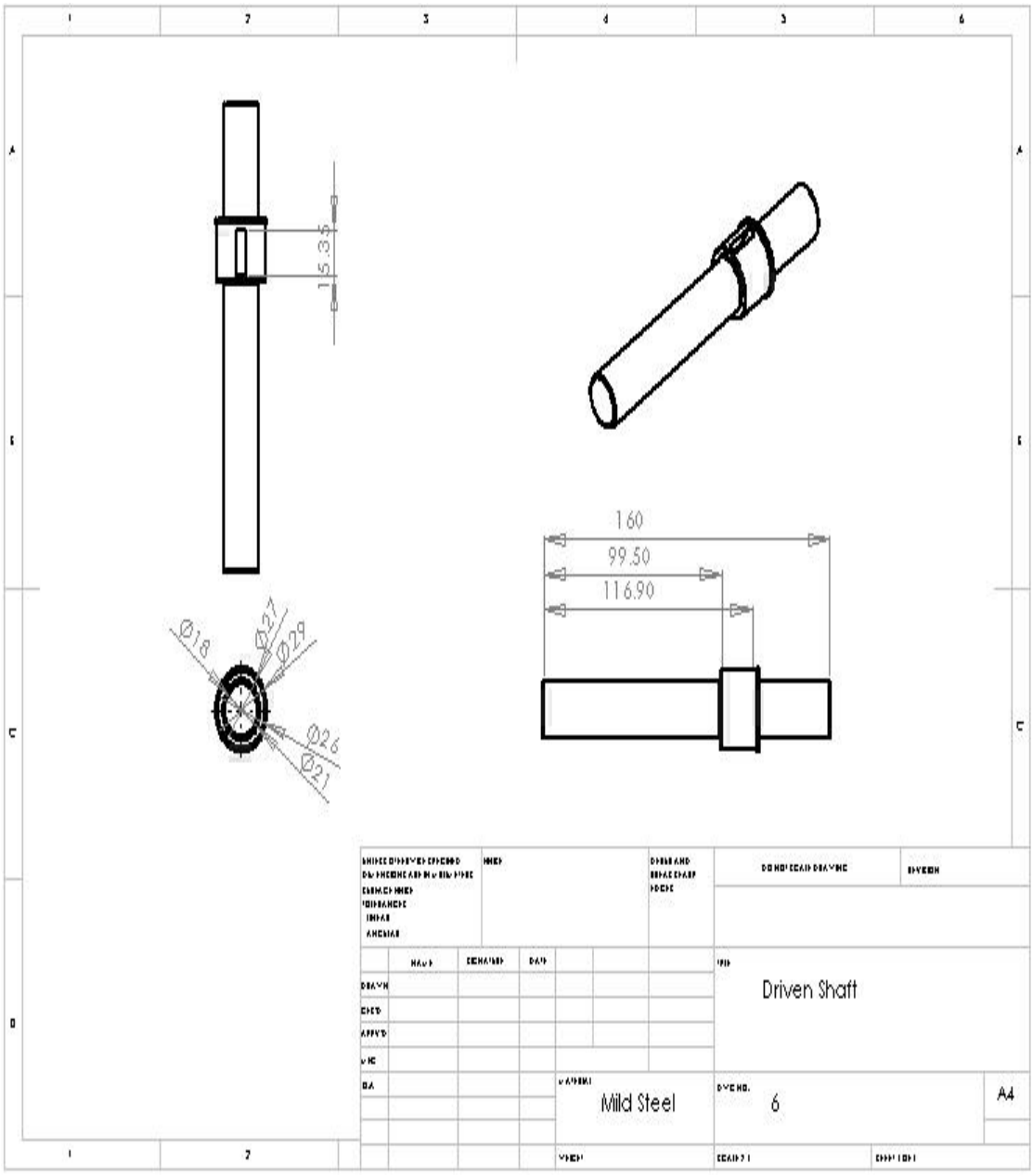
DETAIL DRAWING OF THE PART



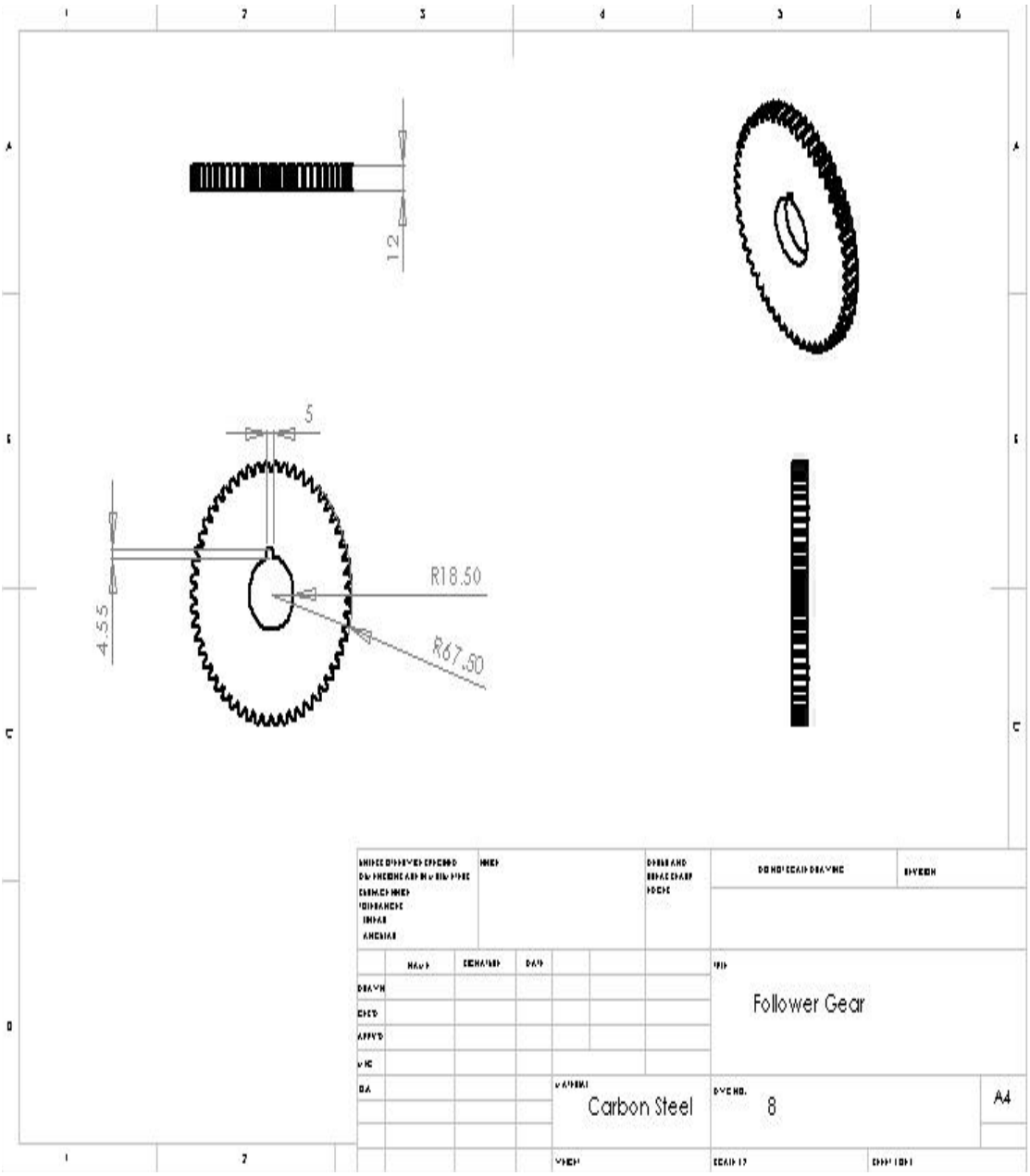
SPEED REDUCER HOUSING



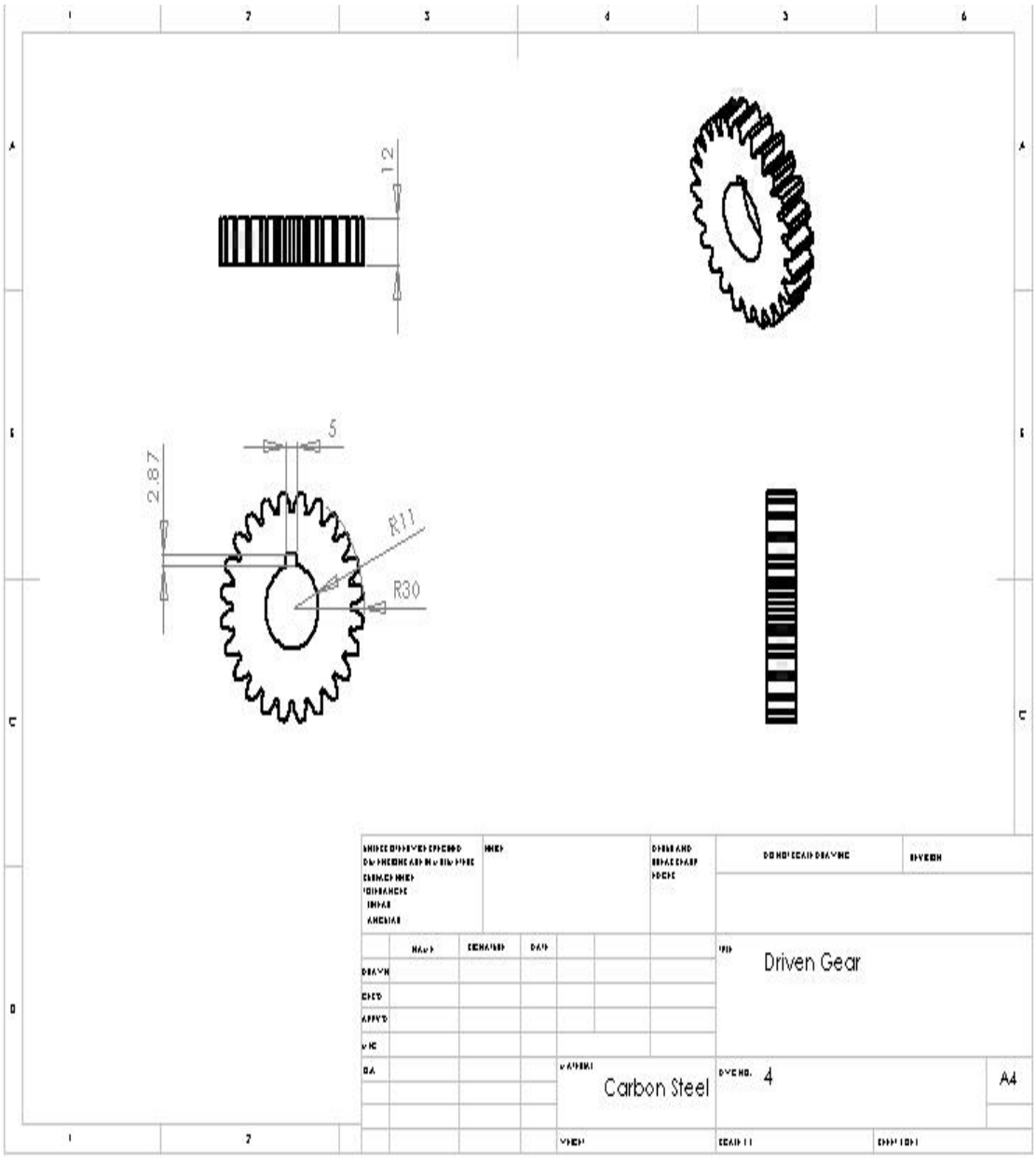
DRIVEN SHAFT



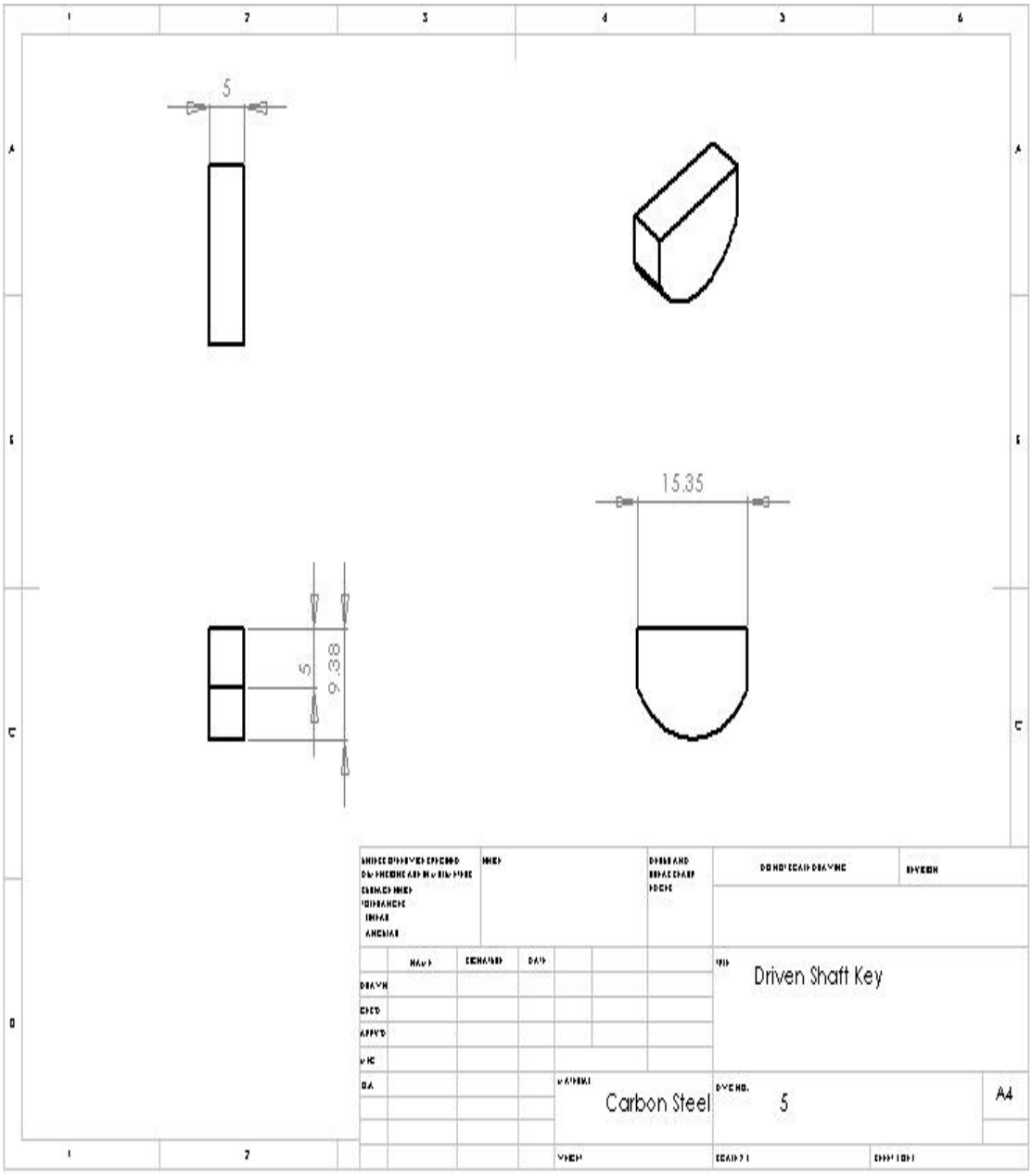
FOLLOWER SHAFT



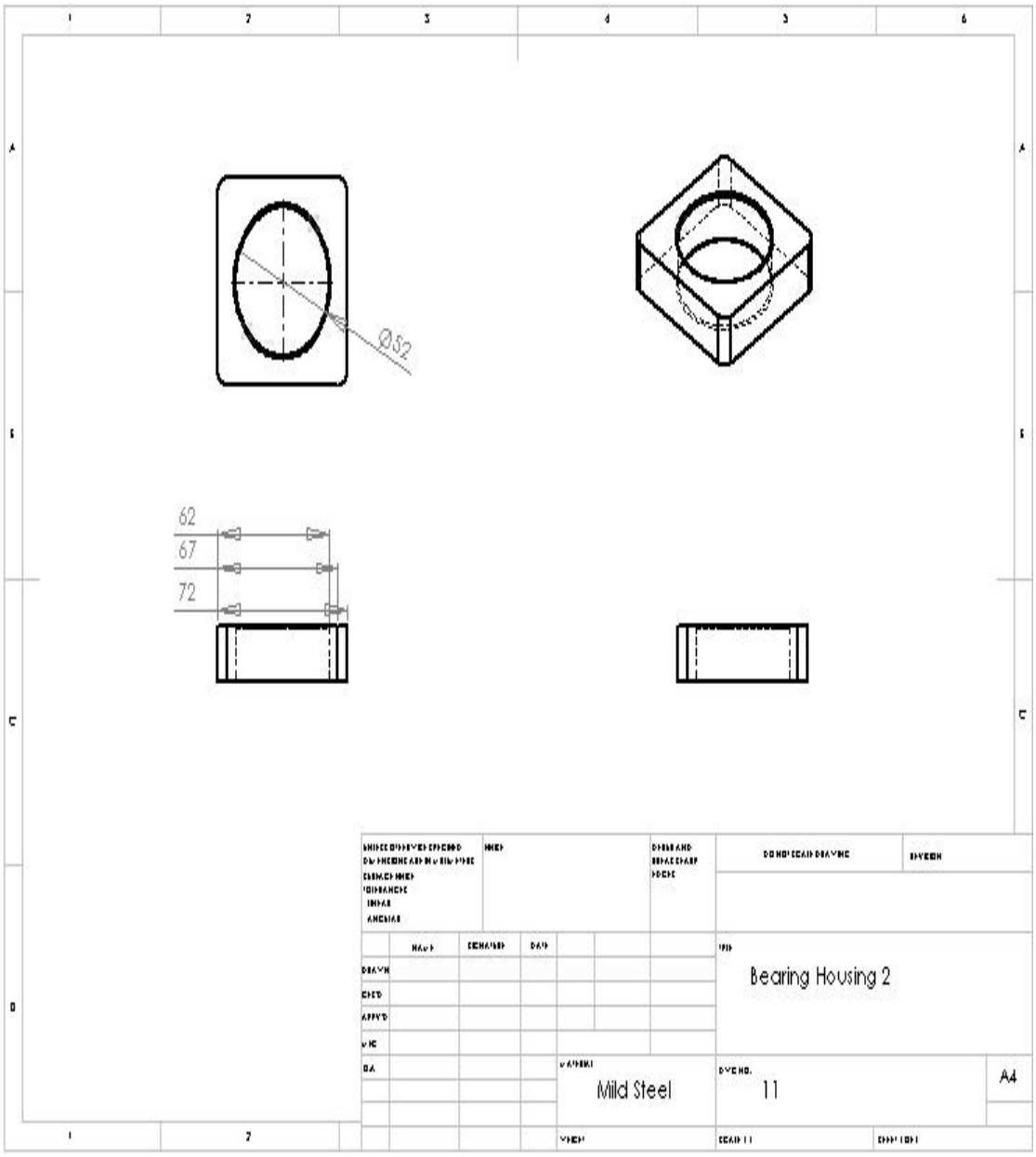
FOLLOWER GEAR



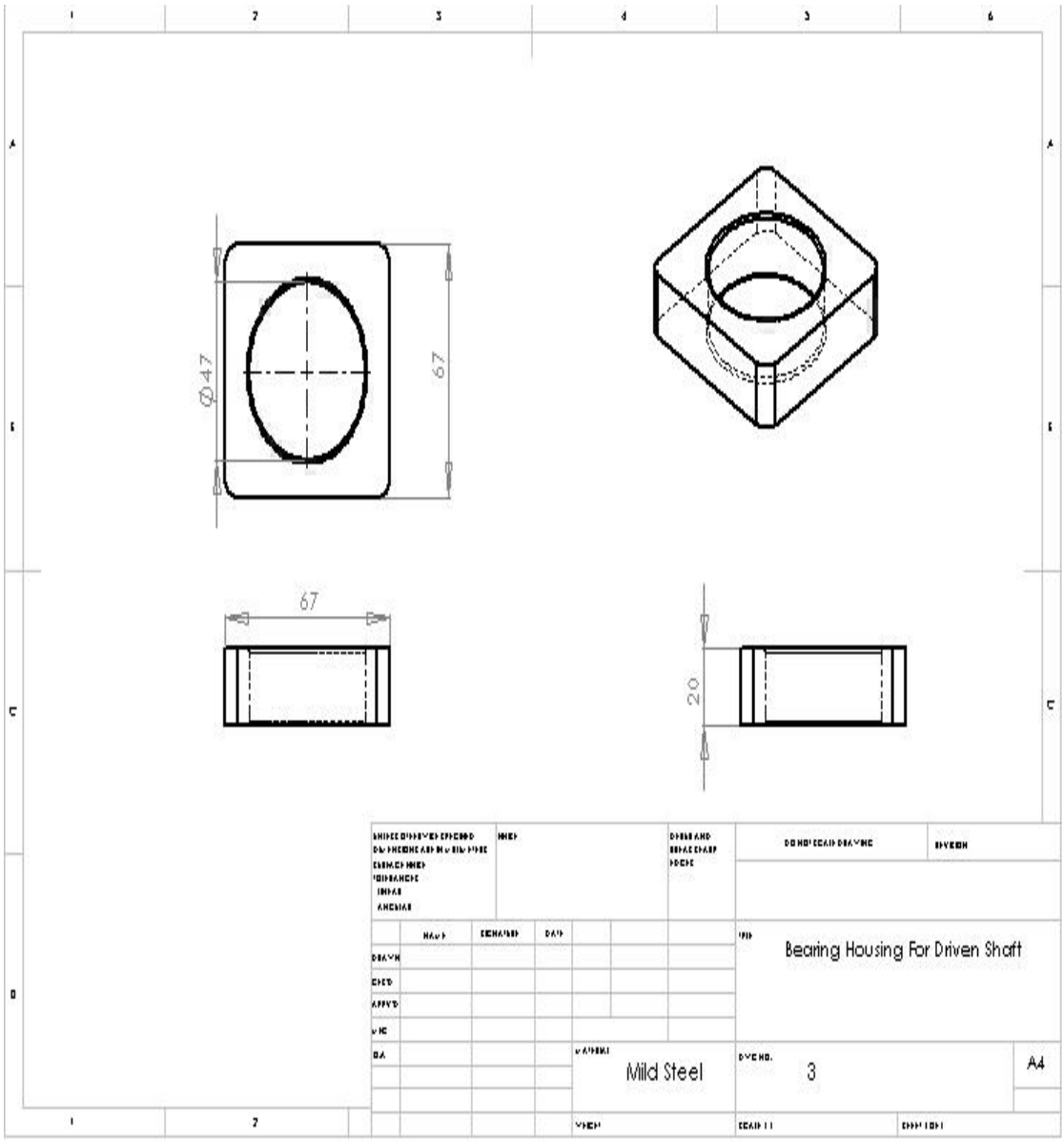
DRIVEN GEAR



DRIVEN SHAFT KEY



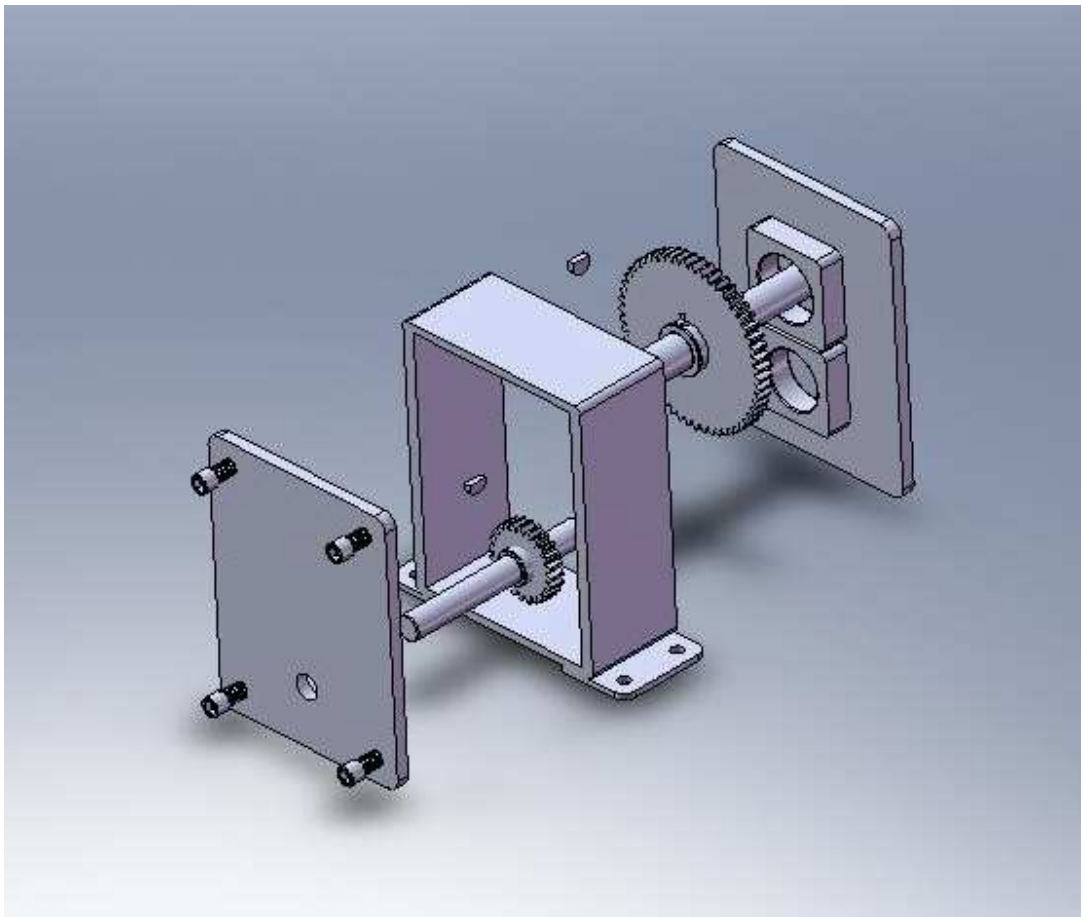
BEARING HOUSING 1



BEARING HOUSING 2

APPENDIX B

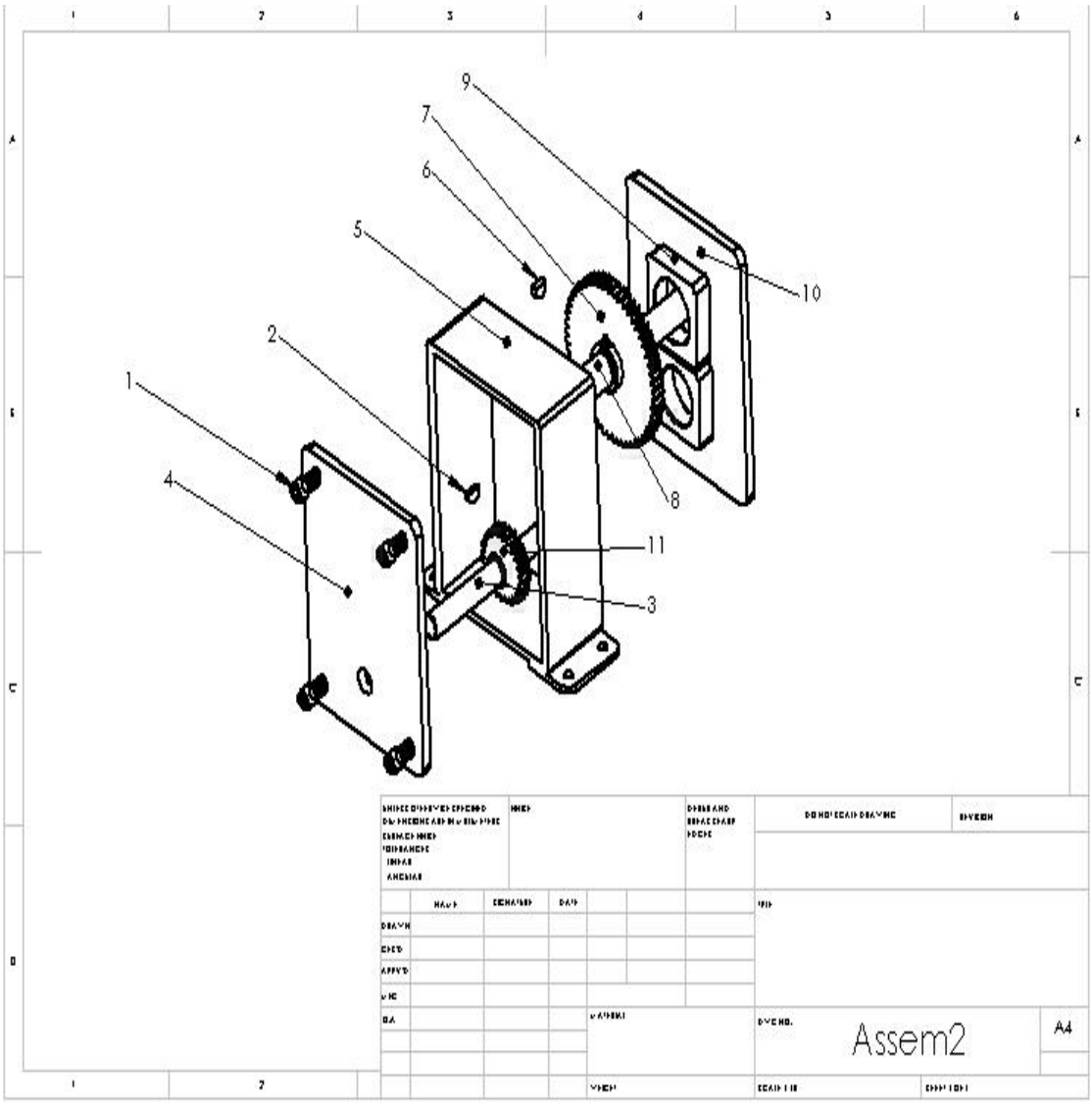
PART OF ASSEMBLY



SPEED REDUCER ASSEMBLY

Bill of material.

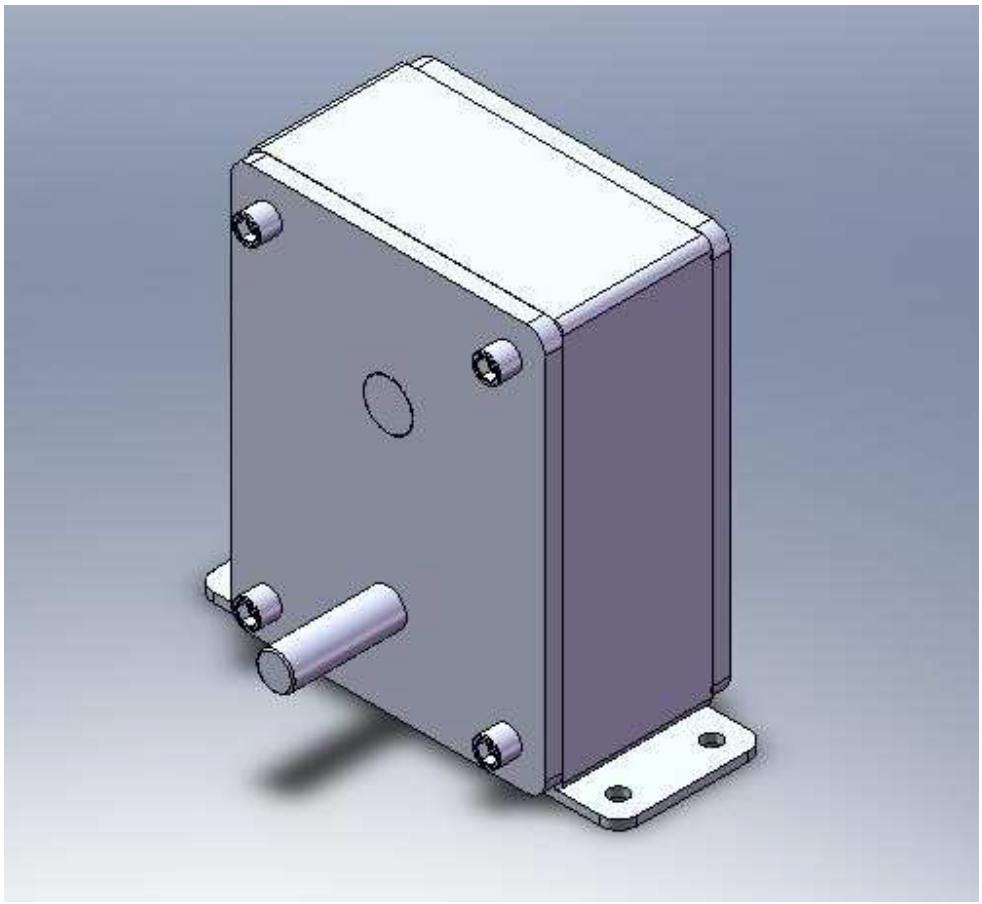
Number	Part
1	Screw
2	Driven gear key
3	Driven shaft
4	Front cover
5	Speed reducer housing
6	Follower gear key
7	Follower gear
8	Follower shaft
9	Bearing housing
10	Back cover
11	Driven gear



SPEED REDUCER ASSEMBLY

APPENDIX C

COMPLETE PRODUCT



SPEED REDUCER GEARBOX