MODAL ANALYSIS TEST RIG FOR CLAMPED-CLAMPED BOUNDRY CONDITION

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BORANG PENGESAHAN STATUS TESIS

JUDUL **FABRICATION OF MODAL ANALYSIS TEST RIG FOR CLAMPED-CLAMPED BOUNDRY CONDITION**

SESI PENGAJIAN: **2010/2011**

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MODAL ANALYSIS TEST RIG FOR CLAMPED-CLAMPED BOUNDRY CONDITION

MOHD HAFIZ BIN RAZILAH

Report submitted in partial fulfillment of the requirements for the award of the Diploma of Mechanical Engineering

Faculty of Mechanical Engineering

Universiti Malaysia Pahang

NOVEMBER 2011

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering.

Signature:
Name of Supervisor: EN FIRDAUS BIN HASSAN
Position: LECTURE
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I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurently submitted for award of other degree.

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ABSTRACT

The main focus of this project is to design and fabricate a mini modal analysis test rig for clamped-clamped boundary condition. The design generation of this project and solid three dimensional structures modelling of the test rig was developed using solid work software. This test rig was made using iron angle and hollow square bar and went through a few fabricating process such as measuring, cutting, welding and finishing. It was successfully been done and able to support a modal analysis specimen for maximum length of plate is 20cm to 30 cm.

ABSTRAK

Fokus utama projek ini adalah untuk menghasilkan rig ujikaji untuk menjalankan modal analisis bagi sempadan yang dikepit pada kedua-dua belahnya. Generasi reka bentuk untuk projek ini dihasilkan melalui perisian solid work. Rig ujikaji ini dibuat daripada besi sudut dan bar berongga dan turut melalui beberapa proses seperti pengukuran, pengeratan bahan, proses arka dan penyudahan projek. Akhirnya projek ini berjaya disiapkan dan boleh menyokong modal analisis spesimen yang mempunyai panjang maksimum antara 20cm hingga 30cm.

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CHAPTER 1

INTRODUCTION

1.1 Background

This project is involves a design and fabricate process of a mini modal analysis test rig for clamped-clamped boundary condition. This test rig can clamp a plate for range 20cm to 30cm. This test rig also adjustable depend on the length of plate that want to use.This test rig is designed for a small and medium size of plate and not for a large scale of plate.The primary challenge in developing this project is to make it functions as an adjustable test rig. However, safety is a primary concern and the test rig must meet stringent strength and safety requirements. Modal analysis is the study of the dynamic properties of structures under vibrational excitation.Modal analysis, or more accurately experimental modal analysis, is the field of measuring and analysing the dynamic response of structures and or fluids when excited by an input. Examples would include measuring the vibration of a car's body when it is attached to an electromagnetic shake

1.2 Objective

The main objectives of this project is to design and fabricate a modal analysis test rig for clamped-clamped boundary condition that can clamp small plate to perform experimental modal analysis.

1.3 Problem Statement

To perform experimental modal analysis for plate,a modal analysis test rig has to be designed and fabricated.Currently, there is no test rig for plate available in FKM except test rig for large application such as cars,bikes and heavy duty machines.

1.4 Scope

1. Develop test rig that can clamp plates for range about 20cm to 30cm.
2. Adjustable for variety of usage
3. Total test rig weight around 2 to 3 kg.
4. The material used in fabricate of this test rig is mild steel.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review of the project is totally highlighted in this chapter. In this chapter, there is a history and type of test rig. Besides that, it is consists with the design which were available in the industrial.

2.2 Type of Test Rig in Industrial

2.2.1 The Reciprocating Piston Test Rig

A model of the Reciprocating Piston Test Rig (RPTR) is shown in Fig. 2. This floating liner type test rig utilizes the crankshaft, piston, and cylinder block from a single-cylinder, 10hp engine. The 318 cc engine has a cylinder bore of 7.94 cm (3.125 inches) and a stroke of 6.43 cm (2.53 inches). A custom fixture was built to maintain accurate geometric locations for the engine components. A 2.2 kW (3hp) variable speed DC motor, located under the fixture table, drives the crankshaft through a set of pulleys. The toothed pulleys provide a speed reduction of 14:3, and the pulley connected to the crankshaft also acts as a flywheel to help reduce vibrations. A digital encoder, located on the opposite end of the crankshaft, records the angular position of thecrankshaft and can be used to determine piston location. A section of the cylinder block,containing the cylinder liner, is suspended from the rigid fixture above the crankshaft by two piezoelectric force sensors. The arrangement of the force sensors allows for the simultaneous measurement of piston position and friction forces in both the axial and thrust directions. The signals from the two Kistler 3-axis force transducers are amplified and then recorded along with the digital encoder signal through a National Instruments data acquisition board and software.

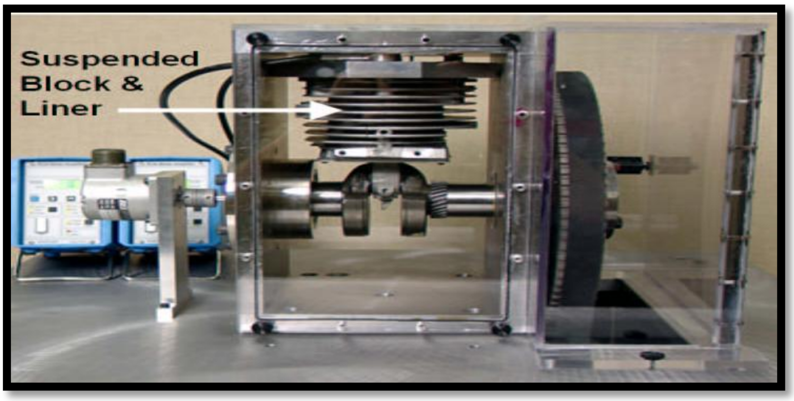

Figure 2.1: The Reciprocating Piston Test Rig

2.2.2 A Small Engine Dynamometer Test Rig

A bench scale dynamometer and the corresponding data acquisition system with measurement and control software were developed and built. The test rig has a capacity ofmotoring and braking at 10 hp with a maximum continuous torque of 39 Nm and a maximum speed of 5400 rpm. It is equipped with a torque sensor capable of measuring an average torque of up to 56.5 Nm and handling torque spikes of up to 226 Nm. A pressure sensor and an angular encoder with a maximum resolution of 0.09º are available for combustion pressure indication. For motored experiments the testing is operated and controlled automatically by the program developed using the LabView software. For fired tests a closed loop BMEP control with a servo throttle is available.

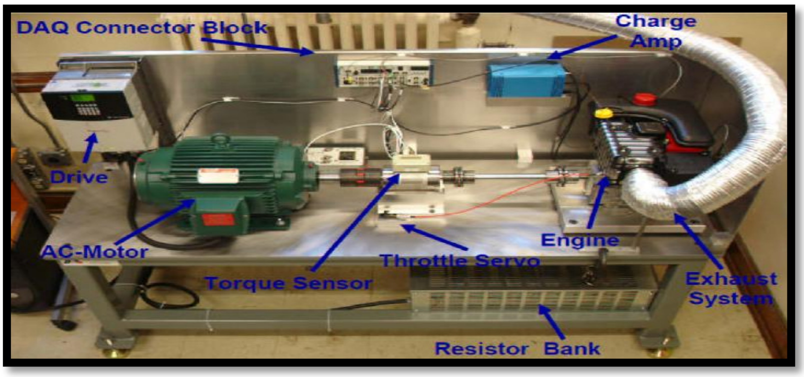

Figure 2.2: Small Engine Dynamometer Test Rig

2.2.3 Pin on Disk Test Rig (POD)

Rotation of the disk sample is controlled by a DC servo motor and a set of speed reducing pulleys located beneath the fixture table. The pin is held vertically by a balanced arm. A loadcell is used to measure the friction force. Normal force is applied by placing weights on the platform above the pin. A stationary proximity sensor, located on the fixture table, was directed toward a rotating steel target which was mounted to the bottom of the platen. The signal from the proxy sensor served as an index for the position of the specimen and was used to trigger thedata acquisition system at the beginning of each revolution. Data was acquired using a National Instruments board and a custom LabVIEW virtual instrument.

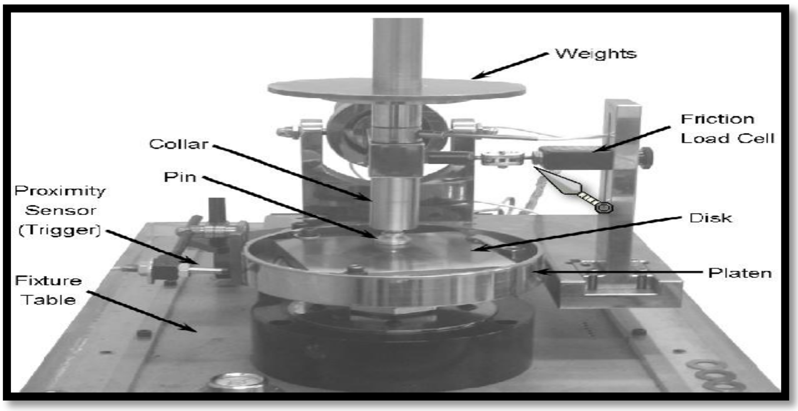

Figure 2.3 Pin on Disk Test Rig

2.2.4 Reciprocating Liner Test Rig (RLTR)

The RLTR simplifies the situation by neglecting piston secondary motion, thrust loads, multiple ring interactions, and the effects of combustion temperature and pressure. In the RLTR, a segment of a single piston ring is held stationary while a 60 degree section of a cylinder liner is reciprocated beneath it. Liner motion is provided by a slider crank mechanism with connecting rod and crank lengths comparable to those found in actual engines.

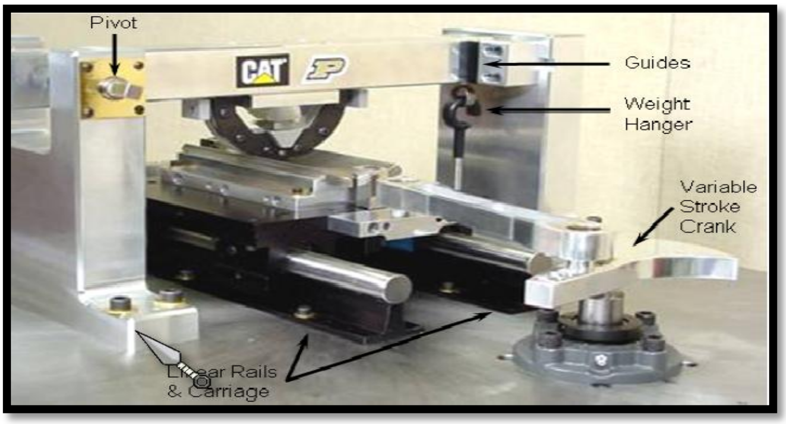

Figure 2.4: Reciprocating Liner Test Rig (RLTR)

2.2.5 Shear Driven Test Rig (SDTR)

SDTR includes: *i)* a 0.23N-m 1.8° stepper motor with an integrated controller, *ii)* amicropositioning table and *iii)* a stainless steel flat belt. The stepper motor used has a step resolution of 1/256, this allows 0.007° of rotation of motor output shaft for each step. This step resolution is necessary in order to be able to video the fluid flow out of microcavities at extremely low speeds. The micro-positioning table has a maximum travel distance of 6.4mm, and a resolution of 1_m. The stainless steel belt is 12.7mm wide, 0.0762mm thick and 280mm in circumference. There are three 20 mm diameter pulleys which guide the belt over the microcavity specimen. One of the pulleys is powered by the stepper motor and the other two are free rolling. Four posts are used to support and install the SDTR to the microscope table. Due to the limited space available on the microscope table, the SDTR is only 45mm wide, 84mm long and 84mm high.

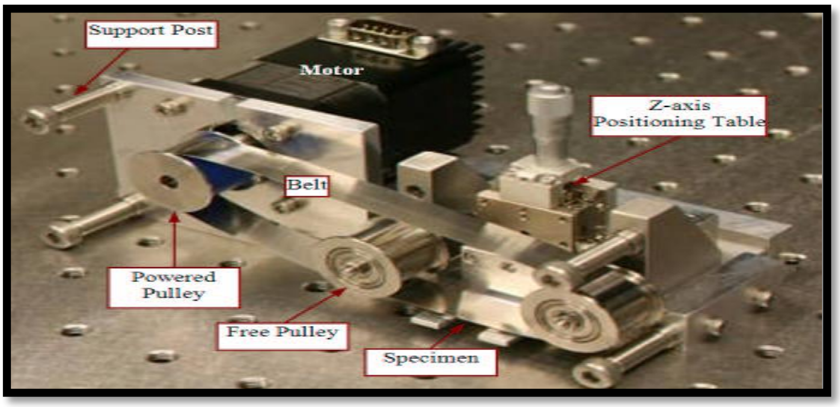

Figure 2.5: Shear Driven Test Rig (SDTR)

2.2.6 Lola Test Rig

Structural testing

Car wheels positioned on individual pans with chassis restrained to surface table.Wheel pans raised to stress suspension up to maximum expected loading.Simple load-versus-deflection plots used to show structural integrity and performance of suspension arms plus springs, dampers, torsion bars, anti-roll bars, and bump rubbers.Influence on corner weights throughout load range also recorded

Dynamic testing 4-post mode aerodynamic simulation via constant-rate force application using tensators .Full 7-post mode offers fixed or variable aerodynamic load testing with aero mapping.Track replay requires access to professional team engineers and budget

Figure 2.6: Lola Test Rig

2.2.7 Engine Diesel Test Rig

This unit mainly includes single-cylinder diesel engine, 4-stroke cycle, air cooling.Hydraulic brake, provided with electronic load cell for torque measurement,electronic pick-up for rpm measurement, base and vibration damping joints for engine supporting.Frame with bolts for floor fastening.Instrumentation:graduate burette for fuel flowrate measurement complete with feed pump,micromanometer connected to calibrated diaphragm for measuring combustion air flowrate, thermometer for measuring exhaust gas temperature, accelerator, main switch, tachometer, torque indicator.

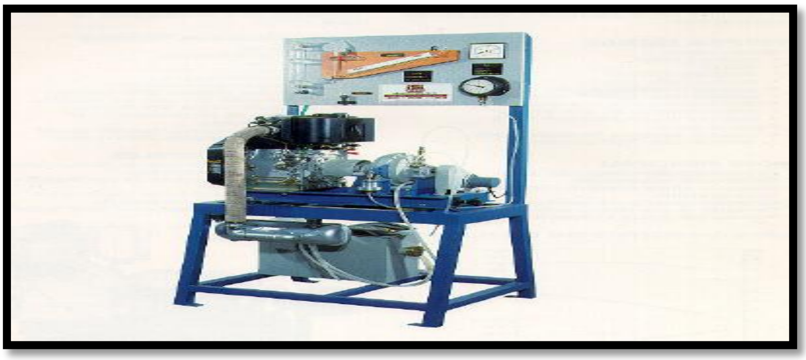

Figure 2.7: Engine Diesel Test Rig

2.2.8 Quarter-car Test Rig

A quarter-car test rig is used to study the behavior of vehicle due to the variation in road profile which is commonly known as ride analysis. The performance criteria in designing vehicle suspension system are body acceleration, suspension travel and wheel acceleration. Performance of the suspension system is characterized by the ability of the suspension system in reducing those three performance criteria effectively. The quarter car test rig should be developed in such a way that closely resembles the quarter part of a real vehicle. The quarter car test rig should have the ability to mount several different designs of actual car suspensions, able to perform a wide range of tests which include variation in body loads and the frequency of road disturbance, and still have the ability to expand for future developments.

A state-of-the-art quarter-car test rig has been designed and constructed to offer increased accuracy and testing flexibility at a reasonable cost which has the following features:

1. More realistic in representing the quarter portion of real vehicle compared with the existing quarter car test rig
2. The frequency of road disturbance can be easily adjusted
3. Variations in vehicle body and passenger masses can easily be simulated
4. Vertical and rotational dynamics of tire are considered in vehicle modeling to avoid a gross error in the representation of the actual vehicle response

5. To investigate the vehicle response in the presence of road disturbance
6. To study the damping characteristics of suspension system
7. To perform a study on the application of a control system to the rig for reproducing test vehicle response.

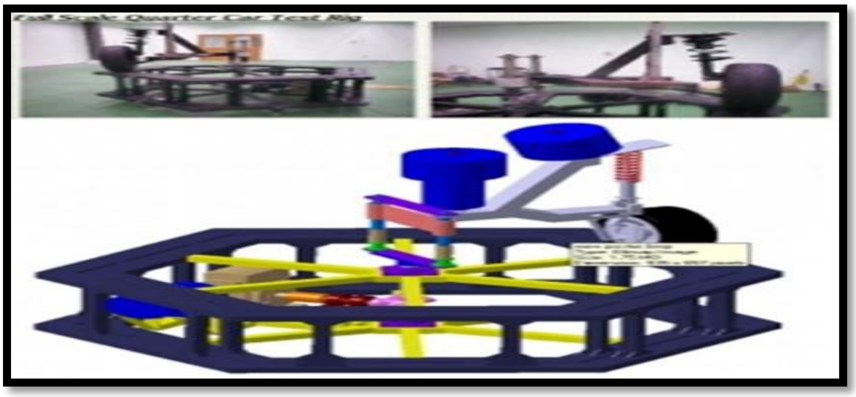

Figure 2.8: Quarter-car Test Rig

2.2.9 Pendulum Impact Test Rig

Pendulum impact test rig is designed and developed for simulating impact conditions experienced by structural component in real world crash or full scale crash test. The test rig can be adopted for crash testing individual vehicle component. The test rig comprise o a base plate which is anchored to a concrete ground, a pendulum supporting structure positioned on the base plate, a pendulum member constructed from structural T-beam that permanently secure to a rotatably shaft.

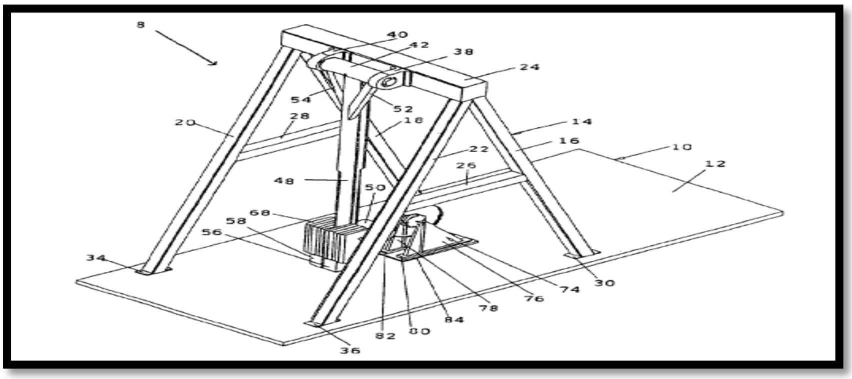

Figure 2.9: Pendulum test rig

i. Rotordynamic Test Rig for Rotor-Stator Rub Investigation

New rotordynamic test rig for rotor-stator rub investigation is built within scientific project *Nonlinear dynamics of rotational machinery* granted by Croatian ministry of education and science. Figure 2.9 shows design sketch and picture of the built rotordynamic test rig. From the Figure 2.9 it can be seen that test rig consists of the steel foundation, massive base plate elastically suspended and three subsystems mounted on it: drive, rotor and stator subsystem. Drive subsystem consists of the asynchronous electric motor rigidly mounted on the base plate and connected with the rotor via elastic coupling. Rotor subsystem includes shaft with three discs (two measuring discs and one for getting into contact with the stator) made from steel suspended on the base plate via two SKF roller bearings. Stator subsystem consists of stator ring , four circular beams and two stator casing foots rigidly connected to base plate. Two specially designed noncontact sensor supports are built in order to avoid measuring errors regarding support flexibility. First sensor support carries two Bruel & Kjaer Vibro IN 085 noncontacting displacement sensors for measuring rotor lateral movement in horizontal and vertical direction. Second sensor support carries three mentioned noncontacting displacement sensors; two for measuring stator lateral movement in horizontal and vertical direction and third noncontacting sensor for measuring torsional stator movement.

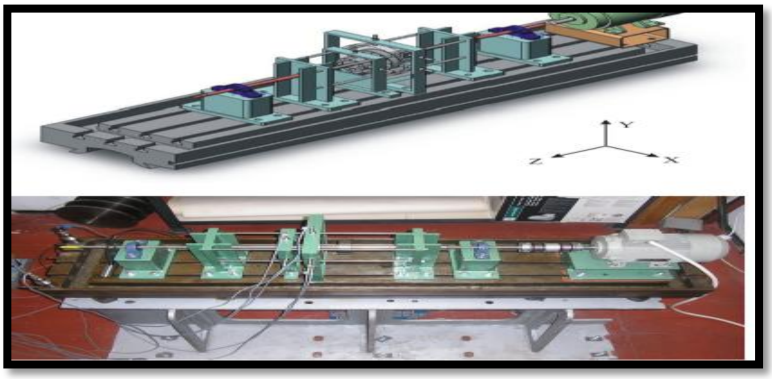

Figure 2.10: Rotordynamic Test Rig for Rotor-Stator Rub Investigation

ii. **Single Cylinder Diesel Engine Test Rig**

The ‘DYNAMIC’ test rig provided study of a diesel engine testing. The rig comprises of a four stroke diesel engine coupled to a rope brake for variable speed or electrical dynamometer. A water cooled brake drum alongwith spring balances, comprises rope brake. For electrical dynamometer water- rheostats is used as loading arrangement. With the help of various measurement provided, the test rig can determine BHP, IHP, mechanical & thermal efficiencies, air fuel ratio, specific fuel consumption and heat balance sheet at various loads.

Specification

Engine – Four stroke single cylinder water cooled, vertical diesel engine, developing 5 BHP at 1500 rpm.Dynamometer - Rope brake: Rope wound around water cooled brake drum and spring balance. Electrical: Suitable capacity Generator, and water rheostats and load bank with load measurement. Hydraulic dynamometer can be also supplied instead of rope or Electrical Dynamometer.Air intake measurement arrangement.Fuel intake measurement arrangement.Multichannel Digital Temperature Indicator to measure the temperatures at various points.Water circulated exhaust gas calorimeter. The whole unit is mounted on a sturdy frame. A technical manual accompanies the unit.

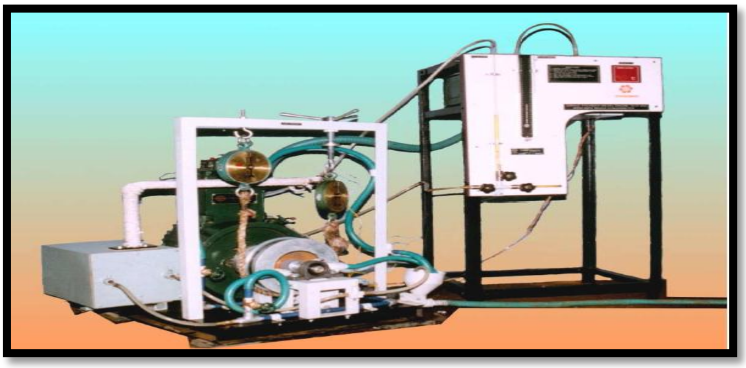

Figure 2.11: Single Cylinder Diesel Engine Test Rig

iii. **Rotary Air Compressor Test Rig**

The ‘DYNAMIC’ apparatus consists of a rotary vane compressor driven by an electric motor. Air intake is measured by an orifice meter and manometer. Discharge pressure is measured by a pressure gauge. Power input of the compressor is measured by an energymeter. Thus the students candetermine volumetric efficiency, power consumption and free air discharge of compressor.

Specification.

Vane compressor - Rotary compressor, driven by 3 HP motor. Calibrated orificemeter with water manometer to measure air intake. Energymenter to measure input of the meter. Pressure gauge to measure discharge pressure. Control valve at delivery side.Stop clock.

Figure 2.12: Rotary Air Compressor Test Rig

iv. Single Cylinder Two Stoke Petrol Engine Test Rig

The 'DYNAMIC' test rig comprises of air cooled petrol engine provided with rope brake dynamometer. Rope brake is water cooled. Temperatures are measured by a digital temperature indicator. Various measurements provided enable to determine B. H. P., fuel and air intake and brake thermal efficiency, at various loads.

Specification.

Engine - 150 cc. Horizontal cylinder, air cooled petrol engine developing 3 kw at 6000 rpm.Rope brake - Coupled to engine, with rope wound around the drum. Spring balance for loading the engine. Water cooling arrangement for the brake drum OR Electrical Dynamometer can be also supplied with water rheostat Air Intake Measurement - Intake tank of 250 x 250 x 250 mm. Fitted with orifice and water manometer. Fuel Intake Measurement – Calibrated burette with there way cock assembly for cutting off the fuel supply from the tank. Exhaust Gas Calorimeter – Water cooled exhaust gas calorimeter shell and coil type to study the heat lost to exhaust gases.

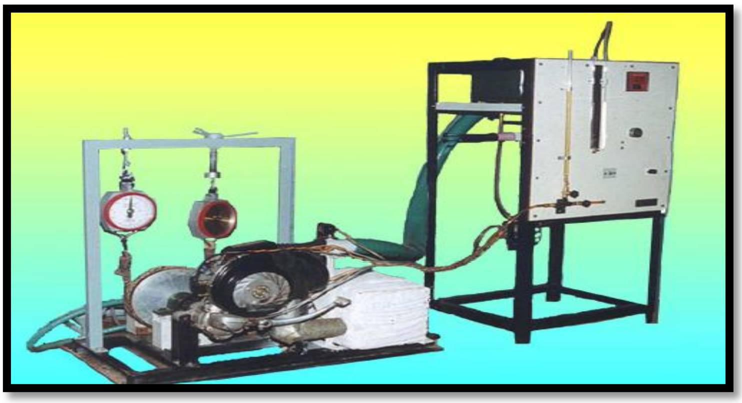

Figure 2.13: Single Cylinder Two Stoke Petrol Engine Test Rig

CHAPTER 3

METHODOLOGY

3.1 Introduction

Methodology includes a philosophically coherent collection of theories, concepts or ideas as they relate to a particular discipline or field of inquiry.

Methodology refers to more than a simple set of methods rather it refers to the rationale and the philosophical assumptions that underlie a particular study relative to the scientific method. This is why scholarly literature often includes a section on the methodology of the researchers. This section does more than outline the researchers' methods (as in, "We conducted a survey of 50 people over a two-week period and subjected the results to statistical analysis", etc.); it might explain what the researchers' ontological or epistemological views are.

Another key (though arguably imprecise) usage for methodology does not refer to research or to the specific analysis techniques. This often refers to anything and everything that can be encapsulated for a discipline or a series of processes, activities and tasks. Examples of this are found in software development, project management and business process fields. This use of the term is typified by the outline who, what, where, when, and why. In the documentation of the processes that make up the discipline that is being supported by "this" methodology that is where we would find the "methods" or processes. The processes themselves are only part of the methodology along with the identification and usage of the standards, policies, rules, etc.

3.2 Material Selection

3.2.1 Hollow Square Bar

Figure 3.1: Hollow square bar

This type of material is used to be the frame for the test rig. It is selected because the stand is preferred to be tough and strong.

3.2.2 Angle Iron

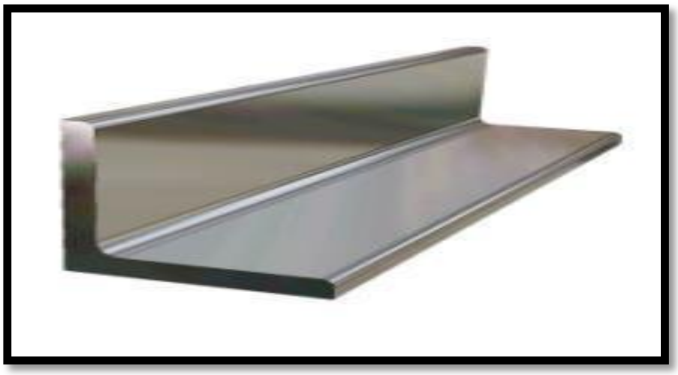

Figure 3.2: Angle iron

An angle iron is a flat metal rod that has been folded to a 90-degree angle along its length, resulting in an L-shaped piece. Usually the two sides of the angle are of equal length. Heavier angleiron is often a structural element in buildings, bridges, and so on, while lighter angleiron is used for a variety of supports.

3.3 Flow Chart

A flowchart is a common type of diagram, that represents an algorithm or process, showing the steps as boxes of various kinds, and their order by connecting these with arrows. Flowcharts are used in analyzing, designing, documenting or managing a process or program in various fields.

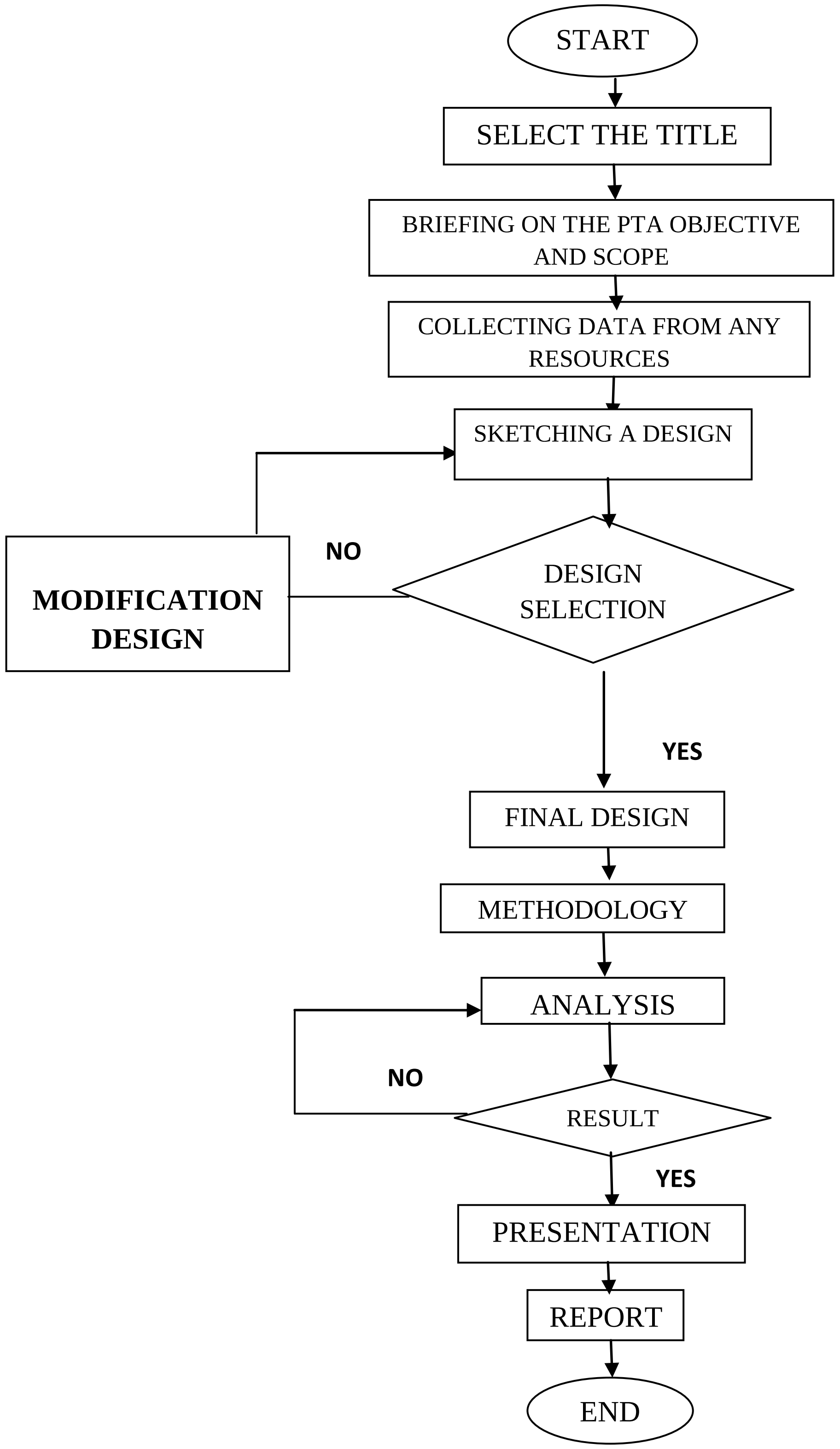

Figure 3.3: Flow Chart

3.4 Sketching

A sketch is a rapidly executed freehand drawing that is not intended as a finished work. If in oil paint it is called an oil sketch. In general, a sketch is a quick way to record an idea for later use. Artist's sketches primarily serve as a way to try out different ideas and establish a composition before undertaking a more finished work, especially when the finished work is expensive and time consuming (as in the case of a large painting or fresco. Sketching sharpens an artist's ability to focus on the most important elements of a subject and is a prescribed part of artistic development for students.

Dry media such as pencil or pastel are often preferred due to time constraints, but a quickly done watercolor study or even quickly modeled clay or soft wax can also be considered a 'sketch' in the broader sense of the term. Graphite pencils being a relatively new invention, the artists of the Renaissance could make sketches using the expensive method of a silver stylus on specially prepared paper (known as silverpoint), with results similar to a modern pencil sketch, or, more cheaply, using charcoal, chalk, or pen-and-ink.

Contrary to popular belief, artists often use erasers when drawing; the eraser may be used to remove rough construction lines, or to soften lines for visual effect. The most commonly used eraser for pencil drawing is the kneaded eraser, which has a soft, sticky surface that enables the artist to lift the graphite or charcoal from the drawing surface without smudging. White plastic erasers can cleanly erase line work, but tend to smudge heavy shading.

3.4.1 First design

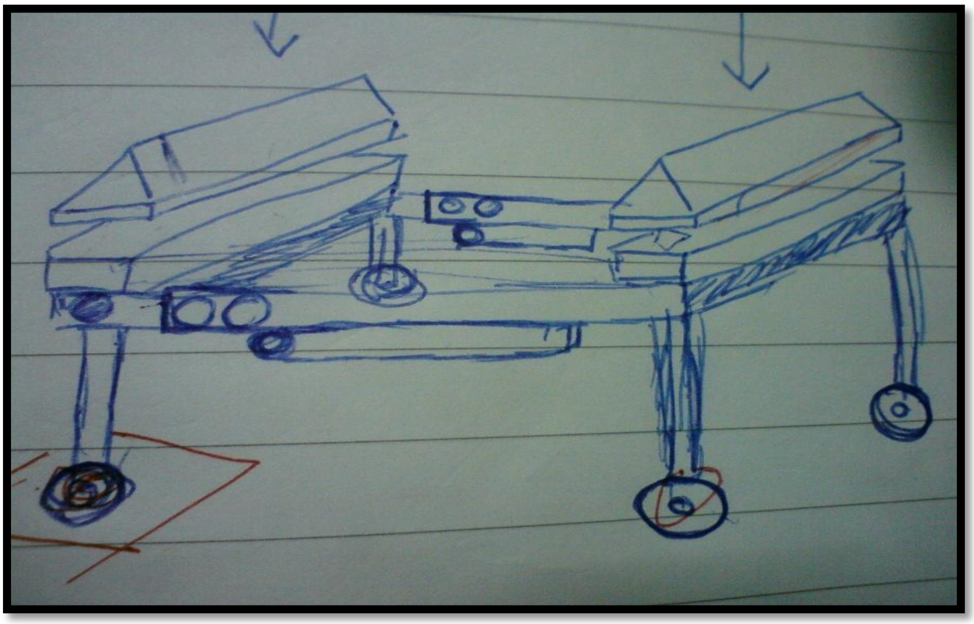

Figure 3.4: First design

Advantage

This design can be adjustable.It can clamp plate around 20cm to 30cm.Easy to store.This design also have stability because it has four stand to support load that want to be clamped.

Disadvantages

Have many edge and hard to fabricate because some part in this design is very difficult to build.

3.4.2 Second design

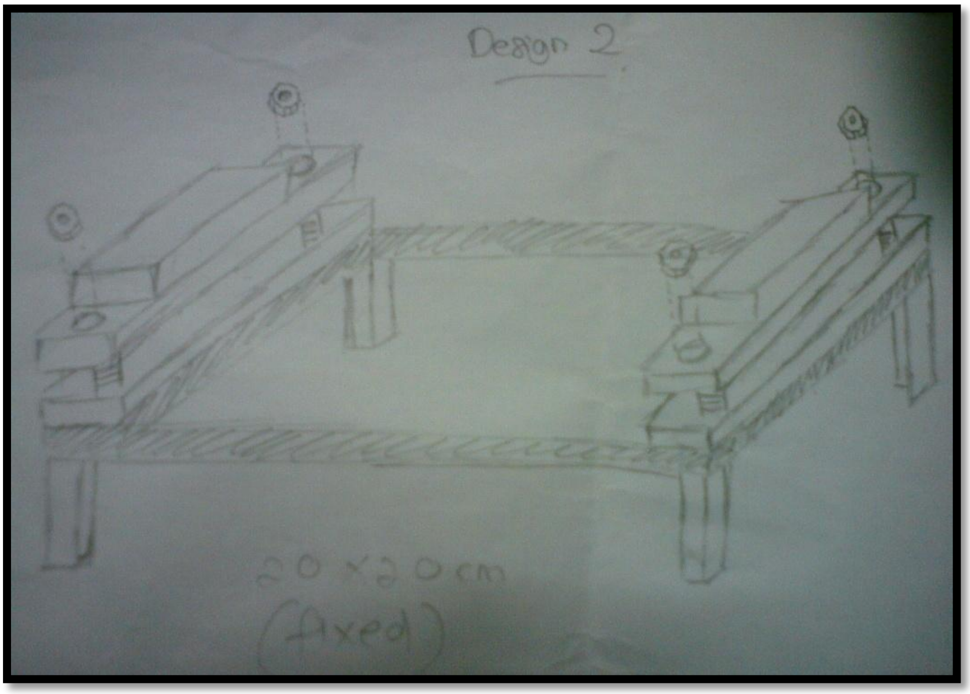

Figure 3.5: Second design

Advantage .

This design easy to store because it small and can store at large or small place.It also have stability because have four stand.

Disadvantages

This design have many edge. It also hard to fabricate.Just can clamp 20cm plate only.Cannot be adjustable

3.4.3 Third design

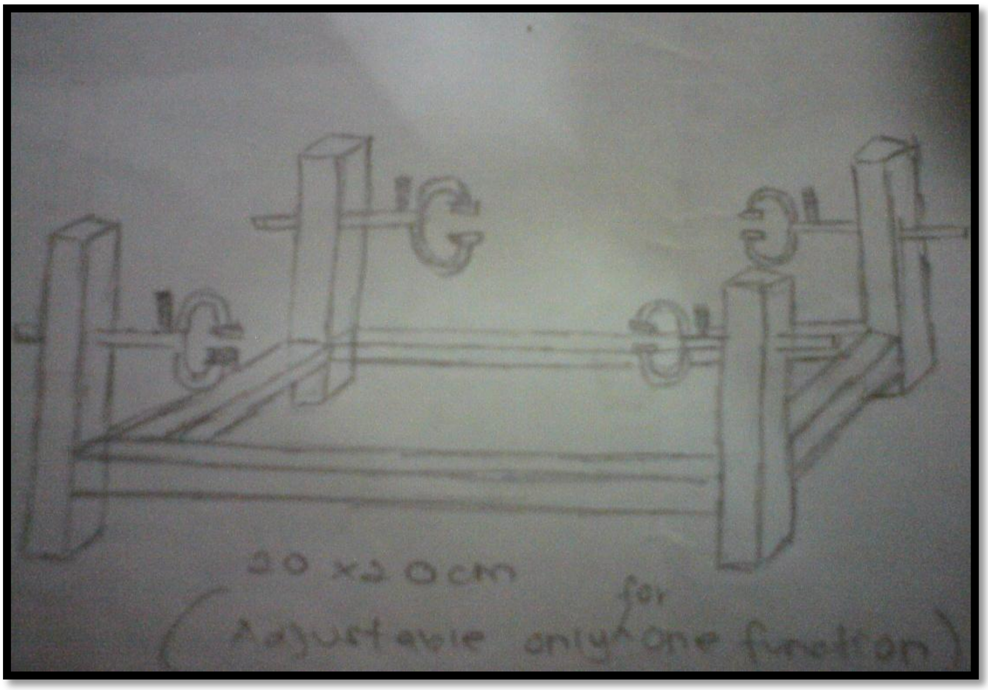

Figure 3.6: Third design.

Advantage .

Low cost.Light in weight.Simple and easy to handle.Easy to store

Disadvantages

Have many edge.Just can clamp 20cm plate only.Cannot be adjustable.Not have stability

3.5 Concept Screening

Invented by Stuart Pugh the decision-matrix method, also Pugh method, is a quantitative technique used to rank the multi-dimensional options of an option set. It is frequently used in engineering for making design decisions but can also be used to rank investments options, vendor options, product options or any other set of multidimensional entities.

A basic decision matrix consists of establishing a set of weighted criteria upon which the potential options can be decomposed, scored, and summed to gain a total score which can then be ranked.

The advantage of this approach to decision making is that subjective opinions about one alternative versus another can be made more objective. Another advantage of this method is that sensitivity studies can be performed. An example of this might be to see how much your opinion would have to change in order for a lower ranked alternative to out rank a competing alternative.

Characteristic		**design**		
	(Datum)	1	2	3
Adjustable	0	+	-	-
Stability	0	+	+	-
Ease of manufacture	0	-	-	-
Ease of operate	0	+	+	+
Manufacturing cost	0	-	-	-
Safety on operating	0	+	+	+
Sum of (+)	-	4	3	2
Sum of (0)	6	-	-	-
Sum of (-)	-	2	3	3
Net Score	0	2	0	-1
Rank	4	1	2	3

Table 3.1: Concept screening

3.6 Finalised design

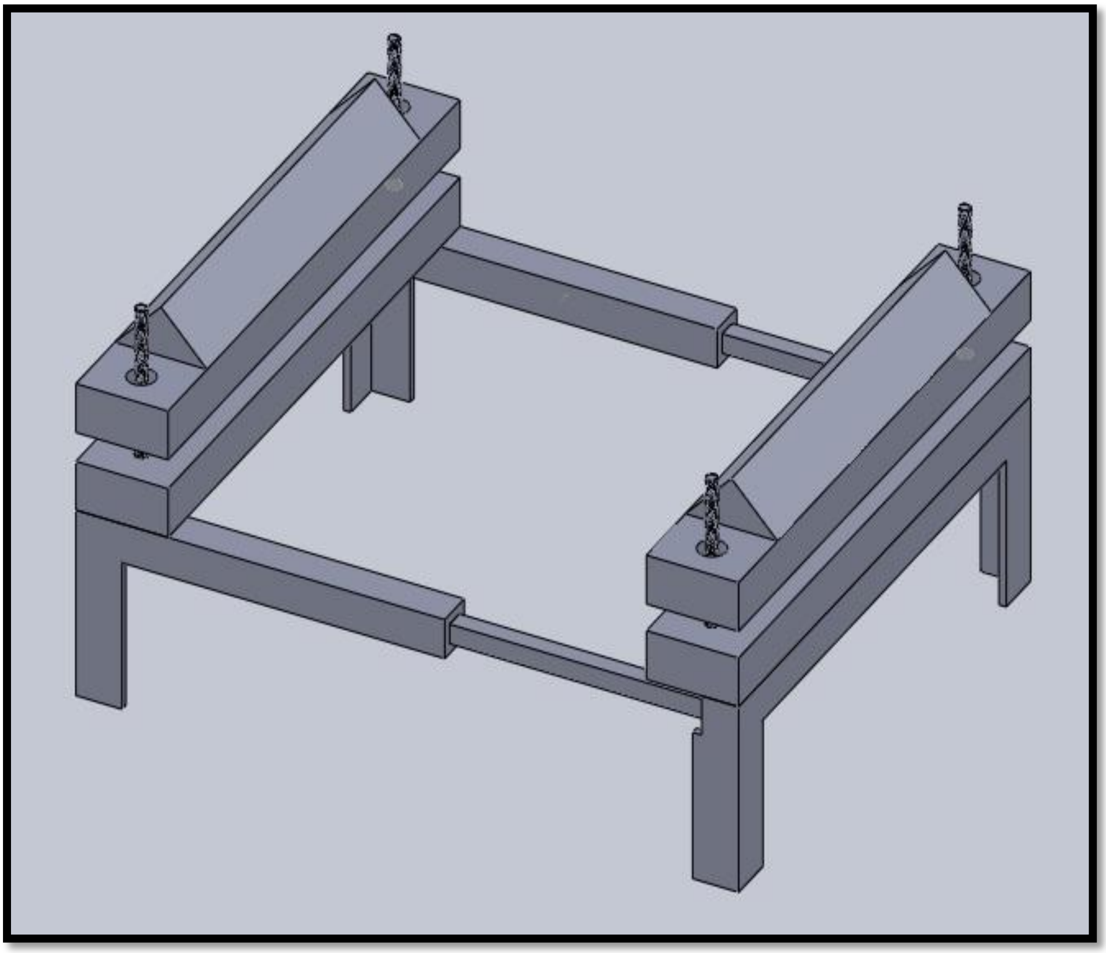

Figure 3.7: Design selected in Solid Work drawing

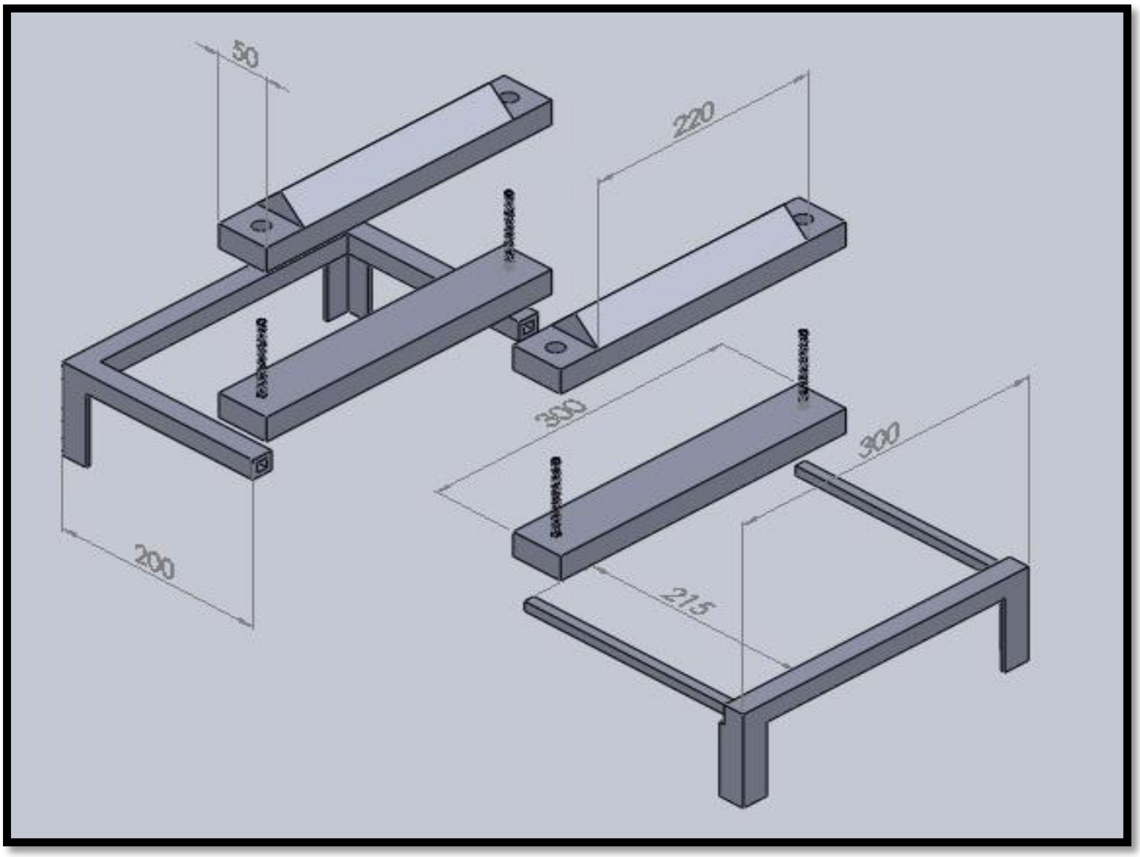

Figure 3.8: Exploded view selected in Solid Work drawing

3.7 Product Design Specification

(a) Product title

Modal Analysis Test Rig for Clamped-Clamped Boundary Condition

(b) Purpose

To fabricate a mini test rig that can clamp small plate.

(c) New or special features

- Can be adjustable.
- Can clamp plate around 20cm to 30cm.
- Easy to store
- Have stability

(d) Competition.

Will compete against standard test rig that available in industrial.

(e) Functional performance

- Long life
- Can clamp plate around 20cm to 30cm.

3.7 Fabrication

Fabrication, when used as an industrial term, applies to the building of machines, structures and other equipment, by cutting, shaping and assembling components made from raw materials. Small businesses that specialize in metal are called *fab shops*.

Steel fabrication shops and machine shops have overlapping capabilities, but fabrication shops generally concentrate on the metal preparation, welding and assembly aspect while the machine shop is more concerned with the machining of parts.

3.7.1 Measuring

In science, measurement is the process of obtaining the magnitude of a quantity, such as length or mass, relative to a unit of measurement, such as a meter or a kilogram. The term can also be used to refer to the result obtained after performing the process.

A tape measure or measuring tape is a flexible form of ruler. It consists of a ribbon of cloth, plastic, fiber glass, or metal strip with linear-measurement markings. It is a common measuring tool. Its flexibility allows for a measure of great length to be easily carried in pocket or toolkit and permits one to measure around curves or corners.

Figure 3.9: Measuring

3.7.2 Cutting

Cutting is the separation of a physical object, or a portion of a physical object, into two portions, through the application of an acutely directed force. An implement commonly used for cutting is the knife or in medical cases the scalpel. However, any sufficiently sharp object is capable of cutting if it has a hardness sufficiently larger than the object being cut, and if it is applied with sufficient force. Cutting also describes the action of a saw which removes material in the process of cutting.

Cutting is a compressive and shearing phenomenon, and occurs only when the total stress generated by the cutting implement exceeds the ultimate strength of the material of the object being cut. The simplest applicable equation is *stress* = *force/area*: The stress generated by a cutting implement is directly proportional to the force with which it is applied, and inversely proportional to the area of contact. Hence, the smaller the area (i.e., the sharper the cutting implement), the less force is needed to cut something.

When referring to propagating plants, cutting is one of the methods that can be used. It involves cutting a part of the plant typically a healthy shoot, with sharp and sterile scissors or any other cutting device, and then placing the removed part in water. Some cuttings do not require water. Certain shoots when cut are able to grow when placed in vermiculite or potting soil. However, the former is the easiest to do as most shoots when cut from the main plant need time to grow roots, and then they are able to be transferred to potting soil.

Floor cutting disc machine will be used to cut all the material following the measuring that have taken during measuring process.

A band saw uses a blade consisting of a continuous band of metal with teeth along one edge. Work pieces are fed into the cutting edge on vertical machines

Figure 3.10: Cutting

Figure 3.11: Band Saw

3.7.3 Joining (Welding)

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the *weld pool*) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the work pieces to form a bond between them, without melting the work pieces.

To join all the material into the part of trolley, welding process will be the selected process.Shield Metal Arc Welding (SMAW) will be used for joining process.

Figure 3.12: Joining

3.7.4 Finishing

Surface finishing is a broad range of industrial processes that alter the surface of a manufactured item for achieve a certain property. Finishing processes may be employed to: improve appearance, adhesion or wet ability, solder ability, corrosion resistance, tarnish resistance, chemical resistance, wear resistance, hardness, modify electrical conductivity, remove burrs and other surface flaws, and control the surface friction. In limited cases some of these techniques can be used to restore original dimensions to salvage or repair an item.

Surface finishing processes can be categorized by how they affect the work piece:

- Removing or reshaping finishing
- Adding or altering finishing

All the broken metal will grinder by grinder machine to make the smooth surface and edge of angle.

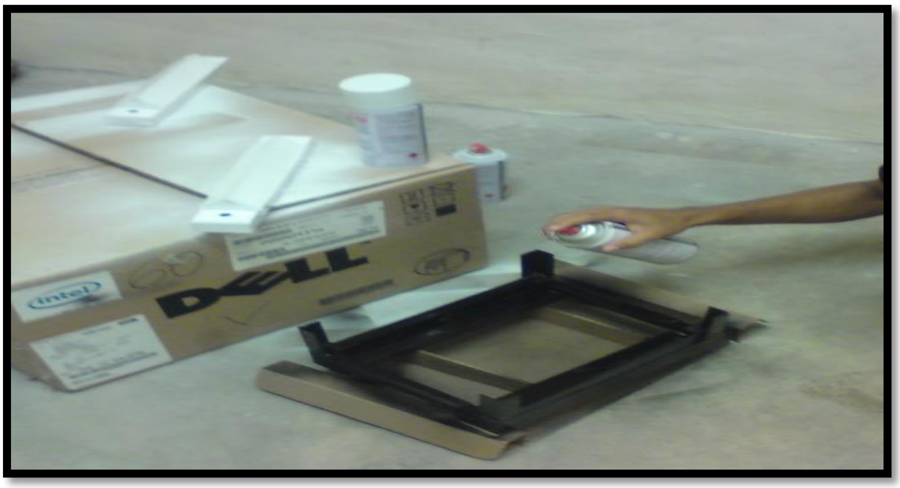

Figure 3.13: Finishing

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

The final fabrication of the Modal Analysis Test Rig for Clamped-Clamped Boundary Condition is done from only limited times due to several problems occur to the project. In this chapter will discuss mainly about the result of the project, analysis about the project and all problems encountered during the whole project was been carried out.

4.2 RESULT

After finish the fabrication, the result shown as the figure above:

Figure 4.1: Isometric View

Figure 4.2: Top View

Figure 4.3: Side View

4.2.1 Product specification

This is another example of analysis process. The product specification is shown on the table below

CATEGORIES	RESULT
Length	415mm
Width	300mm
Height	192mm
Weight	170mm
Plate can be clamped	200-300mm

Table 4.1: Product Specification

4.3 DISCUSSION

In this project, several observations have been done with respect to the fabrication of the Modal Analysis Test Rig for Clamped-Clamped Boundary Condition. The outcome design and fabricate of Modal Analysis Test Rig for Clamped-Clamped Boundary Condition was achieve the objective of this project. The Test Rig can function in good condition for example it can clamp 20 to 30cm of plate.

Besides that, this material can be corrosion if it surface exposed with oxygen and water. The painting method can be used to prevent this problem.

Figure 4.4: Corrosion on the Steel

During fabrication process, there are so many things happen such as defect. This defect happens because lacks of skill to operate a machine such as when handling Shield Metal Arc Welding (SMAW). Although this problem happened, its can gives an experience to avoid the same problem to be repeated again at the future.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The main objectives of this study are to design and fabricate the Test Rig for Clamped-Clamped Boundary Condition is successful.

As conclusion, I have achieved both design and fabricate the Test Rig for Clamped-Clamped Boundary Condition with the qualities of accessible, movement, stability and strong enough to withstand the load. According to the design I have fabricate the final product according to it.

5.2 RECOMMENDATION

The project planning should be start and done before the project start, do all the process on time according to the Gantt chart, so that all the process can be completed. The skills in fabrication process such using arc welding must be improved and well train before running the project. For the next project I will use MIG welding process because the result more better than use arc welding.For addition, the project should be improve by using the materials that more light and have better properties, so they can give the best performance, the great features and more ergonomic value to the project. Besides that,for the future I would like to use stainless steel for this project because it was not rust and long lasting.

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V. http://enlightenments.wordpress.com/2009/01/06/a-new-modified-full-scale-quater-car-test-rig-development-in-my-lab/

APPENDIX A

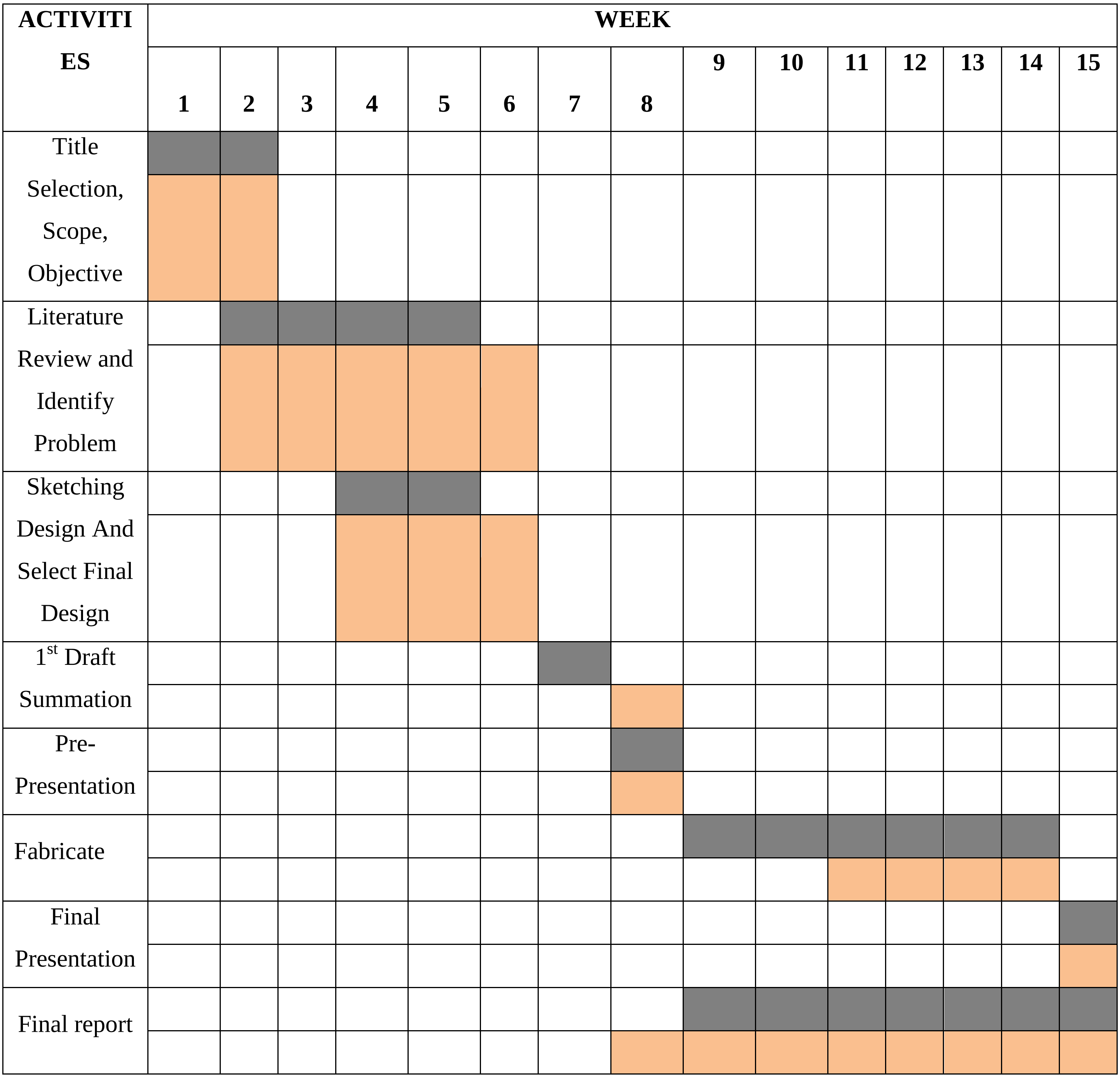
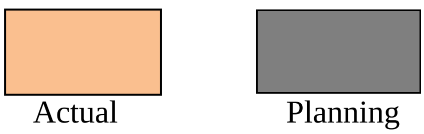
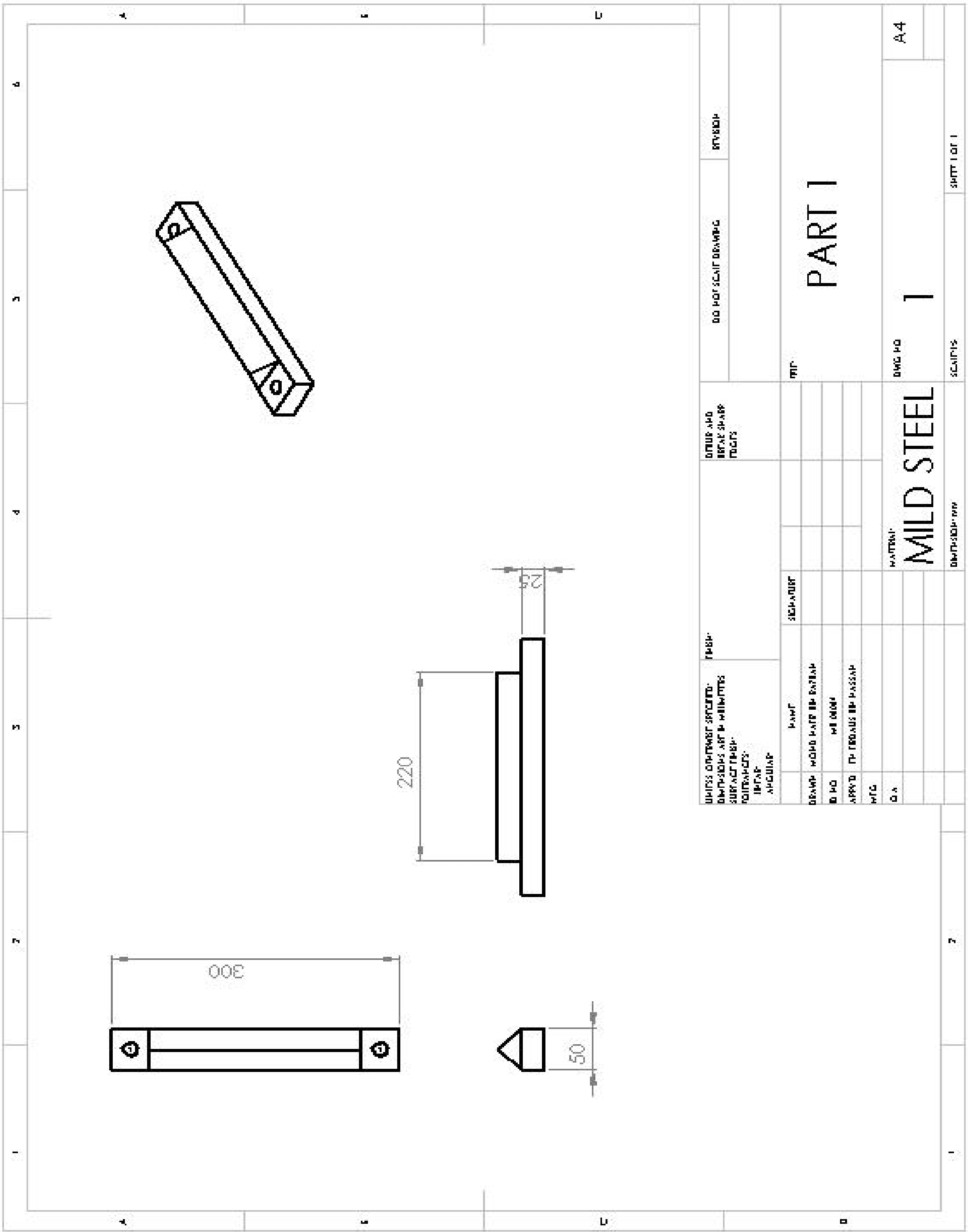


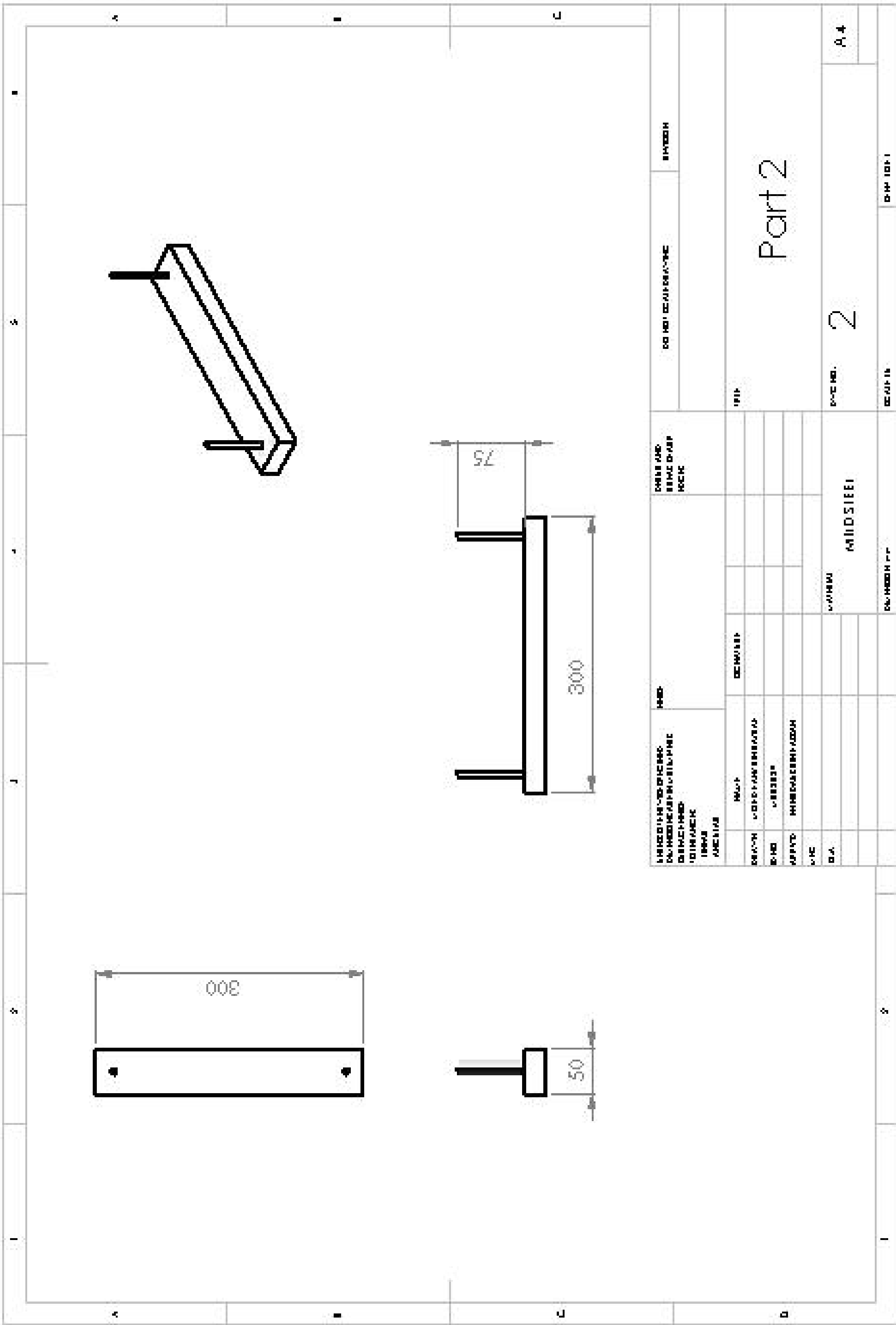
Table 5.1: Gantt Chart



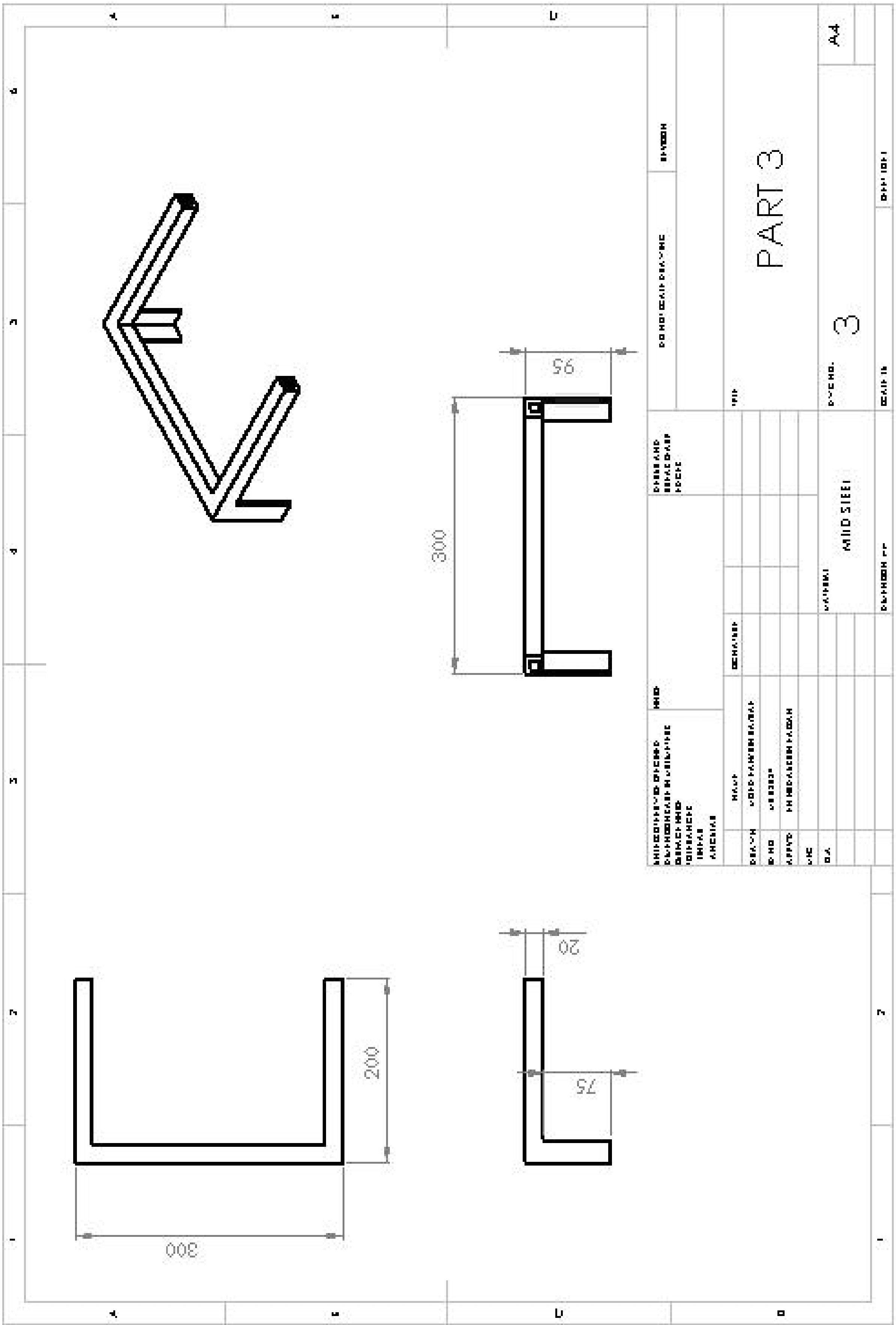
APPENDIX B

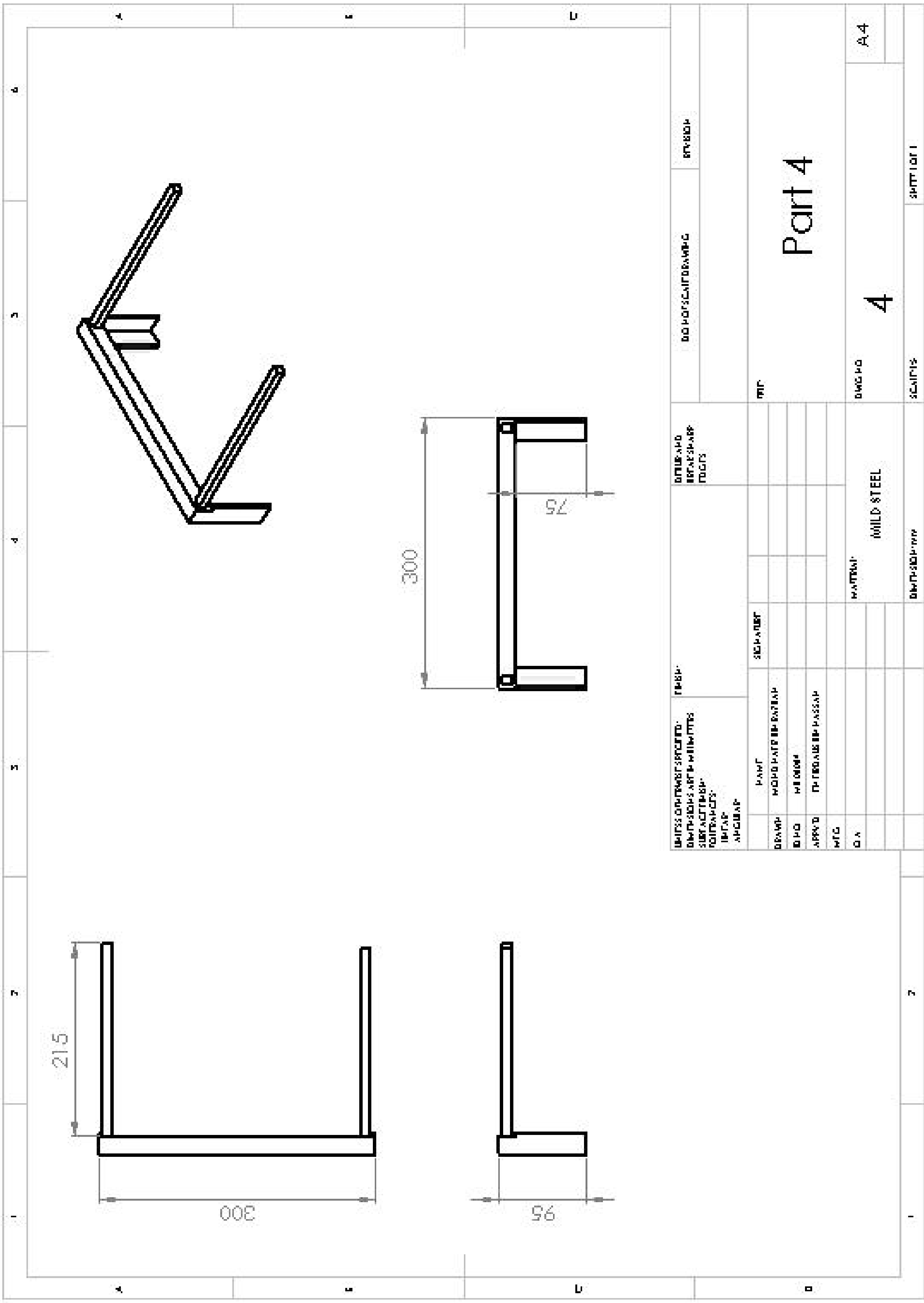
DRAWING



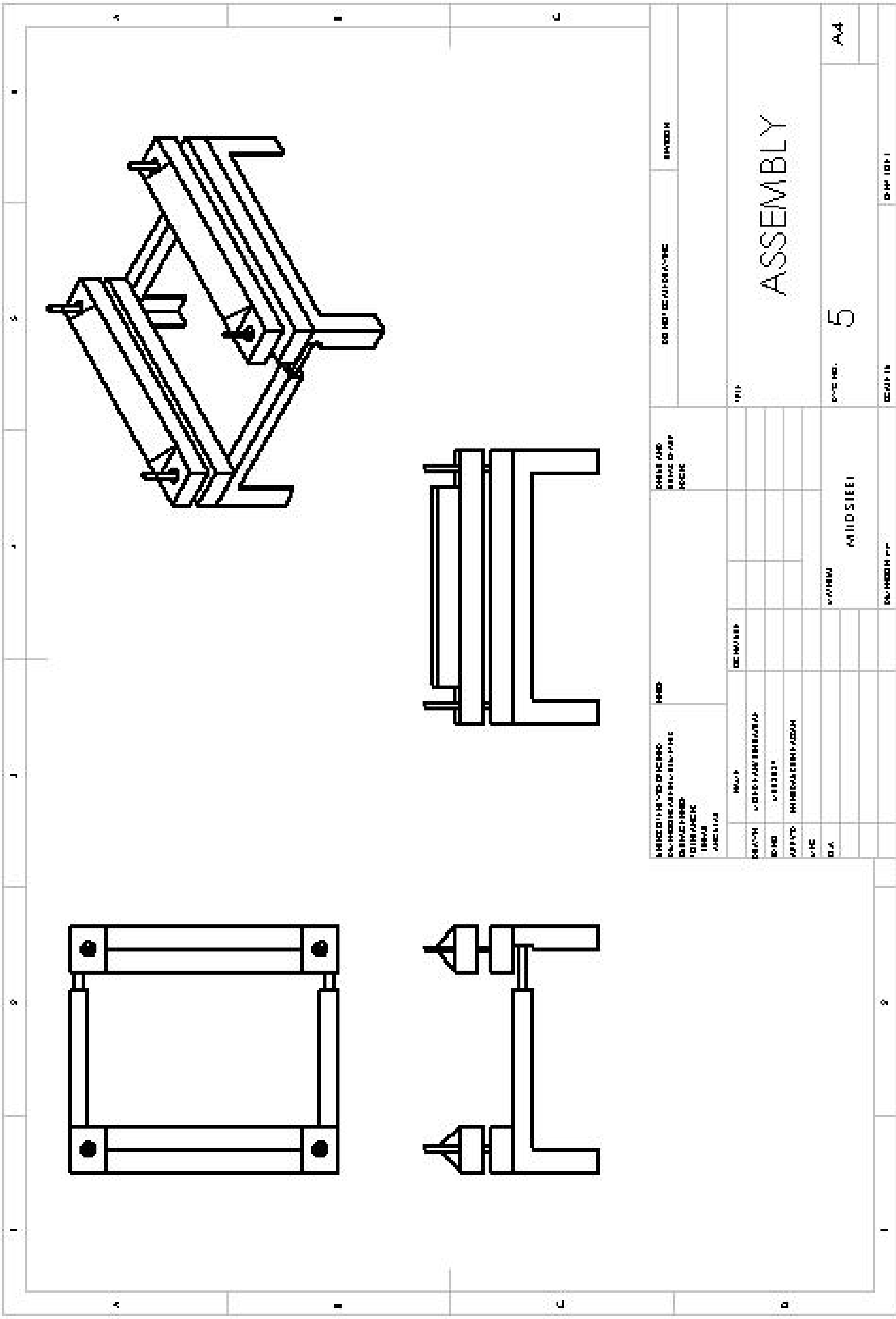


Part 2
2
A4
75
300
300
50


PART 3
A4
3
MILD STEEL
95
300
200
20
75
300



300
75
215
300
95
Part 4
4
MILD STEEL
A4


ASSEMBLY
5
A4