TA201A : MANUFACTURING PROCESSES

PROJECT DESIGN REPORT

DESIGN IDEA : FORKLIFT

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Section	S10
Group	G2

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3	PRABHAT MEENA	200688
4	PRAKHAR MAHESHWARI	200697
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ACKNOWLEDGMENT

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We would also like to thank our Course Instructor, Dr. Sudhanshu Shekhar Singh, for providing us with this opportunity to explore our creativity and create a model of something of our own and expand our knowledge base. The lectures provided were very helpful for understanding how various manufacturing processes worked.

We would also like to extend our gratitude to our teaching assistants, Shubham Prabhudayal Jaiswal and Ankur Srivastava for their valuable time and suggestions.

INTRODUCTION

Forklift is a small industrial vehicle, having a power operated forked platform attached at the front that can be raised and lowered for insertion under a cargo to lift or move it. Forklifts serve the needs of various industries including warehouses and other large storage facilities.

Forklifts are powered by electric battery or combustion engines. Some Forklifts allow the operators to sit while driving and operating the machine while others require the operator to stand. It is being extensively used throughout the industry for transporting materials and goods.

Forklifts are used from delivery trucks to storage regions in the dockside to ships, they are used particularly in transporting steel and wood shipments. Recycling facilities – Besides dockyards, forklifts are also useful in recycling operations. Forklifts serve the needs of various industries including warehouses and other large storage facilities.

MOTIVATION

The project is designed to meet the needs such as movement and transportation of bulky cargos. The idea is then to create a mechanism which would resolve the annoyance resulting from such a menial task.

We have tried our best to build a forklift model at the cheapest cost for use. One of the main uses of forklifts is to lift heavy loads that are way beyond the limitations of a human being. To ease up the amount of work required, we have tried our best to build a forklift machine at a cheap cost to serve most people. Forklifts can save companies money on manpower, but also offer a safer way to pick up heavy goods without any chance of harm coming to employees.

Forklifts are used from delivery trucks to storage regions in the dockside to ships, they are used particularly in transporting steel and wood shipments. Recycling facilities -

WORK DISTRIBUTION

Name	Turn1	Turn 2	Turn 3	Turn 4	Turn 5
Rutuj Palkhedkar	Proposal of Idea and Idea Discussion	Working on Isometric Drawing on CAD	Designing Cab	Designing Tilt cylinder	Cost analysis and review
Pavan Kumar C	Proposal of Idea and Idea Discussion	Working on Isometric Drawing on CAD	Designing Carriage	Designing Hydraulic lift cylinder	Finalising design and assembly
Prabhat Meena	Proposal of Idea and Idea Discussion	Working on Design part	Designing Mast	Materials Envisaged	Final Presentation
Prakhar Maheshwari	Proposal of Idea and Idea Discussion	Naming and Dimensioning	Designing Load Backrest	Materials Envisaged	Cost Investigation
Prashant Kumar Mishra	Proposal of Idea and Idea Discussion	Working on Isometric Drawing on CAD	Designing Forks	Parts assembly	Cost Analysis
Priya Singh	Proposal of Idea and Idea Discussion	Preparing presentation	Designing Overhead guard	Presentation and execution	Final Presentation
Pulkit Dhamija	Proposal of Idea and Idea Discussion	Naming and Dimensioning	Designing Tires	Parts assembly and supervision	Cost Analysis and Review
Pyare Prasoon	Proposal of Idea and Idea Discussion	Working on Design part	Designing Counterweight	Materials Envisaged	Finalising design and assembly

TIMELINE

Week 1: 3 Project ideas and finalising forklift idea - Deciding on Parts Required.

Week 2 :Isometric view of the object.

Week 3: Assembling all Components and Further Changes to Components.

Week 4: Cost Analysis and Description of Manufacturing Processes

Week 5: Finalizing Project.

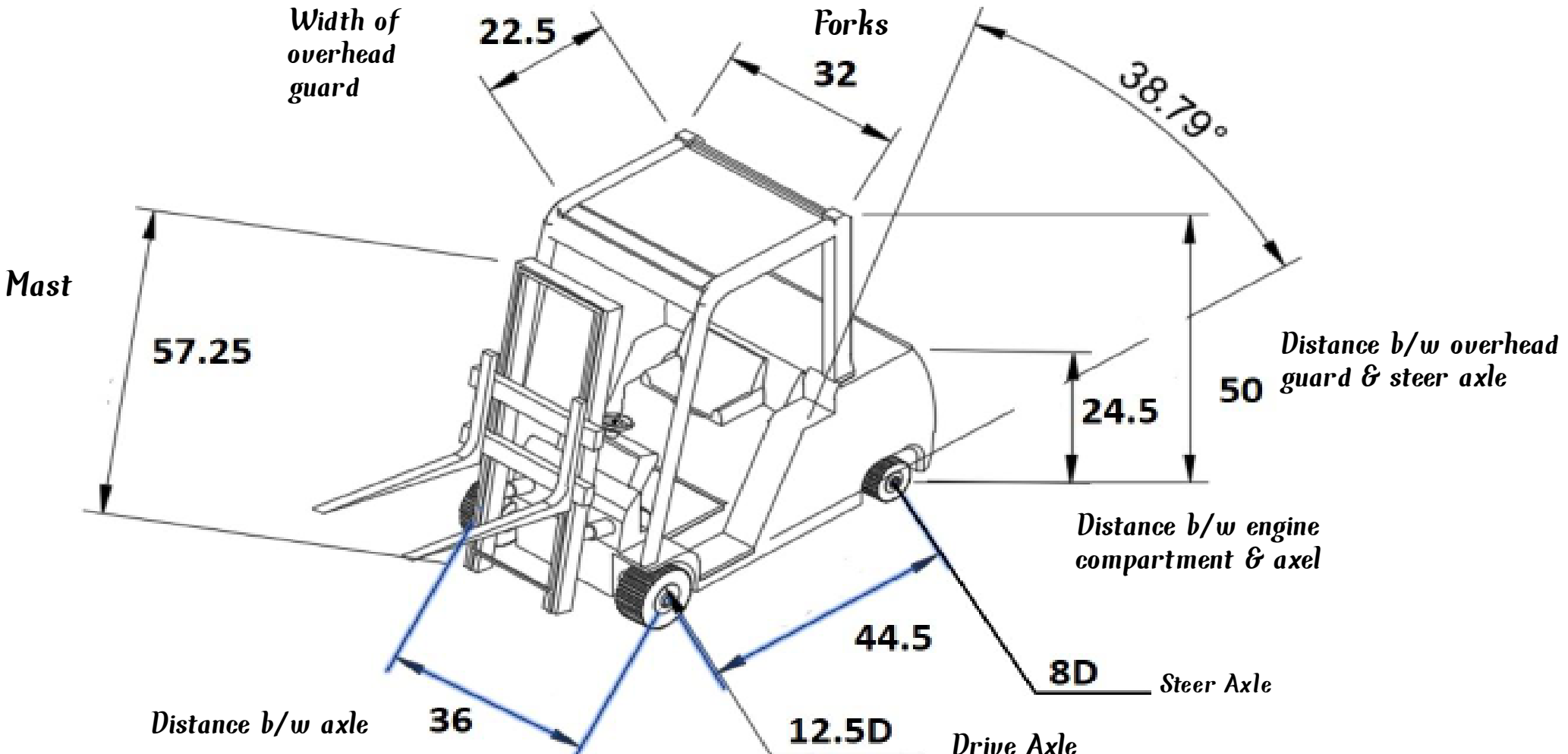
COMPONENTS

1. Cab
2. Carriage
3. Mast
4. Load Backrest
5. Forks
6. Overhead Guard
7. Tires
8. Counterweight
9. Tilt Cylinder
10. Hydraulic Lift Cylinder

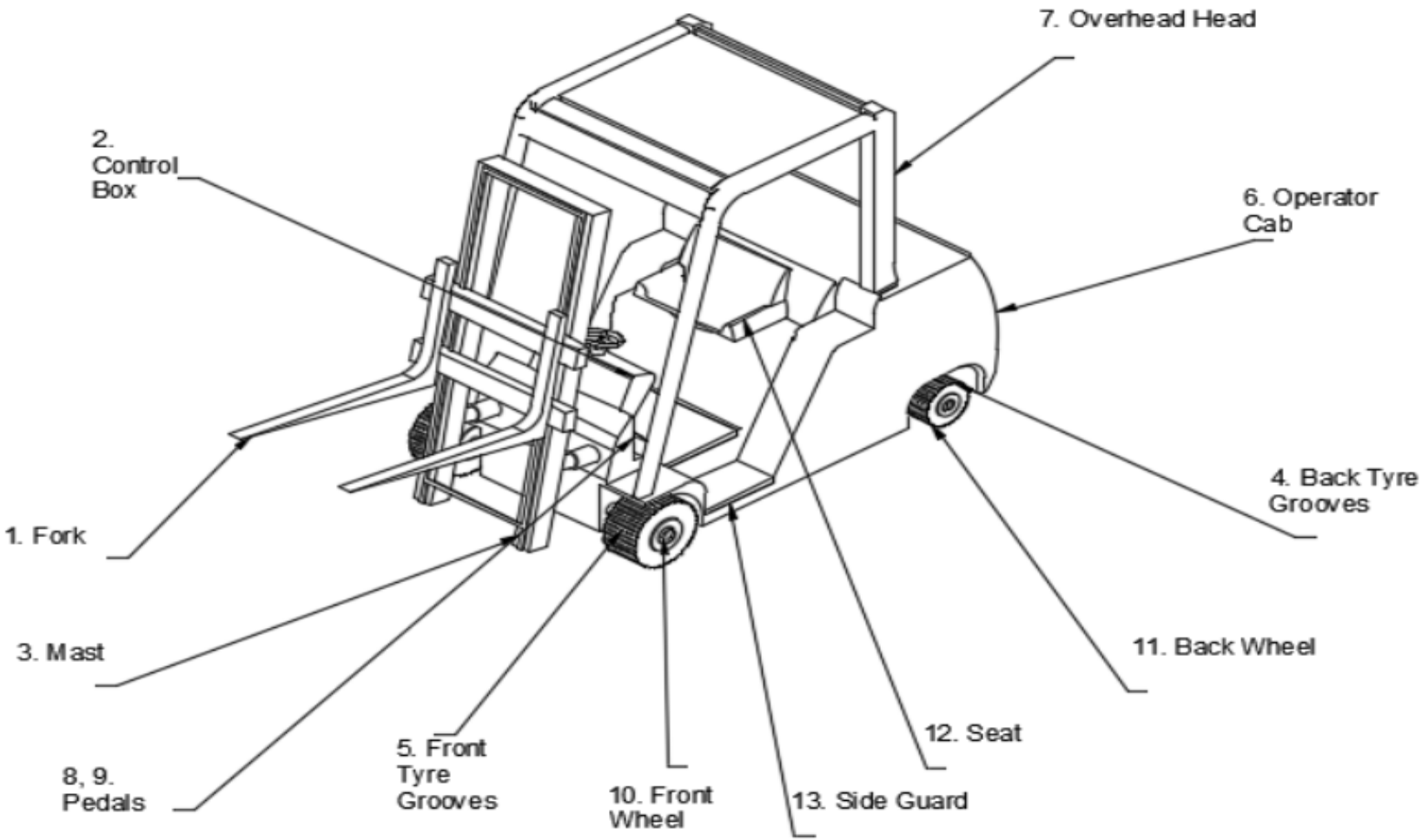
Raw Materials for Parts and Manufacturing Processes:

1. **Cab**: Steel/Aluminium castings ; Casting(Lost foam casting) and Welding(MIG/TIG welding) processes are employed
2. **Carriage**: Steel forgings ; Casting and appropriately bending is done to forge required shape
3. **Mast**: Steel/Aluminium plates ; Casting and Welding is performed
4. **Load Backrest and Forks**: Steel/Galvanized iron sheets and rods ; Cutting, bending and Welding (MIG/TIG welding process)
5. **Overhead Guard**: Steel tubes; Casting and Welding is done
6. **Tires**: Non metallic material like plastic/hardened rubber and steel forgings for mounting; Casting and assembling
7. **Counterweight**: Cast iron bar/ Concrete filled steel shell; Casting, filling and TIG welding
8. **Tilt Cylinder and Hydraulic lift cylinders**: Carbon Steel forgings(tubes)/ aluminium cast; Casting, punching and boring (for pistons)

ISOMETRIC VIEW AND DIMENSIONING



Labeling Of Parts



Materials Required and Cost Analysis

Component	Material Required	Cost Analysis	Manufacturing Process
Forks	2*(27*3. 8*3. 8) square rod, 2*(18. 38*2. 24*2. 24) square rod, casted iron of volume(2*0. 5*4*2. 24*43. 6)	Rs. 654. 4	Casting from Cast Iron and Welding of rods and casted part(MIG/TIG welding process)
Angular Rods	Cast Iron	Rs. 1635	Casting and Moulding
Mast	2 Steel/Aluminium Square Rods(63*4*4) and 1 Steel Rod(22*4*4)	Rs. 3015	Casting and Welding of Rectangular rods
Load Backrest and Forks	4 Steel/Galvanized Iron Rods and Cast Iron	Rs. 655. 4	Casting and Welding (MIG/TIG welding process)

Component	Material Required	Cost Analysis	Manufacturing Process
Overhead Guard	8 rectangular steel tubes	Rs. 800.5	Casting, Bending and Welding
Rectangular Rods	Cast Iron	Rs. 324	Casting (Basic)
Exhaust Part	Cast Iron	Rs. 336.42	Casting and Welding
Seat	Rubber/Thermocol and adhesives	Rs. 607	Cutting and Adhesive Joining
Operator Cab	Cast Iron	Rs. 3000	Cutting of Sheets, Casting and Welding

Component	Material Required	Cost Analysis	Manufacturing Process
Rear Wheel	Aluminium Sheet, Cellotape, Scissors	Mild aluminium(1278rs/sheet) for 120 cm*240 cm*10mm	Metal sheet cutting, hammering
Back Wheel	Aluminium Sheet, Scissors	Mild Aluminium (1278 Rs/ sheet) for 4ft*8 ft*1mm Require 1 sheet = Rs. 1278	Casting and Welding then bolting onto axle
Type Grooves	Cast Iron	Rs 1061.25	Brazing

MANUFACTURING PROCESSES

MANUFACTURING OF FORK

1. The first step towards the manufacturing of fork involves getting a rectangle or square long strip type cast steel with the pallet fork cross section.
2. Then, we cast a long strip type steel of required length, and cut out required inclined-plane. (i.e, design the fork)
3. after the angular part of the fork has been devised, we then implement TIG welding process to weld the rectangular blocks onto the angular forks.
4. These 2 rectangular blocks can be obtained by apply the casting process on a bigger rectangular block of Scrap Iron/Cast Iron.
5. After the angular parts and rectangular parts have been made, and, their assembly is complete, what we finally get is our Fork unit.
6. Further, the devised fork can be complemented by adding colours to it, both for aesthetic purposes and for providing resistance of moisture
   attacks and rusting.

MANUFACTURING OF MAST

1. It is important to understand that the mast consists of two parts. Inner and Outer mast.

2. Thus, to assemble the mast unit, we proceed as follows:

i) Place a pair of the inner mast rails on both outsides of the lift bracket via the lift rollers, respectively;

ii) Connect the inner mast beam to each of the inner mast rails by means of bolt connection so as to form the inner mast. This process is facilitated with the help of Welding, Punching and Boring of bolt connection setup.

iii) Then, we place a pair of the outer mast rails on outsides of the inner mast rails via mast rollers, respectively.

iv) And finally, connecting the outer mast beam to each of the outer mast rails by means of Casting and TIG welding so as to form the outer mast.

MANUFACTURING OF OVERHEAD GUARD

1. The whole structured was prepared with Steel Tubes (Rectangular and Angular) of dimensions as mentioned in the Cost Analysis Slide
2. The rods required cutting and suitably bending to acquire required dimensions
3. Some rectangular rods were welded parallely to a square frame to prepare the top section of the guard
4. Angular rods were welded through TIG method to the top part to provide support and for attachment to the primary body of the Forklift
5. Similarly, two rectangular rods were welded to the previous structure and the primary body to provide complementary support from back

MANUFACTURING OF FRONT WHEEL

1. Front wheel of required diameter was primarily made using "Rubber" as it's raw material.
2. A block of rubber was taken for the manufacturing process.
3. The piece of rubber was cut into a circular shape and then a hole, of internal diameter was bored.
4. This gives us the skeleton of the Front Wheel.
5. Once the skeleton of the rear wheel is ready, the grooves can be added. (Grooves are provided to enhance friction and thus, the grip of the wheels.)
6. The grooves are provided using a standard metal stamp as the design unit.
7. Once the metal stamp is heated to high temperatures, it is applied to the wheel, which creates the grooves of the wheel.

MANUFACTURING OF REAR WHEEL

1. The Rear Wheel is also created in exactly the same way as the Front Wheel, but with different internal and outer diameters.
2. Rear wheel of required diameter (Inner and Outer) was primarily made using "Rubber" as it' s raw material.
3. A block of rubber was taken for the manufacturing process.
4. The piece of rubber was cut into a circular shape and then a hole, of internal diameter was bored.
5. This gives us the skeleton of the rear wheel.
6. Once the skeleton of the rear wheel is ready, the grooves can be added. (Grooves are provided to enhance friction and thus, the grip of the wheels.)
7. The grooves are provided using a standard metal stamp as the design unit.
8. Once the metal stamp is heated to high temperatures, it is applied to the wheel, which creates the grooves of the wheel.

MANUFACTURING OF SEAT

1. The manufacturing of the seat of the forklift in our project was done using the cutting and joining processes.
2. The raw materials which were used to carry out this process were, Foam and thin rubber and Adhesives (for the joining process).
3. The skeleton of the seat was constructed using foam rubber, to provide comfort. Different sized foam rubbers were put together at a suitable angle and were joined with the help of adhesives.
4. This was followed by a Coating of thin rubber as a sort of rotection to the foam rubber against the atmosphere.

MANUFACTURING OF SIDE GUARD

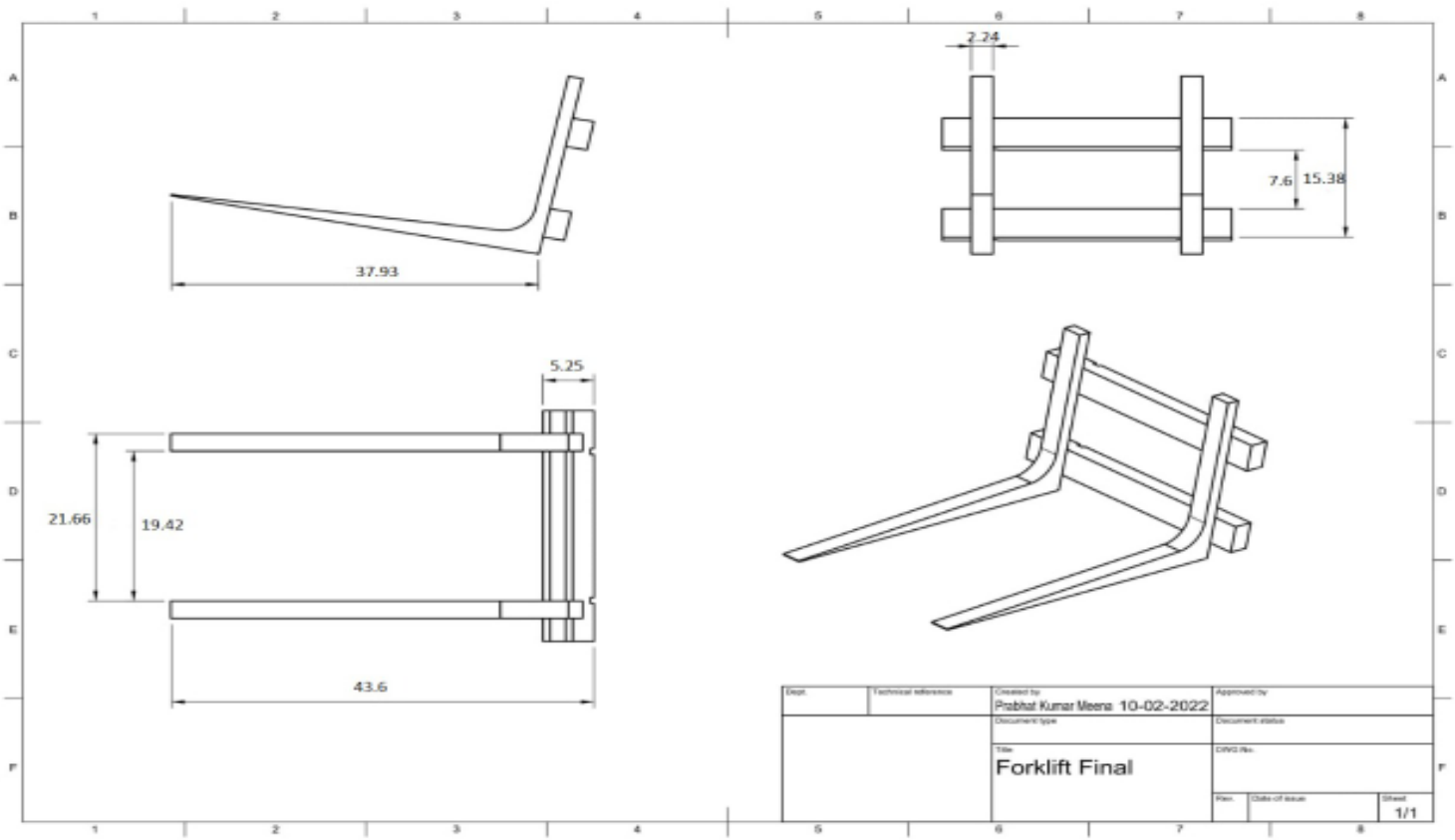
1. The side guard was made using a metal sheet.
2. A metal sheet of required length was put into place and it's ends were made angular using the casting process.
3. The ends of the metal sheet were made to melt at an angle of 90 degrees.
4. This was done to provide structural support to the side guard and enhance it's gripping.
5. The Side guard plays a critical in protecting the forklift from any sort of lateral, external damage.
6. For aesthetics and prevention against corrosion, spray paints or regular paints are also used.

MANUFACTURING OF EXHAUST PART AND DRIVER AXLE

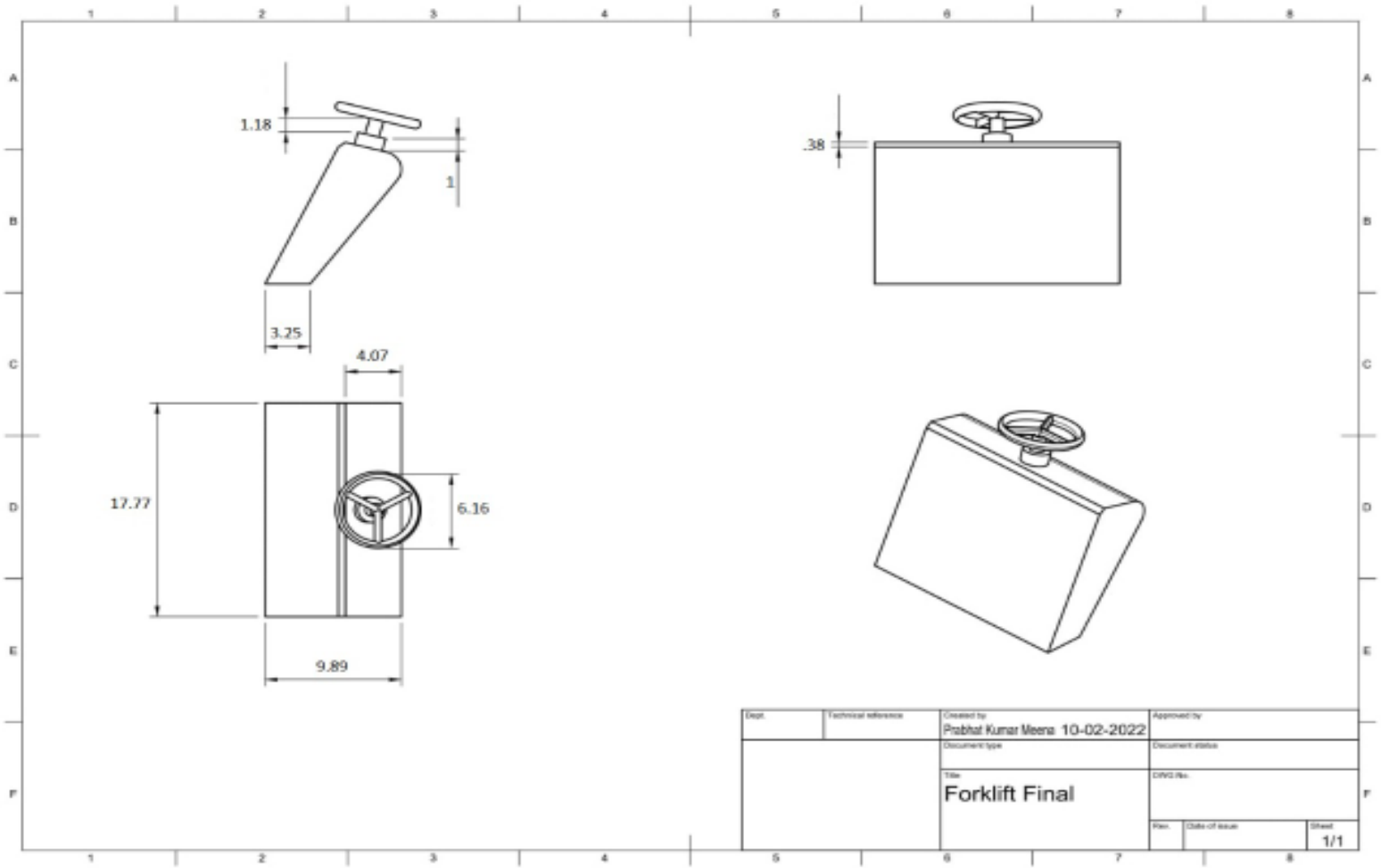
1. Exhaust Part : This required preparation of a hollow rectangular cuboid made of Steel. We welded together 6 different thick steel plates, after proper hammering , of required dimensions to prepare this part and then required surface finishing was done.
2. Driver Axle : Firstly, a long hollow but thick circular steel rod was needed onto which we applied cutting and punching processes to prepare some grooves and holes. The wheel side of the Axle were holed for bolting purposes later and the grooving was required to attach it onto the engine side.

ISOMETRIC AND ORTHOGRAPHIC VIEWS OF PARTS

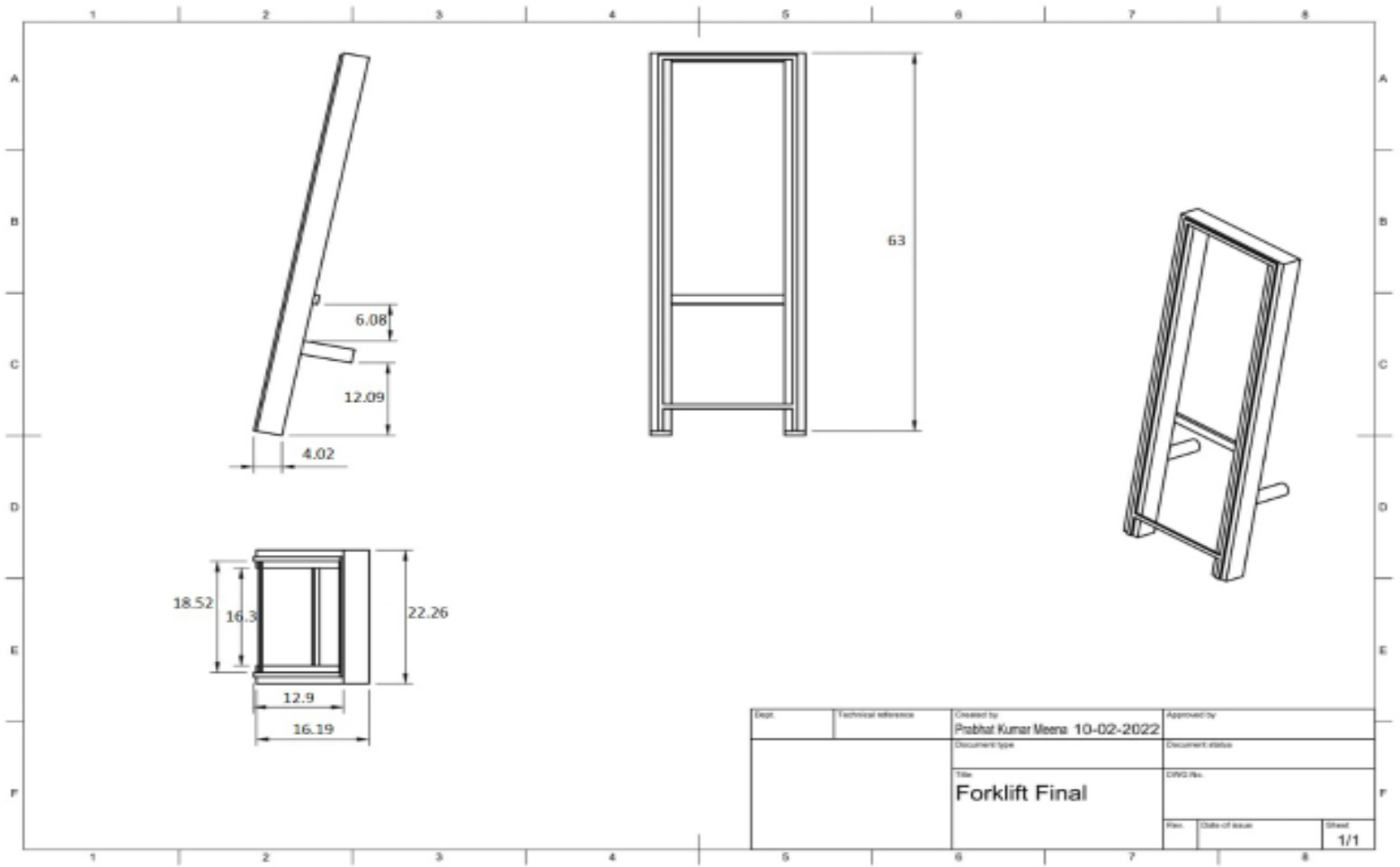
FORK(Part no. 1)



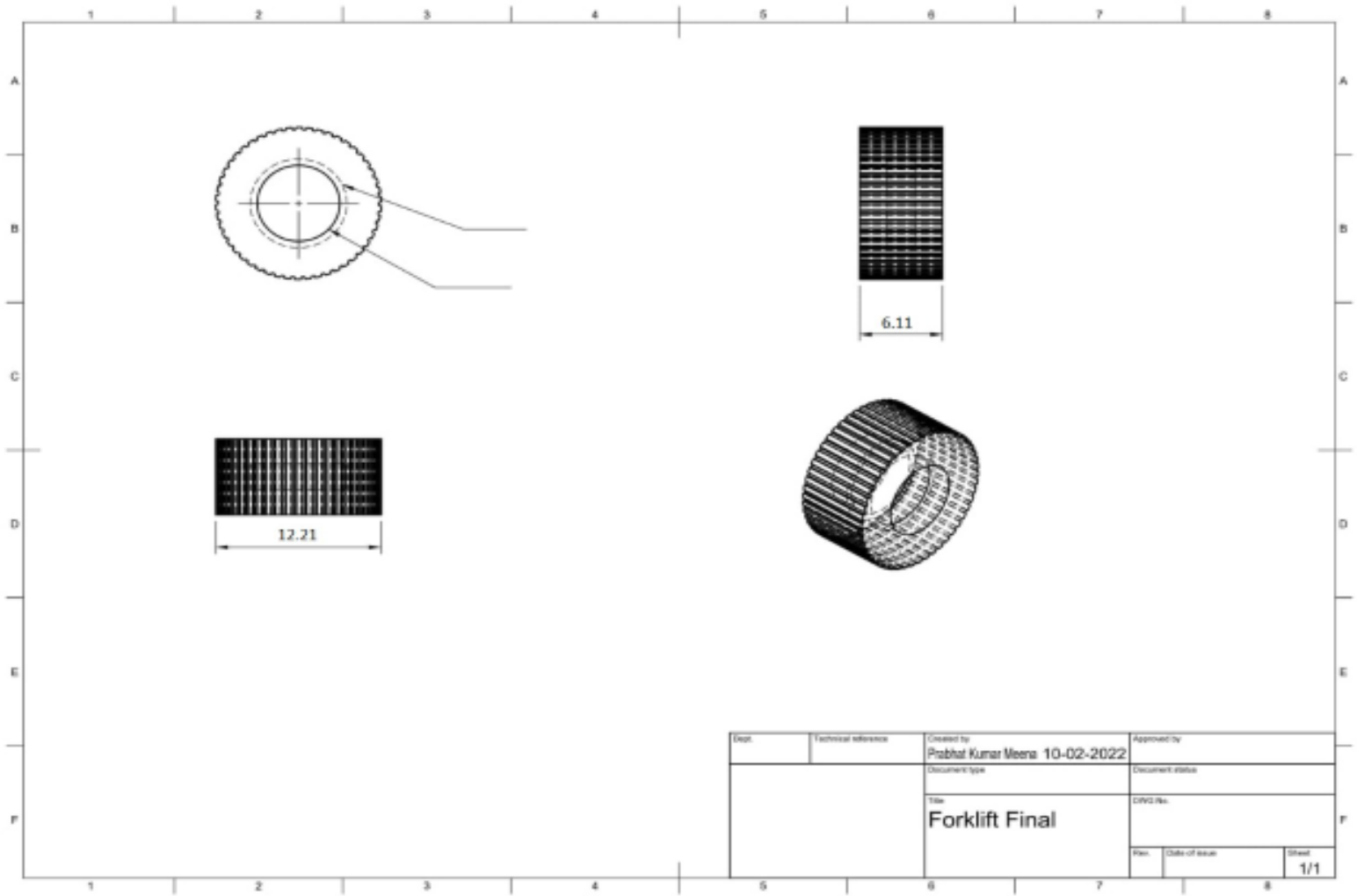
CONTROL BOX(Part no. 2)



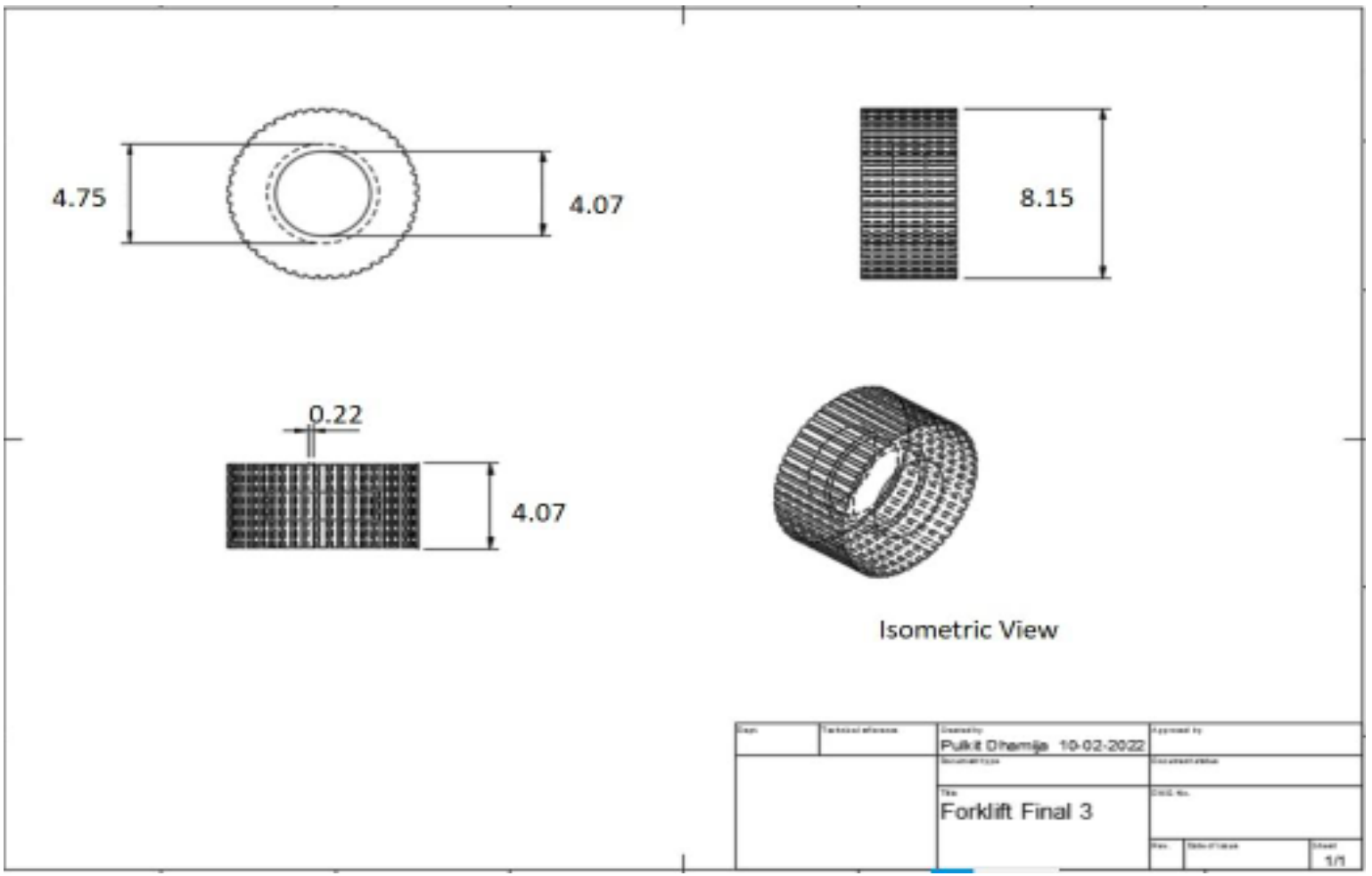
MAST(Part no. 3)



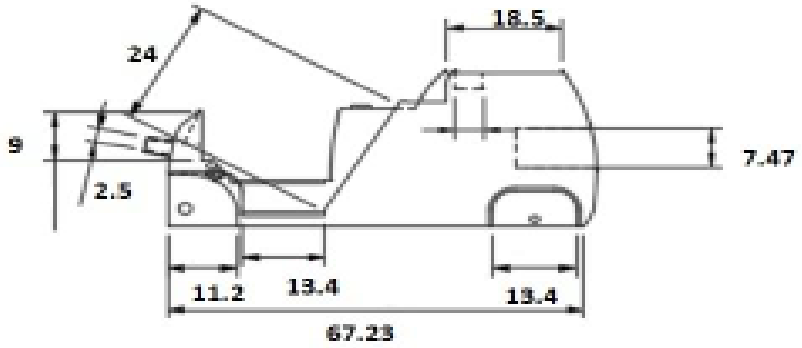
TYRE GROOVES(Part no. 5)

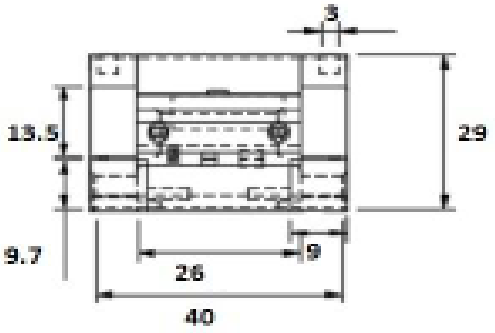


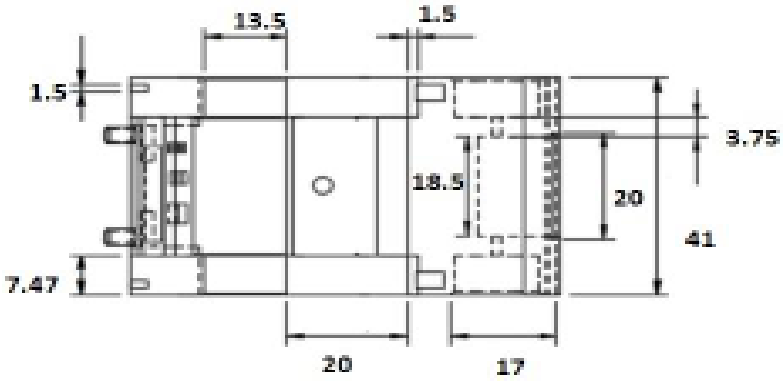
TYRE GROOVES (Part no. 4)

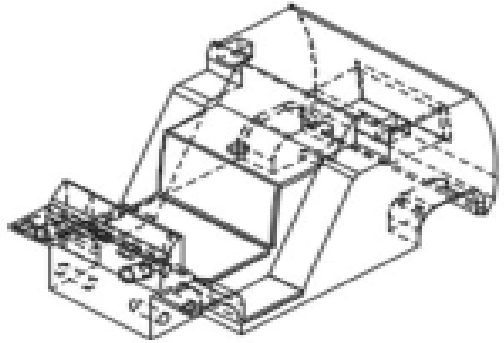


OPERATOR CAB(Part no. 6)









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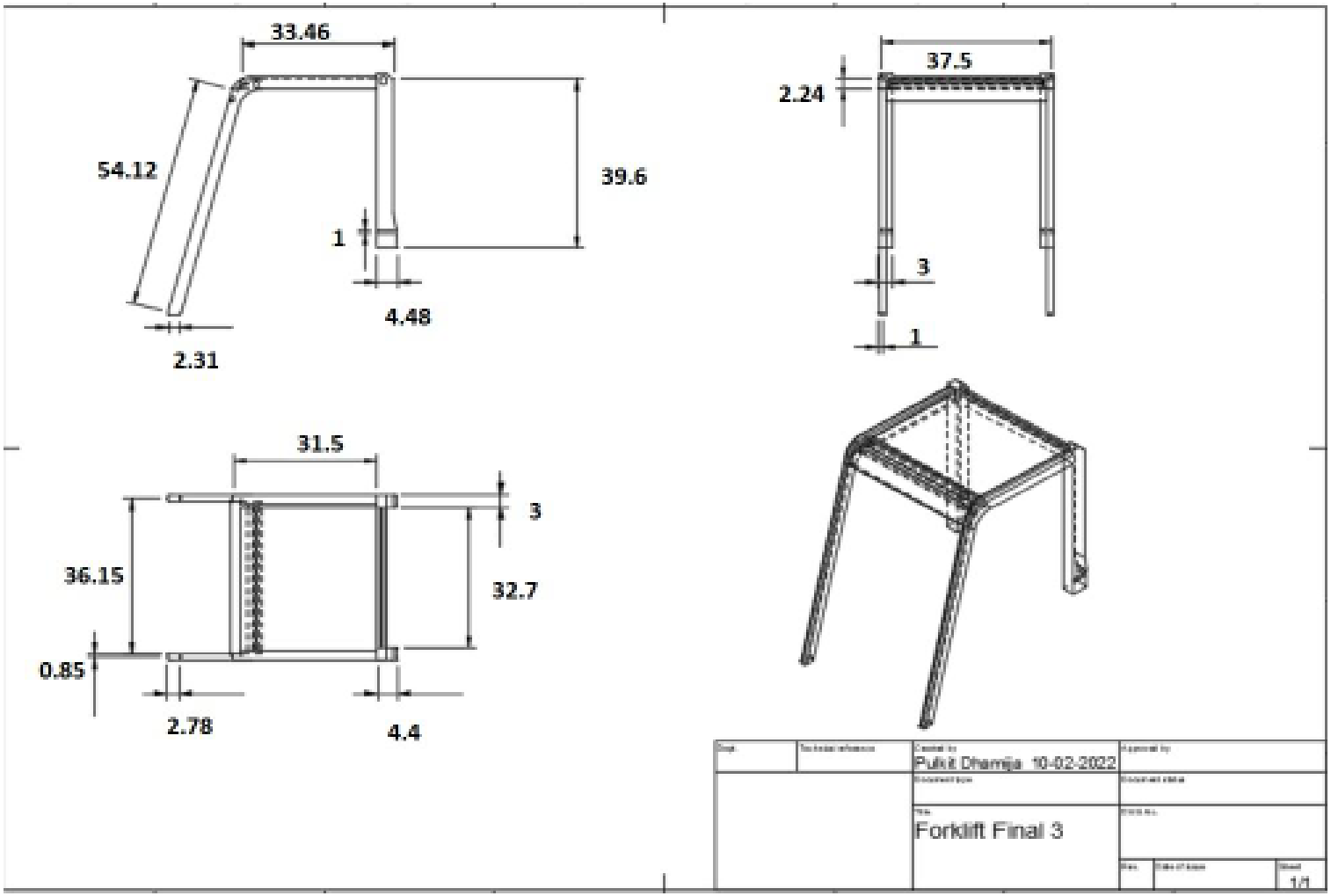
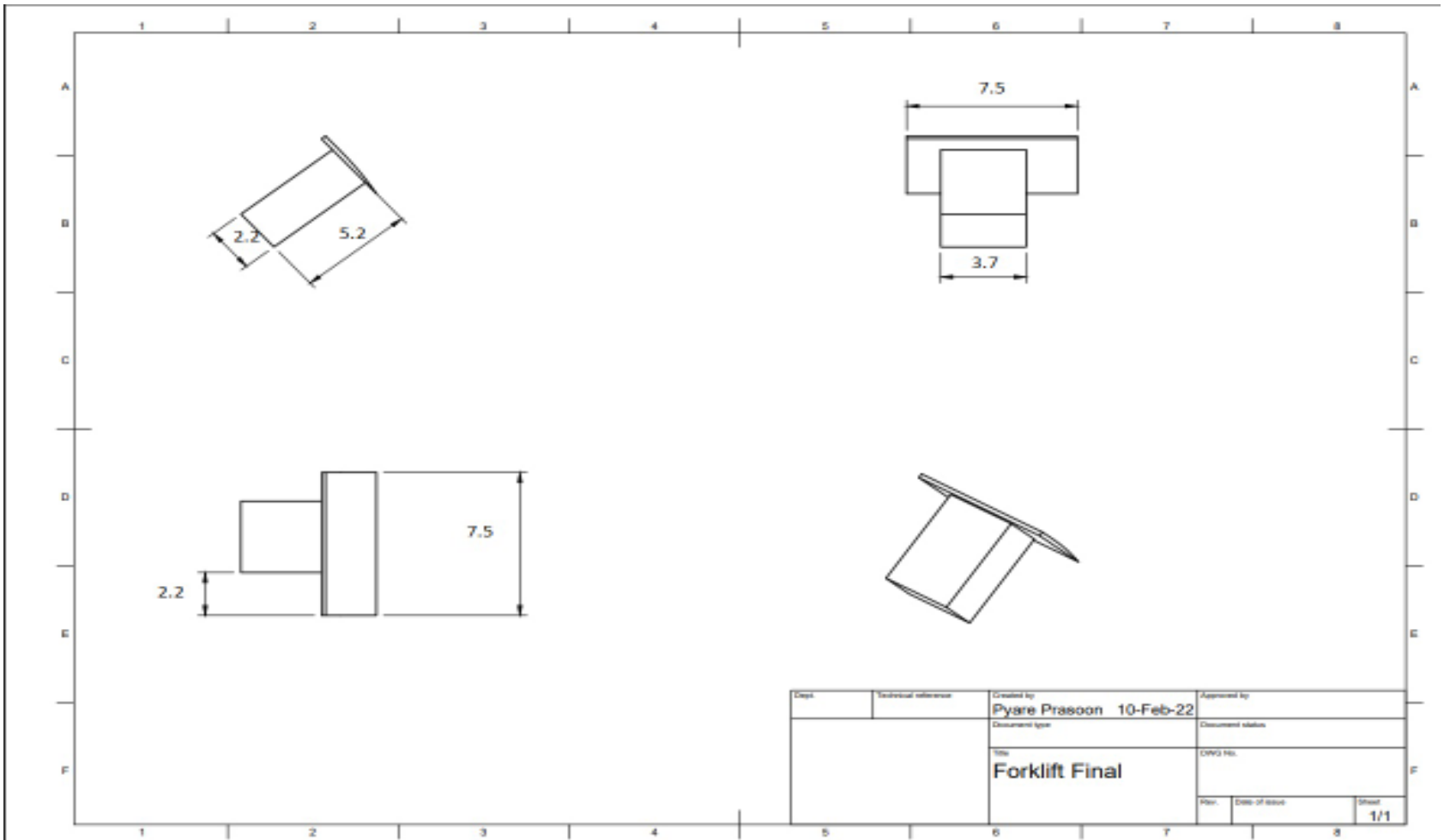
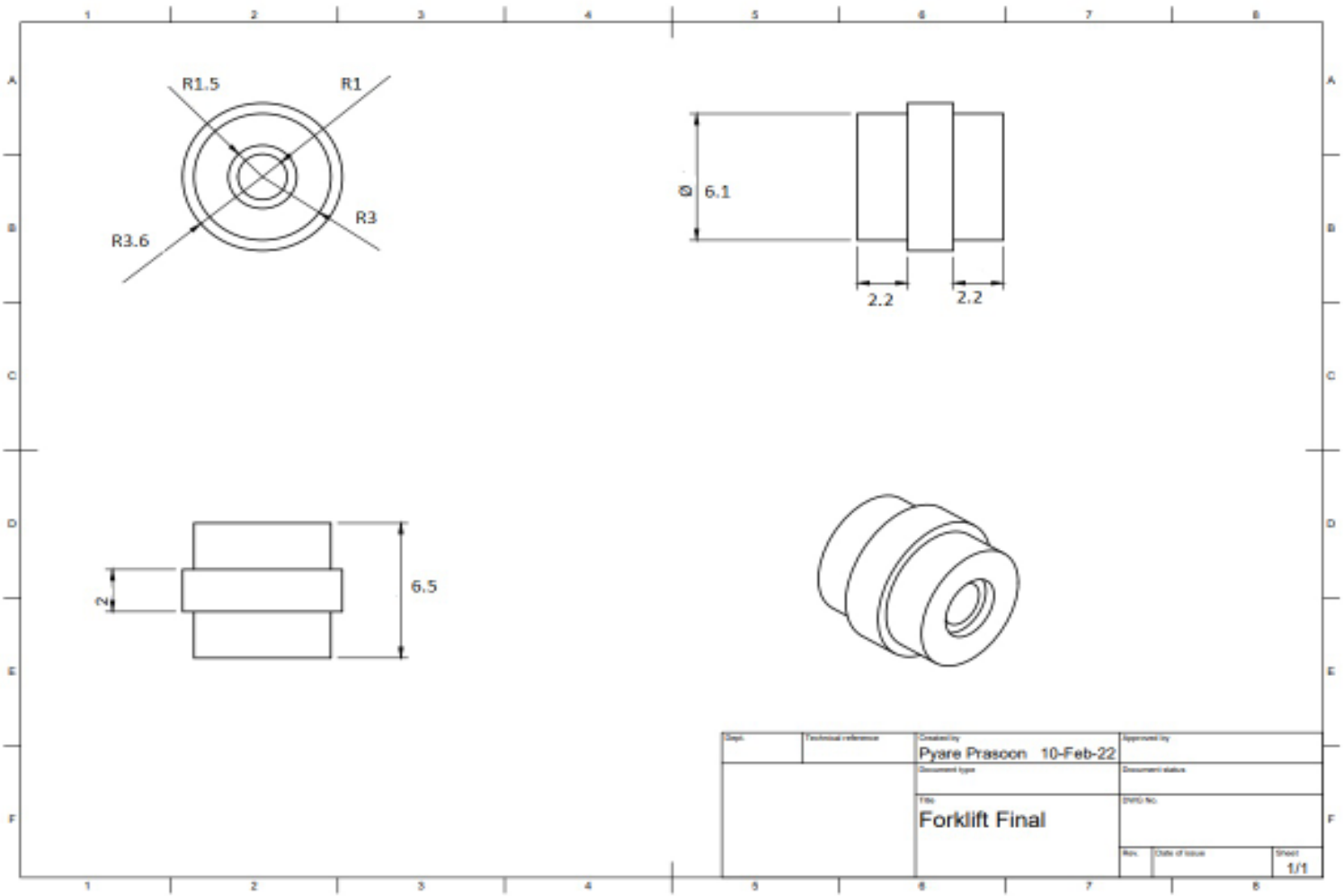
OVERHEAD GUARD(Part no. 7)



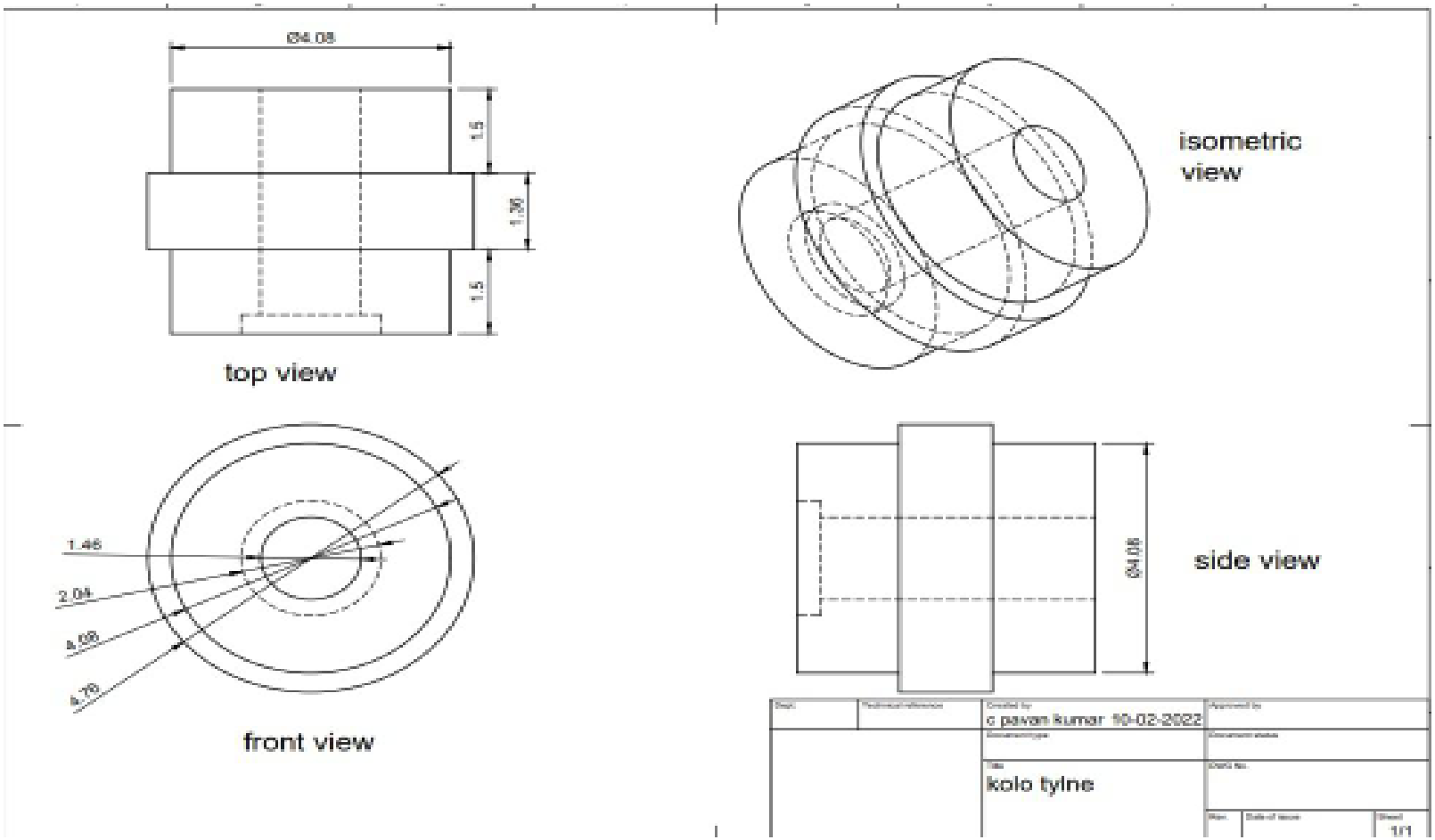
PEDAL-1(Part no. 8)



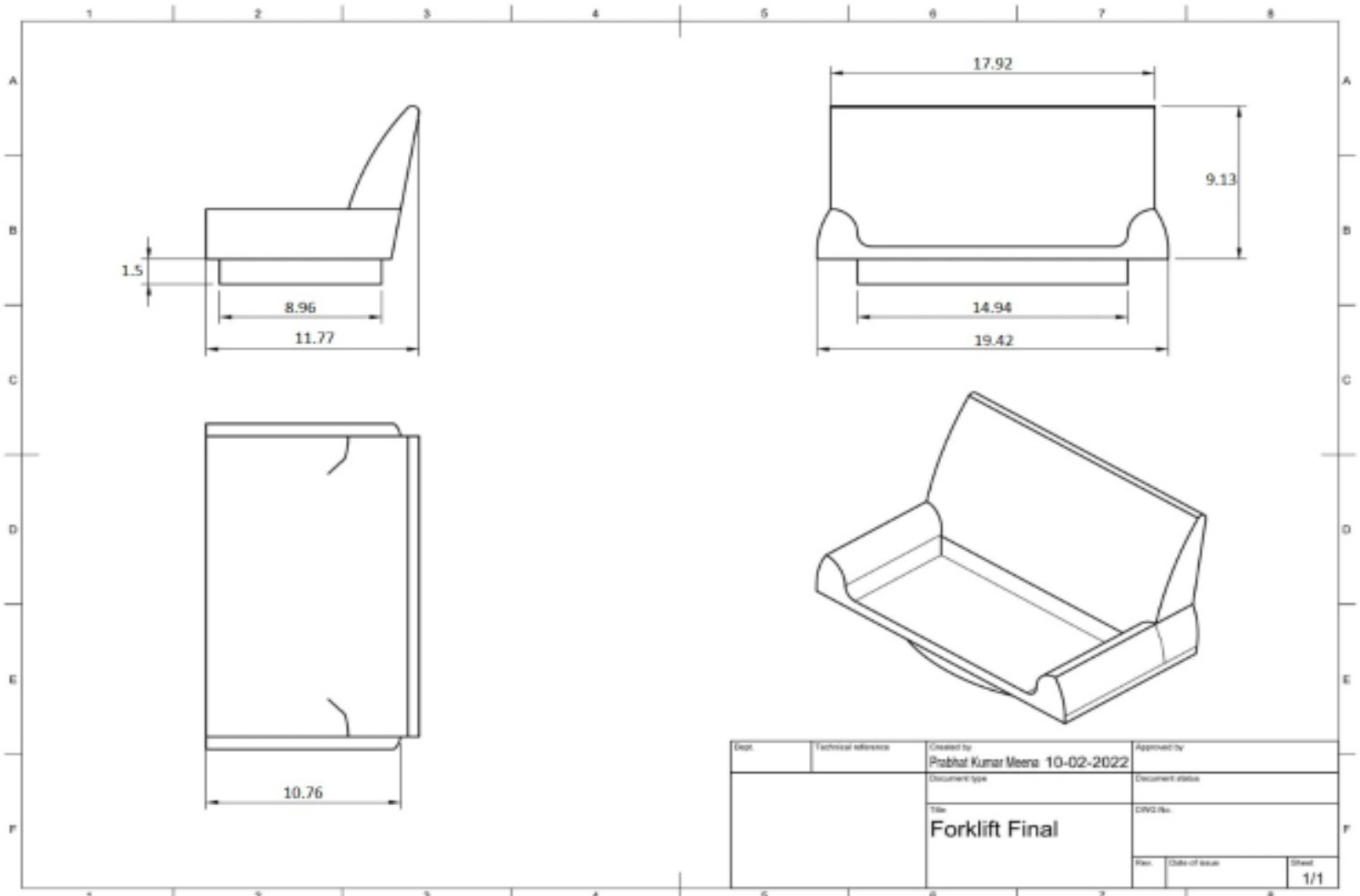
Front Wheel (Part no. 10)



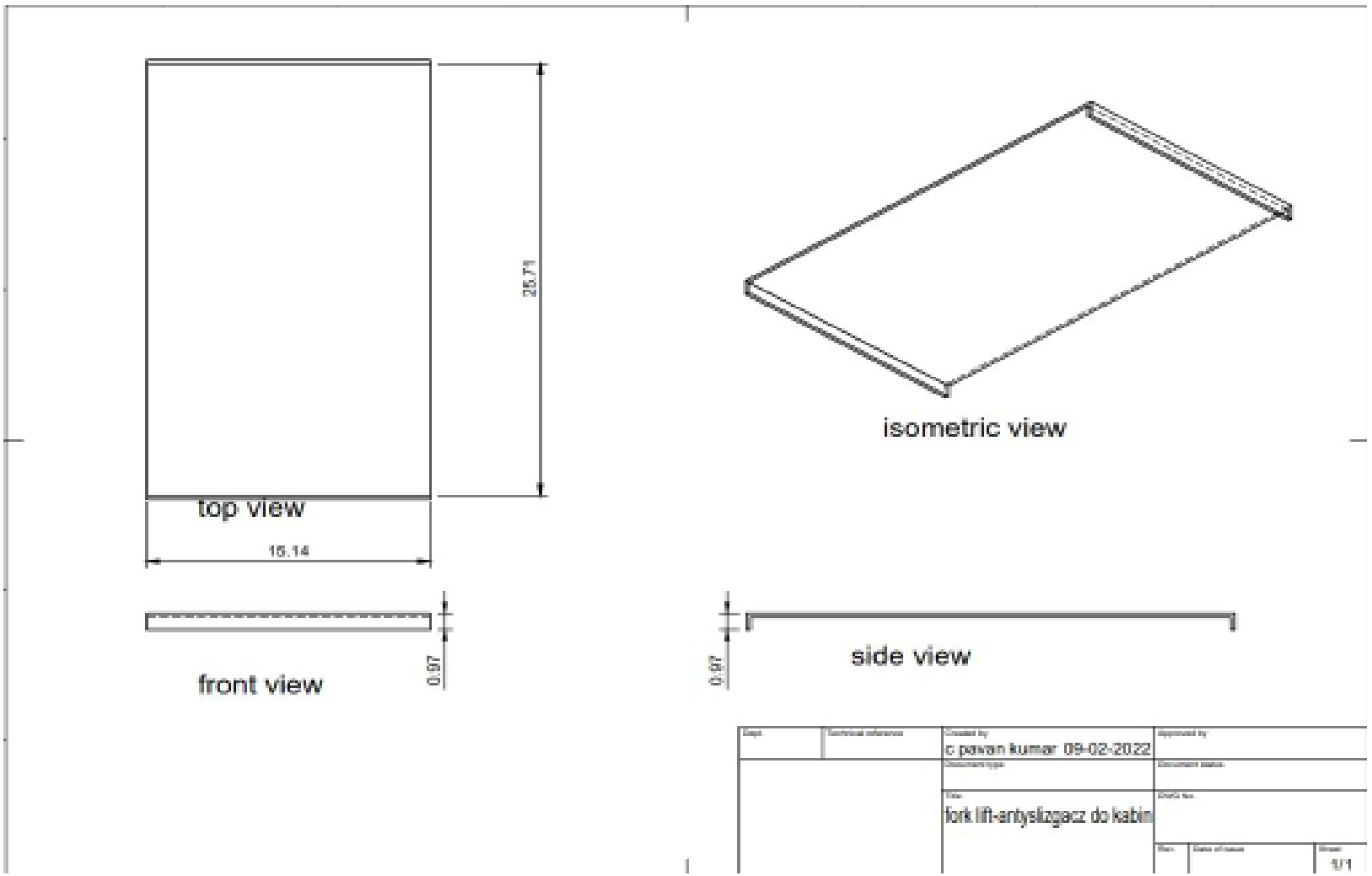
REAR WHEEL(Part no. 11)



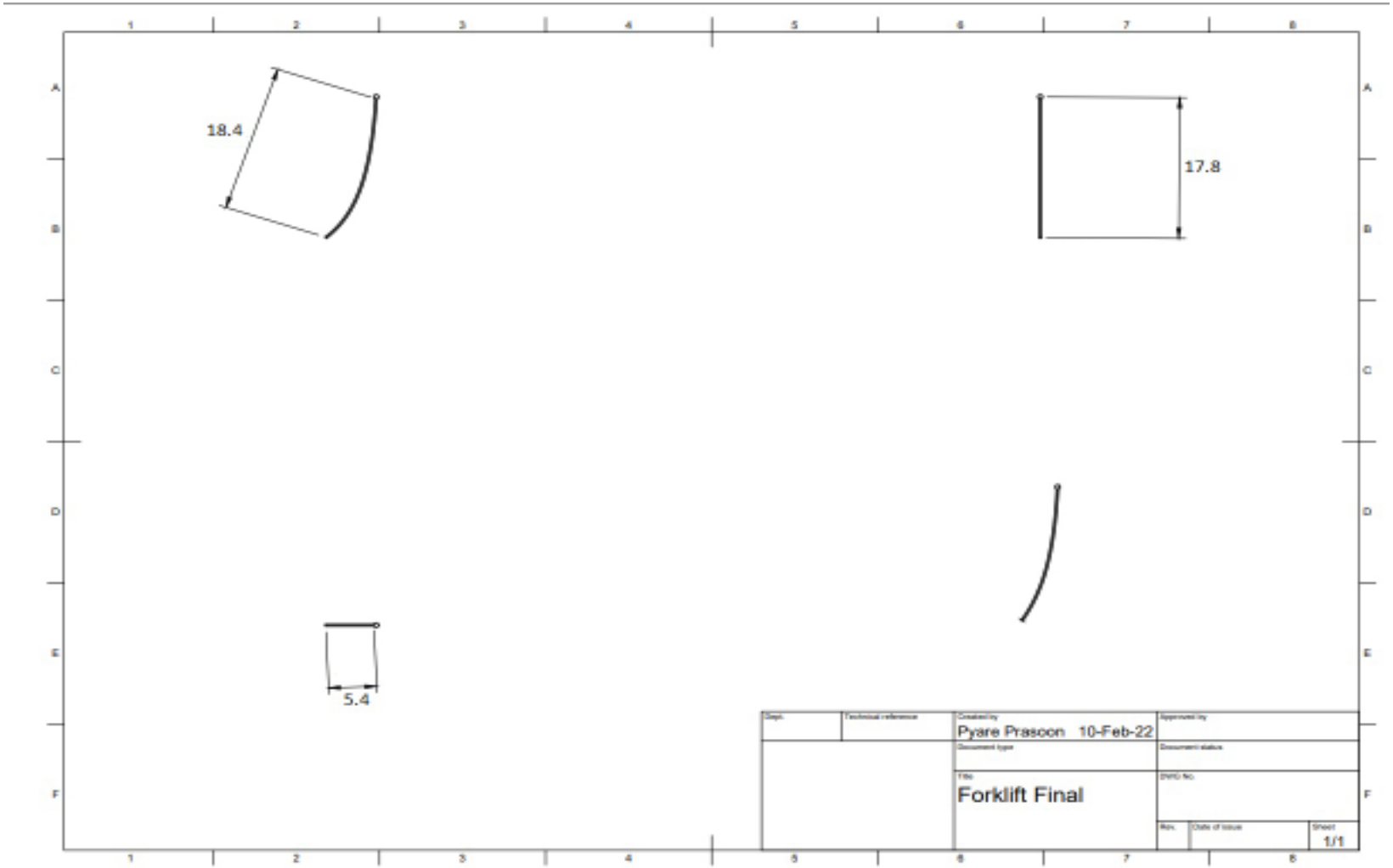
SEAT(Part no. 12)



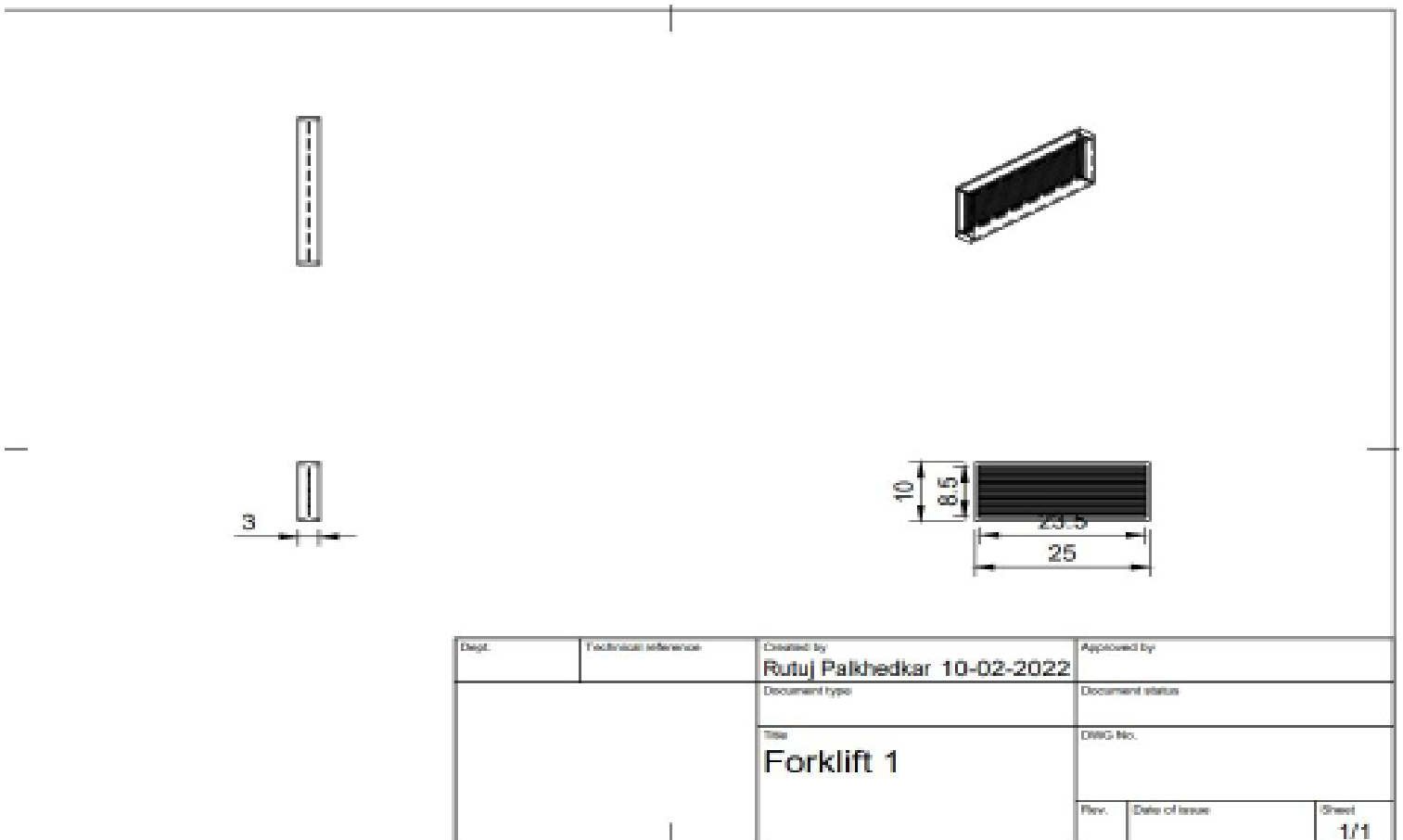
SIDE GUARD(Part no. 13)



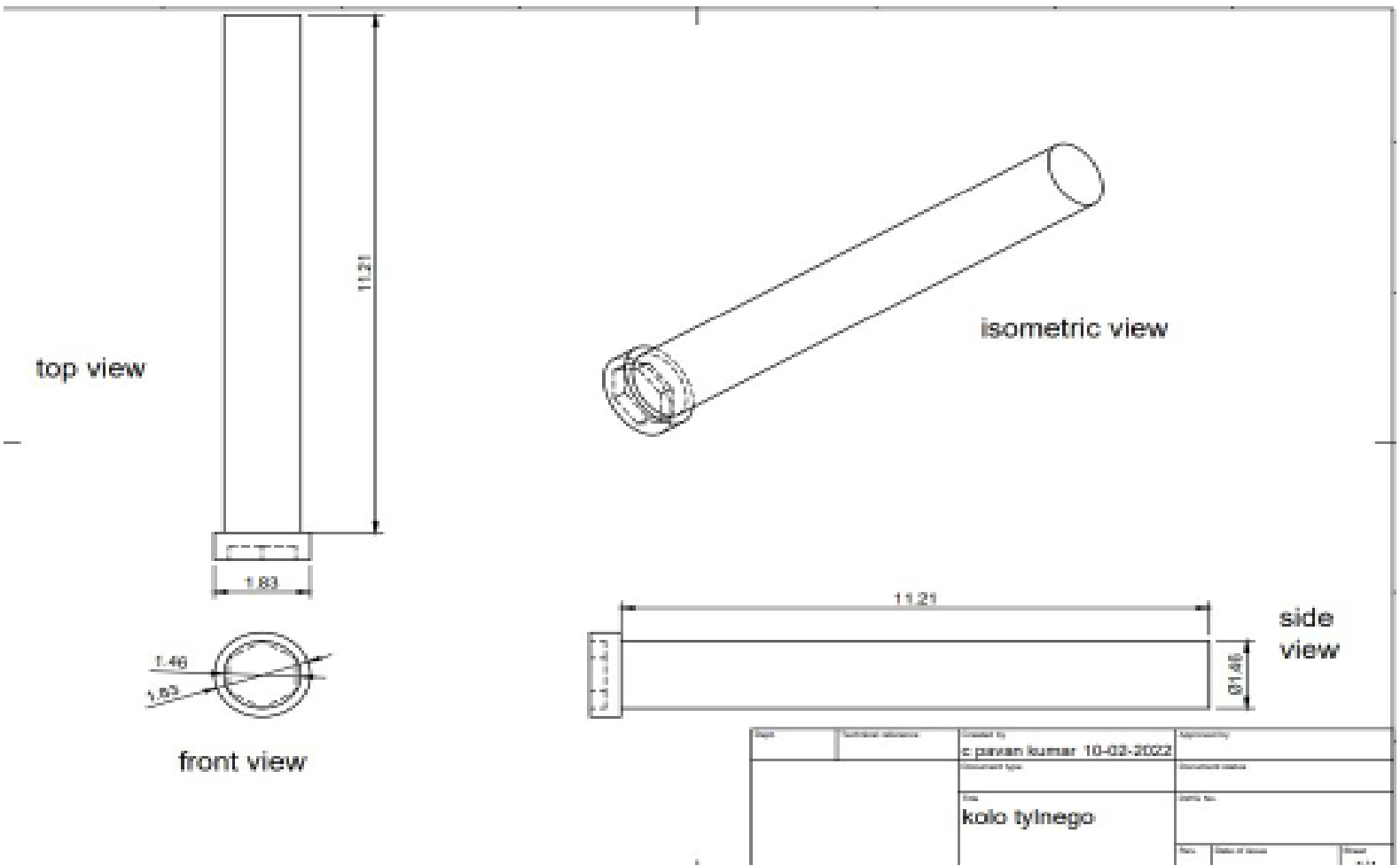
CONTROL GEAR



EXHAUST PART



DRIVER AXLE


top view
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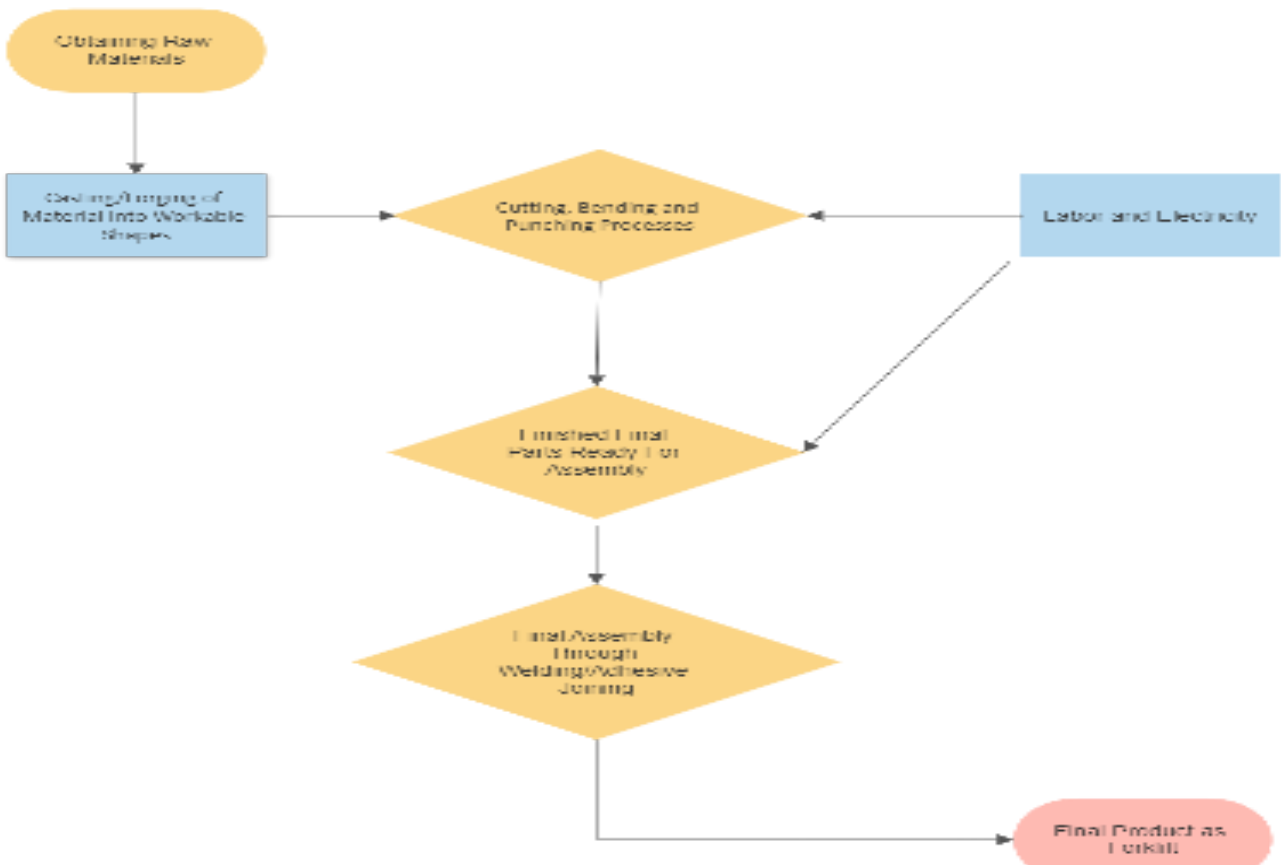
Flowchart Showing the Manufacturing Sequence



Manufacturing Processes in sequence:

1. **Lost foam Casting**: Lost-foam casting (LFC) is a type of evaporative-pattern casting process that is similar to investment casting except foam is used for the pattern instead of wax. We aim to use this method for casting the parts that can't be assembled from general constituting components like rods, bars and discs. The casting of carriage is done by melting, pouring and subsequent cooling. Other parts like forks, counterweight have also been casted in similar manner. We started by casting all the parts first.
2. **TIG Welding**: Tungsten Inert Gas process ensures high quality welding as it replaces traditional slag with an inert gas. We applied this process secondly to weld different parts together in the assembly of carriage, forks, overhead guard and mast.

3. **Assembling and Joining process:** Finally, the assembly of different parts is performed like mounting the tyre onto the axle, counterweight into the rear part and control wheel, seat onto the operator cab. This is achieved by required welding process and joining through adhesives.

4. **Miscellaneous processes:** Punching and Boring were done for the piston part of hydraulic and tilt cylinder. Brazing and cutting was required for parts constituting metallic sheets and tubes like overhead part and carriage.

Involved Manufacturing Processes

1. Basic Casting : It refers to a process in which molten metal flows by gravity or other force into the mold where it solidifies in the shape of mold cavity.

In our project, we have used the methods of **Aluminum and Steel Casting** to devise the different parts of the forklift. **Our motivation behind using the casting process over the methods was to create complex part geometries, 3-D shapes, with a reasonable good surface finish.** Also, the other advantages of Casting, such as, it helps in creating parts relatively quick than the other processes and can be used for mass production, have also been taken into consideration.

*2. Basic Welding: In simple words, Welding is a fabrication process that joins materials, usually metals or thermoplastics, by **using high heat to melt the parts together and allowing them to cool, causing fusion.***

Since, a bigger part can be seen as an agglomeration of multiple smaller parts, we have invoked the usage of Welding in order to combine the different sub-parts together to form a bigger unit of the Forklift.

We have used welding and casting to make cab.

*Also, **NOTE**: We have used both, TIG Welding and Basic Welding principles for the different parts of our forklift. (The description of TIG Welding has been mentioned in earlier slides.)*

3. Forging *: Forging is a manufacturing process involving the shaping of a metal through hammering, pressing, or rolling. In our project, we have used forging to create some metals parts such as, Carbon Steel Tubes. And also, it's application can be seen in the development of the Forklift's Carriage, too.*

4. Boring : In a broad sense, Boring is a common machining method, which can be used to correct errors. It can be *used for enlarging and accurately sizing an existing hole by means of single point cutting tool.*

Boring is used to achieve greater accuracy of the diameter of a hole, and can be used to cut a tapered hole, too.

In our project, we have used boring for devising the Piston, which is used in the Tilt and Hydraulic lift Cylinders.

5. MIG: Metal Inert Gas (MIG) welding is an arc welding process that uses a continuous solid wire electrode heated and fed into the weld pool from a welding gun. The two base materials are melted together forming a join.

We have made forks using a combination of two methods:- Casting from Cast Iron and Welding of rods and casted part(MIG/TIG welding process)

ENVIRONMENTAL IMPACT ANALYSIS

Carbon footprint – It is the total amount of greenhouse gases (sulfur dioxide, carbon dioxide, methane etc.) that are generated from the manufacturing processes.

Our manufacturing processes mainly include aluminium and steel casting, basic welding, TIG welding, MIG welding and forging etc.

Greenhouse gases are released in production of electricity to melt the metal but it is not a part of the manufacturing process. Similarly in case of TIG and MIG welding greenhouses are released in the process of transportation and storage of gases which is not a part of the manufacturing process.

So, in these above manufacturing processes no greenhouse gases is produced. Hence, Carbon Footprint Count is negligible for making of our product.

SUSTAINABILITY ANALYSIS

There are a lot of processes involved in the manufacturing and if harmful processes are maintained with no change, it is likely that we will run out of fossil fuels, huge numbers of animal species will become extinct, and the atmosphere will be irreparably damaged. Therefore, Selection of optimum welding parameters plays a crucial role in attaining sustainability in part manufacturing.

Analysis of TIG Welding

It has many advantages as compared to other manufacturing processes:

1. It is a stable process and can be automated and applied in all welding positions.
2. In this method, there is virtually no smoke and residue.
3. Welding defects are extremely less using TIG welding and the welds are of high quality.
4. Most of the metals can be welded with TIG, even in the case of heterogeneous basic

material: stainless steel, aluminium and copper etc.

Analysis of Lost Foam Casting :

1. Once installed, lost foam casting offers flexibility in casting design and is environmentally friendly.
2. Neither additives, binders, nor cores are required.
3. Scrap volumes are minimized; the equipment's footprint is small; energy and manpower requirements, as well as insurance premiums are reduced; as are the machining and finishing requirements.

Analysis of MIG Welding :

1. MIG Welding Is Fast.
2. MIG Weld Quality: MIG welding allows you to quickly make very high-quality welds - often faster than other welding techniques.
3. Long-Pass Welding
4. Fewer Stops And Starts
5. MIG works with many metals or alloys.

Analysis of Forging

1. It offers better response to heat treatment.

2. It is more reliable and less costly.

3. Parts manufactured by forging are stronger.

4. It offers more consistent and better metallurgical properties and refines structure of metal.

5. The forging industry of the future will be energy-efficient and will protect the environment. In the next century, the forging plant will be a **zero environmental liability**, making it a valued and responsible neighbor in its community.

Analysis of Boring

1. Efficiency: More and more industries are integrating boring milling machines in with their equipment because they are efficient and ease the entire production process in general.

2. Great Investment: Boring milling machines are a great investment for any factory or machining shop. When compared to more traditional boring methods, these sturdy machines are the sound choice for long term production.

3. Longer Lifetime: One of the best things about boring milling machines is that they can be used for a long time thanks to innovative design, sturdy manufacturing and skillful post-sale servicing.

COST ANALYSIS OF MANUFACTURING PROCESSES

Manufacturing Process	Rate	Time Required	Amount
Casting	Rs. 100/hour	2 hour	Rs. 200
Welding	Rs. 100/hour	1. 5hour	Rs. 150
Forging	Rs. 200/hour	0. 5hour	Rs. 100
Bending	Rs. 80/hour	0. 5hour	Rs. 40
Cutting	Rs. 80/hour	0. 5hour	Rs. 40
TIG Welding	Rs. 300/hour	10minute	Rs. 50
Boring	Rs. 70/hour	1hour	Rs. 70
Punching	Rs. 500/hour	0. 5hour	Rs. 250

Total Labour Cost = Rs. 900 Electricity cost(at 15 Rs per hour) = Rs 85 Total : 985 Rs

References :

Books : As mentioned in FCH

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