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| **Student's name** | **Joseph** | **Adriel** | |
| **Student's I.D. number** | **30236843** | 3 0 2 3 6 8 4 3 | |
| **Unit name** | Engineering design 3 | **Unit code** | **MEC4407** |
| **Lecturer's and/or tutor's name** | *Dr. Chiew Yeong Shiong* | **Lab day:** *TUESDAY* | **Lab time:** *3P.M- 5P.M* |
| **Type of submission (eg Assignment 1)** | Project Final Report | **Group Assignment** (tick box) ☑ Note, each student must attach their own signed cover sheet to the assignment. | |

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|---|---|---|---|
| **Student's name** | **Setiawan** | **Andrew** | |
| **Student's I.D. number** | **28134273** | 2 8 1 3 4 2 7 3 | |
| **Unit name** | Engineering design 3 | **Unit code** | **MEC4407** |
| **Lecturer's and/or tutor's name** | Dr. Chiew | **Lab day:** Tuesday | **Lab time:** 3-5 PM |
| **Type of submission (eg Assignment 1)** | Project Final Report | **Group Assignment** (tick box) ☑ Note, each student must attach their own signed cover sheet to the assignment. | |

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| **Student's name** | **Kam** | **Ashton** | |
| **Student's I.D. number** | **30333164** | 3 0 3 3 3 1 6 4 | |
| **Unit name** | Engineering design 3 | **Unit code** | **MEC4407** |
| **Lecturer's and/or tutor's name** | Dr. Chiew Yeong Shiong | **Lab day:** Tuesday | **Lab time:** 3-5pm |
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| **Student's name** | **Chanda Kumar Singh** | **Dhaan** | |
| **Student's I.D. number** | **29404657** | 2 9 4 0 4 6 5 7 | |
| **Unit name** | Engineering design 3 | **Unit code** | **MEC4407** |
| **Lecturer's and/or tutor's name** | Dr. Chiew Yeong Shiong | **Lab day: Tuesday** | **Lab time: 3-5 PM** |
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| **Student's I.D. number** | **29931886** | 2 9 9 3 1 8 8 6 | |
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| **Lecturer's and/or tutor's name** | *Dr. Chiew Yeong Shiong* | **Lab day:** *TUESDAY* | **Lab time:** *3P.M - 5P.M* |
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# MEC4407 Design Project
# PROJECT FINAL REPORT


TEAM NUMBER: 0101

COMPANY NAME: KART - MOBIL

NAME : TAN EE WERN

STUDENT ID : 29931886

NAME : ANDREW SETIAWAN

STUDENT ID :28134273

NAME : ADRIEL SEBASTIAN JOSEPH

STUDENT ID : 30236843

NAME : DHAAN RAAJ CHANDA KUMAR SINGH

STUDENT ID : 29404657

NAME : ASHTON KAM TING YAO

STUDENT ID : 30333164

**Executive Summary**: Go-kart is a fun recreational activity can be enjoyed by many people over the age of 12, however many go-kart companies have not been able to implement such exciting racing experience that is different in comparison with any other competitors. This opportunity has encouraged Team 0101 to launch a project in establishing a go-kart company that offers distinct racing experiences.

The company was established in 27 July 2021 and known as Kart-Mobil with the base of the operation located in Subang Jaya, Selangor, Malaysia. In this document, Kart – Mobil would like to provide adequate information for the reader to engage with the main concept, design approach, integrated engineering analysis, exciting game and business plan that distinct the Kart – Mobil with any normal go-kart companies. Safety is our number one priority and with Kart-Mobil strong work ethic, people can enjoy exciting racing experience at ease.

# Table of Contents

# 1. Introduction and Overall Concept

Kart-Mobil is a company dedicated to bringing the elite lifestyle of racing to everyone at an affordable price, so much so that our slogan is “Now You Can Drive”. We believe that everyone deserves a chance to experience the adrenaline rush that comes from racing at high speeds in a safe environment. To achieve this goal, Kart-Mobil provides the professional expertise to customise and design cars to cater to drivers of varying degrees of skill, age and body type. Our intuitive designs are so revolutionary that anyone over the age of 12 will be able to participate in this thrilling experience. Racers can hop in and start driving immediately without any setup required on their part. Furthermore, Kart-Mobil gives the freedom to each driver to fully customise their car to their own liking whether it be performance or aesthetics, this way the drivers can express themselves through their vehicles. Besides that, we have an array of fun racing games guaranteed to challenge drivers mentally and physically. Kart-Mobil places safety as its highest priority so our customers could race competitively while always knowing that their safety is ensured. In addition, Kart-Mobil aims to provide high quality service and comfort to all clients by providing fully equipped facilities and engaging professionals in the field of business operation and customer care service.

## 1.1 Kart-Mobil Mission Statement

**Mission:** Kart-Mobil designs race karts and customizable parts for racers to be more competitive on the track. Racers can customize the performance of their kart to suit their liking as well as express themselves through the visuals of the kart. Furthermore, Kart-Mobil offers an array of racing packages to suit the budget of different groups of people so that everyone may be included in this unique experience. Our innovative design can cater to racers of all body sizes and height if they are above 12 years of age. Our track and kart designs places safety as the highest priority, thus, racers can compete with peace of mind.

**Vision**: We hope to be a household name in the industry for culturing future professional race-car drivers and an inspiration for the younger generation to appreciate the technical side of race cars and its engineering marvels. We want to expose the public to racing to show that racing can be done safely and enjoyably with the right facilitators and equipment in place.

### 1.2 Overall Concept


*Figure 1.2.1: Logo of Kart-Mobil company*

Kart-Mobil is a kart-racing company that provides professional expertise in the field of motorcar engineering in conjunction with top-rated customer care services. The company logo uses orange to signify the fiery competitive spirit we hope to ignite in our racers paired with the iconic black and white race flag that represents racing at a high level. The simple and cantonized style used in the company logo reminds viewers that at the end of the day, happiness is all that matters, and good sportsmanship is key.

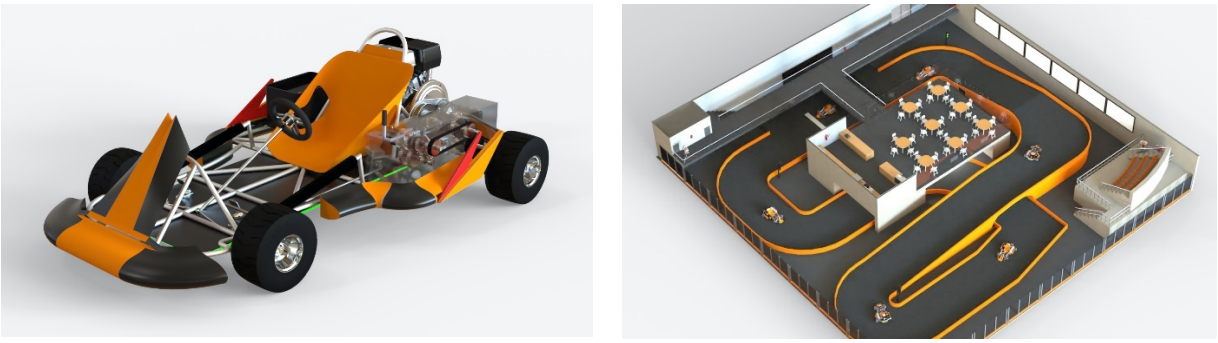

*Figure 11.2.2: Overview of vehicle and track layout*

## 2. Final Design and Solution

### 2.1 Vehicle

The Go Kart is an all-in-one package. It boasts splendid performance while also being aesthetically pleasing. It comes with a powerful engine and a beautiful, streamlined body that will provide optimal aerodynamics to the vehicle, enables racers to accelerate and take sharp corners with ease. This go-kart also comes with a reverse gear which is rarely seen in the go-karting industry. The high-performance torque converter implemented into the engine enables the racer to accelerate

quickly and smoothly. Figure 1.2.2 and Figure C.4.1 in Appendix C shows two isometric views of the car.

### 2.2 Track

The track layout consists of both the track and necessary facilities for racers and spectators designed with safety as its top priority. It includes storage, toilets, concierge, viewing platforms and a café. Safety and emergency provisions such as fire extinguishers, fire alarms and a fire staircase are included.

### 2.3 Business

The targeted market for this business is anyone above the age of 12. We aim to maximize profit by providing clients with an entertaining, safe, comfortable, and stimulating racing environment and facilities. Various promotional activities would be held throughout the year to engage and attract clients. These events are proactive steps taken by Kart-Mobil to engage old and new audiences alike.

## 3. Design Content

### 3.1 Customization

In Kart-Mobil, we want our customers to feel engaged in the designing process. We offer various bumper designs of varying weights, all of which have been proven safe to use. Since the weight distribution on the go-kart will affect the performance of the car, our customers can try out various bumper combinations to improve their racing experience. The bumpers are easily interchangeable as they utilize a convenient detachable mechanism. Various designs have been developed to provide drivers with a diverse and unique range to choose from, thus, drivers can mix and match the front, sides, rear and front bumper to achieve their favorite combination.

*Figure 3.1.1: 1st design and 2nd design of the customizable bumper 1*

*Figure 3.1.22: 1st design and 2nd design of customizable bumper 2*

Another unique feature of our go-kart is that drivers can choose from a range of steering wheel sizes according to their preference. A good steering wheel size will provide drivers with a better grip and handling. The important measurements are the steering wheel diameter and the grip circumference. For example, steering wheel with a smaller diameter may provide more space and comfort in the go-kart, however more effort may be required to turn the go- kart. Drivers may also bring their own preferred compatible steering wheels. These customizations allow drivers to personalize and improve their driving experience.

## 3.2 Engine

In this Go-Kart vehicle, the selection of the engine will be one of the crucial aspects to focus on because the engine is so called to be “The heart of the vehicle”. The first go-kart engine used, the McCulloch MC-10, is a two-stroke engine with a power output of 9kW at 9000rpm. (Srivastava et al, 2020) The main function of the engine is designed to convert one or more forms of energy into

mechanical energy. In a 4-stroke engine, all the five functions which are the intake, compression, ignition, combustion and exhaust are completed in 2 revolutions of the crankshaftt. This rotary motion created from the crankshaft is eventually transmitted to the wheel. The 4-stroke engine is commonly used because it produces more torque than a 2-stroke engine at lower rpm plus it is more fuel efficient and creates less pollution.

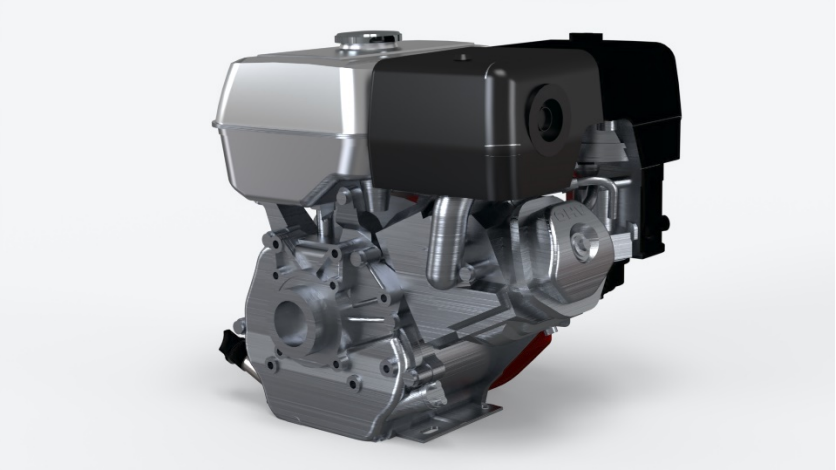

*Figure 3.2.1: The model of the PREDATOR 420cc horizontal engine*

While selecting an engine, it is crucial to identify the specification of the engine to analyse and to calculate the corresponding power transmission system and the fuel consumption. Table C.1.1 in Appendix C.1 shows the important specifications of the engine selected for the company Kart-Mobil. One of the key features of this engine is the ability to produce a high maximum net torque. It also boasts a net power of 13HP with a displacement of 420cc to maximize customers' experience in a race where speed and acceleration is desired.

## 3.3 Chassis

A very stable and good design of the chassis frame is a key technical requirement in order to encapsulate all components of the go kart. The important aspect to consider during the design of the chassis is the driver safety, position of different subsystems, structural weight and operator ergonomics.

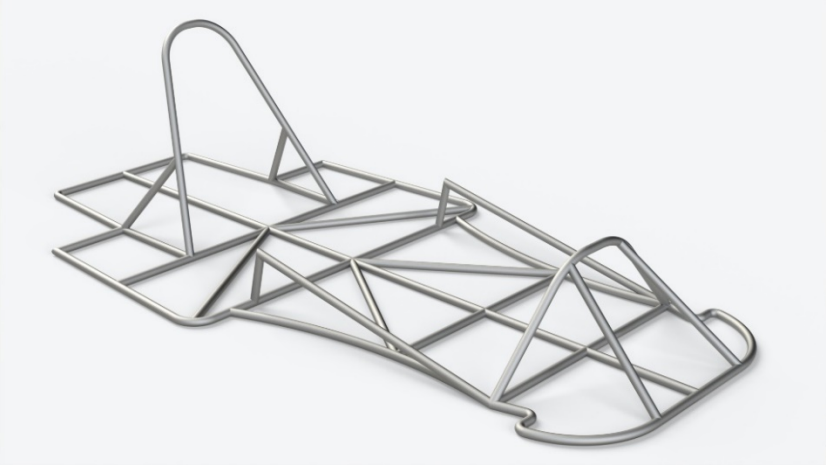

*Figure 3.3.1: Rendered CAD design of the chassis*

The chassis of go-kart is a skeleton frame made up of hollow pipes. The chassis is the backbone of the kart as it has to be flexible so that it must be equal enough to the suspension with high torsional rigidity and high degree of flexibility since suspension will not be installed (Raghunandan and Shajin, 2016).

The chassis is designed to ensure the safety of the driver by ensuring that structural strength of the chassis is not affected by the applied load. Besides driver safety, other important aspects that should be considered are structural weight, position of different subsystems and operator ergonomics (Johnson et al, 2017). Table C.1.2, Table C.1.3 and Table C.1.4 in Appendix C.1 shows the specification chosen for the design of the chassis, the composition of the material used for chassis and the physical property of the material used.

## 3.4 Power Transmission

The power generated by the engine is transmitted to the rest of the vehicle by a transmission system. A transmission provides controlled mechanical power from the engine to the rear axle of the go-kart. For a racing go kart there are two types of transmission used, a torque converter or a centrifugal clutch. Kart-Mobil uses torque converter instead of a centrifugal clutch for various reasons.

Firstly, a torque converter is a variable transmission which offers a wide range of gear ratio over different rpm ranges of the engine, whereas a centrifugal clutch is a non-variable transmission with a fixed gear ratio set by the crankshaft and rear axle sprocket sizes. The gear ratio remains the

same across all rpm ranges of the engine. Gear ratio influences the speed as well as the torque transmitted to the rear axle. A larger gear ratio offers larger torque and slower speed, whereas a smaller gear ratio offers smaller torque but faster speed. Thus, by having a wide range of gear ratios in a torque converter, a more controlled and smoother acceleration is delivered, and this is a significant feature among racing go karts. Torque converters are also less susceptible to wear and tear and hence does not need to replace as often, reducing maintenance cost (Echt, 2020). Furthermore, by using a torque converted complicated assemblies of gears of different sizes can be avoided and this reduces the space required for transmission. The major components of the transmission system are discussed briefly below.

### 3.4.1 Torque Converter

The torque converter used in Kart-Mobil is a Jeremy well Industry 40 series with a 1” shaft for the driver pulley and 3/4" shaft for the driven pulley. It has a low-end gear ratio of 2.68 and low high end gear ratio of 0.9 (Industry, 2021). This model supports engines with horsepower ranging from 8 to 16HP, thus making it suitable with the 13HP engine used in our kart. The torque converter is set to engage at 2500RPM which is the RPM at which the engine produces a maximum torque of 26.84Nm. This enables the kart to have great take off speeds at a powerful low ratio and enter the high overdrive position at a maximum RPM of 3600. A 10% overdrive is possible as the torque converter supports a 0.9 high end gear ratio. This feature makes the karts attain the maximum speed faster, hence enhancing their performance. The gear ratio of the torque converter shifts according to the RPM of the engine. As the RPM increases, the gear ratio decreases gradually from 2.68 until the lowest ratio of 0.9 is achieved. With this, our karts are able to deliver smooth accelerations until the maximum speed is achieved, providing a remarkable driving experience for our customers. Another promising feature is that the torque converter changes the gear ratios immediately corresponding to the RPM of the engine ensuring swift acceleration after slowing down. In short, the torque converter capable in delivering the performance required by the racing kart.

### 3.4.2 Sprocket Chain Ratio

The sprocket ratio is the gear ratio wherever a chain drive is implemented in the system. It is important because it determines the net gear ratio that reaches the final rear axle to the wheels. A chain drive basically comprises of two sprockets coupled by a chain pulley. The chain drive is a

crucial component that connects the rest of the transmission to the rear axle. The sprocket ratio must be small enough to account for the maximum speed transmitted and at the same time must be large enough so that large torque values can be transmitted to the drive axle when the kart is slowing down. In the transmission system, a sprocket chain was used to connect the driven shaft of the torque converter to the input shaft of the reverse gearbox and to connect the output shaft of the reverse gearbox to an intermediary jackshaft. The sprocket ratio for both setups were maintained at 1:1 to maintain constant gear ratio. A final sprocket ratio of 4.8 was chosen as the final chain drive that connects the jackshaft to the rear axle to produce an overall low-end gear ratio of 12.86 and high-end gear ratio of 4.32.

### 3.4.3 Reverse Gear Box

The customized reverse gear box is a key feature of Kart-Mobil. Most racing go karts do not incorporate a reverse feature but here at Kart-Mobil, customers safety is our priority. With this feature, customers would be able to back out immediately in case of a crash without the need of additional manpower to pull it. The mechanism is utilized by the horizontal shifting of a lever above the gearbox. To change from forward drive to reverse gear, the lever is shifted to the left and vice versa. This switches between the motion of reverse gears set and forward gears set which in turn either propels the car forward or backwards. The forward gears are aligned such that the gear ratio is 1:1 so that the net speed and torque developed by the engine is unaffected. The Figure 3.4.3.1 below describes a schematic flow of power from the engine to the drive axle.

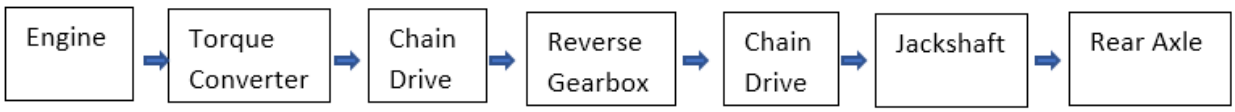


*Figure 3.4.3.1: Power transmission system*

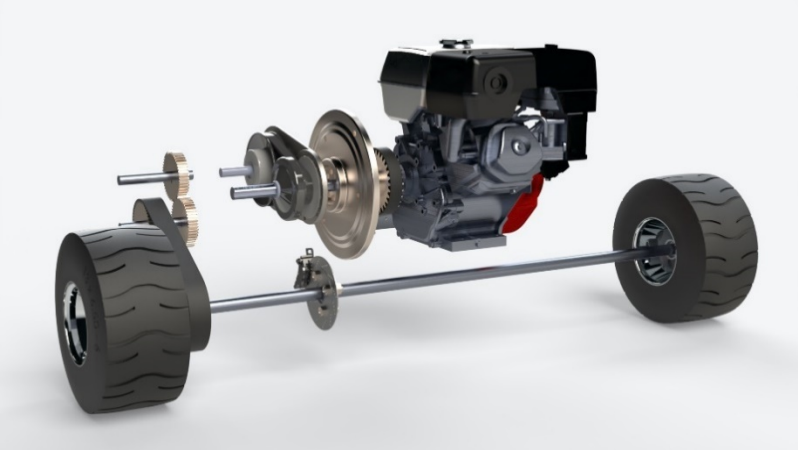

*Figure 3.4.3.2: CAD render of power transmission system*

Thus, based on the gear ratio of the torque converter and sprocket ratios setup, the go kart can reach a maximum speed of 51km/hr and produce a maximum torque of 345 Nm. The torque produced is sufficient to provide the power required to move the full load of the kart with a passenger present. The detail of the calculation is included in Appendix Section E.3.

## 3.5 Steering Mechanism

As for the steering mechanism, the Ackermann steering geometry is used. This steering system is widely used in racing vehicles because of its simple and practical design. With this, the mechanism can be easily modified and optimized to achieve the best cornering performance in our karts. The parts required for this steering mechanism includes basic mechanical linkages, tie rod ends and steering shaft which are relatively less costly compared to the rack and pinion mechanism which requires high maintenance costs. The Ackermann mechanism is based on the concept that that all radii of circles are arranged to a common centre point by making the front wheels rotate in different angles (Yu and Wang, 2017). In this case, the inner front tyre rotates more than the outer front tyre. This reduces the effort required to turn the steering and also prevents the slipping of tyres.

The percentage of Ackermann determines the cornering performance of the vehicle. Most race vehicles do not incorporate a 100% Ackermann steering system due to physical factors such as tyre grip and slip ratio. Slip enables the tyres do develop a lateral grip which is very effective at particular angles of displacement (Vogel, 2021). After carrying out calculations based on the Go-Kart's wheelbase and track width, a 66% Ackermann percentage with turning radius of 3.6m is achieved. The detailed calculation is included in Appendix Section E.2

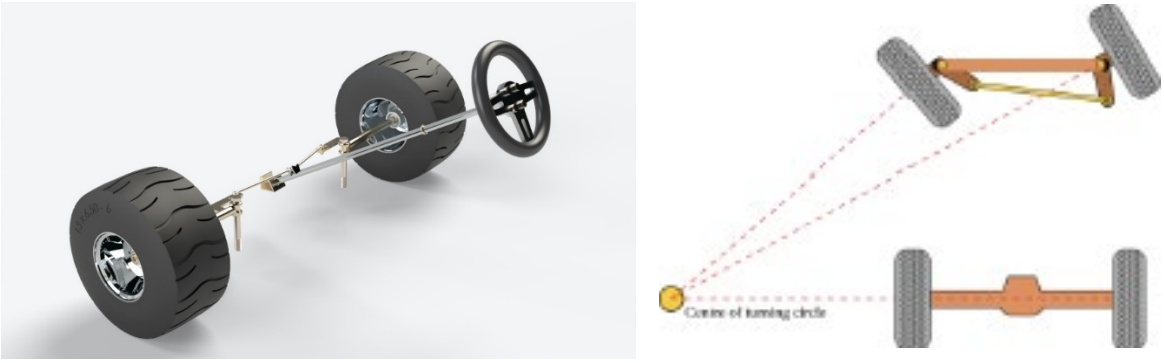


*Figure 3.5.1: CAD render of steering system and Schematical Representation of Ackermann Mechanism*

## 3.6 Wheels and Brakes

The wheels system consists of 3 main parts: tyres, rims and brakes. Starting with the tyre, its tread is stud-tread as it offers a good balance between grip and wear, as compared to slicks and sawtooth-treads. The size of the tyre is 330 x 165 - 152 mm: 330mm outer diameter, 165mm inner diameter and 152mm width. Compared to other go-karts, this is considered bigger than usual. However, it is found that this will result in better grip and handling, and hence, less risk of safety hazards (Research, 2020). As for its optimum tyre pressure, the manufacturer has recommended 76kPa. Tyre pressures below this value can make it difficult for beginners to handle the vehicle.

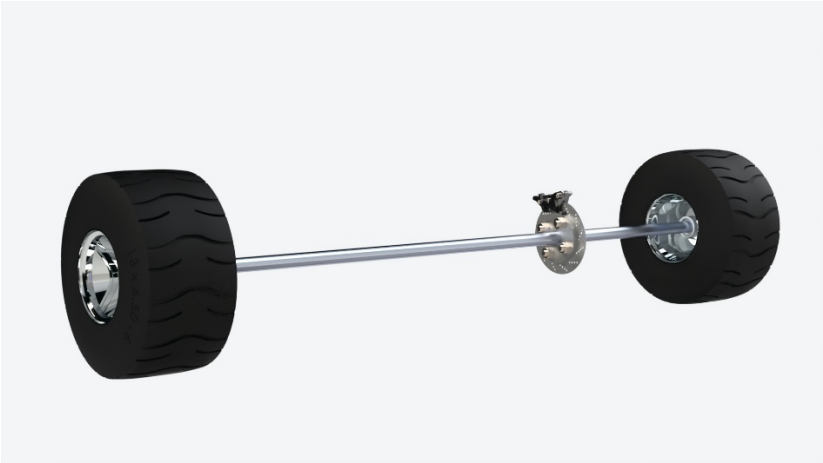

*Figure 3.6.1: Wheels and Brakes*

The material of the rims is aluminium. They have the best cost while not compromising on a solid all-round performance and weather adaptability (Projects, 2021). The diameter of the rims are 165mm.

For the brake system, a disc and caliper system are used. The rotor and caliper is made of an aluminium alloy, due to it being lightweight and dissipate heat quickly (Agbeleye et al., 2020). Since our go-kart will not reach high speeds, its low melting point can be neglected [https://knowhow.napaonline.com/brake-rotors-the-six-different-types/]. The braking force and power absorbed has been calculated to be 1275.3N and 6199.2333W. Detailed calculations can be found in Appendix E.6.

### 3.7 Track

The track construction occupies an outdoor area, covered by a roof, with 2 sides enclosed by walls. The other 2 sides are enclosed by fences. The entire building is subjected to a 40x40x5m layout. Figure 3.7.1 is an isometric roofless view of the track. The view of the track with a roof can be found in Figure C.4.4 in Appendix C.4.

*Figure 3.7.1: Isometric view of the track*

This layout includes the racing track, a café, restrooms, spectator seating, pitstop area, concierge and fire escape staircase. Since there are no suraus present in the building, the location of this track building should be around a walkable distance to a mosque, around 1.6km away. (Rizal and Syed Ariffin, 2019). This is to ensure that any Muslim customers or workers are subjected to their religious rights and practices.

When entering the building through its glass doors, there is a concierge on the right where the staffs can assist with ticket purchase, merchandise, and any enquiries. The biggest thing on the 1st floor is the racing track. The total length of the track is 137.1m. The racing track has 2 levels, connected by an incline and a decline. A tunnel is located below the 2nd level, where vehicles can pass through. A second tunnel is found in the middle, located beneath a structure. These can be seen in Figure C.4.5 in Appendix C.4. Both tunnels are lit and have extra barrier protection. Structural analysis of the barriers can be found in Section 4.1.3: Barrier Analysis.

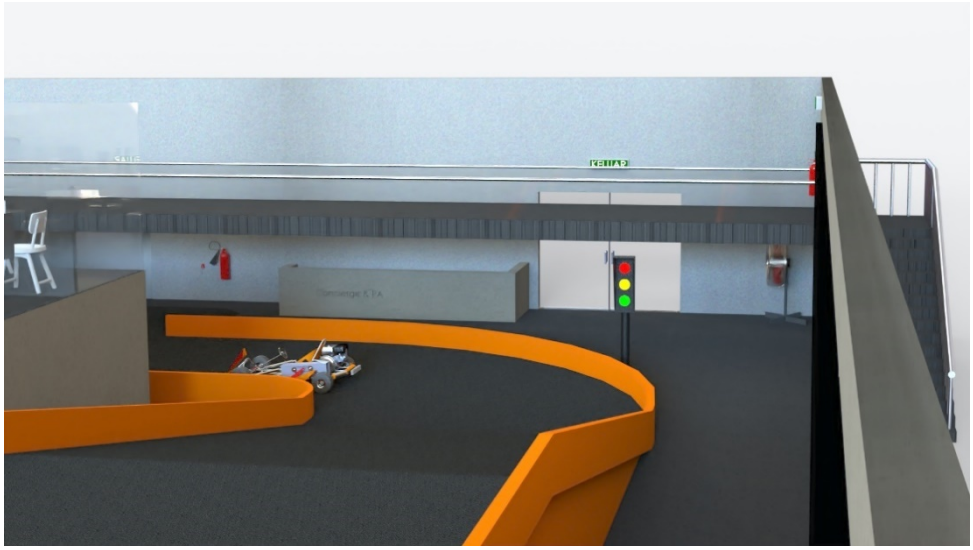

*Figure 3.7.2: Entrance*

At the south of the racetrack, a pitstop area can be found. The pitstop can park 6 go-kart vehicles. Repairs, maintenance, and storage of vehicles can be done here. Next to the pitstop is a garage door to allow go-karts to go in and out of the facility if needed.

North of the entrance, pass the racing track, lies the spectator seating. It is elevated by 1.5 meters, so that the spectators can see the racing happening on the higher platform of the racing track. The platform doesn't just act as an elevation for the spectators, it also serves as a storage room. Railings are built around the perimeter to ensure no one falls from the platform. A second bar is placed to ensure no children slip through the railings. Two fans are located at the spectator seat to provide comfort. A television is placed there to inform the spectators of the racing statistics.

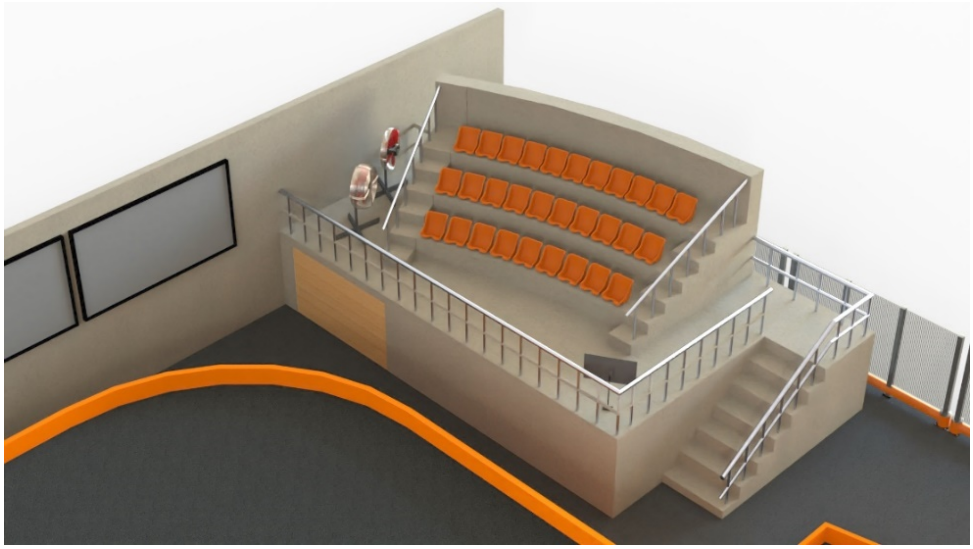

*Figure 3.7.3: Audience Seats*

The 2nd floor is connected to the ground via a staircase next to the entrance area. It has a glass railing and barrier surrounding its perimeter to ensure no one falls from the 2nd floor. Fans and televisions are placed where the standing spectators may gather at. According to a few authors, generally, a minimum thickness of 0.36 meters is required with reinforced concrete (Merritt, 2018, Taylor, 2021). Nevertheless, a simulation was carried out to ensure its structural integrity, which can be found in Section 4.1.4 Second Floor Analysis.

A café is connected to the second floor via a bridge. The café sits on the structure in the middle of the track area. The café has 8 tables and can sit 32 customers. The café has 2 air-conditioning units to ensure a cool comfortable temperature for the customers. On hot days, this will increase the likelihood of spectators being drawn to the café, hence increasing the revenue. The café serves pastries, cakes, beverages, and espresso drinks. There are television sets in the café to display the racing status to the customers. The café will be surrounded by thick soundproof glass and concrete walls, which will help to minimize noise sipping in from the racing track into the café.

On top of just having fun, safety needs to be heavily considered. This is to ensure the safe driving of beginners too. Hence, traffic lights have been placed on each section of the track. Green means go as usual, yellow means to be extra cautious and red means to not cross the section. The traffic light at the starting light also acts as a start race indicator too. Other than that, the track is surrounded by an RB22 barrier to minimize injuries to the driver by absorbing any impact that the vehicle may sustain (Facilities, 2021). An analysis was carried out in Ansys to determine the

deformation of the barrier. A force of 34525.75N was applied to one side of the barrier, with its 2 sides fixed. Simulation details can be found in Section 4.1.3.

In terms of safety, mandatory exit signs are located at each entrance, or exit, at the top of the doorway, as required by government guidelines (Architects, 2012). At least 2 class A fire extinguishers are placed at each floor, 3 meters apart, making it 4 available units in total in the building. Class B fire extinguishers are placed at the pit stop area, and at the other side of the building, in the event of a fire caused by gasoline (Park, 2017). On top of that, the fire staircase was designed according to an architecture firm's interpretation of the Malaysian guidelines (Siong, 2012). Security cameras are also placed around the building. Standard of procedures regarding the COVID-19 pandemic will also be set in place for all staff and customers (Malaysia, 2021).

# 4. Integrated Engineering Aspects

## 4.1 Static Structural Analysis

To make sure that the design of the Go-Kart and track does not fail under different conditions, a Finite Element Analysis (FEA) needs to be carried out to make sure that the design does not fail. ANSYS Workbench version 2019 R2 software has been used for FEA simulation.

The analysis is conducted using the result obtained from ANSYS simulation, the mesh size that has been set needs to be accurate with good computational time that it has took. Therefore, to justify that the mesh size is accurate, a mesh convergence study needs to be carried out which shows that the value obtained from simulation converges as the number of elements varies in ascending order. With reference to Figure 3C.2.0.1, Figure 4C.2.0.1, Figure 5C.2.0.1, and Figure 6C.2.0.1, in Appendix C.2, it shows that the values converge as the graph passes 243083 mesh elements which means the element size that is adequate for the FEA analysis is 10mm.

### 4.1.1 FEA on the Chassis Wireframe

The wireframe of the chassis for the Go-Kart is manufactured from a structural steel which is being designed in SOLIDWORKS and the role cage material used is AISI 1018. The outer diameter and the inner diameter of the circular tube chassis is 21.3mm and 19mm. Since AISI 1018 is used as the material of the chassis, the main physical property that need to be considered for the calculation using FEA result is the tensile yield strength which is 370MPa for this material.

#### *4.1.1.1 Torsional Stiffness*

In this FE analysis, the study is done by creating a force on the important components on the chassis including the weight of chassis while letting the side of the chassis be a fixed support. The force distributed for Engine, Weight of chassis, Gearbox, Chain drive to wheel shaft and Bumper is 485.568928N, 205.5151N, 291.0468N, 126.8166N and 308.8126N respectively which can be referred in Figure C.2.0.5 in Appendix C.2. With the mesh element size of 10mm and a scale factor of 1set in the ANSYS software, the solution for Total Deformation and maximum von Mises stress value in the chassis wireframe for AISI 1018 material is shown in Figure x to Figure y respectively.

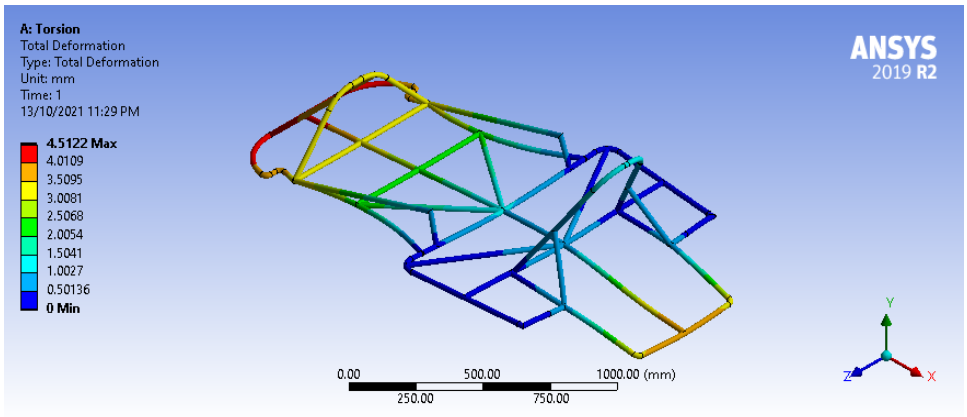


*Figure 4.1.1.1.17: Counter plot of Total Deformation for Torsional Stiffness (AISI1018)*

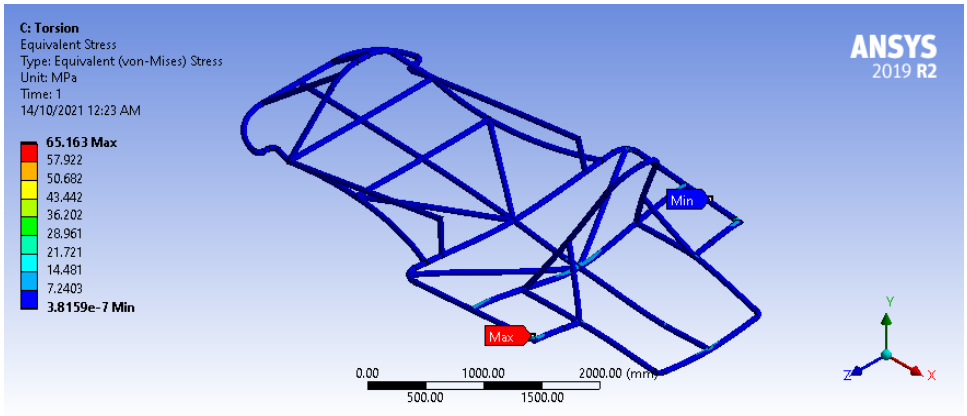


*Figure 4.1.1.1.28: Counter plot of Max von-Mises stress for Torsional Stiffness (AISI1018)*

$$\text{Factor of safety} = \frac{(\text{Yield strength})}{(\text{Maximum von}-\text{Mises})} \quad (1)$$

Tensile yield strength of AISI 1018 = 370MPa

*Table 4.1.1.1.1: Value of Total Deformation, Max von-Mises stress and factor of safety*

| | |
|---|---|
| Total Deformation | 4.5122 mm |
| Maximum von-Mises stress | 65.163 MPa |
| Factor of safety | 5.678 |

From the deformation value obtained from the simulation, it shows that the deformation of the chassis wireframe is only about 4.5122 mm at the critical condition therefore it can be proven that chassis is very stable under the loading of the Go-Kart elements together with the chassis self-weight. Plus, the factor of safety result in a value that concludes the chassis is stable and safe to for application. Similarly, the exact same analysis has been carried out but this time using AISI 4130 as the role cage material for the chassis. The discussion on selection of material is included in section 4.2 Material Analysis.

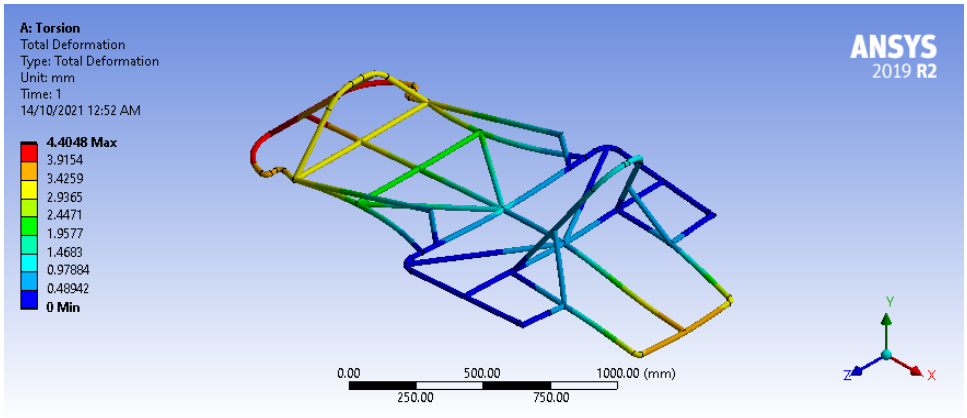


*Figure 4.1.1.1.39: Counter plot of Total Deformation for Torsional Stiffness (AISI4130)*

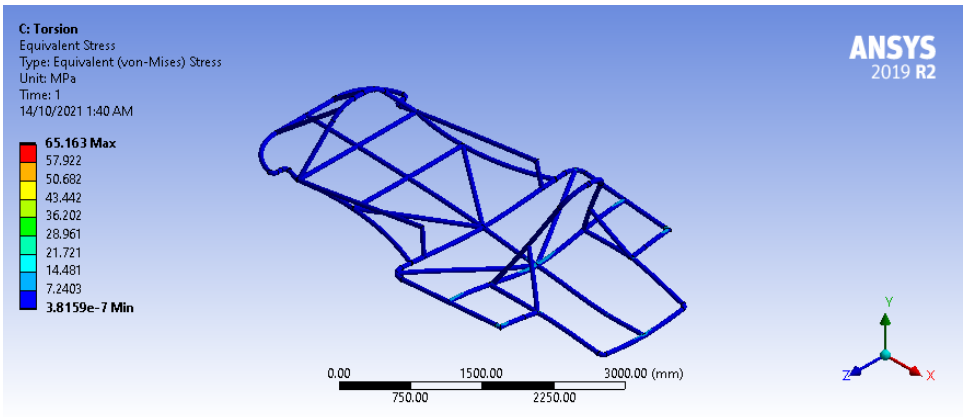


*Figure 4.1.1.1.410: Counter plot of Max von-Mises stress for Torsional Stiffness (AISI4130)*

Tensile yield strength of AISI 4130 = 460MPa

*Table 4.1.1.1.1 : Value of Total Deformation, Max von-Mises stress and factor of safety*

| | |
|---|---|
| Total Deformation | 4.4048 mm |
| Maximum von-Mises stress | 65.163 MPa |
| Factor of safety | 5.678 |

### *4.1.1.2 Crash*

A crash test has been conducted on the wireframe of the chassis while keeping the material of the body as AISI 1018. In this FEA, the study is done by creating a peak impact force of 34.525 kN at the front of the chassis and letting a fixed support at the side of the chassis. The force distribution on the chassis wireframe for the crash test can be found in Figure x in the Appendix C. The calculation to determine the impact force needed to be exerted on the chassis frame is done using the Equation 2 below:

$$\text{Peak impact force} = \frac{\text{Kinetic energy of vehicle}}{\text{Distance of collision}} \quad (2)$$

$$= \frac{\text{Mass of vehicle} * \text{Maximum velocity of vehicle}^2}{2 * Distance\ of\ coliision}$$

$$= \frac{(219.171\text{KG}) * \left(9.722\frac{\text{m}}{\text{s}}\right)^2}{2 * 300mm}$$

$$= 34.525\text{kN}$$

With the mesh element size of 10mm and a scale factor of 1 in the ANSYS software, the solution for Total Deformation is obtained from ANSYS is shown in Figure 4.1.1.2.1:

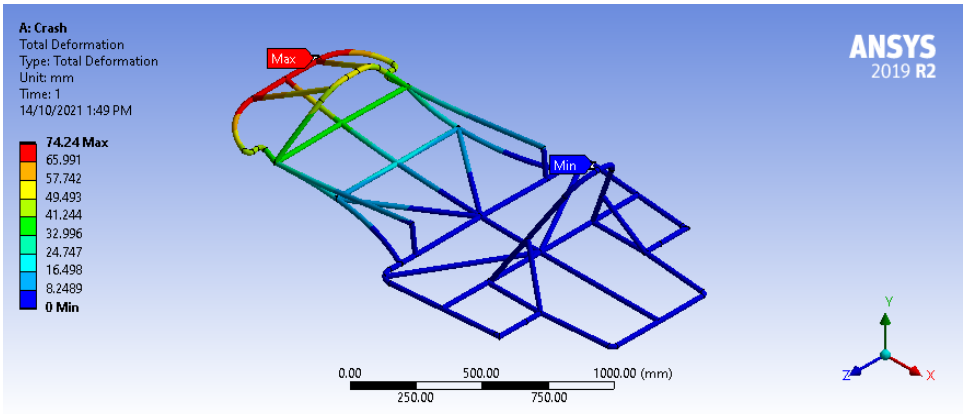


*Figure 4.1.1.2.111: Counter plot of Total Deformation for Torsional Stiffness (AISI1018)*

This 74.24 mm total deformation obtained from ANSYS by using the impact force of 34.525 KN is after setting the "crumple zone" or known as distance of collision to be 300mm. Therefore, during an accident only 74.24mm will be crashed from the front body hence the body of chassis absorbs most of the energy during collision and avoiding the full kinetic energy to pass down to the driver causing to fly away from the seat.

### 4.1.2 FEA on the Bumper

For the FEA simulation for the bumper, two different types of bumpers have been used to perform the crash test at the front, both rear and back part of the chassis. Therefore, the mass of each side of the bumper has been recorded and converted into Newton by multiplying with 10 $m^2/s$ for gravitational acceleration. Since the normal force is defined as the force that a surface exerts on an object. Therefore, if the object is at rest, then the net force on the object is equal to zero; hence, the downward force (weight) must be equal to the upward force (normal force). Since the weight of the bumper is already determined, therefore the normal force is also easily found. After the normal force is found which is acting in the opposite direction to the crash force, the net resultant crash force can be found by using Equation 3. The fixed support is assigned at both sides of the chassis. Hence using all this information, the simulation can be done in ANSYS by setting the mesh size as 10mm with scale factor set to 1.

$$|\text{Crash Force} - \text{Normal Force of bumper}| \quad (3)$$

*Figure 4.1.2.112: Isometric view of customizable Bumper 1*

*Table 4.1.2.1: Total Deformation value obtained for each side for Bumper 1*

| | Net Resultant Force | Total Deformation |
|---|---|---|
| Front Bumper | 34470 N | 6.3122 mm |
| Side Bumper | 34501 N | 0.0002503 mm |
| Back Bumper | 34472 N | 5.0667 mm |

*Figure 4.1.2.213: Isometric view of customizable Bumper 2*

*Table 4.1.2.2: Total Deformation value obtained for each side for Bumper 1*

| | Net Resultant Force | Total Deformation |
|---|---|---|
| Front Bumper | 34418 N | 6.9739 mm |
| Side Bumper | 34504 N | 0.0002503 mm |
| Back Bumper | 34472 N | 5.0666 mm |

The force distribution together with the deformation value obtained from the ANSYS for the bumper has been included in Appendix C.2.1 for Bumper 1 and in Appendix C.2.2 for Bumper 2. To summarize, the values has been tabulated in Table 4.1.2.1 and Table 4.1.2.2. There is a

difference in the deformation value at the front bumper crash test using both bumpers. Therefore, it can be proven Bumper 1 is stronger than Bumper 2 because Bumper 1 gives a lesser deformation compared to Bumper 2 using the same peak impact force. The reason is because the frontal Bumper 1 has higher weight therefore exhibits higher normal force and reduces the resultant crash force.

### 4.1.3 Barrier Analysis

The barrier plays a crucial role in protecting the drivers in the event of an accident. They should prolong the time of impact between the vehicle and the barrier. A force of 34525.75N was implemented perpendicularly to the barrier wall. The fixed supports were assigned to the sides of the wall. The simulation was done in ANSYS by setting the mesh size as 50mm with scale factor set to 1. A total deformation value of 101.12mm was obtained.

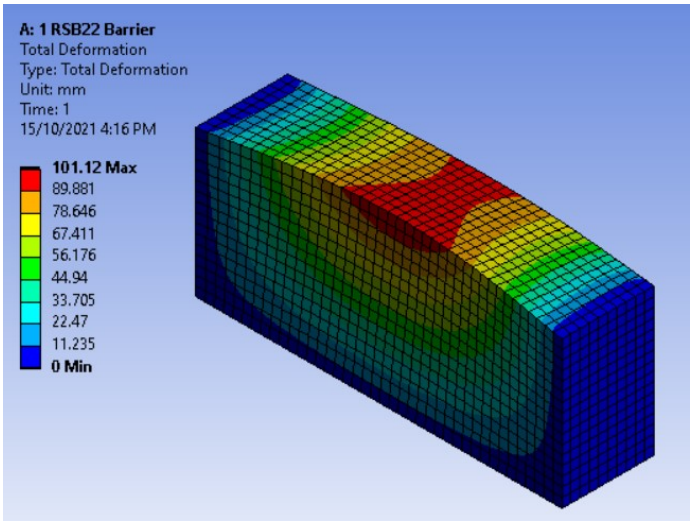


*Figure 4.1.3.1: Total deformation of one RSB22 barrier*

On top of that, two RSB22 barriers were used side by side in the longitudinal direction at higher risk areas, such as the 2nd level of the track and the tunnels. The same force and fixed supports are used as the case of one RSB22 barrier. The total deformation is 36.66mm.

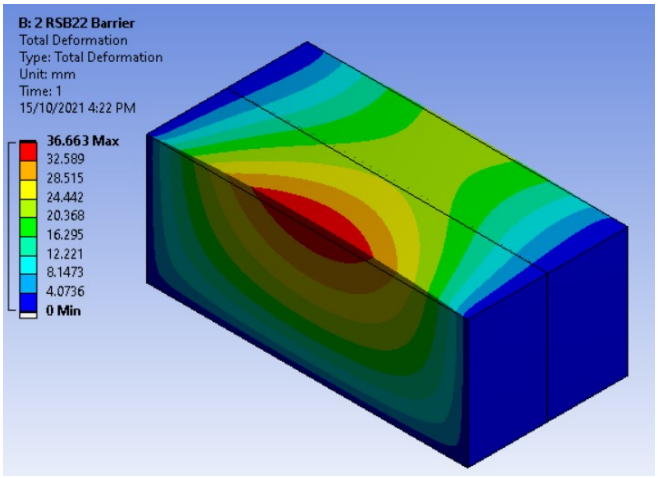


*Figure 4.1.3.2: Total deformation of two RSB22 barriers*

### 4.1.4 Second Floor Analysis

An ANSYS simulation was carried out for the second floor to ensure its structural integrity. A total of 3 areas, with 10 people per area, was modelled and simulated with an average weight of 63kg per person (Azmi et al., 2009). This resulted in a total weight of 18504.9N. The fixed supports were chosen at the faces where the walls were connected to the second floor. The mechanical properties were obtained online to have a modulus of elasticity of 41GPa and a Poisson ratio of 0.21 (Toolbox, 2008). A mesh size of 100mm was used. The results determined the 2nd floor to be safe with a safety factor 3.9 and maximum deformation of 0.988mm.

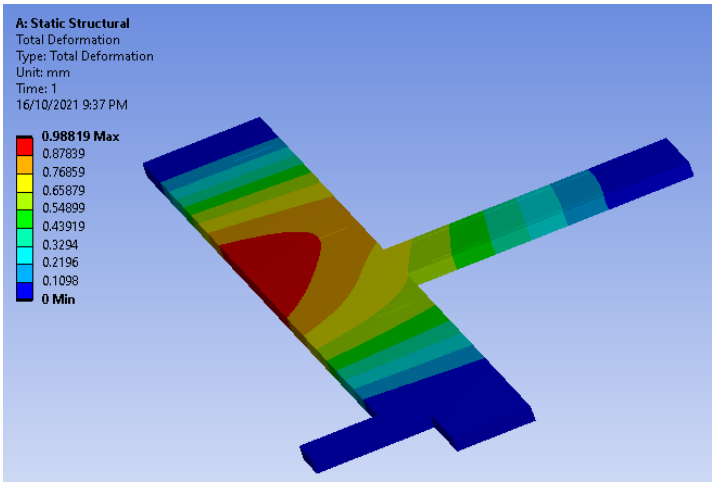


*Figure 4.1.4.1: Total deformation of second floor*

## 4.2 Materials

Material selection is important for the chassis as their properties determine the structural integrity of the design. The chassis material must be rigid enough to support all subsystems especially heavy ones like the engine. Furthermore, material with extremely high density will draw more power from the engine. Initially four materials, namely AISI 1018, AISI 4130, SS316 and SS304 were considered for the chassis. However, SS316 and SS304 were ruled out because stainless steel is generally much harder to shape and weld. The yield strength of alloy and carbon steel is generally higher than stainless steels. Besides, both AISI 1018 and AISI 4130 can be easily welded using commercially available methods. Hence, research was carried out to decide between AISI 1018 (Carbon Steel) and AISI 4130 (Alloy Steel). FEA simulation of a torsional test was carried out and compared for both materials to determine the suitability of the material to meet the design requirements of the chassis at the lowest cost. The main physical property that needs to be considered for the calculation using FEA result is the tensile yield strength of both materials used as the roll-cage and the deformation that occurs. An ideal chassis design requires a sufficient deformation to absorb the impact force to ensure driver safety. The detail of the process is discussed in Section 4.1.1. The material properties and the summary of FEA results for both materials are listed in the tables below.

*Table 4.2.1: Material Properties of AISI 1018 and AISI 4130*

| | AISI 1018 carbon steel | AISI 4130 alloy steel |
|---|---|---|
| Tensile strength | 440 MPa | 560 MPa |
| Yield strength | 370 MPa | 460 MPa |
| Modulus of elasticity | 200 GPa | 205 GPa |
| Density | 7870 kg/m^3 | 7850 kg/m^3 |
| Poisson's ratio | 0.29 | 0.285 |
| Cost per m | 20.60 | 49.44 |

*Table 4.2.2: Summary of FEA Results*

| | AISI 1018 | AISIS 4130 |
|---|---|---|
| Total Deformation | 4.5122 mm | 4.4048 mm |
| Maximum von-Mises stress | 65.163 MPa | 65.163 MPa |
| Factor of safety | 5.678 | 7.06 |

Based on Table 4.2.2, there are not much difference in the chassis deformation values at the critical condition with AISI 1018 having a larger deformation of 4.512mm. Besides, simulation results shows that both materials seem to experience a similar maximum von-Mises stress of 65.163MPa. Therefore, can be seen that even AISI 4130 has a higher tensile yield strength of 460 MPa compared to AISI 1018, there is not much difference in strength performance between AISI 1018 and AISI 4130 based on FEA results. The factor of safety for both materials is also within a safe range meaning the chassis can sustain strong impacts. The material density of both materials is similarly close and hence does not play a role here. However, the price of AISI 4130 is almost double the price of AISI 1018 with it costing RM49.44/m compared to RM20.60/m. With that, AISI 1018 is the preferred chassis material as it fulfils all design requirements at the lowest cost.

## 4.3 Electrical and Electronics

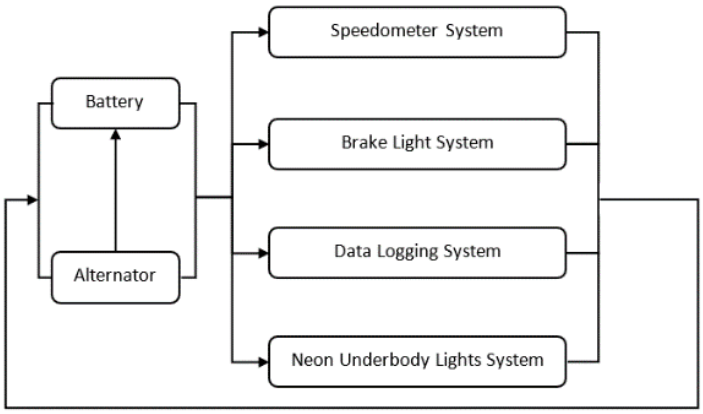


*Figure 4.3.1: The overall diagram of the vehicle electrical system*

The overall electrical system for the go kart is assembled parallelly to abide the 12 V rule with the flow diagram as shown on Figure 4.3.1. The electrical system of the go kart is powered by a 7 Ah sealed lead-acid (SLA) battery when the engine is stationary and provides sufficient energy to all

the electrical components for 3 to 4 hours. The battery is linked to an alternator, then is recharged safely while the engine is in motion and together in turn supply the electricity to the systems. The alternator has the rated output of 60 A at 6000 rpm and the battery can take up to 2.1 A in constant voltage charge while only use 1.8 A in an hour. In this manner, the battery does not require to be dismantled or manually charged. Should the battery be fully depleted, the recharging process will only take 3.3 hours with the chosen alternator.

### 4.3.1 Speedometer System

For this project, the go-kart is equipped with the electronic speedometer to enhance the racing experience, the aesthetic and reliability aspect of the design. The digital speedometer works by harnessing the electromagnetism that is generated between a magnet on the driving shaft and magnetic sensor (Figure 4.3.1.1) that delivers electric pulse to the circuit and converted into speed on LCD screen (Woodford, 2021). The chosen speedometer obeys the same rule and can display up to twelve information that can be adjusted as per requirement.

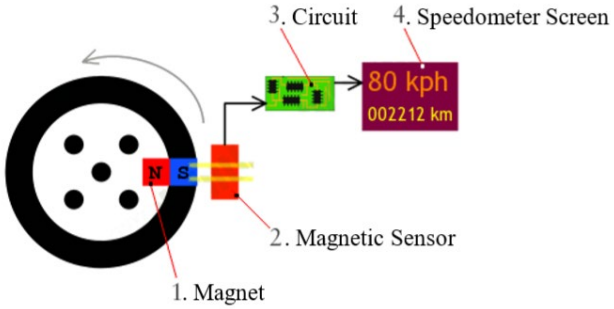


*Figure 4.3.1.1: The electronic speedometer working principle (Woodford, 2021)*

### 4.3.2 Braking Light System

The brake light is a mechanism that signifies the vehicle either slowing down or stopping and, in an attempt, to reduce the risk of crashing, the brake light system is installed to the vehicle. The system consists of the connection between the pedal, the battery, a brake light switch and a brake light that create a closed loop (Figure 4.3.2.1). The brake light switch acts as a separator that completes the circuit only when the pedal is pressed down.

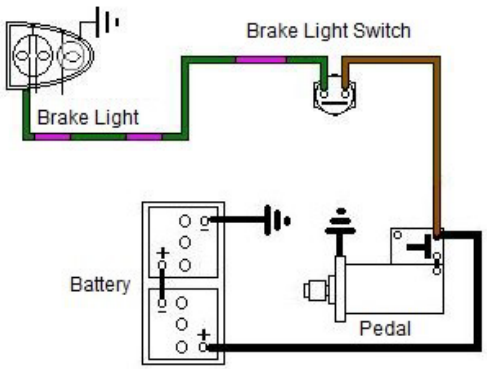


*Figure 4.3.2.1: The braking light system connection (Answers, 2021)*

### 4.3.3 Data Logging System

The technical game plan for the project relies on the communication between data logging system of the vehicle with the network of the company. The project uses Arduino UNO microcontroller as the motherboard of the data logging system that relates to the Wi-Fi Module ESP8266 to provide the data logger access to the network. By opening a pathway, the vehicle electrical system could communicate locally with the computer to ask or send the required data. For a better understanding on data logging system, refer to Figure 4.3.3.1 is shown below.

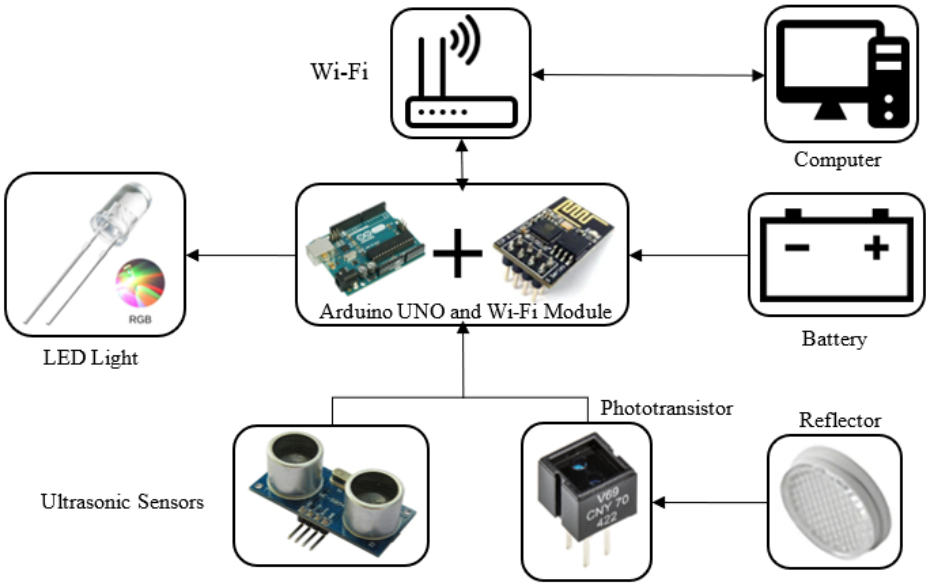


*Figure 4.3.3.1: The data logging system diagram ((Components, 2021, Library, 2021, Shopee, 2021, StickPNG, 2021, Technologies, 2021b, Technologies, 2021c, Technologies, 2021a, TopPNG, 2021)*

To implement the tagging game, the data logging system is equipped with two ultrasonic sensors that are put at the front and back of the vehicle to detect another vehicle and send appropriate responses. The microcontroller will then use the responses to determine and activate the LED light in accordance with the status. Additionally, the phototransistors are also installed on each side of the vehicle to integrate the checkpoint system where if there is photo reflector present at the side of the track, the phototransistor will capture and send the time data to the computer through Wi-Fi.

### 4.3.4 LED Underbody Light System

In an effort to leverage the aesthetic feature and indicate the vehicle status in tagging game, the LED light strips are used. The component has radio frequency control box module that will be connected to the power source and integrated with wireless remote control to adjust the LED colour. The strips will be separately attached at the front, back, and each side of the vehicle. The connection of the underbody light system is shown in Figure 4.3.4.1.

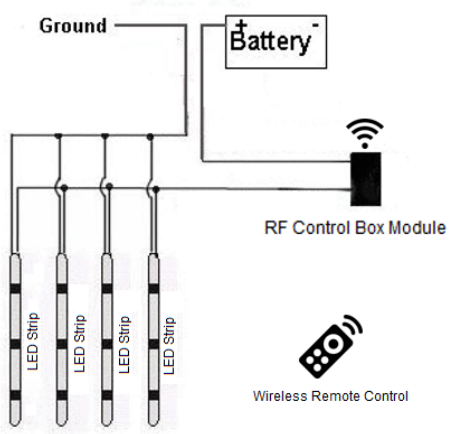


*Figure 4.3.4.1: The connection of the LED strips (PNG, 2021, PNGKey, 2021).*

## 4.4 Programming

Programming in the electrical system is very important to determine the logic of the operation, hence the pseudocode has been prepared and can be examined below (Appendix E.2). Coding algorithms exist in both the microcontroller, which is the Arduino UNO and the PC. The PC and

Arduino interacts with one another via a Wi-Fi module. The pseudocode is based on Arduino. Two modes are used, one for each type of race: Normal and “Ride or Die” (Tagging game).

### 4.4.1 Microcontroller of Car

For all race modes, before starting:

- Calibrate and link with ultrasonic sensor, retroreflector emitter and receiver, Wi-Fi module
- Set Car ID and position (Cars will be set up according to their car ID)

Normal Racing

- When race starts, PC sends code to start timer to all cars.
- When retroreflector receiver receives a high signal, timer is stopped. Time is recorded and sent to PC. Time is reset to time another lap.
- PC stores the time in an array.

Ride or Die

- To start the game, the last car will be the tagger. Everyone else are taggees. (Car #6 = Tagger, Car #1-5 = Taggee).
- If the ultrasonic sensor senses that the distance between the car and the one in front is less than 1m for more than 1 second, the tagger status switches. Figure 4.4.2.1 visually explains this (e.g., Car #6 = Taggee, Car #5 = Tagger).
- LED Light switches colour. (Red = Tagger, Blue = Taggee).
- As tagger status switches, it sends the status to the PC so that the administrator at the PC can keep record of what is happening.

Emergency Situation(s)

1. If the vehicle is visually or audibly determined to have issues, the LED will turn yellow. This signals the driver to return to the pitstop ASAP
2. If this system fails, the administrator will announce it to via speakers in the racing building and traffic light system.

### 4.4.2 Personal Computer (PC)

For all race modes, before starting:

- Record how many vehicles on track
- Set predetermined number of laps
- Pre-allocate an array to store lap times for the cars

Normal Racing: If receive time from a specific car, check which car, receive and store its time into the array.

Ride or Die: If receive tagger status change, check for car ID for position in front of tagger and change that car ID's status to tagger.

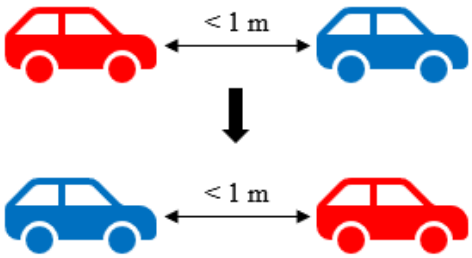


*Figure 4.4.2.1: Tagger status switching diagram*

## 4.5 Ergonomics

In Kart-Mobil, safety is our number one priority. Thus, the ergonomics of our go kart is crucial to ensure a pleasant racing experience while keeping the risk of injuries to the bare minimum. In accordance with the average height of a typical Malaysian male, about 1.64m, the drivers position in our go-kart is as shown in Figure 4.5.1 (Eyes, 2021). The design of the kart takes into consideration the comfort of the driver by ensuring that the leg and heel of the driver rest at a comfortable distance from the accelerator and brake pedals. The seat is designed in a way where the body of the driver is held in place even during sharp turns. The 60° inclination and distance of the body of the driver from the seat to the steering wheel puts the driver in a position of power to achieve maximum control over the vehicle (Karting, 2021).

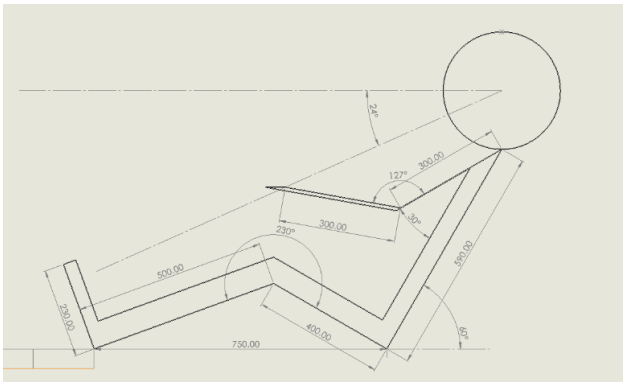


*Figure 4.5.1: Driver position in vehicle*

### 4.5.1 Crumple Zone

Based on our analysis in Section 4.1.1, our crumple zone has been designed to have a length of 350 cm. From the feet of the driver to the front tip of the chassis, it has an approximate length of 456.84 cm. The maximum impact force that the chassis can withstand is approximately 34 kN. This evidently shows that if an accident were to occur and the crumple zone of the chassis is fully deformed, the impact will not reach the driver.

### 4.5.2 Adjustable Seat

Adjustable seat is installed in the design as a good driving position is crucial for the balance of the vehicle. This is because the driver plays an important part in the overall moving mass of the car. Usually, the driving position is based on the height and weight of the drivers. The adjustable seat is installed to cater to a wider audience. This is to ensure that the vehicle balance is maintained and will not affect the performance of the car, and most importantly to cause any unwanted accidents. Our seats can be adjusted to an offset distance of 15cm. Assuming the weight limit of the driver is at 70kg considering the typical weight of a Malaysian from this analysis, a heavy person weighing at 100kg is safe to adjust the seat to the backward position of the adjustable seat (Azmi et al., 2009). For lightweight drivers, assuming the minimum weight limit of the driver is at 40kg, counterweights can be added to the seat to ensure that the go-kart has enough stability, and it can be safely driven by lightweight drivers.

### 4.5.3 Adjustable Steering Hub and Steering Wheel shaft

Steering wheel is a mechanism that is responsible to drive the vehicle in a certain direction and has to be connected to at least two tires. There are four main points that affect the ease of use of the steering wheel: distance from the driver to the steering wheel, the elbow room when turning,

the steering angle and steering wheel size. Nevertheless, every driver has different body height and shape which imply every person has personal preference when driving the vehicle. Thus, the adjustable steering mechanism is introduced which allows the driver to personalize the steering wheel that corresponds with the preference of the driver (Team, 2021).

A good principle to determine the proper driving position is by having the driver straighten his or her arm then resting the wrist on top of the steering wheel and having the distance between the breastbone of the driver to the centre of the steering wheel to be approximately 25 - 30 cm. With the adjustable steering wheel, there is a 30mm vertical distance and the 30 degrees angle tilt to modify the steering wheel position. Figure 4.4.3.1 is used as a reference for illustration purposes (Export, 2018, Safety, 2016). In addition, to cater to drivers with different arm length, our extendable steering wheel rod provides an extra 20 cm in length.

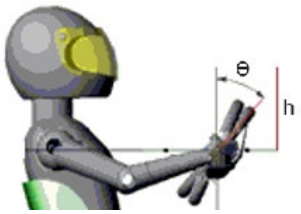


*Figure 4.4.3.1: The illustration of the adjustable steering hub (Chico's Gokart, n.d)*

### 4.5.4 Additional safety gears

While doing motorsports activities such as Go Kart, safety is always the number one priority and to enhance the safety of the driver, safety gears are required to help driver avoid undesired accidents and improve the driver performance ergonomically. Go-kart helmets are one of the components that is compulsory for each go-kart driver. This component will also provide provides the air circulation through the helmet vents.

# 5. Business Operation

## 5.1 Business Operation Overview

Kart-Mobil utilises a space of 40m x 40m x 5m in I-City, Shah Alam and will be equipped with first-rate facilities to attract and enable customers to enjoy their time with Kart-Mobil in comfort. The Kart-Mobil track and team will be based in I-City, Shah Alam. This prime location is in the centre of a densely populated financial hub, shopping malls and residential areas, making it

convenient for clients to visit. Moreover, the high spending power of the surrounding populace is sufficient and present. Furthermore, this strategic location has a lot of human traffic flow and is sure to attract clients. These facilities along with the main attraction which is the race track and race karts hope to maximise profit earned while keeping the customers happy and returning for more.

*Table 5.1.1: Operational details*

| | |
|---|---|
| Operating Days | Mondays till Sundays. |
| Operation Hours (Go-Kart racing) | 11:00am – 3:00pm,<br>4:00pm – 1:00am (13 Hours)<br>*Night tag mode will be operating from 8pm to 12 am (5 Hours)<br>*Operating hours during the Seasonal TAG, YOU'RE IT! Championship league games will differ. |
| Operation Hours (Mobil's café) | 10:00am – 10:00pm (12 Hours) |

### 5.1.1 Game operation overview

Kart-Mobil strives to be different from other go-kart companies. At Kart-Mobil, we want our customers to indulge in the racing experience and provide a memorable experience for them to want to return to Kart-Mobil for another race. Thus, our team has come up with different game modes for customers to enjoy. There are three game modes available in Kart-Mobil, the Normal Mode, Ride or Die (Day Tag), and the Ride or Die (Night Tag) mode.

Normal Mode provides go-kart drivers the experience of go-kart racing together with 6 other individuals on the track, where they will compete on lap time and the fastest speed they can achieve per lap. Normal mode targets customers of all ages, be it professionals, novice, or amateur races, everyone can have a taste of racing competitively through our normal mode. Record holders will be placed in our Hall of Fame for the fastest racing speed ever achieved when crossing checkpoints, fastest time to finish one lap and the whole race.

Most go-kart ranges in Malaysia only offers regular racing modes. At Kart-Mobil, we would like to encourage our customers to try out our unique Ride or Die Tag mode. For this game mode, we strive to target customers who would visit Kart-Mobil as a group of friends and family, to spend their time together at Kart-Mobil participating in this exhilarating game mode. For this mode, 6 individuals will participate in the one game at a time. One driver will be randomly voted through our system as the tagger and another 5 drivers will be voted as the target. For the drivers to triumph in the game, the tagger will be required to chase the targets and once the tagger succeeds, the tagger role will be passed on to the target that has been tagged. The target is now safe from elimination for the round. There are 5 laps in one round of the game. For each round, the driver that remains as the tagger will be eliminated. The eliminated driver will then proceed to the pit stop. The last go-kart will then be assigned as the tagger for the next round. One driver will be eliminated for each round and after 5 rounds, the last remaining driver will emerge victorious. The total time needed for this session is approximately 15 minutes. For all the drivers to differentiate between tagger and targets, they will be given an earpiece with automated voiceover informing them on their status and underbody light kits installations on the car to indicate their status. The taggers and targets go-kart will have different underbody light colours to show their status as taggers or targets throughout the game. Our track is also equipped with excellent sound systems to announce the progress on the game: the current tagger, the eliminated drivers, the number of targets left and the final victor. The Ride or Die Night Tag Mode will only happen at night after 8pm. The game will take place after 8pm. Our Ride or Die Night Tag mode is one of the major attractions of Kart-Mobil's racing game. Our tracks will be equipped with be equipped with various lightings along the tracks. Briefing will be given by our go-kart safety instructor/ assistant to let the drivers understand the mechanics of the game.

The schedule of the games is as shown in Table xx. Pre-booking is subjected to availability and can only be done during off-peak hours. On Mondays, the track will be booked for go-karting academies to provide training for new racers at our tracks. Ride or Die (Night Tag mode) will still be available on Mondays. Details on operating schedule for each game modes can be referred to Table C.3.1.1 in Appendix C.3.1.

### 5.1.2 Sources of revenue

Kart-Mobil go-karting range is a go kart range and family fun industry to provide not just go-karting experience but facilities to accommodate different purposes of visiting our go-kart ranges. We are optimistic that our fully equipped facilities will satisfy the comfort and needs of our customers. Details of our facilities can be found in Table C.3.1.2 in Appendix C.3.1.

### 5.1.3 Operation management tools

In Kart-Mobil, we priorities systematic and efficient business operation model. Thus, we will be developing a mobile application and website for all customers purchasing and booking process. Customers will be encouraged to purchase e-tickets to reduce the chances of lost tickets and increase the efficiency of the purchasing process. All booking will be done online as well, and the availability for pre-booking will be stated in our application and website. As not all our game modes run simultaneously, our application will provide information on the operation schedule of each game mode. By downloading our application, first-time customers who has registered into our database will be eligible to receive a 20% promotion. With our customers registration, we can track the return rates and game mode preference of our customers. This will help us to do future planning on the improvements that can be done on the business operation and analyse the general trend of the preference of our customer. In our application, the winning streak of each customer will be shown in our application interface. This will be a motivation for customers to return for more wins to increase their winning streaks. The leader board and the Hall of Fame of the games will constantly be updated in the application as well. Referral promotions will also be given to customers that bring in new faces into the game using the referral code in the application. Details on referral promotions is stated in Section 5.6 Promotional Activities.

## 5.2 Market Analysis

At Kart-Mobil, we want our racers to be able to get the full experience of driving competitively at an affordable price. To set an attractive and competitive price package, a short market research was conducted to evaluate the price packages of other competing kart racing companies, most of which offers a driving time of 10 minutes for a price of RM30 and above. Naturally, the price package increases in accordance with the duration of the race and the performance of the car (e.g. a more powerful go-kart). Appendix C.3.2 shows the competitive packages shows price packages offered by 5 highly reputable go-karting companies in Malaysia. For Kart-Mobil to stand out from

other go-karting companies, Kart-Mobil offers exciting new game modes that racers can indulge in while still offering a competitive price. The new game mode named “Ride or Die” challenges the driving skill and strategic thinking of the racers for them to win.

To gain further insight from the general audience, a short survey was conducted in a one-week timespan through Google Forms to better gauge the market Kart-Mobil would be facing. This survey was distributed via social media to people of all age and gender for an unbiased response. There are 66 survey participants involved from age of 19- 30 of various backgrounds. This survey tries to capture the opinion of the public on whether they have tried go-kart racing or not, if yes, how frequent do they go-kart. In addition, the preferred time of the day where survey participants would most likely participate in go-kart racing was also assessed regardless of if the has tried go-kart racing before or not. Furthermore, this survey asks the participants what would most likely attract them to take part in go-kart racing and how much are they willing to spend on go-karting per visit. At the end of this survey, a total of 66 responses were recorded and analysed. Appendix C.3.5 shows the questions and pie chart results taken from the survey.

Judging from the survey results, it could be hypothesized that price factor does have a strong correlation with the willingness of respondents to participate in go-karting, however, proper correlation analysis tool should be used to further confirm this. Moreover, it was surprising to see that the performance of go-kart was the least prioritized factor that attracts them to go-karting. The data obtained for preferred timeslot and respondent age groups could be used to formulate promotional packages to attract customers depending on the chosen marketing strategy. Appendix C.3.5 shows the results from the survey.

### 5.3 Business Packages

After considering the cost analysis of the vehicle and the operational cost needed for the business (details can be found in Section 6.3 Vehicle Costing and Section 6.4 Operational Cost), and through evaluating the go kart competitors in the industry, the estimated price packages for walk-in customers that are offered in Kart-Mobil are shown in Appendix C.3.3.

The price range of our packages are classified into three groups: individual package, group packages, and special day package. For the individual packages, the price range is about RM30 to RM45 per pax depending on the game modes and the duration of the session. For the 3-person

group package (3 in 1 package), the price range is about RM 84 to RM129, with each person spending approximately RM35 to RM43, with approximate price difference of RM5 per pax as compared to the individual packages. For the 6-person group package (6 in 1 package), the price range is about RM 170 to RM 270, with each person spending approximately RM 30 to RM 45, with an estimated price difference of RM 10 and RM 5 per pax as compared to the individuals in the 3 in 1 package respectively. With the discount that is given for a bigger group of customers, customers will tend to join the game as a group. For Public Holidays, an extra 10% charges will be inflicted upon all packages as most customers would visit go-kart centres during Public Holiday where they are off from work and study. In Malaysia, weekdays are usually where working people and students are occupied for the day. Another special day package (Mayhem Wednesday) is introduced. This package is offered to attract more customers to come enjoy the game while having 10% off from all the packages on Wednesday. This is targeted towards non-working or work-from-home groups of people who have more spare time on weekdays to participate in the race.

Membership subscription plans are available in Kart-Mobil as well. We want to ensure there are loyal customers that are most likely to return to participate in the race. There are 3 packages available: 1-month subscription plan, 3-months subscription plan and a 6-month subscription plan. Customers who have subscribed to Kart-Mobil membership plan will be eligible for unlimited go-kart races at Kart-Mobil during the period of subscription. To increase the attractiveness of the package, members of Kart-Mobil are eligible to exchange food vouchers or merchandizes as a reward for their achievement. Details of our business packages can be found in Appendix C.3.3.

### 5.4 Company Management Team

A team of dedicated professional would ensure the operation and facilities at Kart-Mobil are maintained with the highest standard while also providing a red-carpet customer service experience to all our client. Here at Kart-Mobil, we believe that a conducive and friendly work environment encourages productive work to be done, thus, all employees are subject to fair and unbiased treatment. With that said, all employees would have a chance for career growth opportunities working in Kart-Mobil. Details on the responsibilities for each job roles at Kart-Mobil are stated in Appendix C.3.4.

### 5.5 Biannual ‘Tag, You’re it!’ Seasonal League Games

Seasonal league games will be held twice a year in June and December for races to compete competitively for exclusive cash prizes and Kart-Mobil gift vouchers. The objective of the seasonal league game is to promote awareness on safe and fun racing while also culturing good sportsmanship amongst racers. Furthermore, it will serve as an event to bring in human traffic that raises brand awareness and attract potential customers. We encourage not just professionals' drivers, but drivers of different skill levels and off different ages participate. Table C.3.1.3 from Appendix C.3 shows the structure of the seasonal league game.

### 5.6 Promotional Activities

A strong marketing strategy is important to build a solid foundation in increasing engagement of our brand to attract potential customers. Digital marketing plays a crucial role in engaging social media users of all ages. By developing our application and website in the early phase of the business, it lays a good foundation to create online presence. At an early stage, it is not necessary to have an over-developed website as long as the fundamental functionality and general information are provided to the customers. With a large amount of traffic in our website, customers will be sure to visit us. To achieve that, our sales and marketing team is dedicated in managing the content in our social media well to increase brand awareness. Contents regarding go-karts are posted up two times each week. Customers review on the game is posted up constantly, serving as testimonies to other potential customers. Several social medias that will be used are Facebook, Instagram, Twitter and TikTok.

Recently, influencers played a huge role in influencing the decision-making process of their followers, especially in purchasing a product. Advertisers are now embracing influencers as part of their marketing strategy. 86% of women refers to social network while 71% customers will be likely to make a purchase based on references from social media (StarNGage, 2021). Thus, Kart-Mobil is keen to invest in influencers to advertise our brand, creating interest for their followers to be our potential customer. Famous go-kart racers should also be invited to race at our go-kart range for free as most of their followings includes many racings enthusiast. Kart-Mobil will also be doing customer referral programs to attract new customers to join our games. For each customer that is being referred, they will receive a 10% off in their next purchase as an incentive. To promote the referral programs, Kart-Mobil will be paying advertisement fee in several available advertising

platforms. Furthermore, for our customers that have registered in our system database, we will be sending out newsletters to their email addresses, reporting the latest news that has happened in the games, the leader board, and upcoming events that will be held in Kart-Mobil go-kart range.

### 5.7 Collaboration

Kart-Mobil is motivated to provide more opportunity to individuals who are passionate about racing to learn how to race competitively. Therefore, Kart-Mobil will be collaborating with different go-karting school for drivers as young as age 12, if they are physically and mentally capable, to have the opportunity to participate in racing using our tracks. Some schools that are available in Malaysia are Stratos Racing School and Nexus International School. Our administration team will approach these schools to collaborate and provide the necessary training. As mentioned in our operating hour schedule, go-karting classes will only be available to be conducted on Mondays. Classes on other days will be subjected to availability.

Collaboration with large marketing platforms such as Shopee is done as these platforms provide heavy customer traffic. They usually provide very good marketing for merchants to sell their products on their platform. By selling cash vouchers that are slightly discounted in their platform, customers visiting these huge platforms will be inclined to purchase the cash vouchers.

### 5.8 Goals for Future Operations

Kart-Mobil is always looking into new ways to improve the business operations to engage with more potential customers. To provide a more thrilling experience to our drivers during the games, we envisage to integrate Augmented Reality (AR) helmets for each player. AR can provide an immersive experience during the games, providing our drivers the opportunity the unique interaction and stimulation by the game. Although a huge investment may be needed, this concept has not been implemented widely and there is a rising trend in the adaptation of this technology. Kart-Mobil strive one of the pioneer companies to adapt this technology in the racing industry. We believe that this investment is worthwhile in a long run to attract larger crowds. With the success of the business, we envisage that for the expansion of our business, longer racetracks and better facilities will improve the overall experience of our customers. Thus, we will be looking into purchasing bigger lands for future operations.

# 6. Project Management and Costing

## 6.1 Project Management

The work breakdown structure (WBS) and work breakdown document (WBD) will be found in Appendix F. The WBS is the breakdown of project into smaller subsystems, and it shows the work assigned and completed by each team member. This makes the project more manageable and increases team efficiency. The WBD has an explanation with the task description which shows what are the task required to perform the specific work in the WBS. Plus, the assumptions and constraints that is present also gives a complete overview of how this task has been justified. Finally, a Gannt Chart from the start of the project is developed and included in Appendix F. The Gannt chart includes the person responsible for respective tasks and shows the timelines planned. Thus, with an organised management as stated above, our team members are more productive in completing the assigned tasks. Appendix Section C.3.6 shows the weekly milestones for a total of 11 weeks and the status either it is “Done”, “Undone” or “Progressing”

## 6.2 Communications

In keeping the project on track, effective communications were crucial between team members. Meetings are held twice in a week. One day is on Tuesday and the other day is subjected to the availability of all members. In these meetings, all members update on their current task progress and seek assistance whenever required. On Tuesdays, the meetings are conducted with project manager, Dr Chiew Yeong Shiong where he shares his experience and guidance on the project. The communication tools used and their purposes can be found in Appendix Section C.3.7. All the communication tools mentioned helped in keeping our team stay connected regardless of not being able to meet each other. The platforms were used as a purpose of ensuring effective communications among the team members and to achieve the project goal in time.

## 6.3 Vehicle Costing

The estimated cost to build one Go-kart is RM 4948.04 and is within the RM5000 budget allocation. The costing is done based on four major subsystems as shown in Table 6.3.1 below. It is observed that the power transmission has the highest cost at RM 3018.98. This is because it consists of important components such as the engine, torque converter and steering mechanism which is the source and means of transferring power in the kart. The second most costly is the wheels and brakes subsystem followed by the body subsystem. The electronics subsystem is very

crucial in the implementation of the game plan hence more than usual cost is allocated here to buy required electrical components. The assumptions made were that all listed parts are available at time of purchase. The detailed cost breakdown of the subsystems is listed in the cost estimation table found in Appendix D.1.

*Table* 6.3.1*: Cost Estimate based on Subsystem*

| Subsystem | Cost Estimate (RM) | Percentage (%) |
|---|---|---|
| Body | 649.35 | 13.1 |
| Power Transmission | 3018.98 | 61.0 |
| Wheels and Brakes | 803.76 | 16.2 |
| Electronics | 480.81 | 9.70 |
| Total | 4952.90 | 100 |

### 6.4 Operational Cost

The Table D.2.1 denotes the operational cost that is needed to start up the company and to run it annually. The total annual recurring cost is RM 1,190,957.80, while our potential revenue has been calculated to be RM3,282,842.20. With an estimated start-up cost of RM15,000,000, Kart Mobil is estimated to be profitable in 5 years' time. Appendix D.2 shows the detailed calculation of the operational cost.

# 7. Risk, Safety and other Regulatory Requirements

In Kart-Mobil, the safety of customers is utmost prioritized and it is our responsibility to ensure the safety of all drivers while experiencing a thrilling Go-kart experience. This includes abiding the SOPs regulations due to the recent COVID-19 pandemic. With that, a list of rules that are compulsory to be followed by all customers is included in Appendix C.3.8 (sport.gov.mo, 2021).

Apart from the safety guidelines, the safety features are also installed on the go-kart such as a kill switch to immediately shut the engine and a reverse mechanism to back out after a crash. It is also fitted with hollow bumpers on all sides to reduce impact on drivers in a crash. Brake lights are also installed to keep drivers always alert as a safety measure. Finally, a firewall is attached between

the seat and engine to protect the driver from excess heat. The details on track safety have been included in Section 3.7 Track.

# 8. Conclusion

In conclusion. Kart Mobil has successfully produced the design of a racing go-kart, its racing track as well as developed a detailed blueprint of our business operation. The go-kart features a structural chassis, a gasoline powered engine, connected to a transmission system which incorporates a reverse mode feature. The design is completed with other subsystems, like Ackermann steering system, brake systems and electrical system. The electrical system is incorporated with a Data Logger connected to Wi-Fi. This provides communication between the kart and the system which is an important feature for the company's game plan. Furthermore, customization is offered by allowing customers to choose the design of bumpers. The design of the go-kart is supported by different engineering analysis like, FEA structural and material analysis on chassis, electrical and electronics, engineering programming and ergonomics. Our track is a covered outdoor track and is equipped with various facilities and safety features for the convenience of our customers. The total cost for manufacturing the go-kart is within budget at RM 4948.04.

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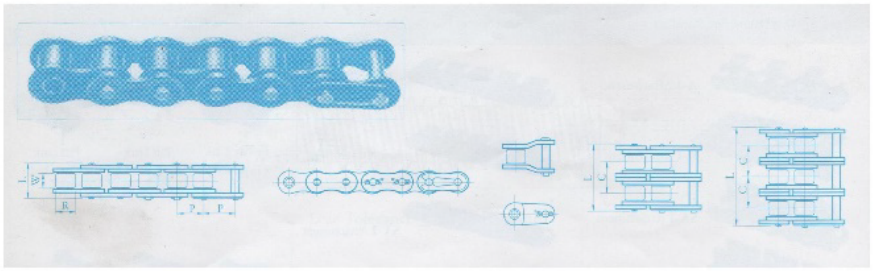
# Appendix A (Part drawing and assembly drawing)

# Appendix B (Catalogue)

## B.1 Power Transmission

| | |
|---|---|
| Manufacturer | Soon Hock Gear & Precision Engineering |
| Product Name | Roller Chains ANSI |
| Model Number | B29 No.40 |
| Page | 63 |

ROLLER CHAINS ANSI B29. 1-1975 63



Dimension : inch & mm

| Catalog No. | | Catalog No. | | Width Between Inner Plates | | Roller Diam. | | Pin Diam. | | Pin Length | | Transverse Pitch | | Breaking Load | | Weight | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSI No. | DIN ISO Nr | P | | W min | | R max. | | D max. | | L max. | | C | | mim | min | | |
| | | in | mm | in | mm | in | mm | in | mm | in | mm | in | mm | Lb | Kg | Lb/ft | Kg/m |
| **25** | | 1/4 | 6.35 | 0.125 | 3.18 | 0.130 | 3.30 | 0.091 | 2.31 | 0.339 | 8.60 | | | 990 | 450 | 0.09 | 0.14 |
| **35** | | 3/8 | 9.525 | 0.188 | 4.78 | 0.200 | 5.08 | 0.141 | 3.59 | 0.510 | 12.95 | | | 2420 | 1100 | 0.22 | 0.33 |
| **40** | **08A** | 1/2 | 12.70 | 0.313 | 7.95 | 0.312 | 7.92 | 0.156 | 3.97 | 0.691 | 17.45 | | | 4290 | 1950 | 0.41 | 0.62 |
| **41** | **08S** | 1/2 | 12.70 | 0.251 | 6.38 | 0.306 | 7.77 | 0.141 | 3.59 | 0.567 | 14.40 | | | 2640 | 1200 | 0.27 | 0.41 |
| **50** | **10A** | 5/8 | 15.875 | 0.375 | 9.53 | 0.400 | 10.16 | 0.200 | 5.09 | 0.856 | 21.75 | | | 7040 | 3200 | 0.71 | 1.06 |
| **60** | **12A** | 3/4 | 19.05 | 0.500 | 12.70 | 0.469 | 11.91 | 0.234 | 5.96 | 0.059 | 26.90 | | | 9680 | 4400 | 1.01 | 1.50 |
| **80** | **16A** | 1 | 25.40 | 0.625 | 15.88 | 0.625 | 15.87 | 0.312 | 7.96 | 1.390 | 35.30 | | | 16500 | 7500 | 0.68 | 2.50 |
| **100** | **20A** | 1 1/4 | 31.75 | 0.750 | 19.05 | 0.750 | 19.05 | 0.375 | 9.54 | 1.699 | 43.15 | | | 25300 | 11500 | 2.55 | 3.80 |
| **120** | **24A** | 1 1/2 | 38.10 | 1.000 | 25.40 | 0.875 | 22.22 | 0.437 | 11.11 | 2.122 | 53.90 | | | 35200 | 16000 | 3.76 | 5.60 |
| **140** | **28A** | 1 3/4 | 44.45 | 1.000 | 25.40 | 1 | 25.40 | 0.500 | 12.71 | 2.303 | 58.50 | | | 45100 | 20500 | 5.10 | 7.60 |
| **160** | **32A** | 2 | 50.80 | 1.250 | 31.75 | 1.125 | 28.57 | 0.562 | 14.29 | 2.742 | 69.65 | | | 59400 | 27000 | 6.38 | 9.50 |
| **25-2** | | 1/4 | 6.35 | 0.125 | 3.18 | 0.130 | 3.30 | 0.091 | 2.31 | 0.691 | 15.00 | 0.252 | 6.40 | 1760 | 800 | 0.18 | 0.26 |
| **35-2** | | 3/8 | 9.525 | 0.188 | 4.78 | 0.200 | 5.08 | 0.141 | 3.59 | 0.907 | 23.05 | 0.398 | 10.10 | 3970 | 1800 | 0.42 | 0.64 |
| **40-2** | **08A-2** | 1/2 | 12.70 | 0.313 | 7.95 | 0.312 | 7.92 | 0.156 | 3.97 | 1.254 | 31.85 | 0.567 | 14.40 | 7050 | 3200 | 0.80 | 1.20 |
| **50-2** | **10A-2** | 5/8 | 15.875 | 0.375 | 9.53 | 0.400 | 10.16 | 0.200 | 5.09 | 1.569 | 39.85 | 0.713 | 18.10 | 10700 | 4860 | 1.36 | 2.02 |
| **60-2** | **12A-2** | 3/4 | 19.05 | 0.500 | 12.70 | 0.469 | 11.91 | 0.234 | 5.96 | 1.957 | 49.70 | 0.898 | 22.80 | 15500 | 7040 | 2.02 | 3.00 |
| **80-2** | **16A-2** | 1 | 25.40 | 0.625 | 15.88 | 0.625 | 15.87 | 0.312 | 7.96 | 2.543 | 64.60 | 1.154 | 29.30 | 27300 | 12400 | 3.38 | 5.02 |
| **100-2** | **20A-2** | 1 1/4 | 31.75 | 0.750 | 19.05 | 0.750 | 19.05 | 0.375 | 9.54 | 3.108 | 78.95 | 1.409 | 35.80 | 41000 | 18600 | 5.12 | 7.64 |
| **120-2** | **24A-4** | 1 1/2 | 38.10 | 1.000 | 25.40 | 0.875 | 22.22 | 0.437 | 11.11 | 3.909 | 99.30 | 1.787 | 45.40 | 59500 | 27000 | 7.38 | 10.98 |
| **140-2** | **28A-2** | 1 3/4 | 44.45 | 1.000 | 25.40 | 1 | 25.40 | 0.500 | 12.71 | 4.228 | 107.40 | 1.925 | 48.90 | 80700 | 36600 | 9.36 | 13.92 |
| **160-2** | **32A-2** | 2 | 50.80 | 1.250 | 31.75 | 1.125 | 28.57 | 0.562 | 14.29 | 5.045 | 128.15 | 2.303 | 58.50 | 104900 | 47600 | 12.58 | 18.72 |
| **25-3** | | 1/4 | 6.35 | 0.125 | 3.18 | 0.130 | 3.30 | 0.091 | 2.31 | 0.843 | 21.40 | 0.252 | 6.40 | 2650 | 1200 | 0.27 | 0.39 |
| **35-3** | | 3/8 | 9.525 | 0.188 | 4.78 | 0.200 | 5.08 | 0.141 | 3.59 | 1.305 | 33.15 | 0.398 | 10.10 | 5950 | 2700 | 0.63 | 0.96 |
| **40-3** | **08A-3** | 1/2 | 12.70 | 0.313 | 7.95 | 0.312 | 7.92 | 0.156 | 3.97 | 1.821 | 46.25 | 0.567 | 14.40 | 10600 | 4800 | 1.20 | 1.80 |
| **50-3** | **10A-3** | 5/8 | 15.875 | 0.375 | 9.53 | 0.400 | 10.16 | 0.200 | 5.09 | 2.281 | 57.95 | 0.713 | 18.10 | 16100 | 7290 | 2.04 | 3.03 |
| **60-3** | **12A-3** | 3/4 | 19.05 | 0.500 | 12.70 | 0.469 | 11.91 | 0.234 | 5.96 | 2.854 | 72.50 | 0.898 | 22.80 | 23300 | 10560 | 3.03 | 4.50 |
| **80-3** | **16A-3** | 1 | 25.40 | 0.625 | 15.88 | 0.625 | 15.87 | 0.312 | 7.96 | 3.697 | 93.90 | 1.154 | 29.30 | 41000 | 18600 | 5.07 | 7.53 |
| **100-3** | **20A-3** | 1 1/4 | 31.75 | 0.750 | 19.05 | 0.750 | 19.05 | 0.375 | 9.54 | 4.518 | 114.75 | 1.409 | 35.80 | 61500 | 27900 | 7.68 | 11.46 |
| **120-3** | **24A-3** | 1 1/2 | 38.10 | 1.000 | 25.40 | 0.875 | 22.22 | 0.437 | 11.11 | 5.697 | 144.70 | 1.787 | 45.40 | 89300 | 40500 | 11.07 | 16.47 |
| **140-3** | **28A-3** | 1 3/4 | 44.45 | 1.000 | 25.40 | 1 | 25.40 | 0.500 | 12.71 | 6.154 | 156.30 | 1.925 | 48.90 | 121000 | 54900 | 14.04 | 20.88 |
| **160-3** | **32A-3** | 2 | 50.80 | 1.250 | 31.75 | 1.125 | 28.57 | 0.562 | 14.29 | 7.348 | 186.65 | 2.303 | 58.50 | 157000 | 71400 | 18.87 | 28.08 |

*Figure B.1.1: Soon Hock Roller Chain ANSI B29 Catalogue*

| | |
|---|---|
| Manufacturer | NTN Bearing Corp. |
| Product Name | Deep Groove Ball Bearings |
| Model Number | 6902, 6903JRX, 6804JR |
| Page | 110 |

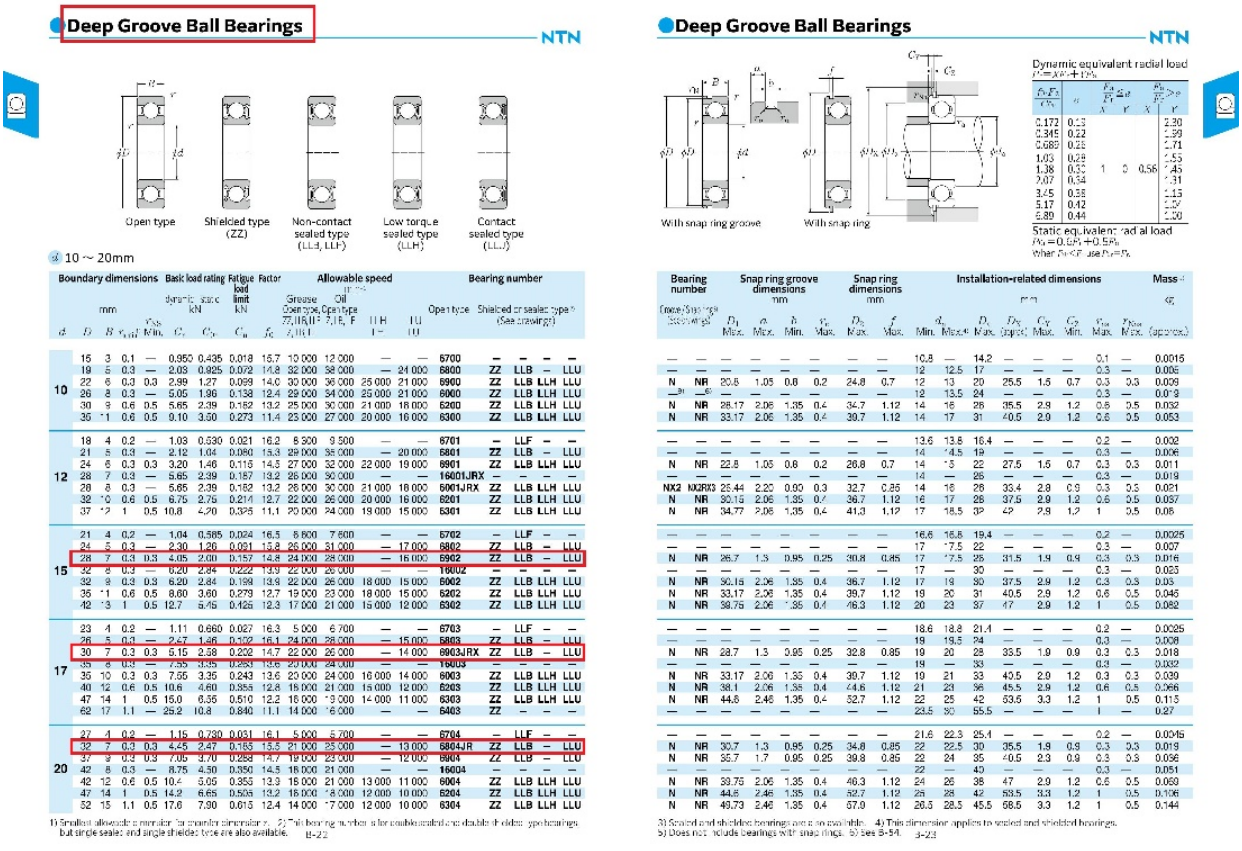
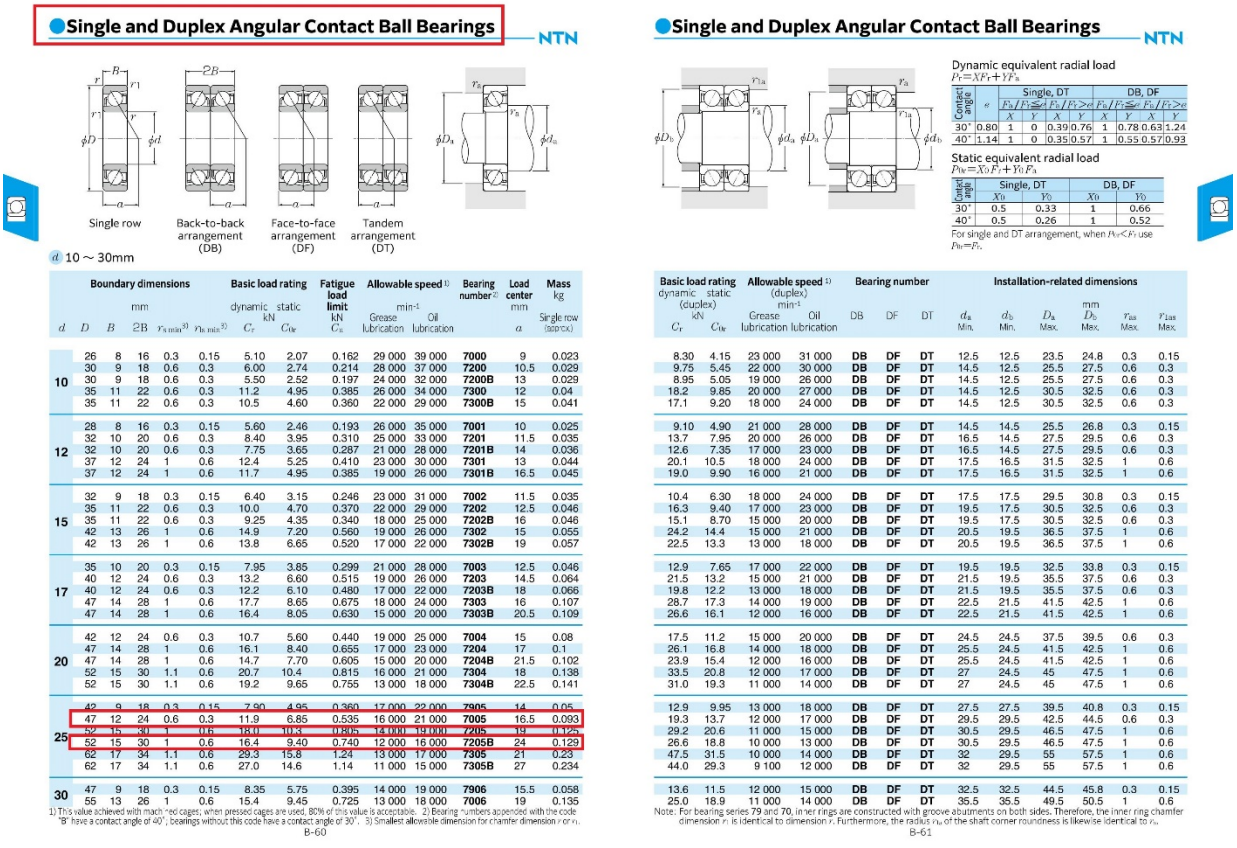



*Figure B.1.2: NTN Deep Groove Ball Bearings Catalogue*

| | |
|---|---|
| Manufacturer | NTN Bearing Corp. |
| Product Name | Single And Duplex Angular Contact Ball Bearings |
| Model Number | 7005 and 7205B |
| Page | 129 |



●Single and Duplex Angular Contact Ball Bearings NTN

Single row | Back-to-back arrangement (DB) | Face-to-face arrangement (DF) | Tandem arrangement (DT)

d 10～30mm

| d | D | B | 2B | $r_{s\,min}$ 3) | $r_{1s\,min}$ 3) | Basic load rating dynamic $C_r$ kN | Basic load rating static $C_{0r}$ kN | Fatigue load limit $C_u$ kN | Allowable speed 1) min⁻¹ Grease lubrication | Allowable speed 1) min⁻¹ Oil lubrication | Bearing number 2) | Load center a mm | Mass kg Single row (approx.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | 8 | 16 | 0.3 | 0.15 | 5.10 | 2.07 | 0.162 | 29 000 | 39 000 | **7000** | 9 | 0.023 |
| | 30 | 9 | 18 | 0.6 | 0.3 | 6.00 | 2.74 | 0.214 | 28 000 | 37 000 | **7200** | 10.5 | 0.029 |
| 10 | 30 | 9 | 18 | 0.6 | 0.3 | 5.50 | 2.52 | 0.197 | 24 000 | 32 000 | **7200B** | 13 | 0.029 |
| | 35 | 11 | 22 | 0.6 | 0.3 | 11.2 | 4.95 | 0.385 | 26 000 | 34 000 | **7300** | 12 | 0.04 |
| | 35 | 11 | 22 | 0.6 | 0.3 | 10.5 | 4.60 | 0.360 | 22 000 | 29 000 | **7300B** | 15 | 0.041 |
| | 28 | 8 | 16 | 0.3 | 0.15 | 5.60 | 2.46 | 0.193 | 26 000 | 35 000 | **7001** | 10 | 0.025 |
| | 32 | 10 | 20 | 0.6 | 0.3 | 8.40 | 3.95 | 0.310 | 25 000 | 33 000 | **7201** | 11.5 | 0.035 |
| 12 | 32 | 10 | 20 | 0.6 | 0.3 | 7.75 | 3.65 | 0.287 | 21 000 | 28 000 | **7201B** | 14 | 0.036 |
| | 37 | 12 | 24 | 1 | 0.6 | 12.4 | 5.25 | 0.410 | 23 000 | 30 000 | **7301** | 13 | 0.044 |
| | 37 | 12 | 24 | 1 | 0.6 | 11.7 | 4.95 | 0.385 | 19 000 | 26 000 | **7301B** | 16.5 | 0.045 |
| | 32 | 9 | 18 | 0.3 | 0.15 | 6.40 | 3.15 | 0.246 | 23 000 | 31 000 | **7002** | 11.5 | 0.035 |
| | 35 | 11 | 22 | 0.6 | 0.3 | 10.0 | 4.70 | 0.370 | 22 000 | 29 000 | **7202** | 12.5 | 0.046 |
| 15 | 35 | 11 | 22 | 0.6 | 0.3 | 9.25 | 4.35 | 0.340 | 18 000 | 25 000 | **7202B** | 16 | 0.046 |
| | 42 | 13 | 26 | 1 | 0.6 | 14.9 | 7.20 | 0.560 | 19 000 | 26 000 | **7302** | 15 | 0.055 |
| | 42 | 13 | 26 | 1 | 0.6 | 13.8 | 6.65 | 0.520 | 17 000 | 22 000 | **7302B** | 19 | 0.057 |
| | 35 | 10 | 20 | 0.3 | 0.15 | 7.95 | 3.85 | 0.299 | 21 000 | 28 000 | **7003** | 12.5 | 0.046 |
| | 40 | 12 | 24 | 0.6 | 0.3 | 13.2 | 6.60 | 0.515 | 19 000 | 26 000 | **7203** | 14.5 | 0.064 |
| 17 | 40 | 12 | 24 | 0.6 | 0.3 | 12.2 | 6.10 | 0.480 | 17 000 | 22 000 | **7203B** | 18 | 0.066 |
| | 47 | 14 | 28 | 1 | 0.6 | 17.7 | 8.65 | 0.675 | 18 000 | 24 000 | **7303** | 16 | 0.107 |
| | 47 | 14 | 28 | 1 | 0.6 | 16.4 | 8.05 | 0.630 | 15 000 | 20 000 | **7303B** | 20.5 | 0.109 |
| | 42 | 12 | 24 | 0.6 | 0.3 | 10.7 | 5.60 | 0.440 | 19 000 | 25 000 | **7004** | 15 | 0.08 |
| | 47 | 14 | 28 | 1 | 0.6 | 16.1 | 8.40 | 0.655 | 17 000 | 23 000 | **7204** | 17 | 0.1 |
| 20 | 47 | 14 | 28 | 1 | 0.6 | 14.7 | 7.70 | 0.605 | 15 000 | 20 000 | **7204B** | 21.5 | 0.102 |
| | 52 | 15 | 30 | 1.1 | 0.6 | 20.7 | 10.4 | 0.815 | 16 000 | 21 000 | **7304** | 18 | 0.138 |
| | 52 | 15 | 30 | 1.1 | 0.6 | 19.2 | 9.65 | 0.755 | 13 000 | 18 000 | **7304B** | 22.5 | 0.141 |
| | 42 | 9 | 18 | 0.3 | 0.15 | 7.90 | 4.95 | 0.360 | 17 000 | 22 000 | **7905** | 14 | 0.05 |
| | 47 | 12 | 24 | 0.6 | 0.3 | 11.9 | 6.85 | 0.535 | 16 000 | 21 000 | **7005** | 16.5 | 0.093 |
| 25 | 52 | 15 | 30 | 1 | 0.6 | 16.0 | 10.1 | 0.845 | 14 000 | 19 000 | **7205** | 19 | 0.125 |
| | 52 | 15 | 30 | 1 | 0.6 | 16.4 | 9.40 | 0.740 | 12 000 | 16 000 | **7205B** | 24 | 0.129 |
| | 62 | 17 | 34 | 1.1 | 0.6 | 29.3 | 15.8 | 1.24 | 13 000 | 17 000 | **7305** | 21 | 0.23 |
| | 62 | 17 | 34 | 1.1 | 0.6 | 27.0 | 14.6 | 1.14 | 11 000 | 15 000 | **7305B** | 27 | 0.234 |
| 30 | 47 | 9 | 18 | 0.3 | 0.15 | 8.35 | 5.75 | 0.395 | 14 000 | 19 000 | **7906** | 15.5 | 0.058 |
| | 55 | 13 | 26 | 1 | 0.6 | 15.4 | 9.45 | 0.725 | 13 000 | 18 000 | **7006** | 19 | 0.135 |

1) This value achieved with machined cages, when pressed cages are used, 80% of this value is acceptable. 2) Bearing numbers appended with the code "B" have a contact angle of 40°, bearings without this code have a contact angle of 30°. 3) Smallest allowable dimension for chamfer dimension r or $r_1$.

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●Single and Duplex Angular Contact Ball Bearings NTN

Dynamic equivalent radial load
$P_r = XF_r + YF_a$

| Contact angle α | e | Single, DT $F_a/F_r \leqq e$ X | Single, DT $F_a/F_r \leqq e$ Y | Single, DT $F_a/F_r > e$ X | Single, DT $F_a/F_r > e$ Y | DB, DF $F_a/F_r \leqq e$ X | DB, DF $F_a/F_r \leqq e$ Y | DB, DF $F_a/F_r > e$ X | DB, DF $F_a/F_r > e$ Y |
|---|---|---|---|---|---|---|---|---|---|
| 30° | 0.80 | 1 | 0 | 0.39 | 0.76 | 1 | 0.78 | 0.63 | 1.24 |
| 40° | 1.14 | 1 | 0 | 0.35 | 0.57 | 1 | 0.55 | 0.57 | 0.93 |

Static equivalent radial load
$P_{0r} = X_0F_r + Y_0F_a$

| Contact angle α | Single, DT $X_0$ | Single, DT $Y_0$ | DB, DF $X_0$ | DB, DF $Y_0$ |
|---|---|---|---|---|
| 30° | 0.5 | 0.33 | 1 | 0.66 |
| 40° | 0.5 | 0.26 | 1 | 0.52 |

For single and DT arrangement, when $P_{0r} < F_r$ use $P_{0r} = F_r$.

| Basic load rating dynamic (duplex) $C_r$ kN | Basic load rating static (duplex) $C_{0r}$ kN | Allowable speed 1) min⁻¹ Grease lubrication | Allowable speed 1) min⁻¹ Oil lubrication | Bearing number DB | DF | DT | Installation-related dimensions mm $d_a$ Min. | $d_b$ Min. | $D_a$ Max. | $D_b$ Max. | $r_{as}$ Max. | $r_{1as}$ Max. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.30 | 4.15 | 23 000 | 31 000 | **DB** | **DF** | **DT** | 12.5 | 12.5 | 23.5 | 24.8 | 0.3 | 0.15 |
| 9.75 | 5.45 | 22 000 | 30 000 | **DB** | **DF** | **DT** | 14.5 | 12.5 | 25.5 | 27.5 | 0.6 | 0.3 |
| 8.95 | 5.05 | 19 000 | 26 000 | **DB** | **DF** | **DT** | 14.5 | 12.5 | 25.5 | 27.5 | 0.6 | 0.3 |
| 18.2 | 9.85 | 20 000 | 27 000 | **DB** | **DF** | **DT** | 14.5 | 12.5 | 30.5 | 32.5 | 0.6 | 0.3 |
| 17.1 | 9.20 | 18 000 | 24 000 | **DB** | **DF** | **DT** | 14.5 | 12.5 | 30.5 | 32.5 | 0.6 | 0.3 |
| 9.10 | 4.90 | 21 000 | 28 000 | **DB** | **DF** | **DT** | 14.5 | 14.5 | 25.5 | 26.8 | 0.3 | 0.15 |
| 13.7 | 7.95 | 20 000 | 26 000 | **DB** | **DF** | **DT** | 16.5 | 14.5 | 27.5 | 29.5 | 0.6 | 0.3 |
| 12.6 | 7.35 | 17 000 | 23 000 | **DB** | **DF** | **DT** | 16.5 | 14.5 | 27.5 | 29.5 | 0.6 | 0.3 |
| 20.1 | 10.5 | 18 000 | 24 000 | **DB** | **DF** | **DT** | 17.5 | 16.5 | 31.5 | 32.5 | 1 | 0.6 |
| 19.0 | 9.90 | 16 000 | 21 000 | **DB** | **DF** | **DT** | 17.5 | 16.5 | 31.5 | 32.5 | 1 | 0.6 |
| 10.4 | 6.30 | 18 000 | 24 000 | **DB** | **DF** | **DT** | 17.5 | 17.5 | 29.5 | 30.8 | 0.3 | 0.15 |
| 16.3 | 9.40 | 17 000 | 23 000 | **DB** | **DF** | **DT** | 19.5 | 17.5 | 30.5 | 32.5 | 0.6 | 0.3 |
| 15.1 | 8.70 | 15 000 | 20 000 | **DB** | **DF** | **DT** | 19.5 | 17.5 | 30.5 | 32.5 | 0.6 | 0.3 |
| 24.2 | 14.4 | 15 000 | 21 000 | **DB** | **DF** | **DT** | 20.5 | 19.5 | 36.5 | 37.5 | 1 | 0.6 |
| 22.5 | 13.3 | 13 000 | 18 000 | **DB** | **DF** | **DT** | 20.5 | 19.5 | 36.5 | 37.5 | 1 | 0.6 |
| 12.9 | 7.65 | 17 000 | 22 000 | **DB** | **DF** | **DT** | 19.5 | 19.5 | 32.5 | 33.8 | 0.3 | 0.15 |
| 21.5 | 13.2 | 15 000 | 21 000 | **DB** | **DF** | **DT** | 21.5 | 19.5 | 35.5 | 37.5 | 0.6 | 0.3 |
| 19.8 | 12.2 | 13 000 | 18 000 | **DB** | **DF** | **DT** | 21.5 | 19.5 | 35.5 | 37.5 | 0.6 | 0.3 |
| 28.7 | 17.3 | 14 000 | 19 000 | **DB** | **DF** | **DT** | 22.5 | 21.5 | 41.5 | 42.5 | 1 | 0.6 |
| 26.6 | 16.1 | 12 000 | 16 000 | **DB** | **DF** | **DT** | 22.5 | 21.5 | 41.5 | 42.5 | 1 | 0.6 |
| 17.5 | 11.2 | 15 000 | 20 000 | **DB** | **DF** | **DT** | 24.5 | 24.5 | 37.5 | 39.5 | 0.6 | 0.3 |
| 26.1 | 16.8 | 14 000 | 18 000 | **DB** | **DF** | **DT** | 25.5 | 24.5 | 41.5 | 42.5 | 1 | 0.6 |
| 23.9 | 15.4 | 12 000 | 16 000 | **DB** | **DF** | **DT** | 25.5 | 24.5 | 41.5 | 42.5 | 1 | 0.6 |
| 33.5 | 20.8 | 12 000 | 17 000 | **DB** | **DF** | **DT** | 27 | 24.5 | 45 | 47.5 | 1 | 0.6 |
| 31.0 | 19.3 | 11 000 | 14 000 | **DB** | **DF** | **DT** | 27 | 24.5 | 45 | 47.5 | 1 | 0.6 |
| 12.9 | 9.95 | 13 000 | 18 000 | **DB** | **DF** | **DT** | 27.5 | 27.5 | 39.5 | 40.8 | 0.3 | 0.15 |
| 19.3 | 13.7 | 12 000 | 17 000 | **DB** | **DF** | **DT** | 29.5 | 29.5 | 42.5 | 44.5 | 0.6 | 0.3 |
| 29.2 | 20.6 | 11 000 | 15 000 | **DB** | **DF** | **DT** | 30.5 | 29.5 | 46.5 | 47.5 | 1 | 0.6 |
| 26.6 | 18.8 | 10 000 | 13 000 | **DB** | **DF** | **DT** | 30.5 | 29.5 | 46.5 | 47.5 | 1 | 0.6 |
| 47.5 | 31.5 | 10 000 | 14 000 | **DB** | **DF** | **DT** | 32 | 29.5 | 55 | 57.5 | 1 | 0.6 |
| 44.0 | 29.3 | 9 100 | 12 000 | **DB** | **DF** | **DT** | 32 | 29.5 | 55 | 57.5 | 1 | 0.6 |
| 13.6 | 11.5 | 12 000 | 15 000 | **DB** | **DF** | **DT** | 32.5 | 32.5 | 44.5 | 45.8 | 0.3 | 0.15 |
| 25.0 | 18.9 | 11 000 | 14 000 | **DB** | **DF** | **DT** | 35.5 | 35.5 | 49.5 | 50.5 | 1 | 0.6 |

Note. For bearing series 79 and 70, inner rings are constructed with groove abutments on both sides. Therefore, the inner ring chamfer dimension $r_1$ is identical to dimension r. Furthermore, the radius $r_{as}$ of the shaft corner roundness is likewise identical to $r_{as}$.

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*Figure B.1.3: NTN Single and Duplex Angular Contact Ball Bearings Catalogue*

# Appendix C: Figure, tables and graph

## C.1 Design content specifications

*Table C.1.1 Specifications of Engine*

| PREDATOR 420CC HORIZONTAL ENGINE | |
|---|---|
| Engine type | 4 stroke, horizontal single cylinder |
| Displacement | 420 cc |
| Net Power | 13HP |
| Maximum net torque | 26.84 Nm at 3600rpm |
| Engine oil capacity | 1 Gallon |
| Dimension (L x W x H) | 480 mm x 350 mm x 434 mm |
| Dry Weight | 35 kg |

*Table C.1.2 Specifications of Chassis*

| Parameter | Vehicle length | Vehicle width | Roll cage material | Tube dimensions |
|---|---|---|---|---|
| Value | 2000 mm | 1088.59 mm | AISI 1018 | OD = 21.3 mm<br>ID = 19 mm |

*Table C.1.3 Mechanical Properties of AISI 1018*

| Properties | Density | Elastic Modulus | Poisson's Ratio | Yield strength |
|---|---|---|---|---|
| AISI 1018 | 7.9 g/cm3 | 210 GPa | 0.3 | 370 MPa |

*Table C.1.4 Composition of AISI 1018*

| Composition | Iron (Fe) | Manganese (Mn) | Carbon (C) | Sulphur (S) | Phosphorus (P) |
|---|---|---|---|---|---|
| AISI 1018 | 98.8 - 99.25% | 0.6 to 0.9% | 0.15 to 0.2% | 0 to 0.050% | 0 to 0.040% |

## C.2: Mesh Convergence Study and ANSYS simulation result

*Table C.2.0.1: Deformation and von-Mises stress value for AISI 1018 with different element size*

| Element size (mm) | Number of Mesh Elements | Torsion – Total Deformation (AISI 1018) (mm) | Torsion -Max von-Mises stress (AISI 1018) (MPa) |
|---|---|---|---|
| 17.5 | 31055 | 3.0575 | 64.225 |
| 15 | 53632 | 4.1886 | 64.877 |
| 12.5 | 112279 | 4.4997 | 65.159 |
| 10 | 243083 | 4.5122 | 65.163 |
| 7.5 | 573209 | 4.5123 | 65.163 |

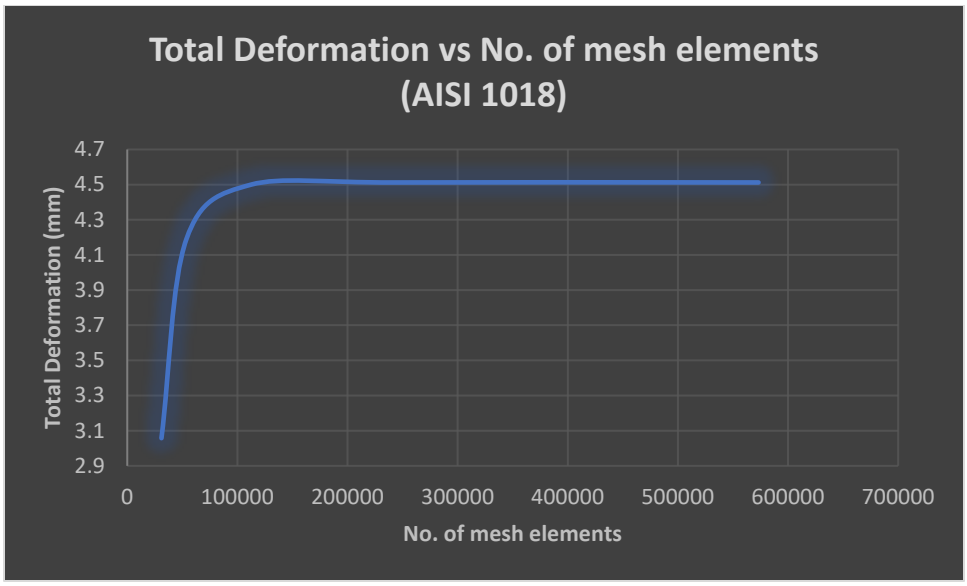



*Figure 14C.2.0.1: Mesh convergence for the AISI 1018 Total Deformation*

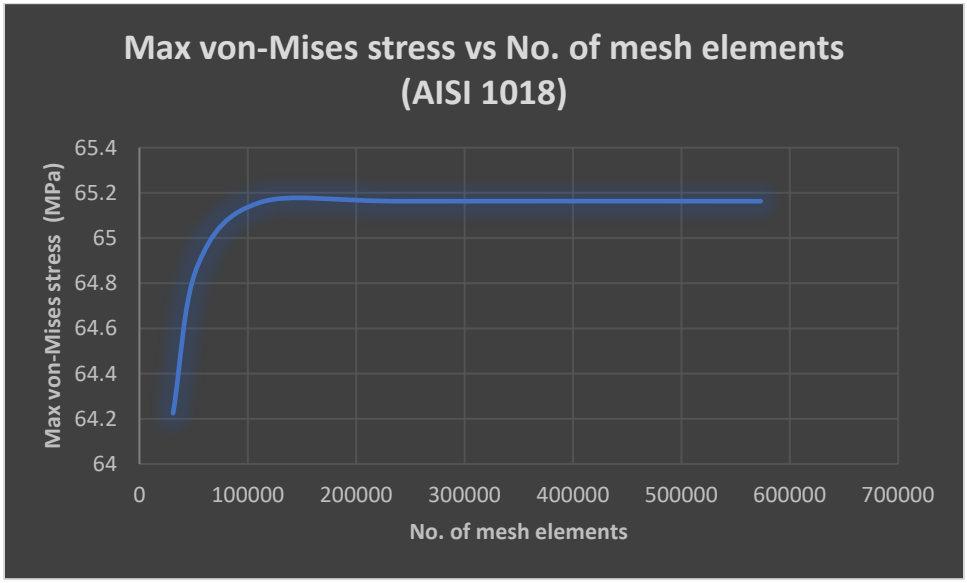



Figure C.2..02 15: Mesh convergence for the AISI 1018 Maximum von-Mises stress

*Table C.2.0.2: Deformation and von-Mises stress value for AISI 4130 with different element size*

| Element size (mm) | Number of Mesh Elements | Torsion – Total Deformation (AISI 4130) | Torsion -Max von-Mises stress (AISI 4130) |
|---|---|---|---|
| 17.5 | 31055 | 3.1574 | 64.225 |
| 15 | 53632 | 4.1964 | 64.877 |
| 12.5 | 112279 | 4.3968 | 65.159 |
| 10 | 243083 | 4.4048 | 65.163 |
| 7.5 | 573209 | 4.4049 | 65.163 |

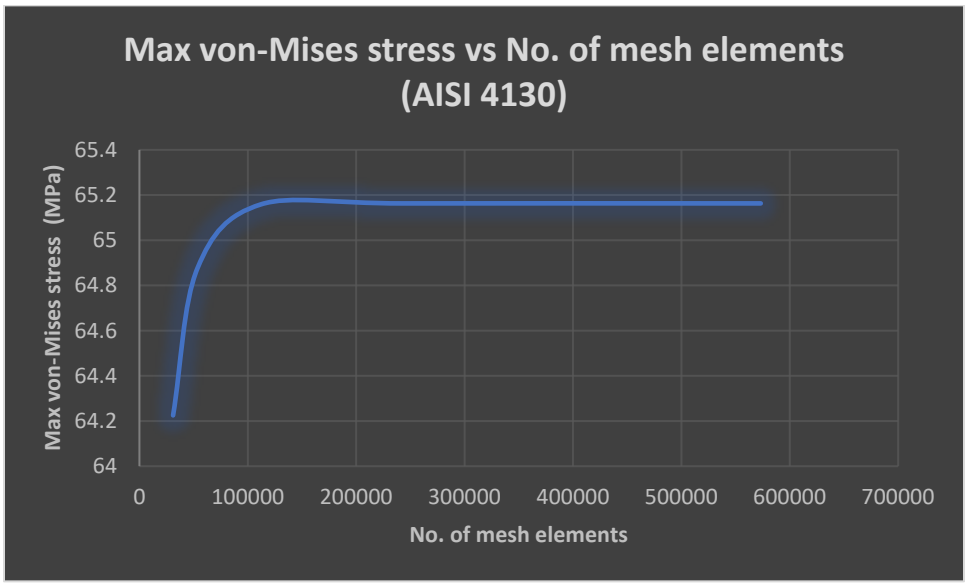



*Figure C.2.0.3 16: Mesh convergence for the AISI 4130 Total Deformation*

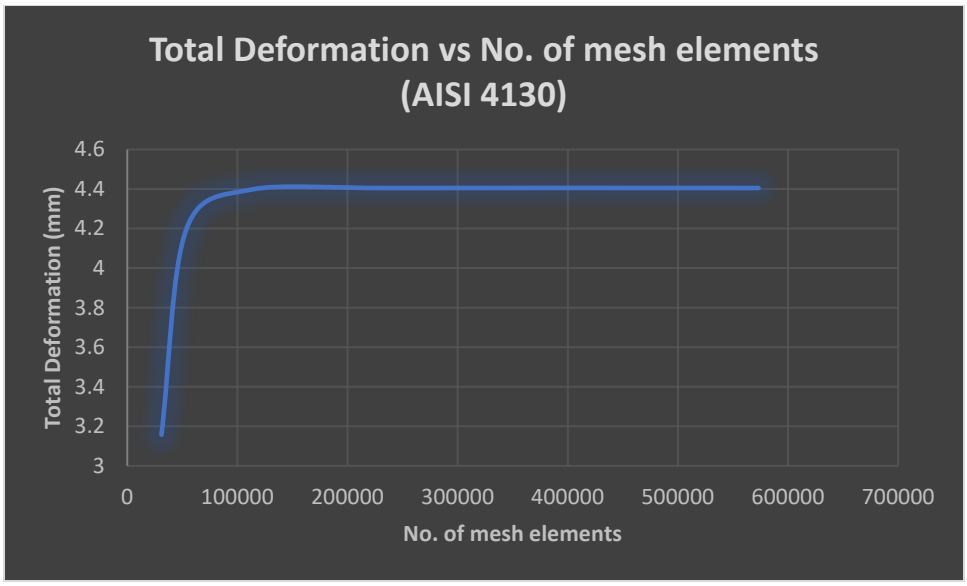



*Figure C.2.0.4 17: Mesh convergence for the AISI 4130 Maximum von-Mises stress*

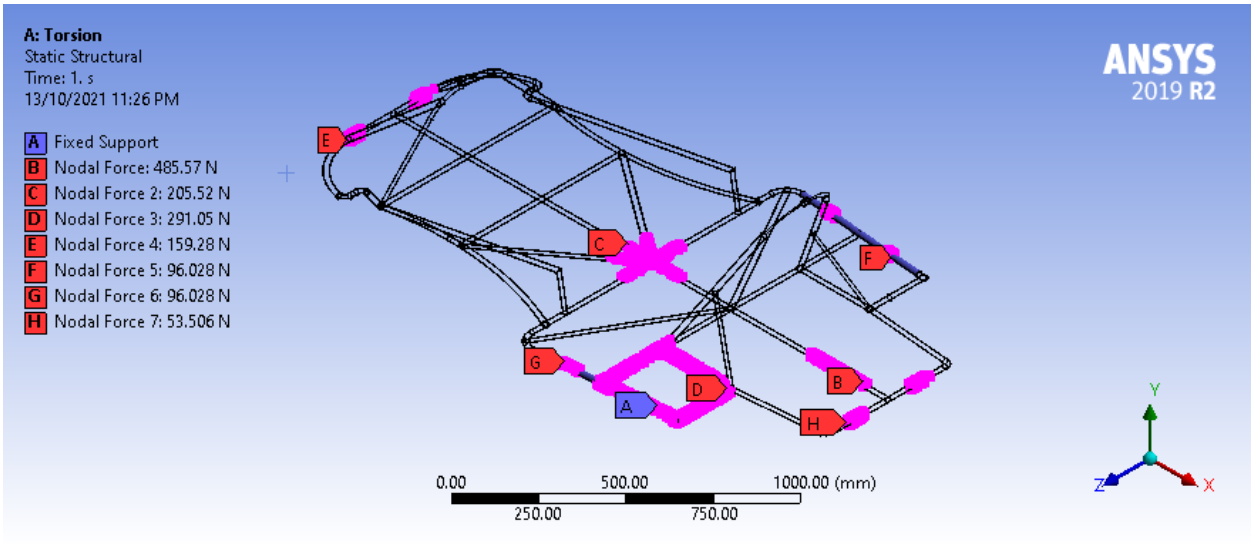



*Figure C.2.0.5: Distribution of load on the chassis for Torsion simulation*

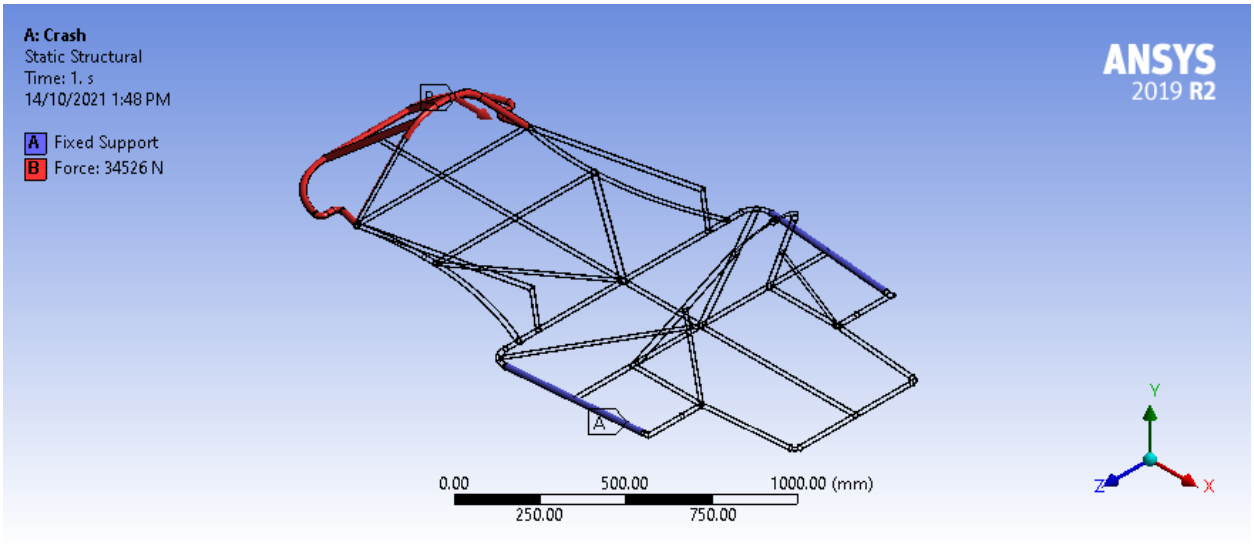



*Figure C.2.0.618: Force distribution for crash test*

### C.2.1: ANSYS Simulation for Hollow Bumper 1

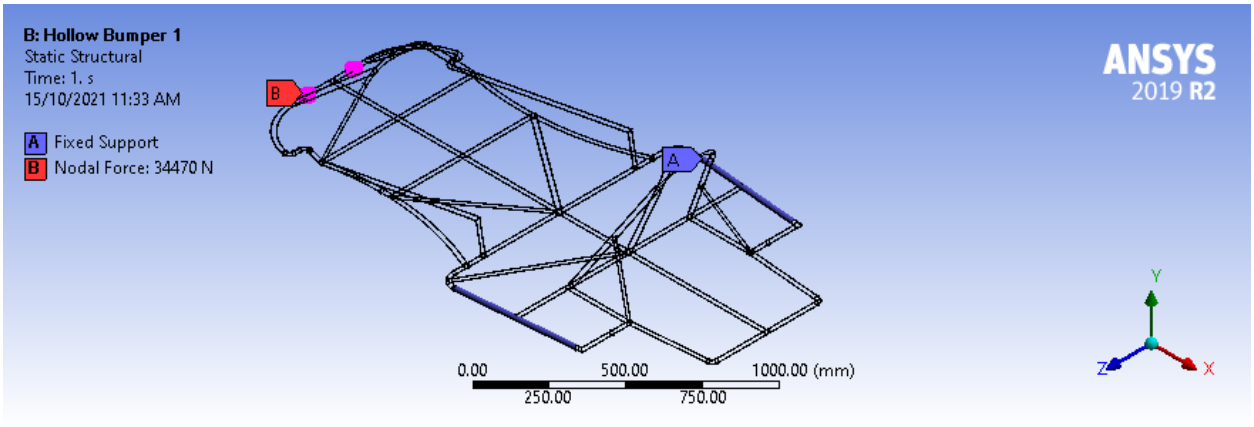



*Figure C.2.1.119: Force distribution for frontal for Bumper 1*

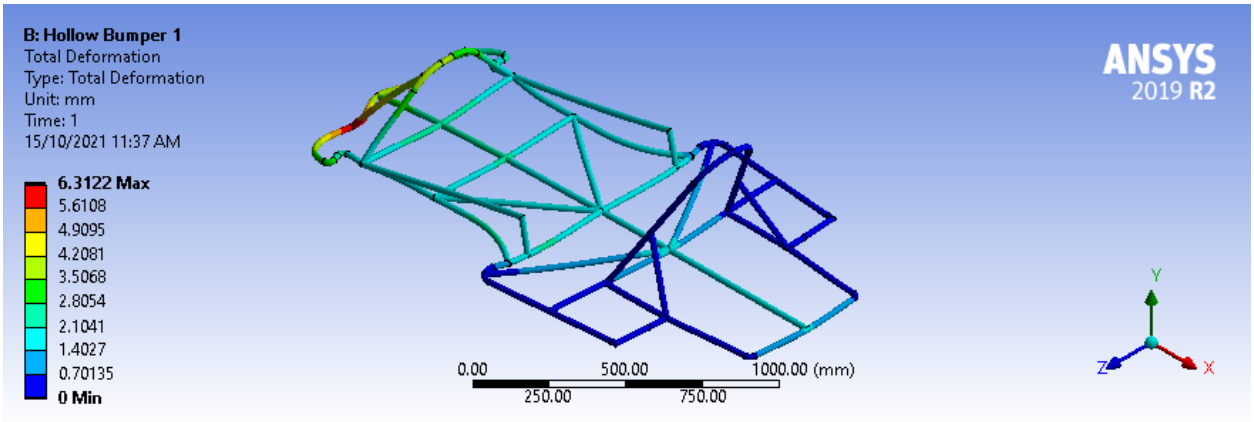



*Figure C.2.1.220: Total Deformation at front for Bumper 1*

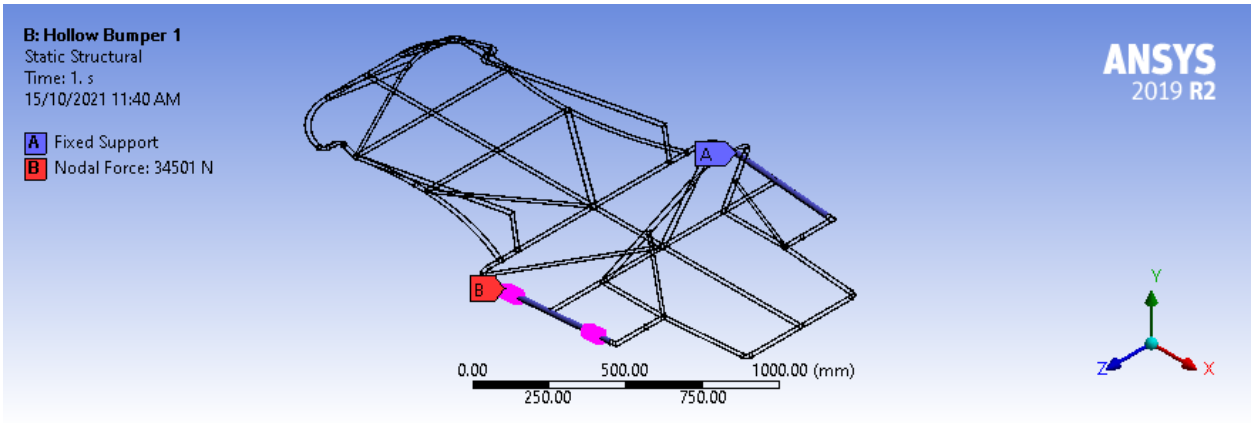



*Figure C.2.1.321: Force distribution of rear for Bumper 2*

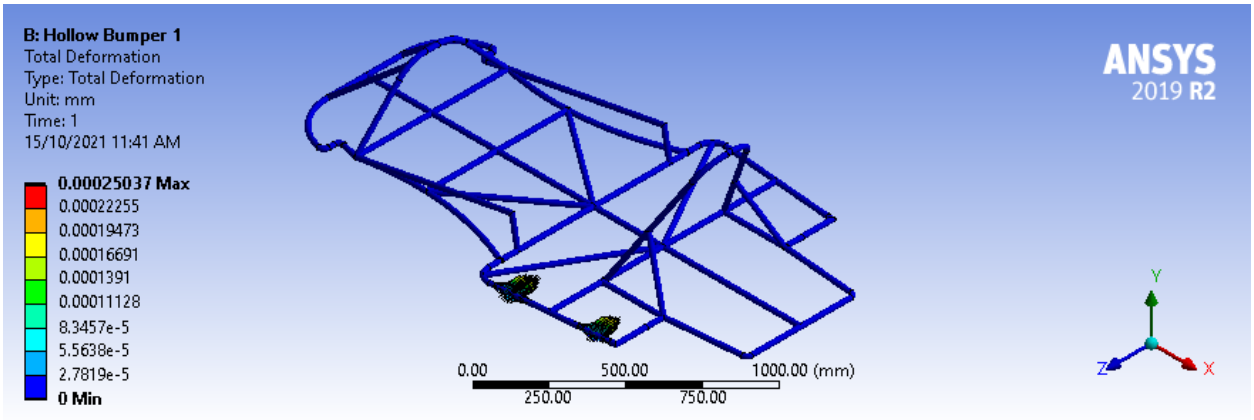



*Figure C.2.1.422: Total Deformation at rear for Bumper 1*

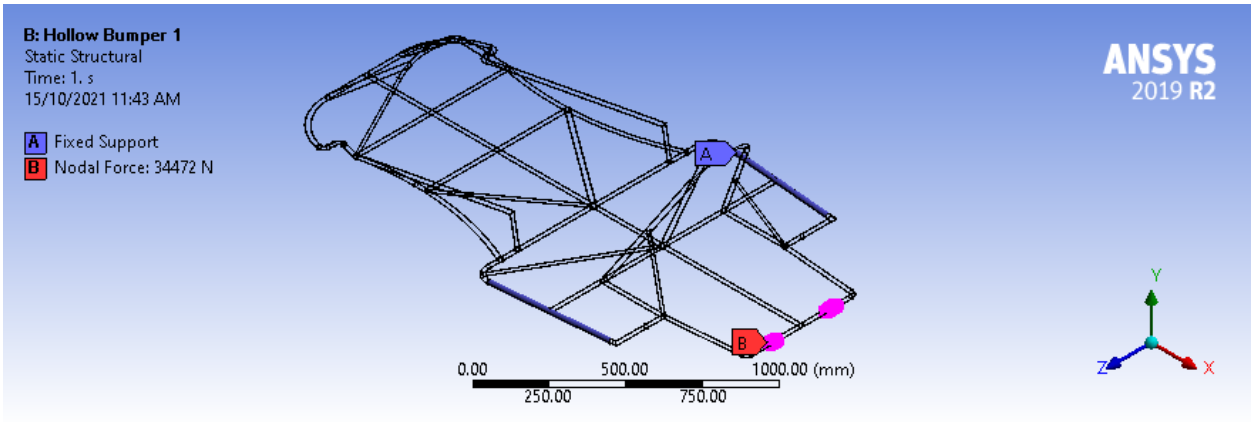



*Figure C.2.1.5: Force distribution of back  for Bumper 1*

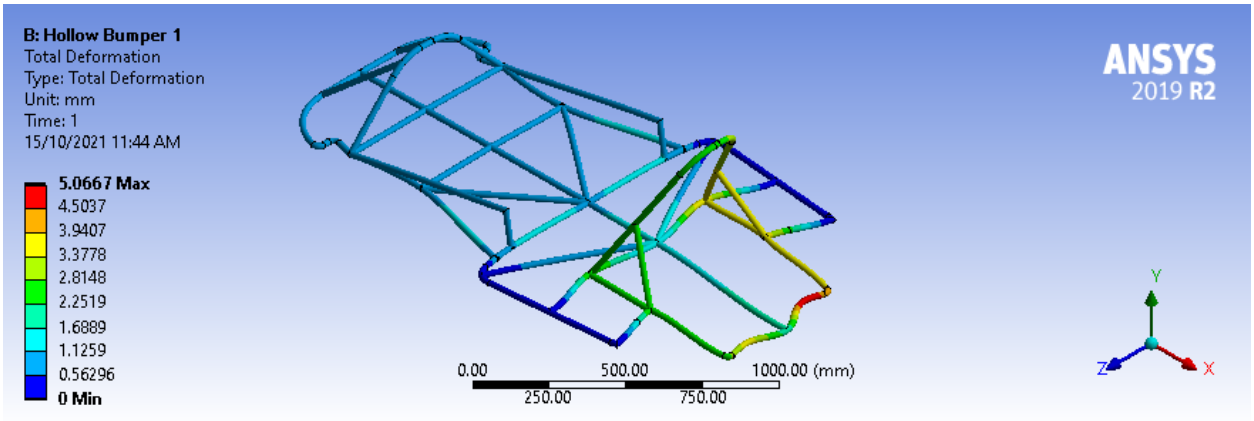



*Figure C.2.1.623: Total Deformation at back for Bumper 1*

### C.2.2: ANSYS Simulation for Hollow Bumper 2

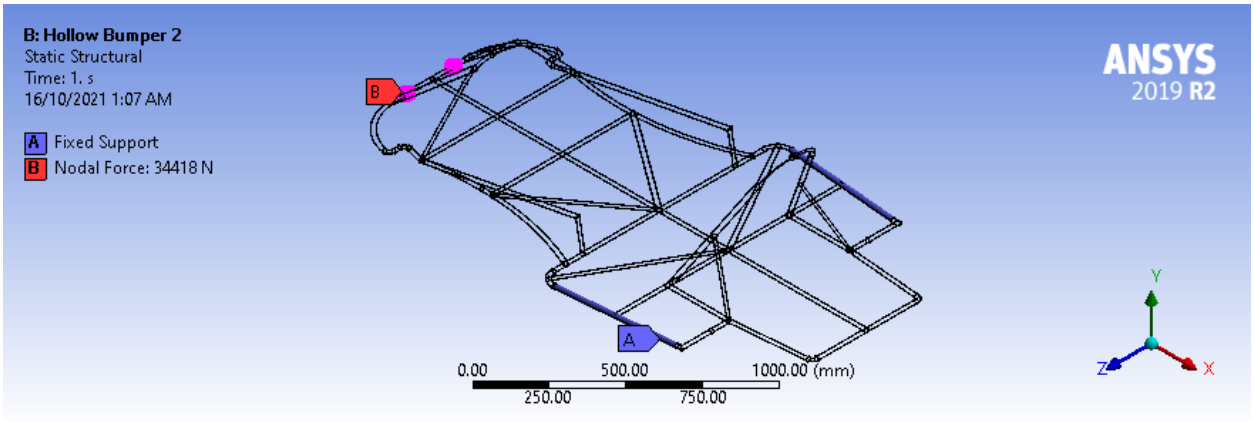



*Figure C.2.2.124: Force distribution for frontal for Bumper 2*

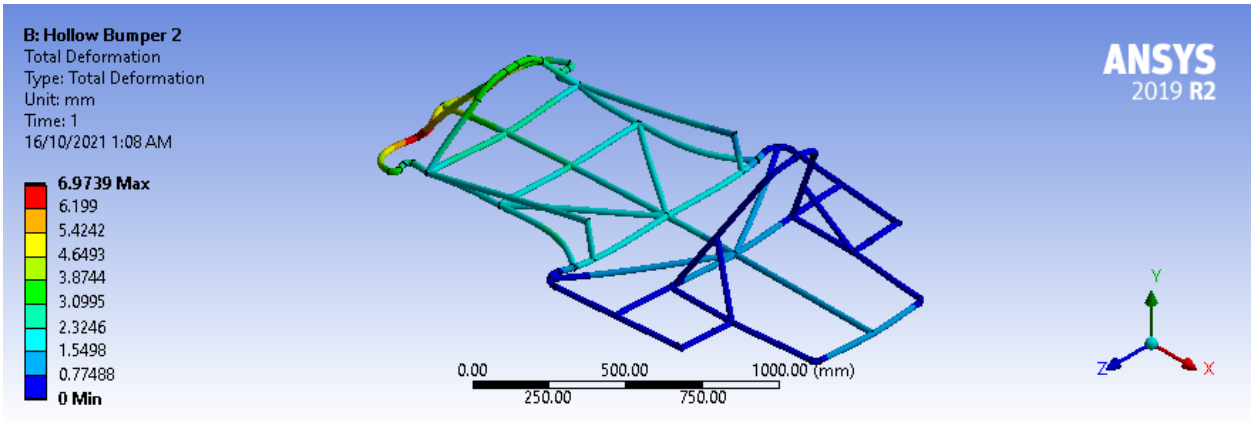



*Figure C.2.2.225: Total Deformation at front for Bumper 2*

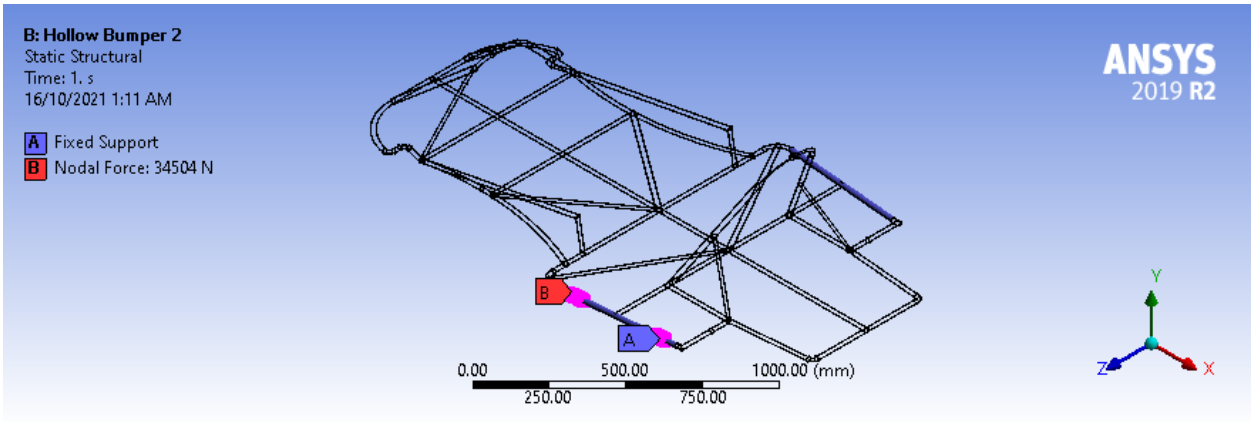



*Figure C.2.2.3 26: Force distribution of rear for Bumper 2*

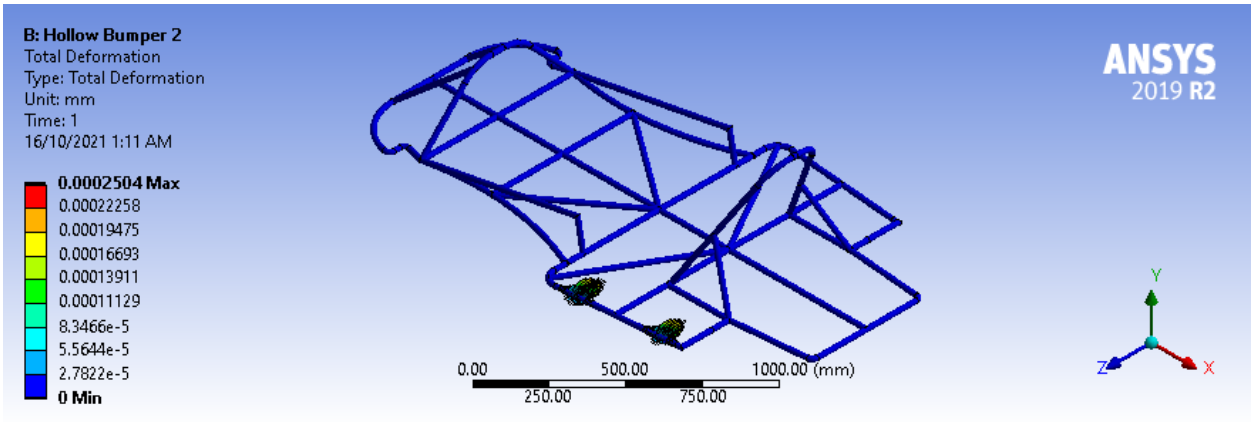



*Figure C.2.2.427: Total Deformation at rear for Bumper 2*

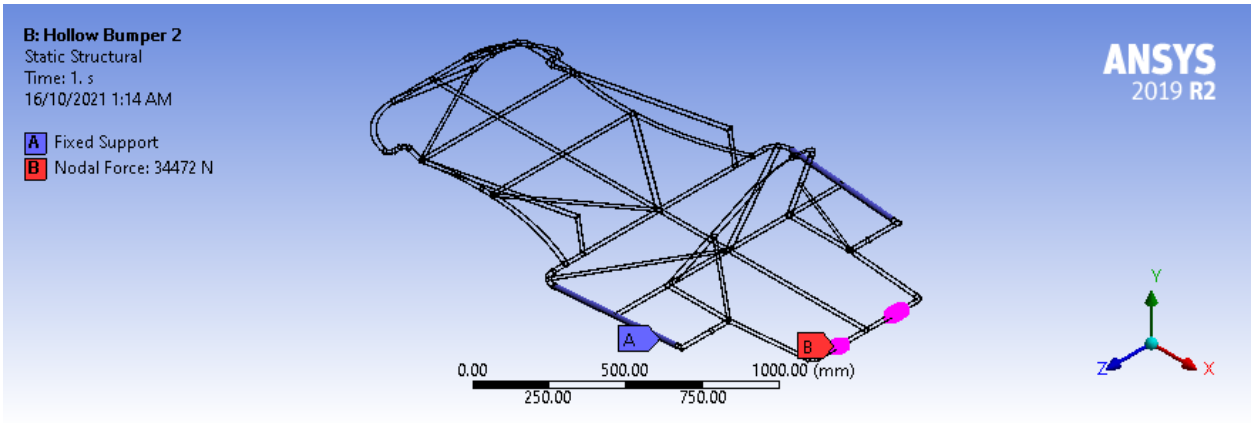



*Figure C.2.2.528: Force distribution of back for Bumper 2*

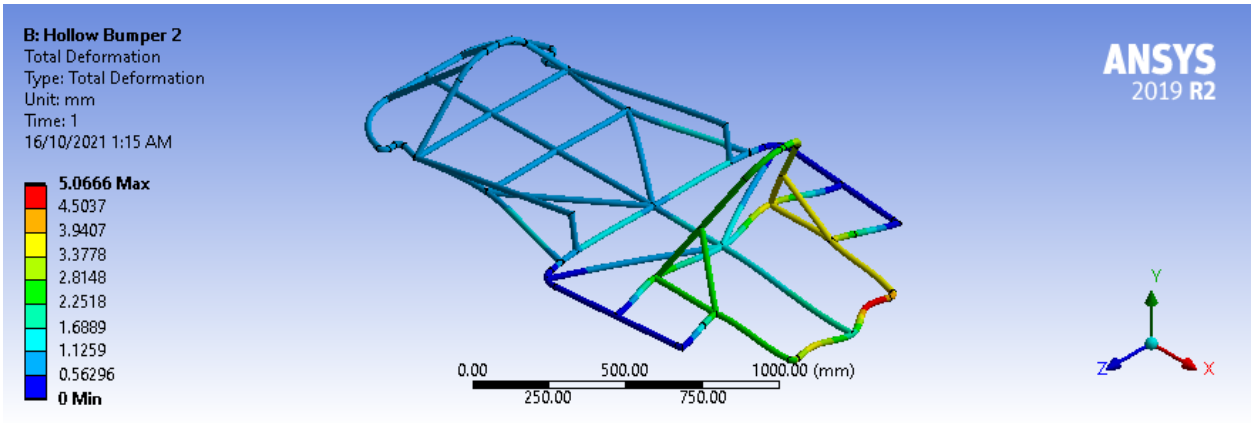



*Figure C.2.2.6 29: Total Deformation at rear for Bumper 2*

## C.3 Business operation details

### C.3.1 Business operation details

*Table C.3.1.1 : Details on operating schedule of each game modes*

| Game modes | Schedule |
|---|---|
| Normal mode | Tuesday to Sundays<br>10:00am – 12:00 pm, 4:00 pm – 8:00pm |
| Ride or Die (Tag mode) | Tuesday to Sundays<br>12:00am – 3:00pm |
| Ride or Die (Night Tag mode) | Mondays to Sundays<br>8:00 pm – 1:00am |

*Table C.3.1.2 Details of sources of revenue*

| Sources of revenue | Details |
|---|---|
| Go Kart Games | -Main source of income. Details of the game is provided in Section 5.1.1 |
| Mobil's Gift Shop | -Includes merchandizes from Kart-Mobil.<br>- Merchandizes available in Kart-Mobil: T-shirts, bottles, keychains, bracelets, souvenirs, customise body panel for go kart toys, Kart-Mobil gift vouchers to be used in any Kart-Mobil-owned stores. |
| Mobil's Café | -Sells food and beverages. Food supply will be obtained through OEM. Beverages will be done in-house. Menu can be referred in Appendix C.3.1, Figure C.3.1.2.<br>-Provides catering for parties consisting of 100-200 people. |
| Go-Kart space rental | -Rent Go-Kart range for events or competitions from external parties. |

| | |
|---|---|
| | - Rental depending on the number of days of the event<br>-Provides services from Kart-Mobil's go kart instructors to provide briefing on the tracks<br>-Provides catering service from Mobil's Café.<br>- Three-months in advanced pre-booking of our go-kart range. Must pay deposit in advance to secure booking |
| Food vendors space rental | -Provides space rental for food vendors.<br>-Food vendor rental space is RM100 per day and is subjected to availability<br>-Rates will be RM200 during seasonal leagues as more audience will visit the go-kart range. |
| Photobooth and Arcade | - 3 arcade video games and 1 photobooth for customers to utilize.<br>-Visitors will be required to pay RM 3 for each video game and RM6 per picture in the photobooth. |
| Sponsorship | -All sponsorship logos will be displayed in our tracks.<br>-Distribute sponsors merchandizes to go-kart drivers as a reward. Drivers for our seasonal league championship will also receive sponsors merchandizes during the race. Sponsor stickers will be placed on the go-kart body panels. Terms and condition applied.<br>-Different sponsorship packages available |
| Advertisement | -Third parties can utilize our advertisement space to put up advertisement.<br>- Rates will be subjected to the advertisement package preferred. |

| | |
|---|---|
| Competition and entry fees (Seasonal TAG, YOU'RE IT ! Championship league game) | -Spectators for the seasonal games will be charged with entry fees.<br>-Participants of the league is required to pay a competition fee of RM150.<br>- Cheering tools will also be sold in our Mobil's gift shop throughout the season. |

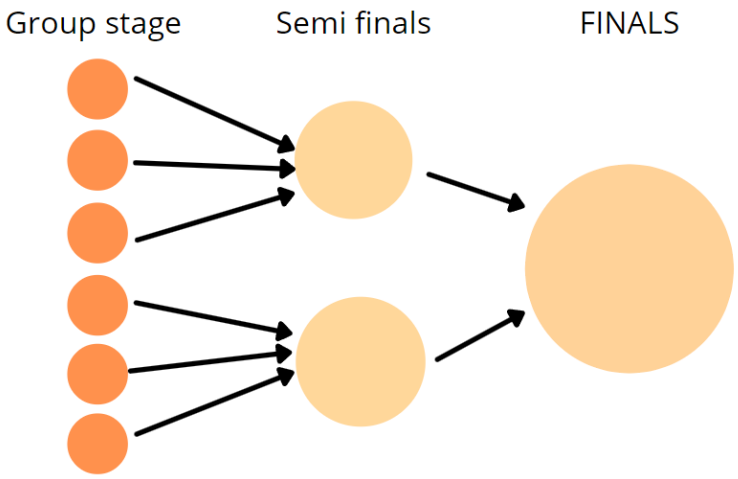



*Figure C.3.1.1 Structure of Seasonal League Competition*


*Figure C.3.1.2: Kart Mobil Cafe*

### C.3.2 Industry Competitors

*Table C.3.2.1 Industry competitors' details*

| Company Name | Location | Indoors/ Outdoors? | Offered packages |
|---|---|---|---|
| City Karting | Shah Alam | Outdoors | RM40 for 10 minutes session– regular go-karts<br>RM80 for 10 minutes session – pro-karts |
| Blastacars | Kuala Lumpur | Indoors | RM60 for 10 minutes session – Novice drivers<br>RM 90 for 10 minutes session – Advanced drivers<br>RM 100 for 10 minutes session – Pro-drivers (They must be able to handle powerful 3900cc go-kart and must be certified) |
| X-Park Sunway Iskandar | Johor | Indoor | RM 40 – RM 60 for 10 minutes session karting rides |
| Sepang International Kart Circuit | Sepang, Selangor | Outdoor | RM 40 – RM 100<br>Offers 'Quick Experience' mode for 10 minutes session<br>Offers race package for 10 people minimum for 45 minutes to an hour session |
| Pinnacle Kart | Subang Jaya, Selangor | Outdoor | RM30 – RM 120<br>*Price range dependant on time of racing and the type of go-kart |

### C.3.3 Business Packages

*Table C.3.3.1 Details of business packages*

| Type of packages | Modes | Sessions | Price (RM) per package | Target customers |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Individual | Normal Mode | 10 minutes (20 laps)<br>15 minutes (30 laps) | RM 40<br>RM 50 | Children to young adults (Age 10-30) |
| | Ride or Die (Day Tag Mode) | 15 minutes (30 laps) | RM 45 | Teenagers and young adults (Age 18-30) |
| | Ride or Die (Night Tag Mode) | 15 minutes | RM 55 | Teenagers and young adults (Age 18-30) |
| Groups (3 in 1 package) | Normal Mode | 10 minutes<br>15 minutes | RM 105<br>RM 135 | Families, Teenagers and adults group ( age 18-40 ) |
| | Ride or Die (Day Tag Mode) | 15 minutes | RM 120 | Families, Teenagers and adults group ( age 18-40 ) |
| | Ride or Die (Night Tag Mode) | 15 minutes | RM 165 | Families, Teenagers and adults group ( age 18-40 ) |
| Groups (6 in 1 package) | Normal Mode | 10 minutes<br>15 minutes | RM 180<br>RM 240 | Families, Teenagers and adults group ( age 18-40 ) |
| | Ride or Die (Day Tag Mode) | 15 minutes | RM 210 | Families, Teenagers and adults group ( age 18-40 ) |

| | | | | |
|---|---|---|---|---|
| | Ride or Die (Night Tag Mode) | 15 minutes | RM 270 | Families, Teenagers and adults group ( age 18-40 ) |
| | | | | |
| Mayhem Wednesday | 10% off for all individual package rates. Discount does not apply on public holidays. | | | |
| | | | | |
| Public Holidays | Extra 10% charges to all the packages. | | | |
| | | | | |
| Kart-Mobil's membership | 1-month subscription<br>3-month subscription<br>6-months subscription | RM 250<br>RM 500<br>RM 750 | -Unlimited individual rides for any modes.<br>-For every 3 wins eligible for food vouchers in Vroom Vroom Café or merchandizes from Kart-Mobil.<br>-For group packages, only members are eligible for free ride and the group package prices will be deducted accordingly.<br>- Terms and condition applied. | |
| *Pre-booking is available for all packages. For extra duration of time per session, pre-booking is needed, and rates will be re-evaluated. Subject to availability.<br>*Exclusive of GST. | | | | |

### C.3.4 Job Roles and Responsibilities

*Table C.3.4.1 Description of responsibilities for specific roles*

| Job Roles | Responsibilities |
|---|---|
| Kart-Mobil Facility Manager | - Responsible in managing all facilities and employees within the go-kart range.<br>- Responsible in managing the food the beverage services in Mobil's café.<br>- Participate in professional organizations to forge relationship with another party.<br>- Responsible for evaluation, assessment, and the training of new employees. |
| Administrator and Accountant | -Responsible in managing all pre-booked orders and organizing the schedule to ensure there are no time clashes within the business operating hours<br>-Arrange for maintenance schedule for both vehicle and the track, call for repairs whenever necessary<br>- Manage phone calls, meetings, and appointments from third parties for collaboration purposes<br>- Responsible for administering payrolls<br>- Responsible for cash managements, and financial report of the organisation |
| Front desk Manager / Cashier x2 (Go-kart, Mobil Kart) | -Manage walk in customers for their purchase to participate in the games<br>-Guide customers to download the Kart-Mobil application. |

| | |
|---|---|
| | -Responsible for calculating daily sales and report it to administration.<br>-Handles all walk-in customers and phone calls for general enquiry. |
| Go-kart safety instructor/ assistant x2 | -Inspect the go-kart's condition to make sure it is at peak condition<br>-Alert the maintenance and service crews on the faulty karts for immediate repairs.<br>-Ensure that and adults are given extra measures on their safety and guide them.<br>-Ensure all go-kart racers are fully equipped with the necessary safety gears |
| Service and Maintenance crew x2 (Car maintenance crew x1, Track maintenance crew x1) | -Responsible to repair faulty parts of the vehicle or tracks.<br>-Weekly servicing and maintenance of go-karts according to schedule.<br>-Ensure that the go-kart's fuel tank is always filled before the next ride<br>-Standby at pitstops for any repair work and fuel refilling needed. |
| Sales and marketing officers | -Manage all social media marketing and ensure new contents are posted every week<br>-Develop and execute promotional activities for Kart-Mobil<br>-Handles business research and market surveys<br>-Develop and execute plans to increase in sales |
| System / Application Manager | -Manage Kart-Mobil's app<br>-Maintain and upgrade the application as a more user-friendly app<br>- Fix bugs that occurs in the app. |

| | |
|---|---|
| | - Handles all bugs that occur in the programmed software of the game.<br>*The development of our Kart-Mobil application will be done by third party developers as a one-time off payment. Our software manager will provide the necessary upgrade to our system and application throughout the business operation. |
| Cleaners x3 | -Ensure that facilities are kept cleaned. |

### C.3.5 Google Form Survey Questions and Results

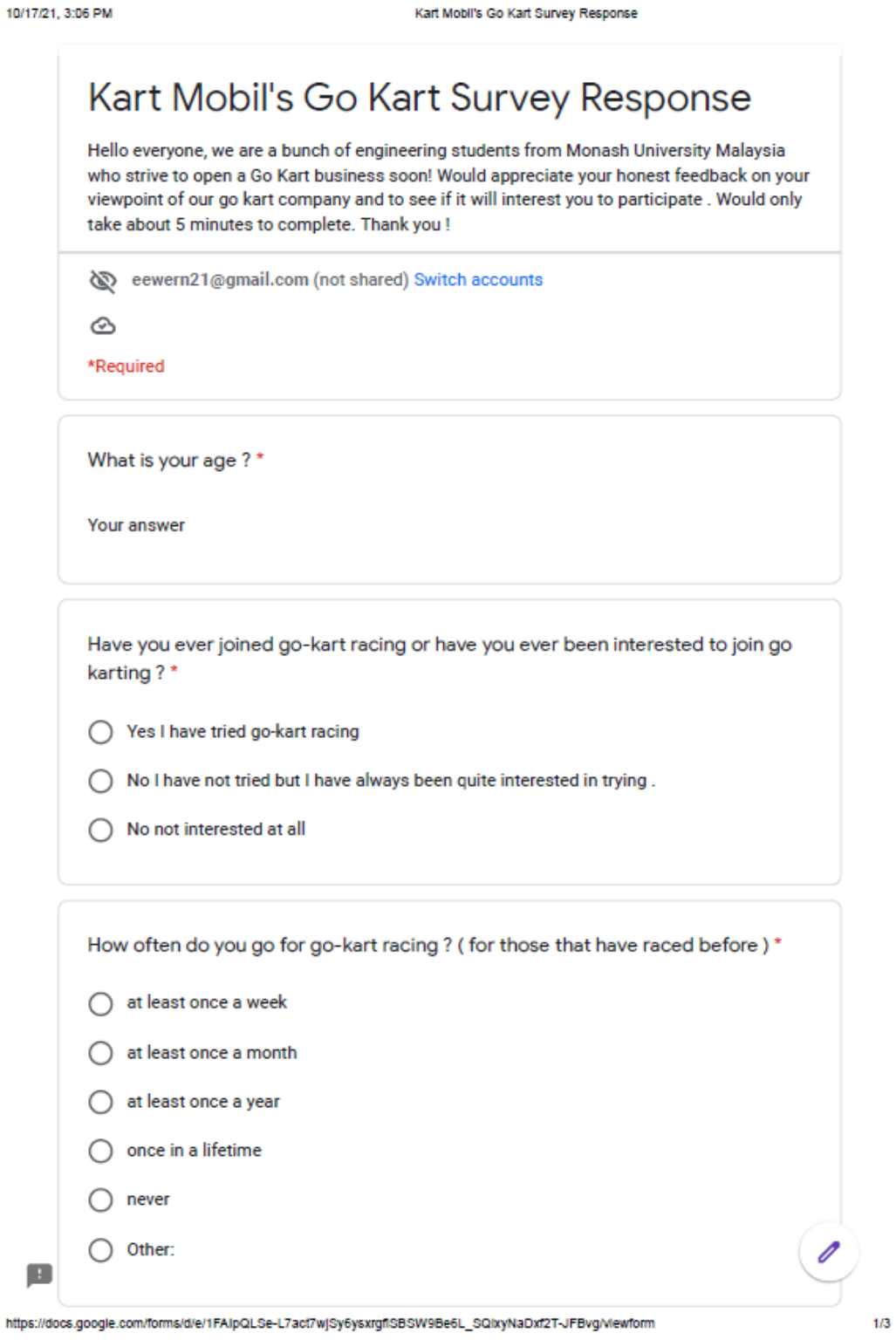



*Figure C.3.5.1 Google Form Survey Questions Page 1*

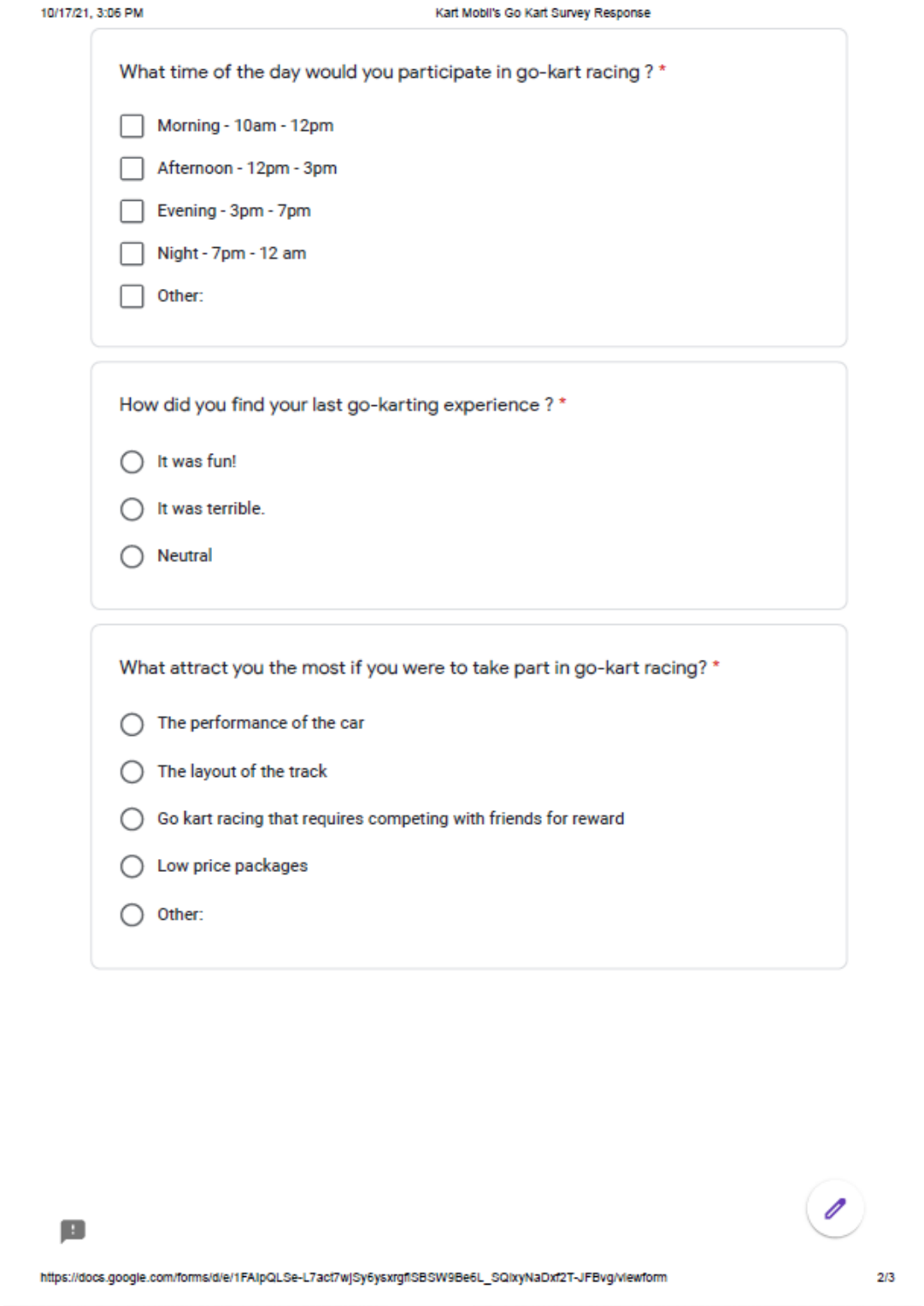



*Figure C.3.5.2 Google Form Survey Questions Page 2*

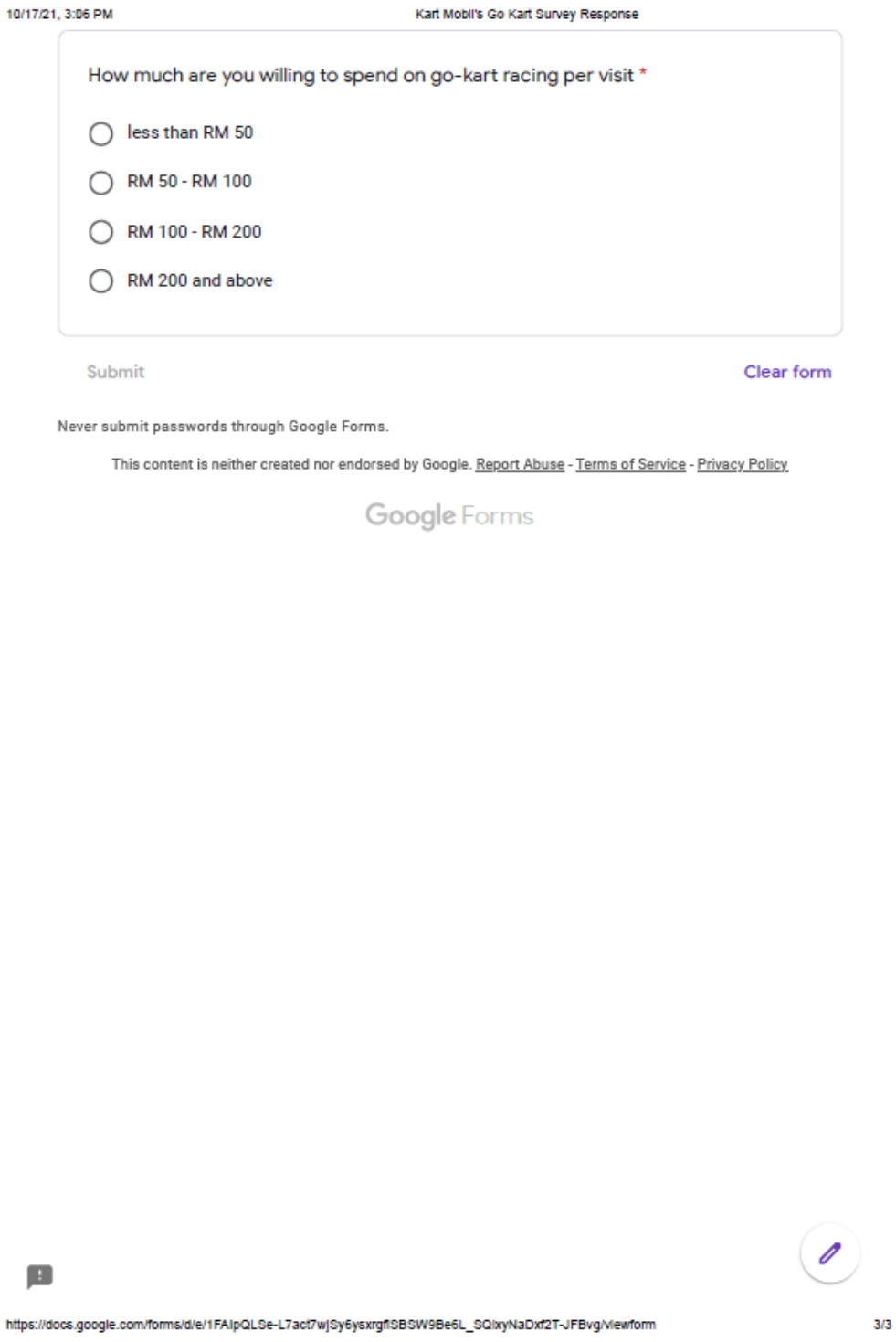



*Figure C.3.5.3 Google Form Survey Questions Page 3*

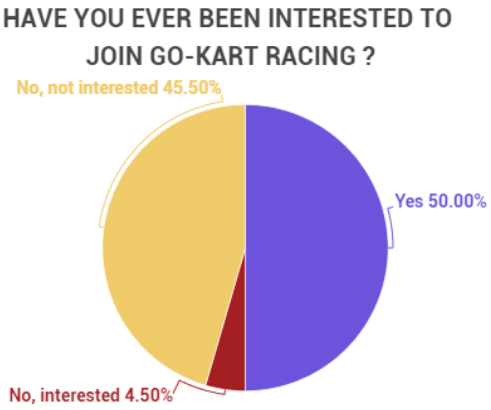



*Figure C.3.5.4 Google Form results 1*

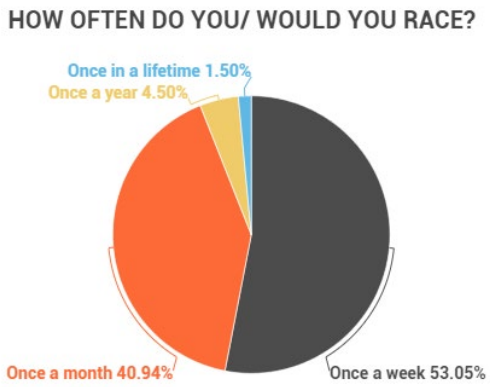



*Figure C.3.5.5 Google Form results 2*

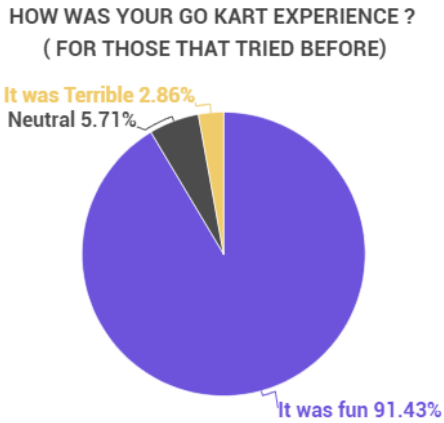



*Figure C.3.5.6 Google Form results 3*

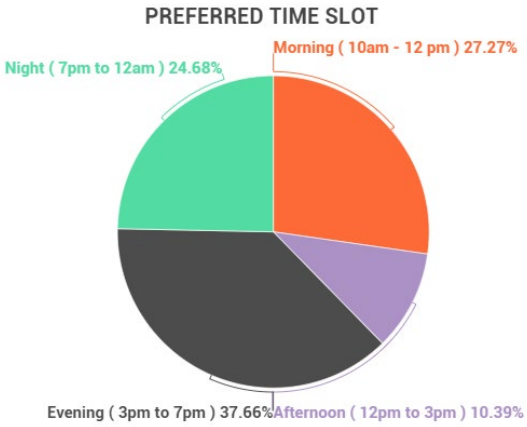



*Figure C.3.5.7 Google Form results 4*

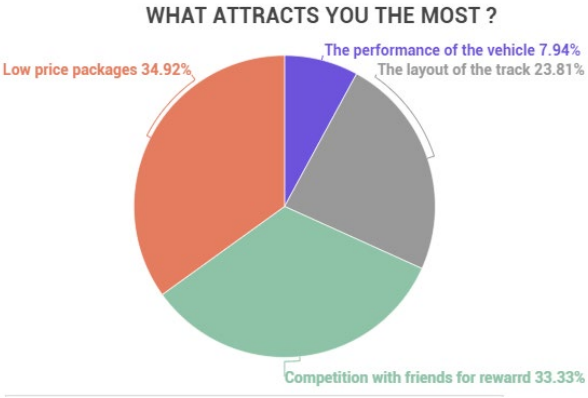



*Figure C.3.5.8 Google Form results 5*


*Figure C.3.5.9 Google Form results 6*

### C.3.6 Project Management

*Table C.3.6.1 Description of milestones in each week*

| WEEK | MILESTONE | STATUS |
|---|---|---|
| 1 | • Forming the company name, logo, theme, the general concept of business and the mission of the business<br>• Research on the components and equations that is governing in the process of setting up a Go-Kart from Literature review from the journals | Done |
| 2 | • Separation of the important components among the 5 teammates to go in detail of the analysis and research | Done |
| 3 | • Construct the vehicle powertrain<br>• CAD the components or subassembly of the overall vehicle using Solidworks<br>• CAD the Track using Solidworks with proper research on the standard track of Go-Kart | Done |
| 4 | • Selection of materials for important components that will be used to deter<br>• Simulation done using ANSYS software to determine the performance and strength of the vehicle using the selected materials<br>• Compilation of theoretical and simulation result for Proposal report | Done |
| 5 | • Further research into electrical components to be implemented into the vehicle<br>• The existing assigned components are researched in depth | Done |

| | | |
|---|---|---|
| 6 | • Brainstorm on the business concept, business operation, business packages, location, funding and ways on profiting | Done |
| 7 | • Work on completing the interior design and brainstorming on the exterior design<br>• Recalculation in some important components to improve the performance of the vehicle<br>• Redesigning the track and implementing some attractive features in the track | Done |
| 8 | • In Depth calculation on the sizing, stress and materials that can be used with corelation with the simulation value<br>• Extra features added in the vehicle and track to enhance the safety of the driver<br>• More facilities ain the track | Done |
| 9 | • All catalogue for the purchase materials need be ready<br>• The game plan needs to be finalized together with the business plan<br>• Research on the customization of the vehicle component<br>• Research on the aerodynamic, kinematic of the track and fuel consumption | Done |
| 10 | • Finalise all the mounting of the component on the vehicle chassis<br>• Perform ANSYS simulation on aerodynamic to see if it is useful for the current design of vehicle<br>• Perform simulation to check the performance and strength of the vehicle with all | Done |

| | | |
|---|---|---|
| | • Start to perform programming corelating with the electronic that has been planned to include | |
| 11 | • Compile all the theory and simulation research and result to be added in the report<br>• Finish the Progress report and submit<br>• Prepare for the presentation | Done |
| 12 | • Final Presentation to Client | Progressing |

### C.3.7 Communication

*Table C.3.7.1 Description of communication tools used*

| Communication Tools | Description |
|---|---|
| WhatsApp | A Whatsapp group with all members is created. This serves as a platform where any inquiries and update on the project can be discussed at all times. Weekly meeting reminders are also conveyed via Whatsapp. |
| Google Drive | Used as an online database where research material of various formats are stored for easy access of files in a Project drive. Folders are created and sorted based on content in an organised manner by all members. Meeting minutes of all meetings are also stored in the drive for recap purposes. Members share any findings into this drive to be acknowledged by other members. |
| Zoom | Platform used for voice and video call during all meetings. Members can freely discuss matters regarding the project here. All members are required to share their progress update to ensure tasks datelines are met. The share screen feature on Zoom makes communications much easier as members can easily share their laptop screen to be viewed by other members. |

### C.3.8 Safety Guideline and Rules

1. All customers are required to scan the MySejahtera QR code or write down their names at the reception entrance followed by a temperature scan before entering Kart-Mobil facility.

2. Due to COVID-19 SOPs implementation, all customers are required to wear a face mask at all times and practice social distancing of at least 1m.
3. No smoking is allowed in Kart-Mobil premises.
4. All drivers are required to sign a waiver form and release of liability disclaimer before being allowed to race. An additional parental consent form signed by parents or guardians are required for drivers under the age of 18.
5. Drivers needs to be at least 16 years old and have a minimum height of 1.50m.
6. For safety purposes, the drivers' weight is not to exceed 100kg.
7. Drivers should attend a briefing session before entering the kart.
8. It is mandatory for participants to wear proper protective equipment (helmet, gloves, goggles) based on instruction given before any go-karting activity.
9. Drivers with shoulder length hair should be tied up, those wearing jackets must be tightly buttoned and caps are not allowed. Other clothing add-ons such as scarves, bow ties, neckties, sandals, slippers, high heels or barefoot and skirts are not allowed.
10. Participants must be in good health conditions any who suffered from heart problems, high blood pressure, sight problems or breathing sicknesses, pregnant women, flustered persons and those affected by drugs are not allowed to participate in kart racing activities.
11. All drivers must check Kart's brakes system condition thoroughly based on instructions before driving.
12. Use right foot to accelerate and left foot to break. Always slow down before any turns.
13. In case of any accidents, make sure to hold onto the steering wheel to prevent from being thrown out of the kart.
14. Bumping of other drivers intentionally is strictly prohibited.
15. Do not stop in the middle of the track unless an accident has occurred.
16. In case of an engine failure, drivers should remain in the karts and raise hands to be assisted by our staffs.
17. If a red flag is signalled on the racetrack, it indicates the presence of hazardous conditions on the track and drivers should return to the assembly area.
18. When returning to the starting point, reduce kart speed and disembark only when the kart has come to a halt.

19. In the case of any kind of bad weather, the staffs are authorized to suspend any karting activities based on the condition of the track.
20. In the case of any fire related incidents, immediately leave Go-kart vehicle and head towards the nearest escape routes.
21. The staffs are authorized to suspend any drivers should they fail to abide by the safety rules and regulations.

## C.4 Additional Rendered images for Vehicle and Track

*Figure C.4.1: Back isometric view of the vehicle*

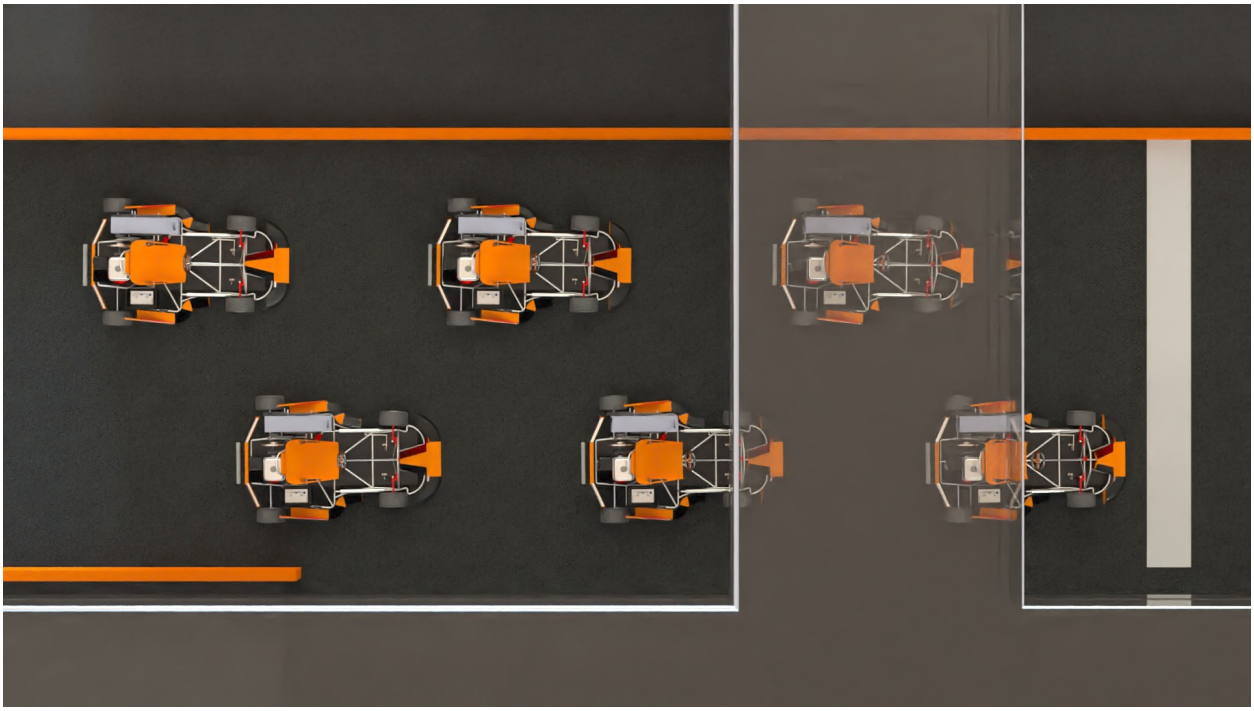


*Figure C.4.2: Maximum number of vehicle racing simultaneously based on length of track*

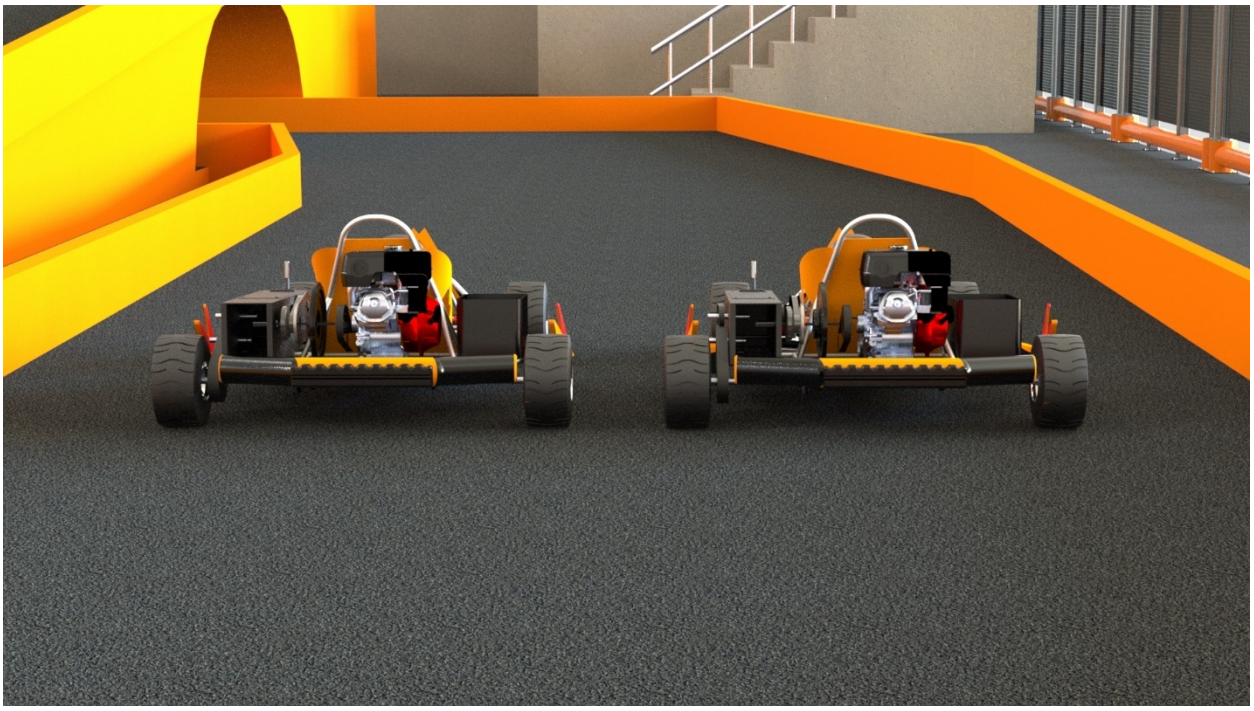


*Figure C.4.3: Maximum number of vehicle based on the width of the track*

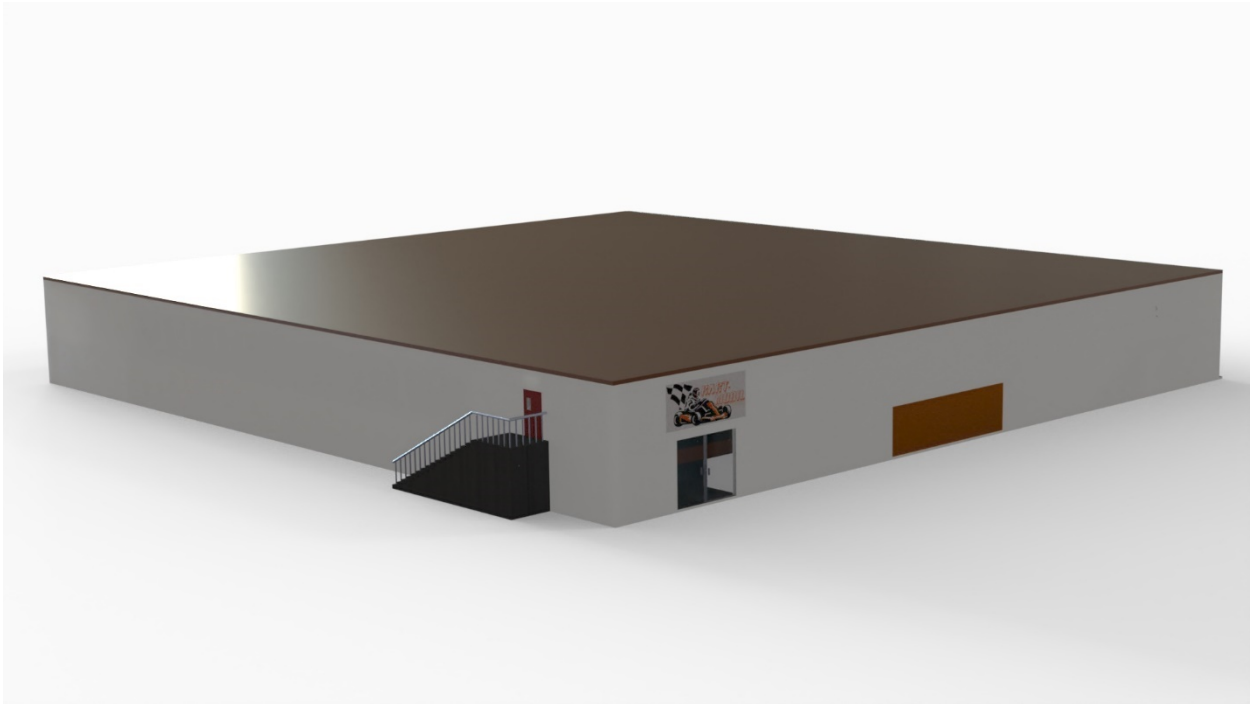


*Figure C.4.4 Isometric view of track with roof*

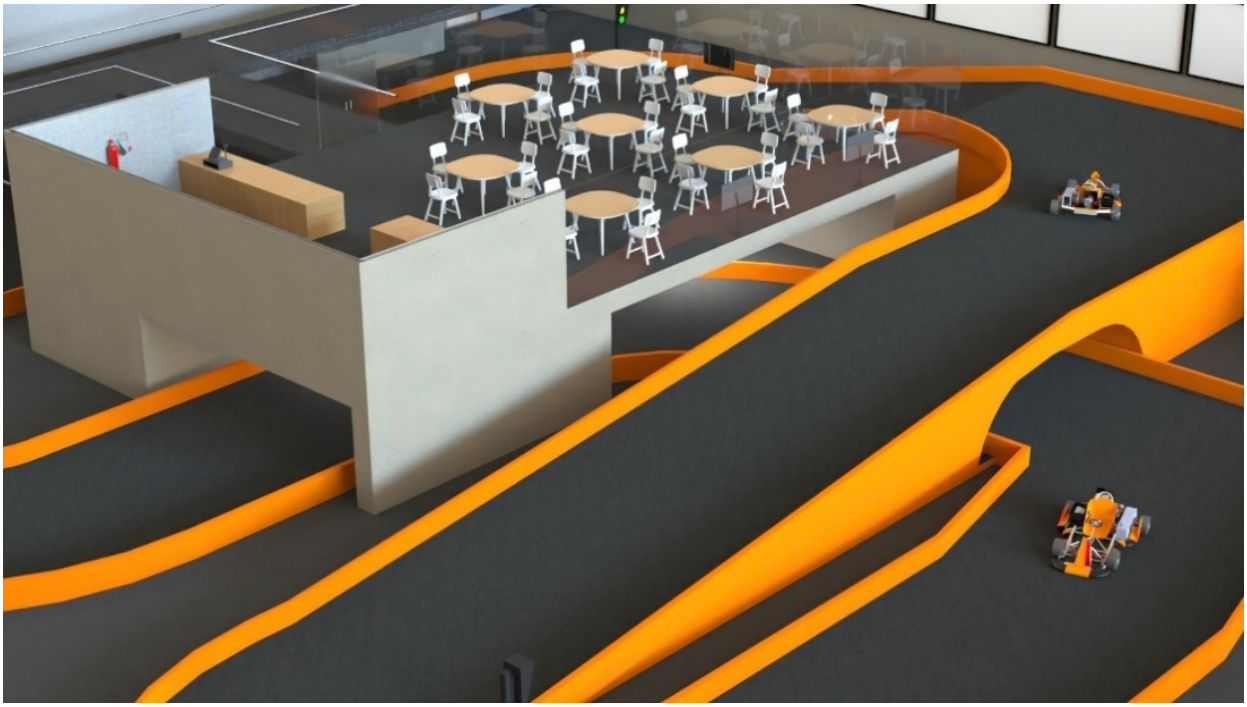


*Figure C.4.5: 2 Tunnel systems of race track*

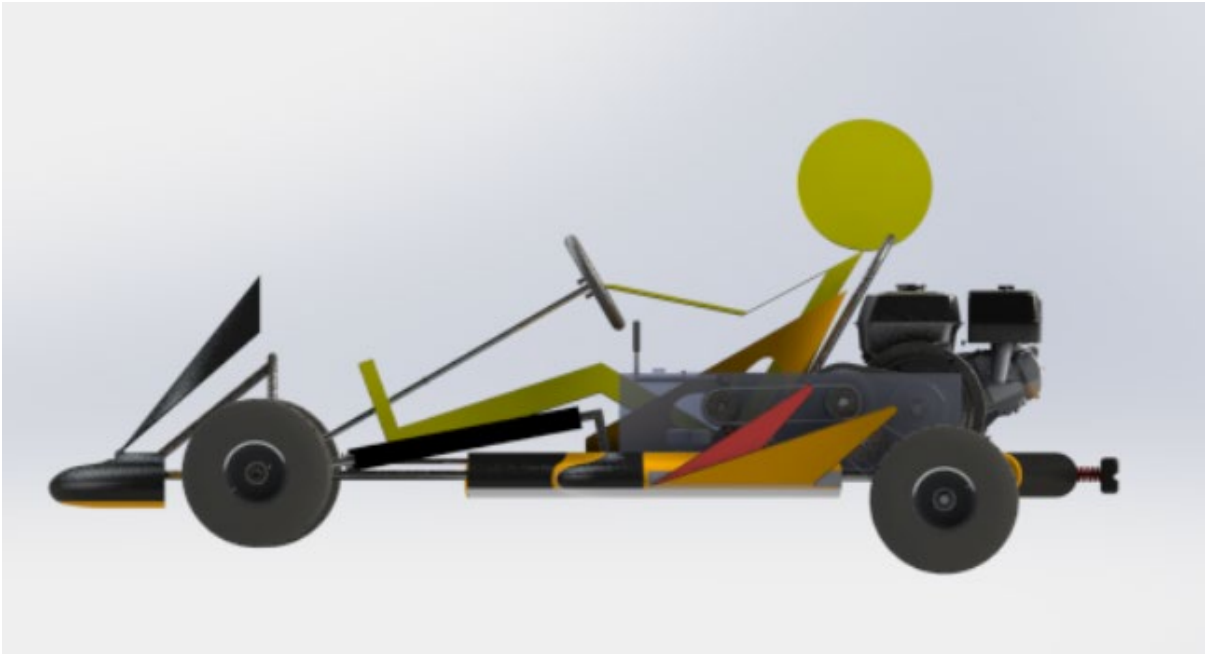


*Figure C.4.5: Driver's position in Go-Kart*

# Appendix D : Vehicle and operational cost

## D.1 Vehicle cost analysis

*Table D.1.1 ; Full breakdown of go-kart vehicle cost*

| Subsystem | Body | | | |
|---|---|---|---|---|
| Item | Description | Cost (RM) | Quantity | Total (RM) |
| Chassis | AISI1018 (RM20.60/m) | 20.60 | 17.1 | 352.26 |
| Body Kit | 1 Complete Bumper Set | 180.00 | 1 | 180.00 |
| Seat | Driver seat (Plastic) | 28.43 | 1 | 28.43 |
| Seatbelt | | 38.76 | 1 | 38.76 |
| Helmet | Safety Helmet | 49.90 | 1 | 49.90 |
| Subsystem | Power Transmission | | | |
| Item | Description | Cost (RM) | Quantity | Total (RM) |
| Engine | Predator 420 cc | 1693.16 | 1 | 1693.16 |
| Gear | SCM 415 (Alloy steel), kg | 8.50 | 15.7 | 133.55 |
| Shaft | AISI 304, 8.4kg | 10.60 | 8.4 | 89.04 |
| Chain Drive | ANSI 40 roller chain, 10ft | 91.48 | 1 | 91.48 |
| Torque Converter | Jeremywell 40 Series | 400.00 | 1 | 400.00 |
| Steering Mechanism | Complete Steering Set | 455.00 | 1 | 455.00 |
| Accelerator Pedal | Electrical Pedal | 28.25 | 1 | 28.25 |

| | | | | |
|---|---|---|---|---|
| Radiator | Radiator | 90.00 | 1 | 90.00 |
| Radiator Fan | Radiator Fan | 38.50 | 1 | 38.50 |
| Subsystem | Wheels and Brakes | | | |
| Item | Description | Cost (RM) | Quantity | Total (RM) |
| Wheels | 13X6.50-6" Tyre + Rim | 157.33 | 4 | 629.32 |
| Rotor/Caliper | 140mm Rotors Caliper | 41.22 | 2 | 82.44 |
| Master Cylinder | Brake Master Cylinder | 63.75 | 1 | 63.75 |
| Brake Pedal | Electrical Pedal | 28.25 | 1 | 28.25 |
| Subsystem | Electronics | | | |
| Item | Description | Cost (RM) | Quantity | Total (RM) |
| Alternator | Perodua Kancil Alternator | 138.00 | 1 | 138.00 |
| Battery | Seal Lead-Acid Battery 12V 7Ah | 39.00 | 1 | 39.00 |
| Brake Lights | Brake lights and switch set | 21.50 | 1 | 21.50 |
| Speedometer | | 83.00 | 1 | 83.00 |
| Data Logger | Arduino Uno Rev3-Main Board | 109.00 | 1 | 109.00 |
| Data Logger | Wi-Fi Transceiver Module | 7.90 | 1 | 7.90 |
| Data Logger | 5VDC Ultrasonic Sensor | 2.90 | 2 | 5.80 |
| Data Logger | 5mm LED RGB -housing | 4.85 | 1 | 4.85 |

| | | | | |
|---|---|---|---|---|
| Kill switch | Engine shut down kill toggle switch | 4.86 | 1 | 4.86 |
| Wires | DC cables, 7m | 3 | 7 | 21.00 |
| Phototransistor | | 6.80 | 1 | 6.80 |
| Accessories | LED Strips | 39.10 | 1 | 39.10 |
| | | | Total | 4952.9 |

## D.2 Operational Cost

*Table D.2.1: Full breakdown of Kart-Mobil operation cost per year*

| Parameter | Cost | Description |
|---|---|---|
| **Insurance coverage** | | |
| Property Insurance | RM5189.16/year | Monthly premium which covers up to RM500000 and above<br>RM432.43/month |
| **Licensing fee** | | |
| Registration fees | RM8000 | Authorised Shared Capital of RM1 million - RM5million |
| | | |
| Trade Name | RM60/year | Annual fees for Business operation |
| Personal Name | RM30/year | |
| Branch (s) | RM5/yearr for each branch | |
| Business Updates | RM20 | |
| Business Information | RM10 | |
| **Marketing cost** | | |
| Social media influencer | RM 10000 ( Assuming 10 post ) | Inclusive of sponsored posts. Influencer must have brain and at least 100000 followers or subscribers on Instagram, Tik-Tok or YouTube. RM 1000/ sponsored post |
| Social media advertisement | RM1.25 per view or action | If 1 person engages with the advertisement posted, company pays RM1.25 to YouTube or Tik-Tok |
| Kart components and material | | |
| **Maintenance cost** | | |

| | | |
|---|---|---|
| Fuel | RM 195447/year | Cost per litre of RON95 = RM2.05<br>1gallon = RM9.307 (price for full tank of 1 Go-Kart Engine)<br>15 Go-Kart = RM139.605 (price for full tank of 15 Go-Kart Engine)<br>Total price for fuel a month = RM16287.25 |
| Spare parts | RM 50000/year | Including Gearbox, Seats, Steering wheels, Bumpers, Chain belt, Tyre vehicles Other small parts (Assuming parts will be replaced due to unforeseen circumstances) |
| Facilities | RM 10000/year | Pothole filling, Barrier repairing, aircon servicing, toilet servicing, sanitation of facilities etc. |
| **Merchandise shop** | | |
| T-shirts | RM7200/year | Assume 50 short sleeve T-shirt order/month, RM12×50=RM600 |
| Long sleeve T-shirts | RM9000/year | Assume 50 longsleeve T-shirt order/month, RM15×50=RM750 |
| Bottles | RM9000/year | Assume 50 bottle order/month,<br>RM15×50=RM750 |
| Keychains | RM3000/year | Assume 50 keychain order/month,<br>RM5×50=RM250 |
| Bracelets | RM3000/year | Assume 50 bracelets order/month,<br>RM5×50=RM250 |
| Go-Kart toy | RM3000/year | Assume 50 Go-Kart toy order/month,<br>RM5×50=RM250 |
| Gift voucher | RM16500/year | Assume<br>500 RM5 gift voucher/year<br>500 RM10 gift voucher/year<br>20 RM20 gift voucher/year<br>50 RM100 gift voucher/year |

| | | |
|---|---|---|
| **Food and supply for cafe** | | |
| Espresso | RM12000/year | RM1000/month |
| Not Coffee | RM12000/year | RM1000/month |
| Pastries | RM18000/year | RM1500/month |
| Cakes | RM21600/year | RM 1800/month |
| **Event hosting for league games** | | |
| Part-time workers | RM5300 | Event hosting for league games<br>Part-time workers 25 part time worker = RM2500 (RM 100 per day)<br>Job Description: to guide customers, to maintain the cleanliness and harmony of the place<br>Eligibility<br>18 years and above<br>Minimum educational requirement: SPM or equivalent<br>Catering facilities + space rental<br>100 chairs = RM2000 (RM20 per chair)<br>10 tables = RM800 (RM80 per chair) |
| **Labour cost** | | |
| Full-timers | RM500,000/year | Estimated labour cost for 13 people of different job roles |
| **Utility cost** | | |
| Utility cost | RM25200/year | Water = RM1000/month<br>Electricity = RM 1000/ month<br>Wifi = RM 100/ month |
| Start-up cost (one - time payment) | | |
| Start-up | RM 15,000,000 | Property, land, renovation, construction cost, manufacturing cost, Business registration |
| | | |

| | | |
|---|---|---|

**Total recurring cost per year = RM 1,190,957.80**

*Table D.2.2: Full breakdown of Kart-Mobil estimated sales per year*

| | Estimated sales | Details |
|---|---|---|
| Go-kart Games | RM 3,942,000/year | Assumption:<br>- 6 people participate for one game<br>- 10 hours non-stop customer traffic participating in go-kart games, all which participates in 15 minutes session games.<br><br>Total number of racers per day = 240<br>Estimated sales per day from go-kart games: RM45 * 240 = RM 10800 |
| Merchandizes and café | RM 365,000 / year | Estimated sales per day from merchandizes and café = RM 1000 (Assuming most sales are from café) |
| Advertisement | RM 146,000/ year | Assumption<br>- RM 200 advertisement fee charged to third party merchants per day<br>- 2 merchants advertisement per day<br><br>Estimated sales from advertisement per day<br>= RM 200 * 2<br>= RM 400 |
| Seasonal League games | RM 20800 / year | Assumption<br>Number of participants per season = 36 |

| | | |
|---|---|---|
| | | Total number of participants = 72<br>Total number of spectators for both seasons = 500<br><br>Estimated sales from competition fees = RM 150 * 72 = RM10,800 / year<br>Estimated sales from spectator's entry fee = 500 * RM 20 = RM 10,000 / year |
| Other forms of revenue | RM 30000 / year | Vending machine, Photobooth, Arcade games, Space rental, Vendor rental, Event hosting, Catering services) |

**Total estimated sales per year = RM4,473,800 (Excluding sponsorship, go-karting school)**

**Estimated revenue per year = RM 3,282,842.20**

**Number of years needed for company to turn profitable**

$$\frac{RM\ 15{,}000{,}000 + RM1{,}190{,}957.80}{RM3{,}282{,}842.20} = 5 \text{ years}$$

# Appendix E: Calculation

## E.1: Kinematic of Track

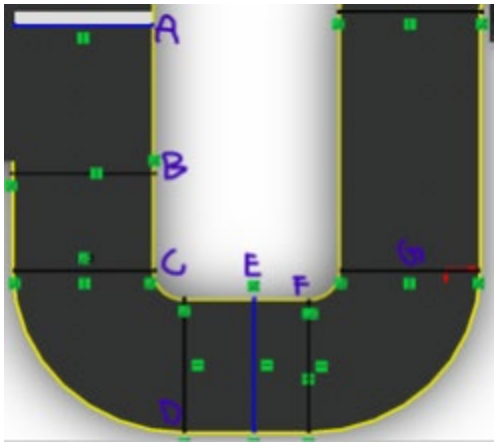



*Figure 30: The first part of the curve in the track with landmarks for calculation*

*Table 2: Parameters obtained for the calculation*

| Parameters used for calculation | |
|---|---|
| Breaking Force, BF | 892.71 N |
| Mass of the vehicle, M | 219.171 kg |
| Maximum speed | 9.722 $\frac{m}{s}$ or 35 $\frac{km}{hr}$ |
| Gravitational acceleration, g | 9.81 $\frac{m}{s^2}$ |
| Static Coefficient of friction, μs | 0.9 (When the surface is dry) |

**Point A to B**

Need to find the time for the distance travelled

Initial velocity, U= 0 $\frac{m}{s}$

Final velocity, V = 9.722 $\frac{m}{s}$

Distance, S = 5.710705 m

S = $\frac{1}{s}$ * (U + V) * t

**Time, t = 1.174773 s**

**Point C to D**

The safe speed needs to know using centripetal force before turning at the curvature

Fc = Centripetal Force

Ff = Frictional Force

Fn = Normal force

Fc = Ff

Fc = μs*Fn

Fc = μs*(M/4) *g

$Fc = \frac{(M * Velocity^2)}{Radius\ of\ curve}$

$\mu s*(M/4)*g = \frac{(M * Velocity^2)}{Radius\ of\ curve}$

Velocity = 3.570 $\frac{m}{s}$

Want to find the time assuming constant speed during curve

Initial velocity, U=Final velocity, V= 3.570 $\frac{m}{s}$

Distance, S = 5.699995

Acceleration = 0 $\frac{m}{s^2}$

$S = U*t + \frac{1}{2}*A*t^2$

**Time, t = 1.610 s**

**Point B to C**

Wants to make sure that the deceleration meets the breaking force value

Initial velocity, U = 9.722 $\frac{m}{s}$

Final velocity, V = 3.570 $\frac{m}{s}$

Breaking force, BF = $\frac{M*(V-U)}{t}$

**Time, t = 1.107 s**

**Point D to E**

Need to find the time for the distance travelled

Initial velocity, U= 3.5470 $\frac{m}{s}$

Final velocity, V = 9.722 $\frac{m}{s}$

Distance, S = 2.52458 m

S = $\frac{1}{s}$ * (U + V) * t

**Time, t = 0.380 s**

**Point F to G**

The safe speed needs to know using centripetal force before turning at the curvature

μs*(M/4) *g = $\frac{(M*Velocity^2)}{Radius\ of\ curve}$

Velocity = 3.577 $\frac{m}{s}$

**Want to find the time assuming constant speed during curve**

Initial velocity, U=Final velocity, V= 3.577 $\frac{m}{s}$

Distance, S = 5.79799

Acceleration = 0 $\frac{m}{s^2}$

S = U*t + $\frac{1}{2}$*A*$t^2$

**Time, t = 1.620 s**

**Point E to F**

Wants to make sure that the deceleration meets the breaking force value

Initial velocity, U = 9.722 $\frac{m}{s}$

Final velocity, V = 3.577 $\frac{m}{s}$

Breaking force, BF = $\frac{M*(V-U)}{t}$

**Time, t = 1.101 s**

Using the similar approach has been able to identify the time taken for the car to travel 1 Lap

**1 Lap = 29.582904 seconds**

## E.2: Steering Mechanism Calculation

Calculations for Ackermann Percentage

Wheelbase (L) = 1556 mm

Track Width (d) = 1000 mm

Turning Radius (R) = 2500 mm

Inner Angle, $\theta_i$

$$\theta_o = tan^{-1}(\frac{L}{R - \frac{d}{2}})$$

$$\theta_o = tan^{-1}(\frac{1556}{2500 - \frac{1000}{2}})$$

$$\theta_i = 0.6612\, rad$$

Outer Angle, $\theta_o$

$$\theta_i = tan^{-1}(\frac{L}{R\ +\ \frac{d}{2}})$$

$$\theta_i = tan^{-1}(\frac{1556}{2500\ +\ \frac{1000}{2}})$$

$$\theta_o = 0.4785\ rad$$

Actual Turning Radius, $R_{act}$

$$R_{act} = \frac{d}{2} + L \cdot cosec(\frac{\theta_o\ +\ \theta_i}{2})$$

$$R_{act} = \frac{1000}{2} + L \cdot cosec(\frac{0.6612\ +\ 0.4785}{2})$$

$$R_{act} = 3384.23\ mm$$

Ackermann angle, $\theta_{ack}$

$$\theta_{ack} = tan^{-1}(\frac{L}{\frac{L}{tan(\theta_o)}\ -\ d})$$

$$\theta_{ack} = tan^{-1}(\frac{1556}{\frac{1556}{tan(0.6612)}\ -\ 1000})$$

$$\theta_{ack} = 0.9996\ rad$$

Ackermann Percentage, $\%_{ack}$

$$\%_{ack} = \frac{\theta_i}{\theta_{ack}} \times 100\ \%$$

$$\%_{ack} = \frac{0.6612}{0.9996} \times 100\ \%$$

$$\%_{ack} = 66.1\%$$

## E.3 Analysis on Transmission

$V_{max}$ = 50 km/hr = 13.89 m/s

$r_{wheel}$ = 0.1651m

Angular speed, $\omega_{wheels}$ (rad/s) = $\frac{13.89}{0.1651}$ = 84.13 rad/s

$\omega_{wheels}$ (RPM) = $\frac{84.13\ x\ 60}{2\pi}$ = 803.38 rpm

Net high-end gear ratio required = $\frac{Max\ Engine\ Speed}{Max\ Kart\ Speed} = \frac{3600}{803.38}$ = 4.48

where, $V_{max}$ is the maximum Go-kart speed

$r_{wheel}$ is the radius of wheel

Torque Converter Specification

| | |
|---|---|
| High-end gear ratio | 0.9 |
| Low-end gear ratio | 2.68 |

Max engine torque at 2500 RPM (engagement rpm of torque converter) = 26.84 Nm

Sprocket and forward gear ratios

| | |
|---|---|
| Forward gear ratio | 1:1 |
| Sprocket ratio:<br>- Torque converter-reverse gear input shaft<br>- Reverse gear output shaft-jackshaft | <br>1:1<br>1:1 |

Final drive ratio required = $\frac{\text{Net high−end gear ratio required}}{\text{High−end gear ratio}} = \frac{4.48}{0.9}$ = 4.97~4.8

Hence, a sprocket of 48 teeth is used at the jackshaft and a sprocket of 10 teeth is used at the rear axle to get a final drive ratio of 4.8.

Starting Torque required at wheels

Overall Gear Ratio = Gear ratio $_{\text{torque converter}}$ x Final drive ratio

Overall Low-end gear ratio (kart starts to move from rest) = 2.68 x 4.8 =12.86

$T_{wheels}$ = Engine torque (at 2500rpm) x overall gear ratio

= 26.84 x 12.86 = 345.16 Nm (Engine torque is based on engine curve attached below Figure E.3.1 )

$T_{start} = F_t \times r_{wheels}$

$F_t = \mu g W = 0.7 \times 9.81 \times 200 = 1373.4$ N

$T_{start} = 1373.4 \times 0.1651 = 226.75$Nm

$T_{wheels} = 345.16$ Nm sufficient

Where,

$T_{wheels}$ is the starting torque produced at the wheels

$T_{start}$ is the starting torque required

$F_t$ is the tractive force

μ is the static friction coefficient (Dry track), 0.7

g is the gravitational acceleration, 9.81m/s$^2$

W is the total weight of the kart (including passenger) = 200kg

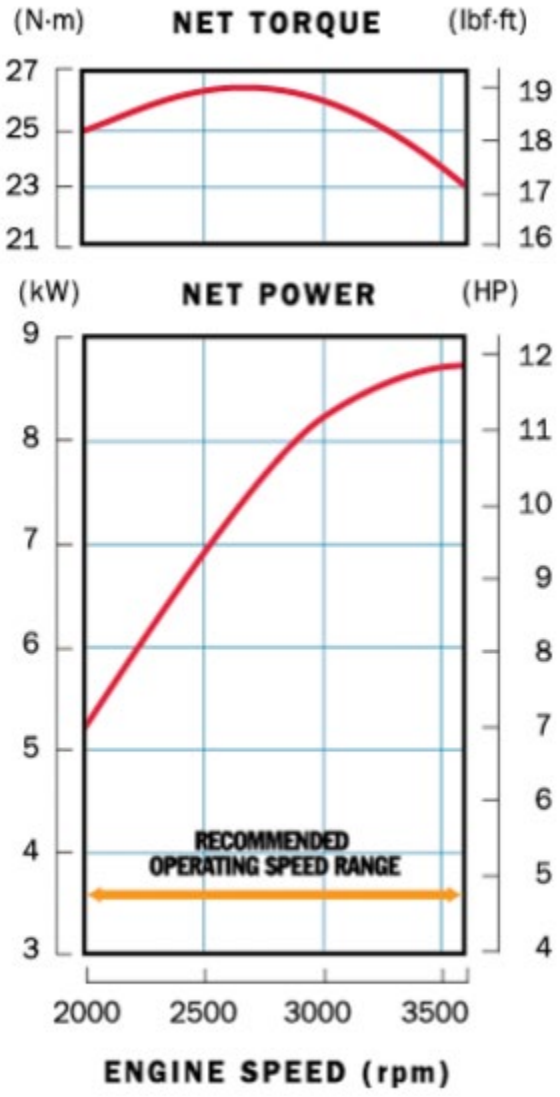



*Figure E.3.1: Engine Torque Curve*

## E.4 Electrical components calculation

Power (W) = Voltage (V) × Current (A)

Capacity = Current × time (h)

| Components | Power (W) | Current (A) | Voltage (V) | Qty. |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Alternators | 720 | 60 | 12 | 1 |
| Brake Lights | 5 | 0.416666667 | 12 | 1 |
| Arduino Uno | 0.2 | 0.04 | IN:7-12V; OP: 5V | 1 |
| Ultrasonic Sensor | 0.15 | 0.03 | 5 | 2 |
| LED Stop Indicator | 0.09 | 0.03 | 3-5 | 1 |
| Speedometer | | N/A | 12 | 1 |
| Wi-Fi Module | 1.25 | 0.25 | 5 | 1 |
| Underbody light kits | 0.24 | 0.02 | 12 | 1 |
| Photoemitter | 0.5 | 0.1 | 5 | 2 |
| Total Requirement | 6.9 | 1.78 | N/A | N/A |

*Table E.4.1: Power, Voltage and Current for each component*

| Electricity Supply vs Demand | Supply | | Consume | |
|---|---|---|---|---|
| | Alternator | Battery | Battery | Electrical System |
| Current per hour (A) | 20 - 36 | N/A | 2.1 | 1.78 |
| Voltage (V) | 12 | 12 | 12 | 12 |
| Capacity (Ah) | N/A | 7 | N/A | N/A |

*Table E.4.2: Electricity supply vs demand*

| Alternators Information | |
|---|---|
| Rated Current | 60A @ 6000 rpm |
| RPM from Go kart (rpm) | 2000-3600 |
| Min Current (A) | 20 |
| Max Current (A) | 36 |
| Max Battery Acceptance (A) | 2.1 |
| Charging Time (h) | 3.3 |

*Table E.4.3: Alternator information*

## E.5 Programming Pseudocode

```
%% Include external components
#include Ultrasonic sensor
#include Retrorefelector emitter and receiver module
#include WiFi module

car_ID = 1 % Car number, 1-6
tagger = 1 % Tagger? 1 = Yes, 0 = No
pos = car_ID % Before race s(eg. Car #1 in 1st place, Car #2 in 2nd place)
textBox="Which mode is the game? \n1: Normal\n2: Ride or Die\n";
mode = input(textBox);
 if mode ~= 1 && mode ~=2

     error("The choice has to be either 1 or 2")

 end


%% Normal racing

    if mode == 1

    % Start
    Start timer from wifi module

    % Mid-way, cross finish line
    if retrorefelctor receiver = 1 % 1 = HIGH indicates signal is reflected
from emitter to receiver
        Time stop
        timeend = time
        Send time to main PC via wifi module
        Reset time to zero
        Time start
    end
end
```

```
if mode == 2


    % Determining if tagger at start of race
    if pos == 6
        tagger = 1
        turn LED colour to RED
    else
        tagger = 0
        turn LED colour to BLUE
    end

    % Passing the tagger status at 1m
    if us_distance < 1 % Ultrosonic Distance
        if t > 1
            tagger = 0

            send tagger status to main PC via wifi module

            turn LED colour for red to blue
        end
    end

    % Original Taggee in front of Tagger at 1m

    if car_ID to tagger = 1

        turn LED colour from blue to red

    end

    % If the vehicle needs to go to the pitstop in case of emergency
    function GoToPitstop

        turn LED colour to yellow

    end

end
```

```
%% Main PC
% Initializing variables
n = no. of cars driving
laps = no. of laps
car time = size(laps, n);
Checking frequency = 4Hz
textBox="Which mode is the game? \n1: Normal\n2: Ride or Die\n";
mode = input(textBox);
 if mode ~= 1 && mode ~=2

     error("The choice has to be either 1 or 2")

 end

% NORMAL RACING
% Race start
Send time start execution to all cars

% Car cross finish line
if receive time from car ID
    check which car ID
    receive time variable
    store time into array that stores car time
end

% TAG GAME
if current tagger's status = 0
    check for car ID in front of current tagger
    change that car ID to tagger = 1
end

% If vehicle needs to go to the pitstop
execute function GoToPitstop % This function can be found in the car's
microcontroller
```

*Figure E.5.1: The pseudocode for the programming*

## E.6 Brake Calculations

All calculations and formulae is based on (Mahajan et al., 2021).

Requirements as stated by (Stone, 2004):

Max deceleration, $a_{req} = 6.3765 ms^{-2}$

Constraints and Parameters of the vehicle:

Weight of the car and passenger, $W_{cp}$ (kg) = 200

Maximum car velocity, $v_{max}$ ($ms^{-1}$) = 9.722

Height of centre of mass (m) = 0.297

Distance of front axle to centre of mass (m) = 1.108

Distance of rear axle to centre of mass (m) = 0.543

Wheel base (m) = 1.61

Force and Power absorbed calculations

Braking F, $F_b = W_{cp} \times a_{req}$

$= 200 \times 6.3765$

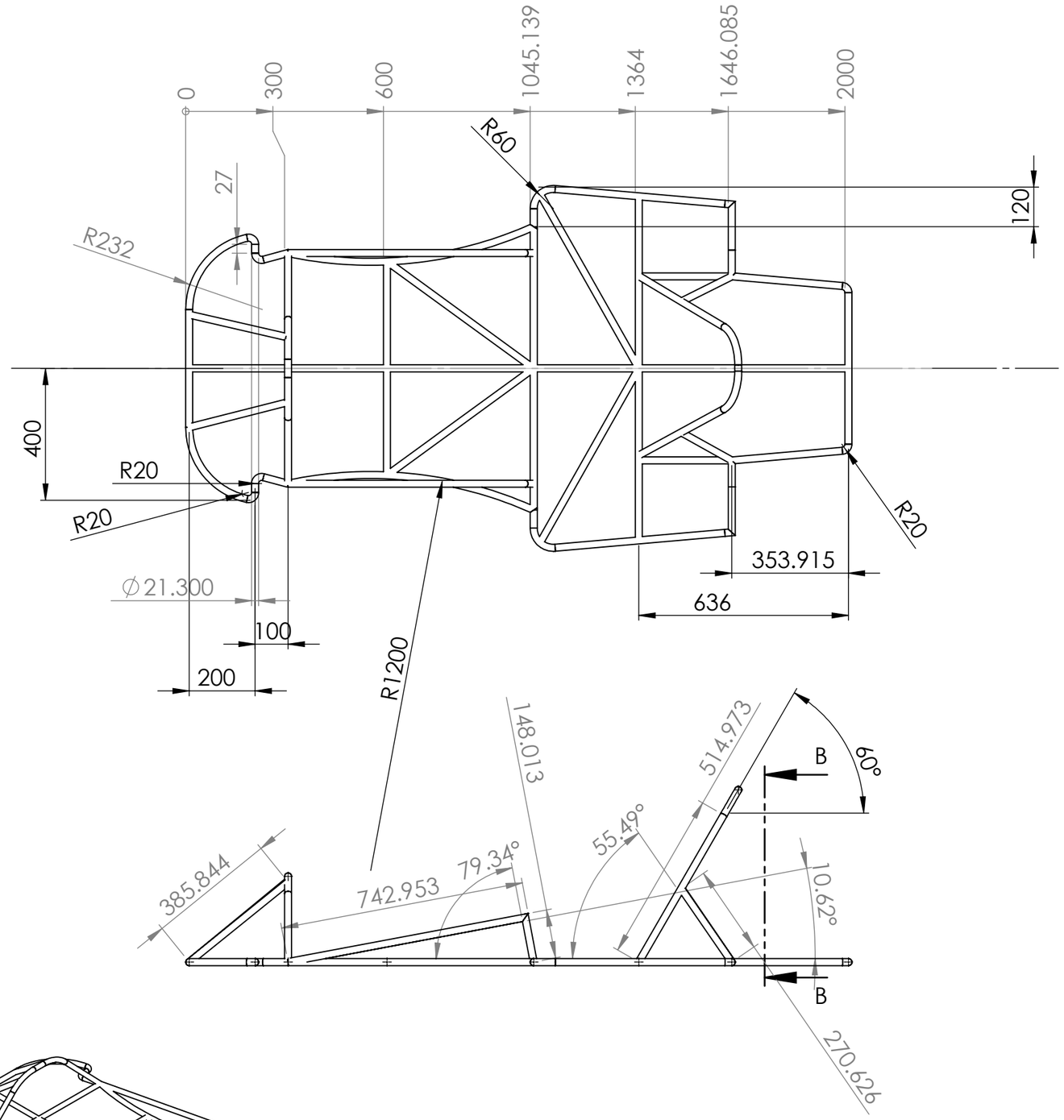
$= 1275.3N$

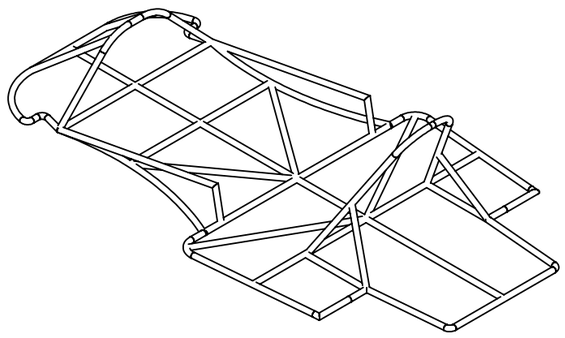
Power absorbed = $(F_b \times v_{max}) / 2$

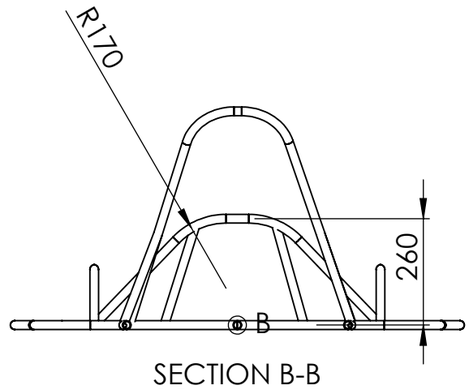
$= (1275.3 \times 9.722) / 2$

$= 6199.2333W$

# Appendix F: WBD, WBS and Gantt Chart



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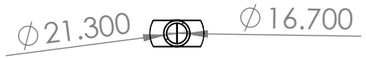


DETAIL B
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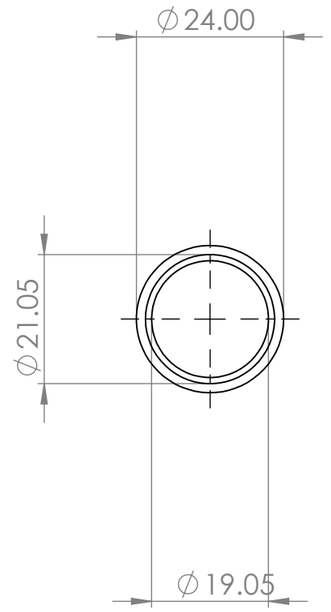
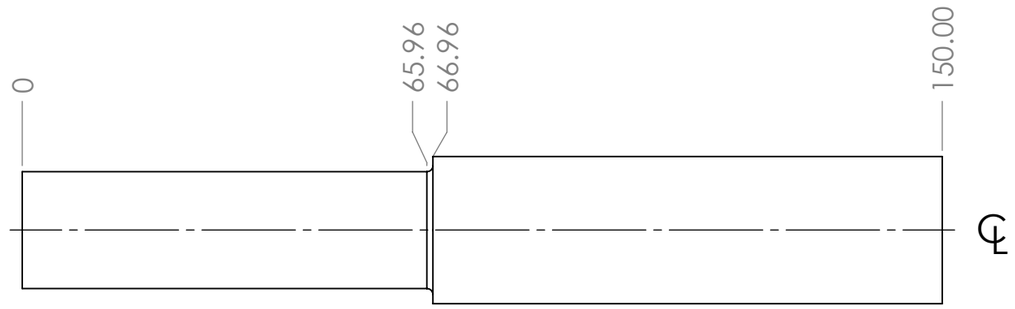
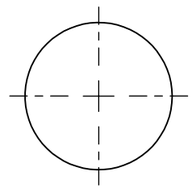
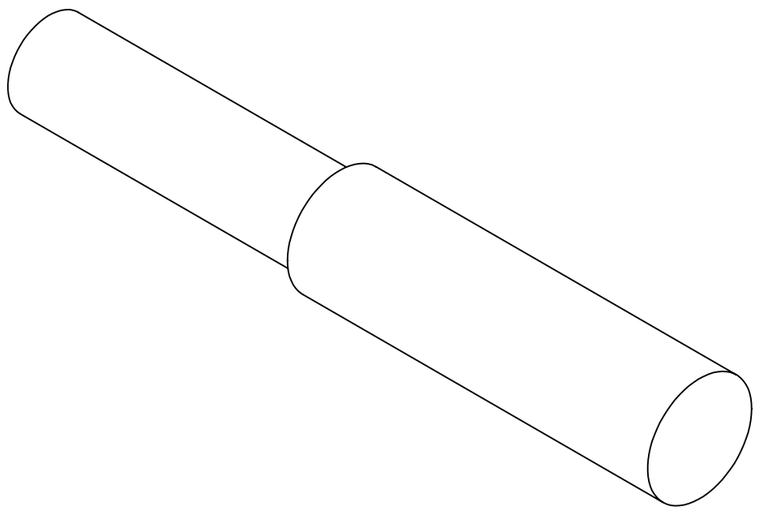
| | MATERIALS:<br>AISI 1018 | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING<br>DRN BY: TAN EE WERN | DATE: 13/10/2021<br>A3<br>SCALE: 1:15<br>DWG NO. 1000 |





NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
+/- 0.2

TITLE:

# TORQUE CONVERTER OUTPUT SHAFT

TORQUE CONVERTER OUTPUT SHAFT DETAIL DRAWING

MATERIALS: AISI 304

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

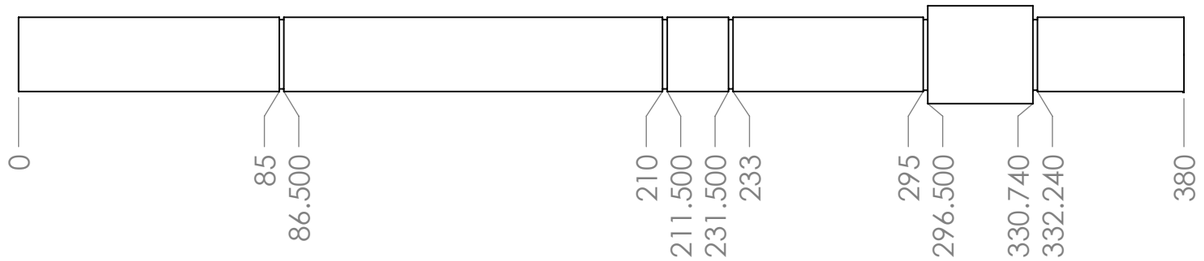
DRN BY: TAN EE WERN

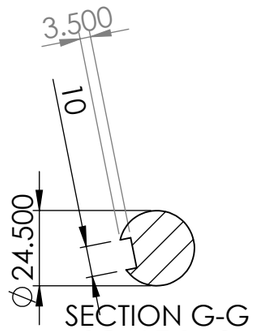
DATE: 13/10/202

A3

SCALE: 1.1

DWG NO. 1001




SECTION G-G
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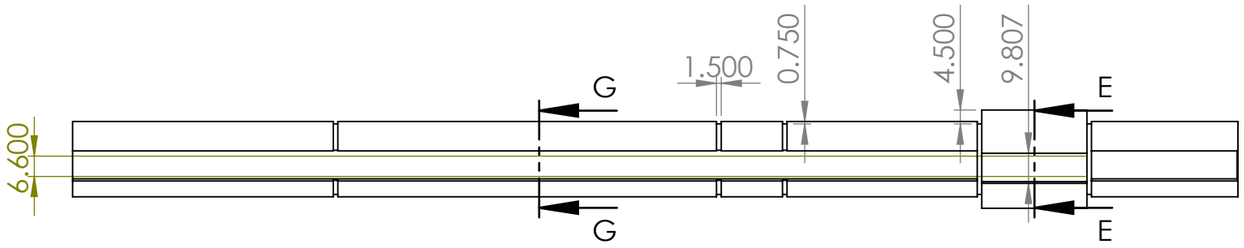


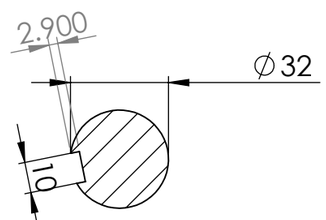


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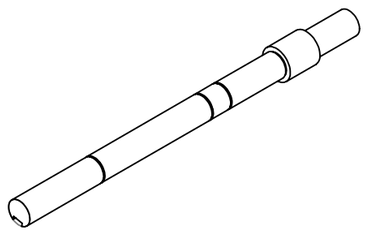

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|---|---|---|---|---|
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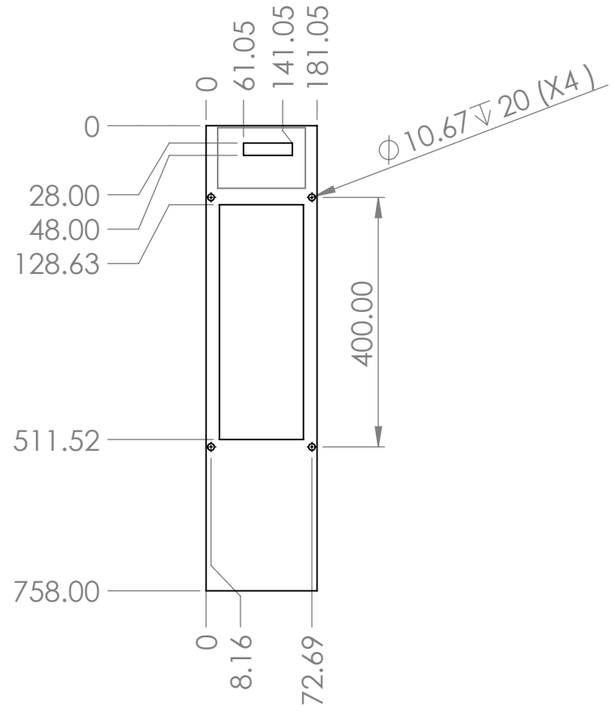
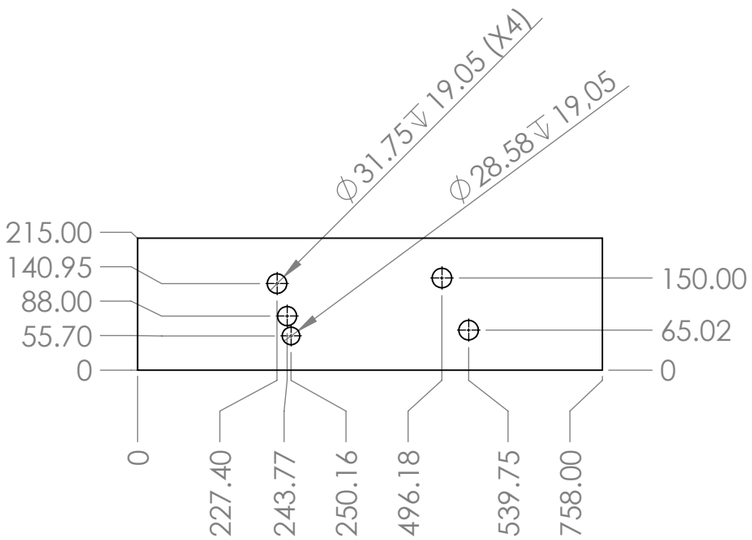
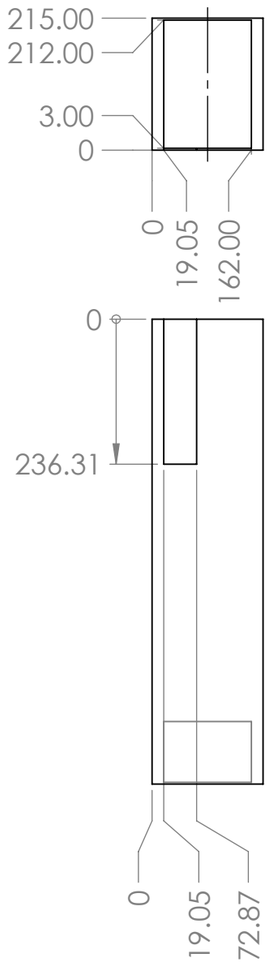
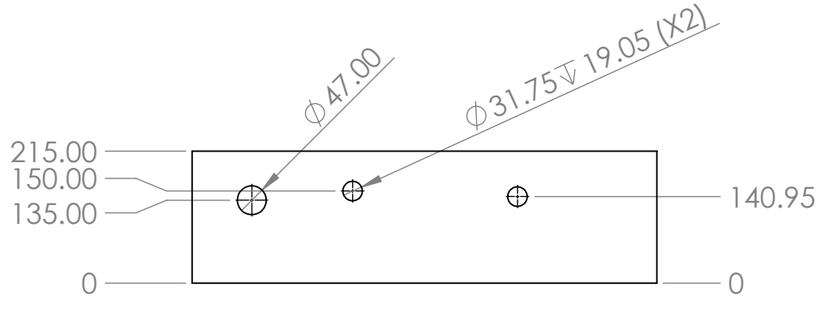
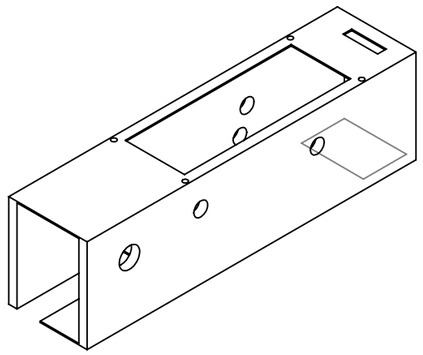
| | MATERIALS:<br>AISI 304 | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING | DATE: 13/10/2021 | A3 |
| | | DRN BY: TAN EE WERN | | SCALE: 1: 5 |
| | | | | DWG NO. 1002 |



| | | | | |
|---|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>GEAR HOUSING | | | GEAR HOUSING DETAIL DRAWING |
| | MATERIALS: AISI304 | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING | DATE:13/10/2021 | A3 |
| | | DRN BY: TAN EE WERN | | SCALE:1:10 |
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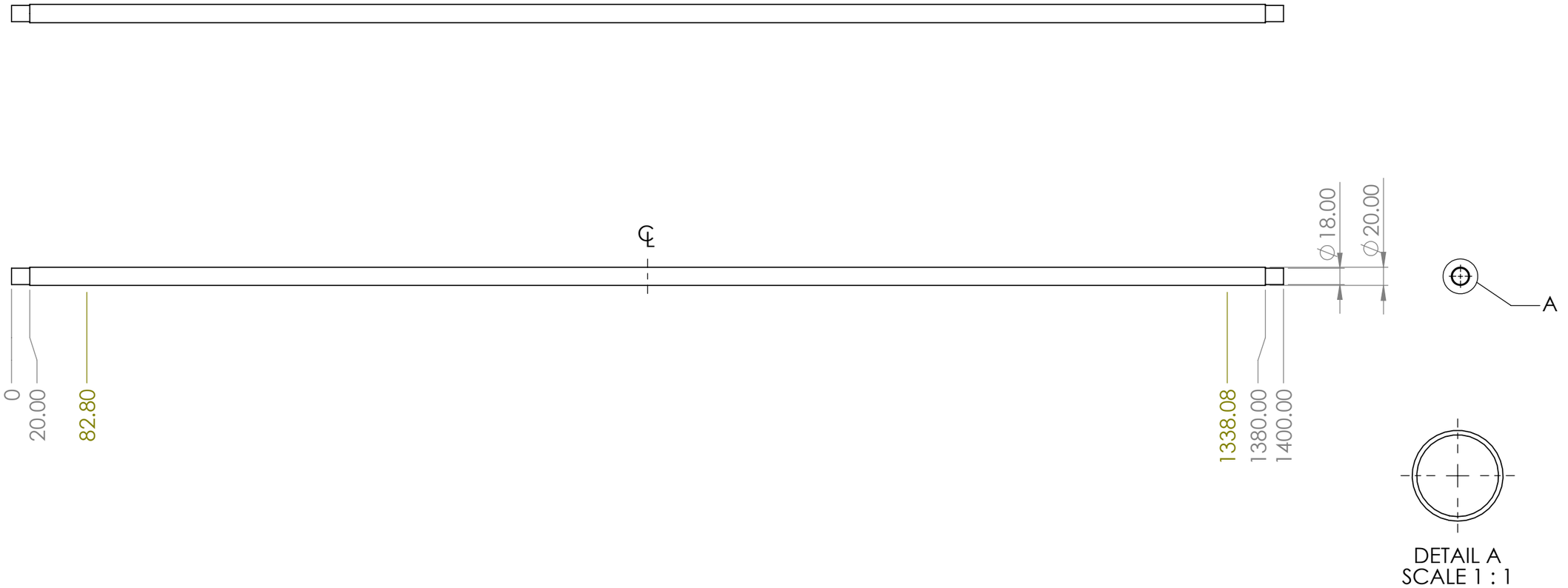


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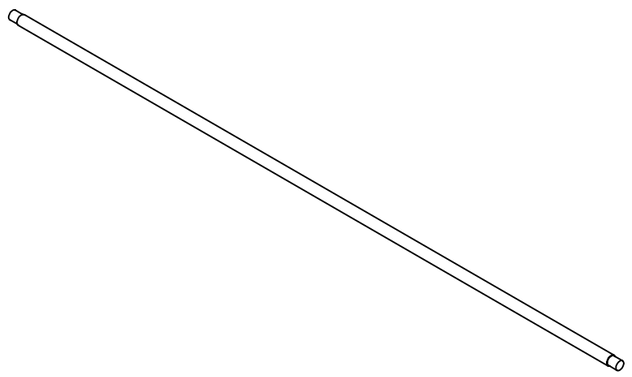


NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
+/- 0.2

TITLE:

# WHEEL SHAFT

WHEEL SHAFT DETAILED DRAWING

MATERIALS: AISI 304

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

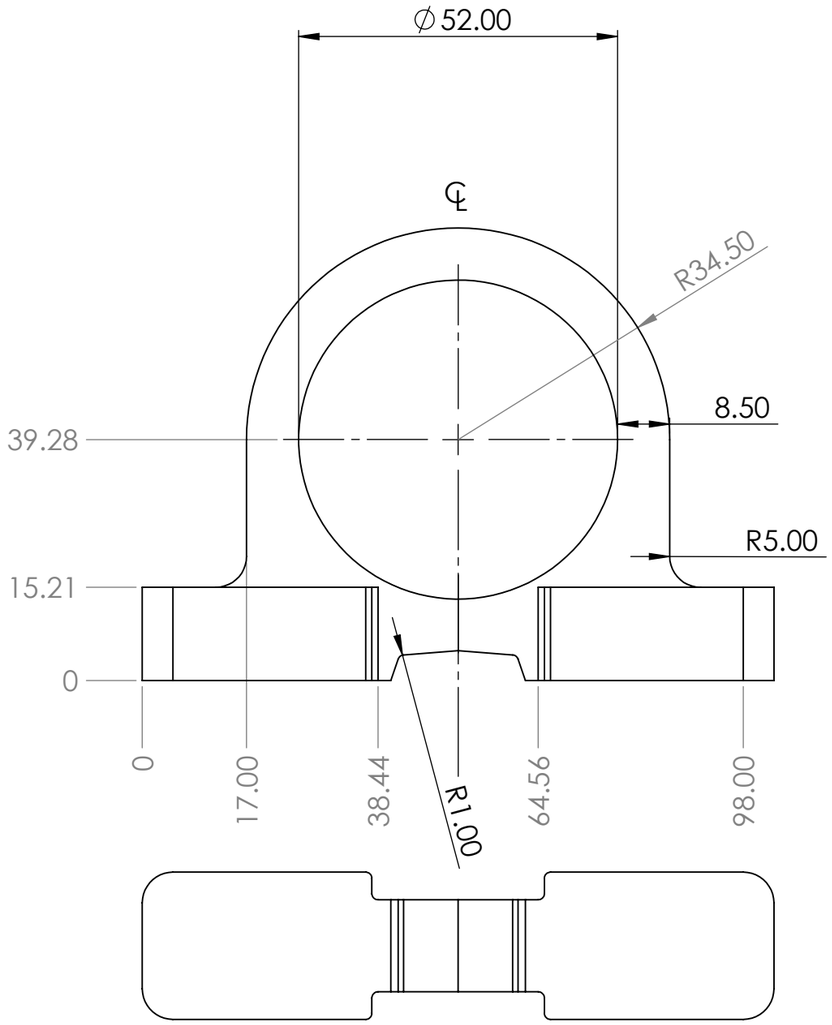
DRN BY: TAN EE WERN

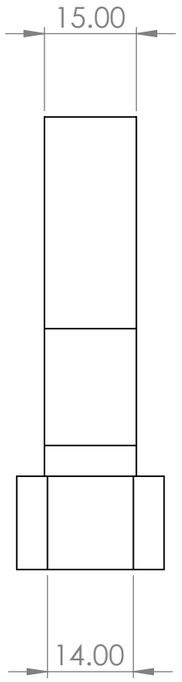
DATE:13/10/2021

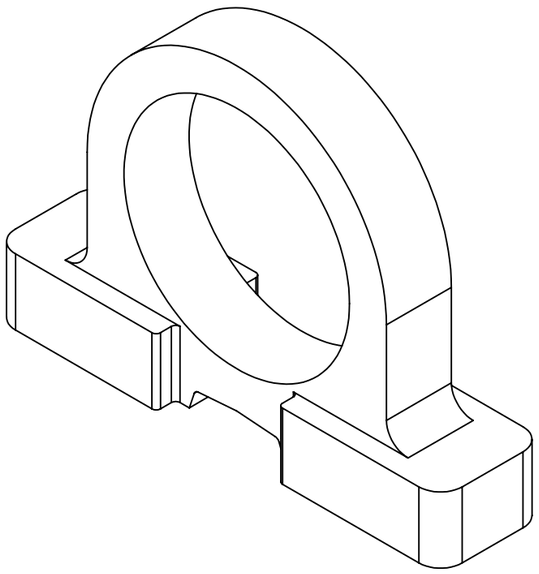
A3

SCALE:1:5

DWG NO. 1004



NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
+/- 0.2

TITLE:

# BEARING HOLDER

BEARING HOLDER DETAIL DRAWING

MATERIALS: AISI 304

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

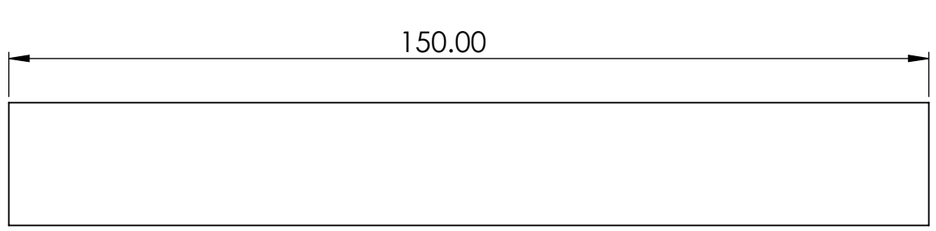
DRN BY: TAN EE WERN

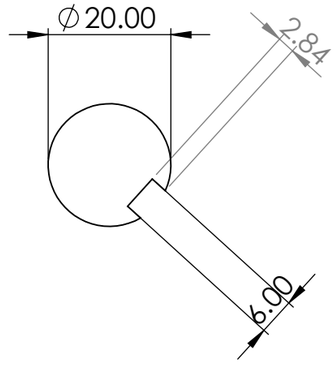
DATE: 13/10/202

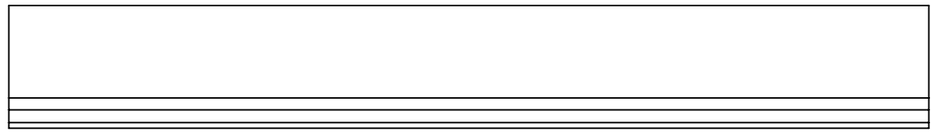
A3

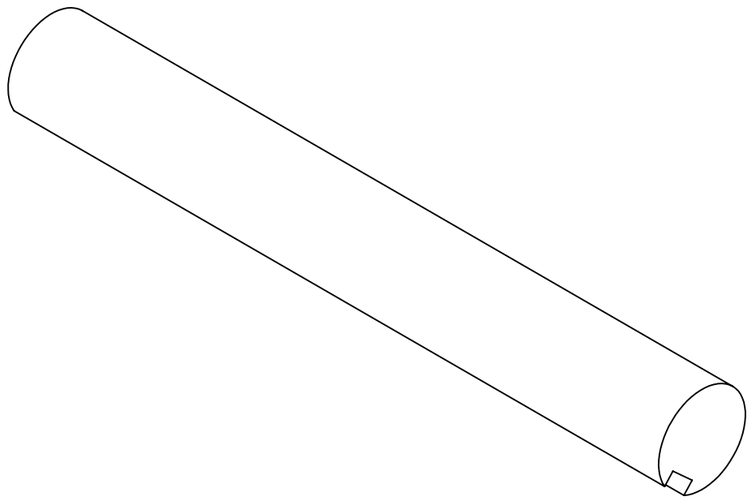
SCALE: 1:1

DWG NO. 1005





NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
+/- 0.2

TITLE:

# OUTPUT GEARBOX SHAFT

OUTPUT GEARBOX SHAFT DETAIL DRAWING

MATERIALS: AISI 304

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

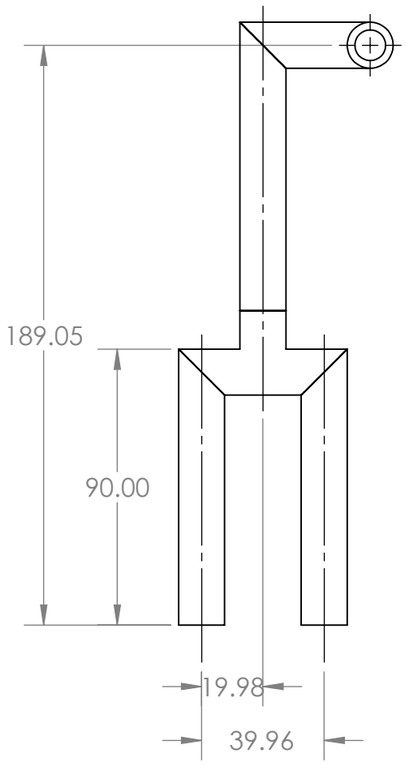
DRN BY: TAN EE WERN

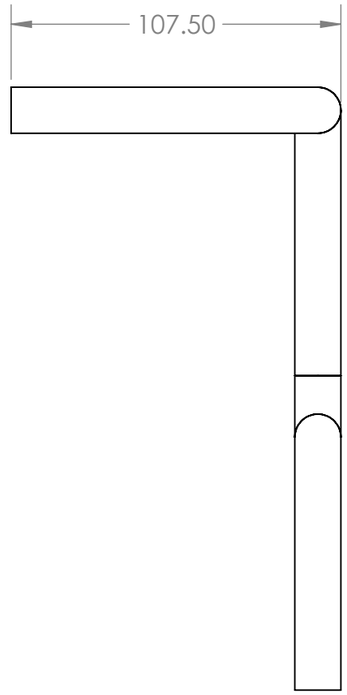
DATE: 13/10/202

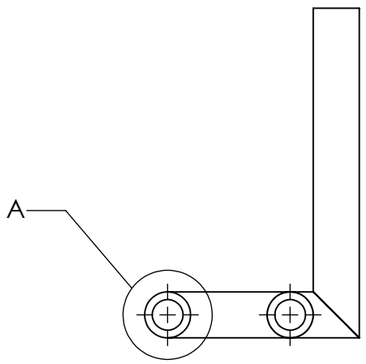
A3

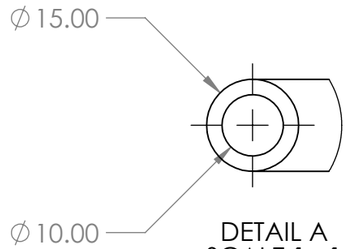
SCALE:1:1

DWG NO. 1006

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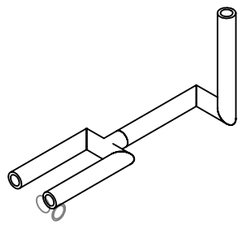
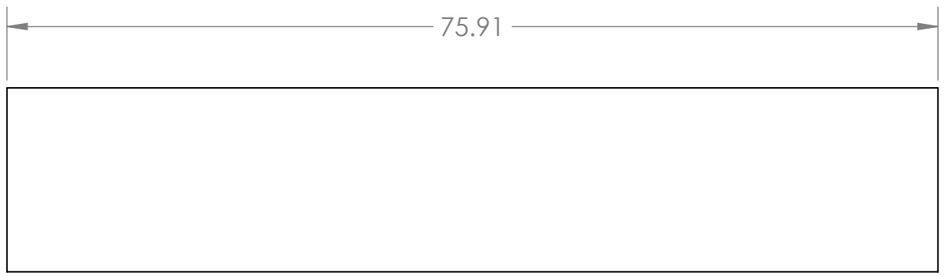
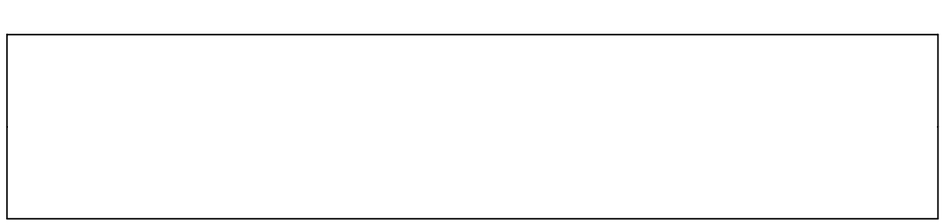
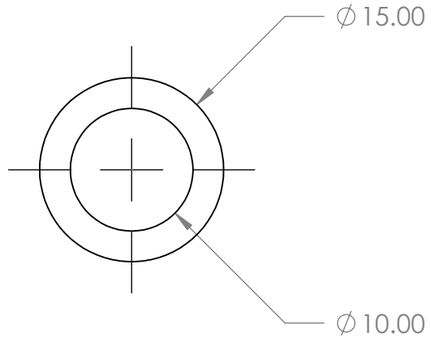
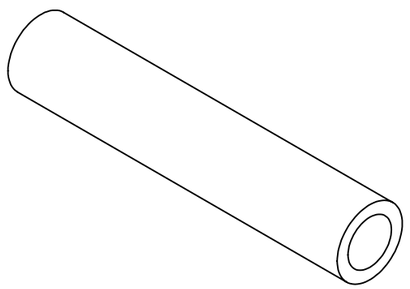


| | | | | |
|---|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>LEVER JOINT | | | LEVER JOINT DETAIL DRAWING |
| | MATERIALS:AISI 304 | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING | DATE:13/10/2021 | A3 |
| | | DRN BY: TAN EE WERN | | SCALE: 1:2 |
| | | | | DWG NO. 1007 |

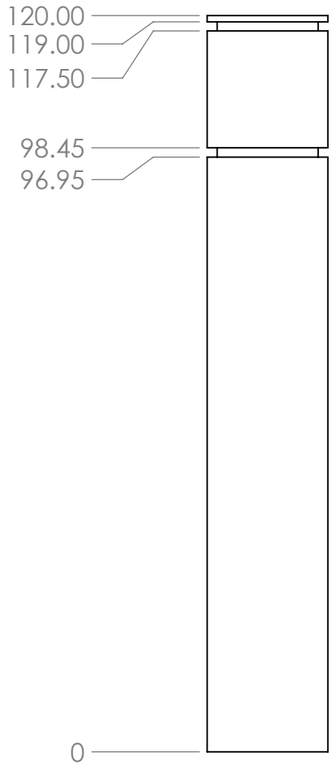


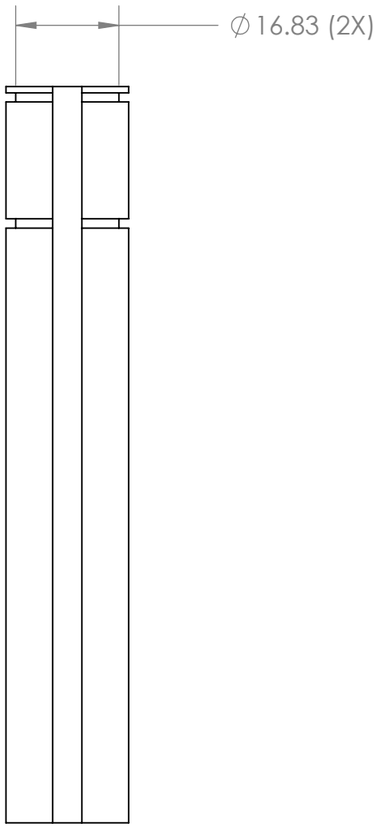



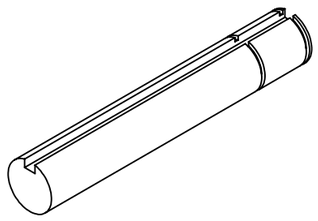


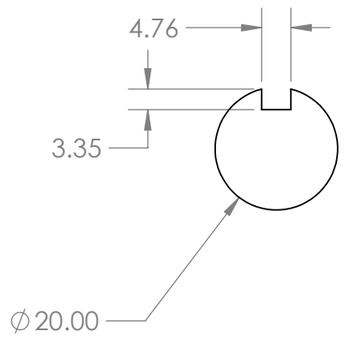



| | | | | |
|---|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>LEVER JOINT CONNECTOR | | | LEVER JOINT CONNECTOR DETAIL DRAWING |
| | MATERIALS: AISI 304 | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING | DATE:13/10/2021 | A3 |
| | | DRN BY: TAN EE WERN | | SCALE:1:1 |
| | | | | DWG NO. 1008 |

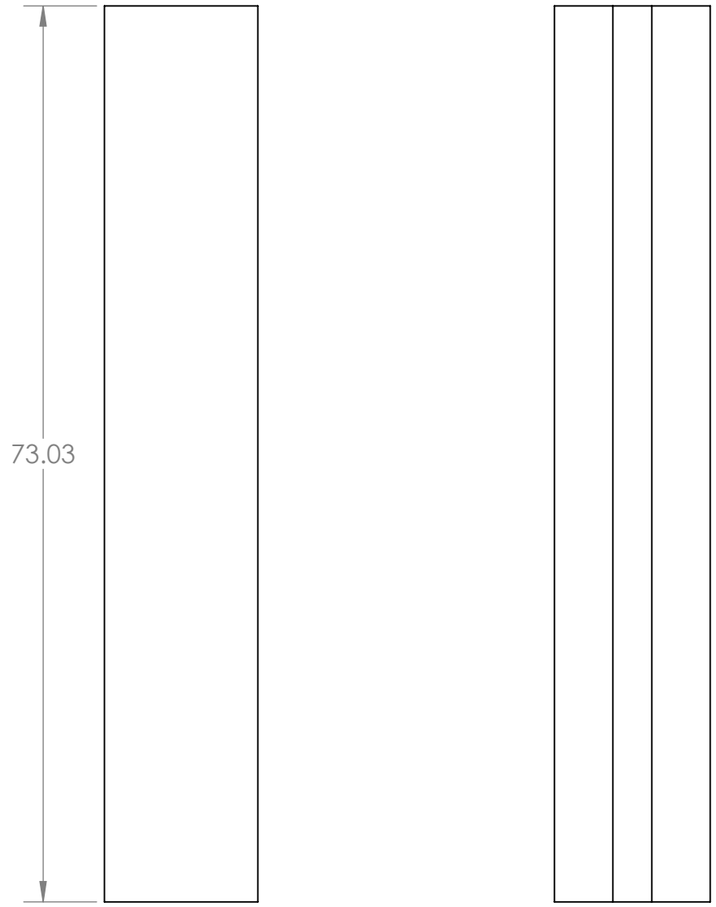


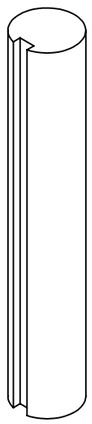



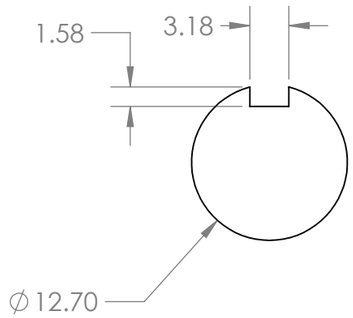





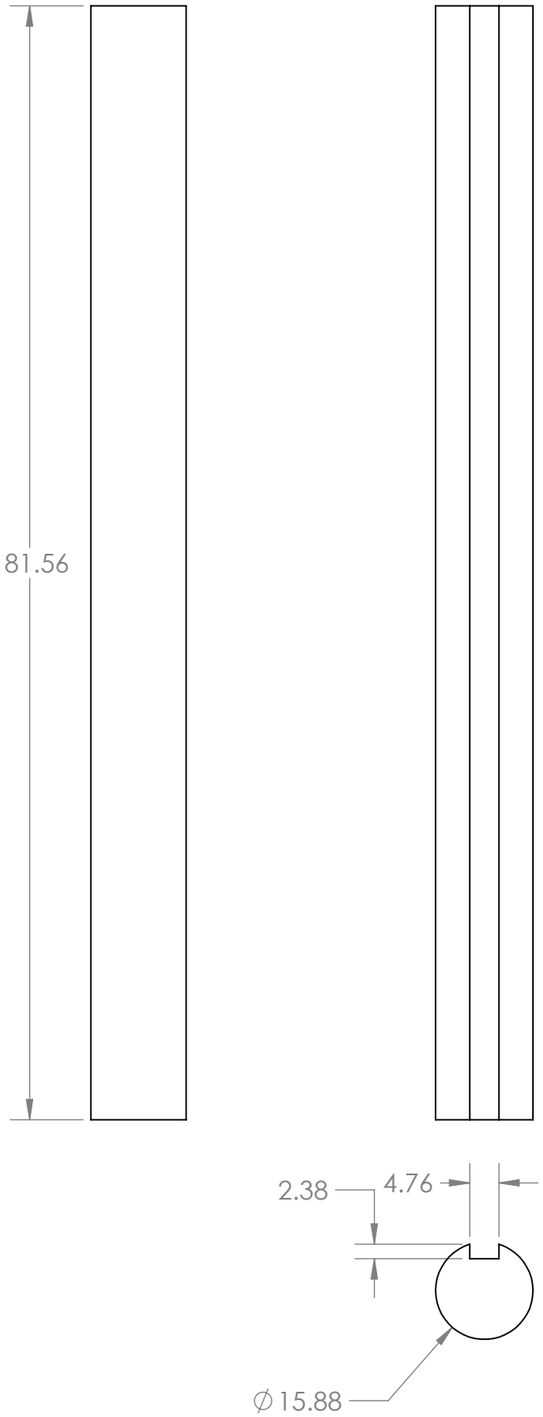

| | | | | |
|---|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>INPUT GEARBOX SHAFT | | | INPUT GEARBOX SHAFT DETAIL DRAWING |
| | MATERIALS:AISI304 | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING | DATE:13/10/2021 | A3 |
| | | DRN BY: TAN EE WERN | | SCALE:1:1 |
| | | | | DWG NO. 1009 |



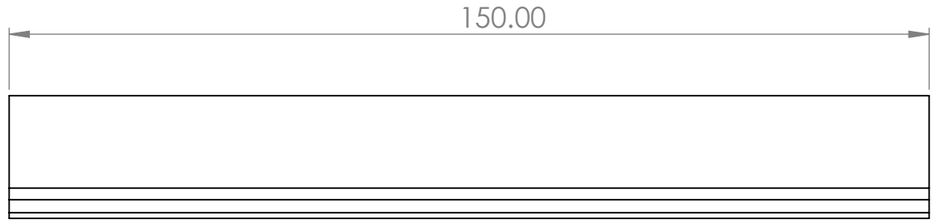



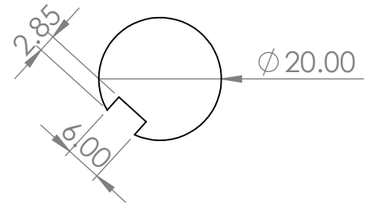


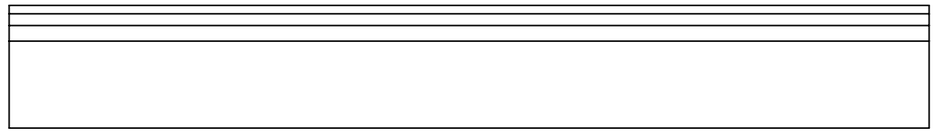

| | | | | |
|---|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>REVERSE IDLE SHAFT | | | REVERSE IDLE SHAFT DETAIL DRAWING |
| | MATERIALS: AISI 304 | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING | DATE:13/10/2021 | A3 |
| | | DRN BY: TAN EE WERN | | SCALE: 1:1 |
| | | | | DWG NO. 1010 |

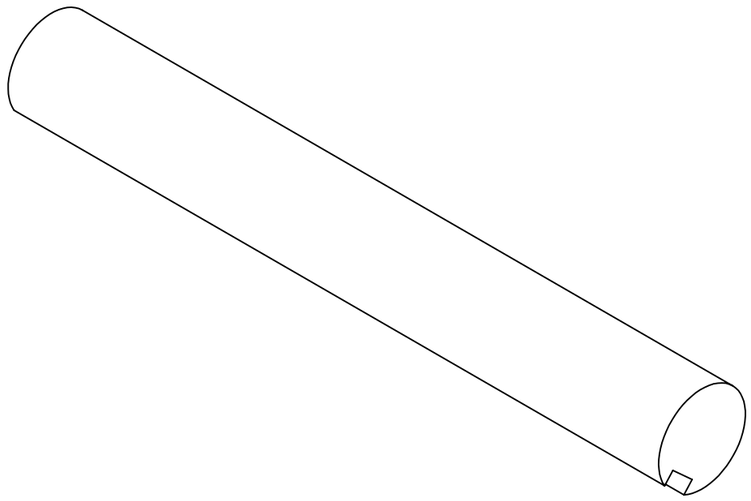



| | | | | |
|---|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>COUNTERSHAFT | | | COUNTERSHAFT<br>DETAIL DRAWING |
| | MATERIALS: AISI 304 | MONASH UNIVERSITY DEPARTMENT<br>OF MECHANICAL ENGINEERING | DATE:13/10/2021 | A3 |
| | | | | SCALE: |
| | | DRN BY: TAN EE WERN | | DWG NO. 1011 |

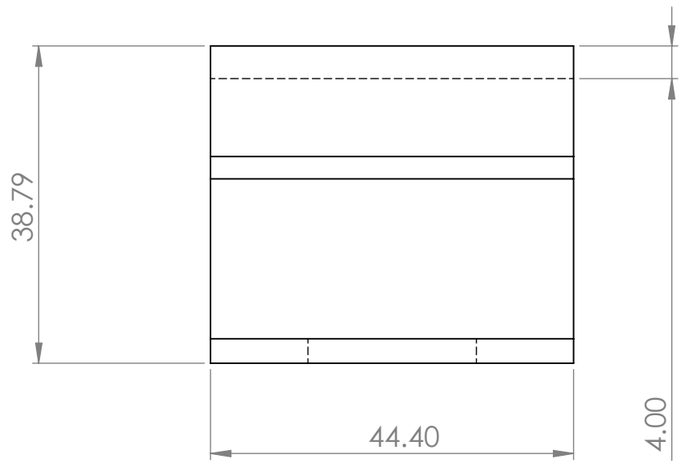


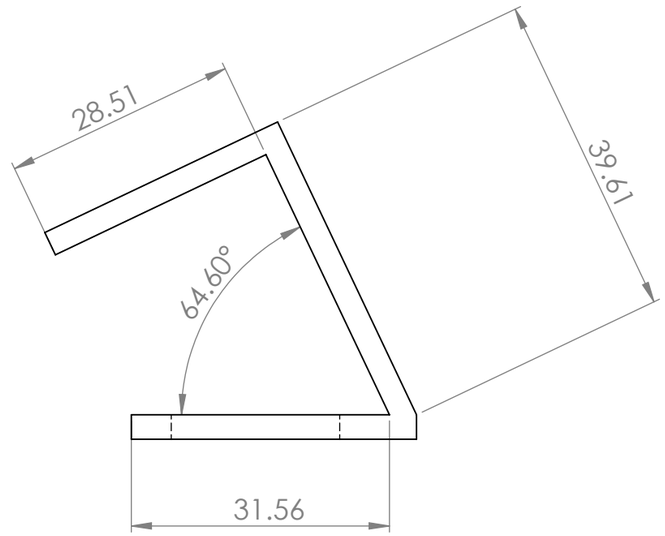



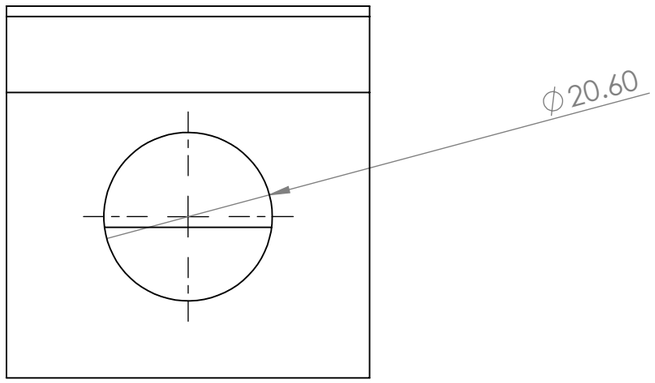



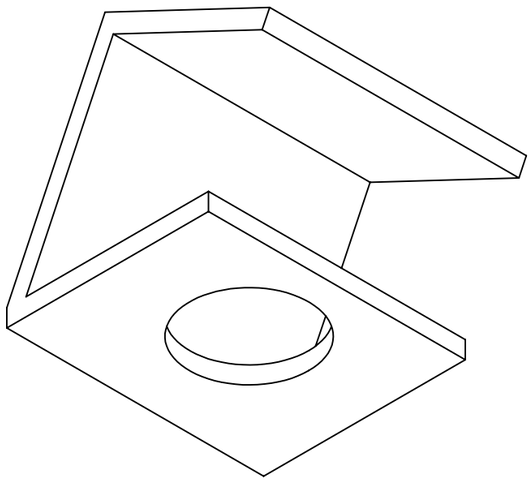


| | | | | |
|---|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>Chain drive input shaft | | | Chain drive input shaft detail drawing |
| | MATERIALS: AISI 304 | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING | DATE:13/10/2021 | A3 |
| | | | | SCALE:1:1 |
| | | DRN BY: TAN EE WERN | | DWG NO. 1012 |



NOTES:

DIMENSION IN MM
GENERAL TOLERANCE:
+/- 0.2

TITLE:

# STEERING HOLDER

Steering Holder Part Drawing

MATERIALS: AISI 304

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

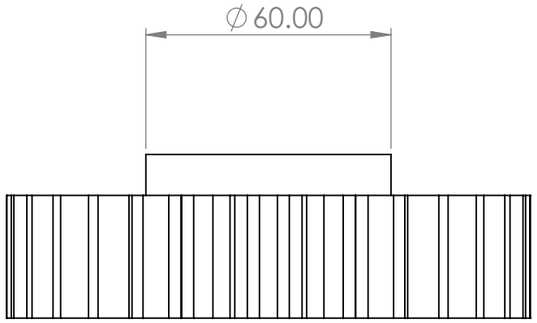
DRN BY: Adriel Sebastian

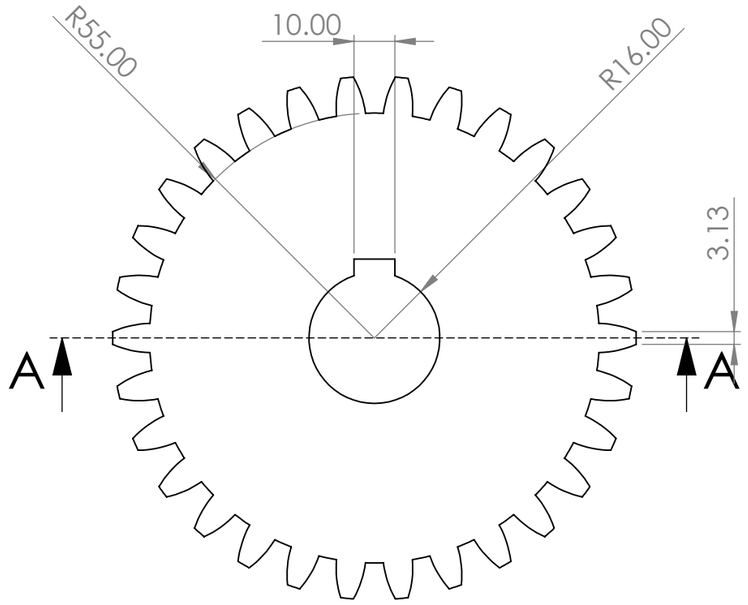
DATE: 17/10/2022

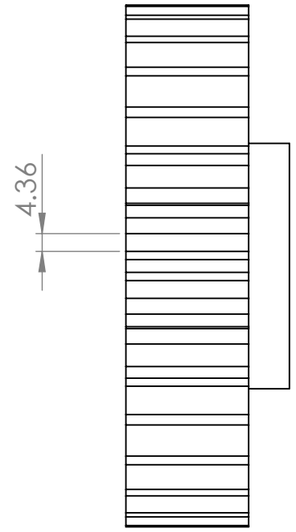
A3

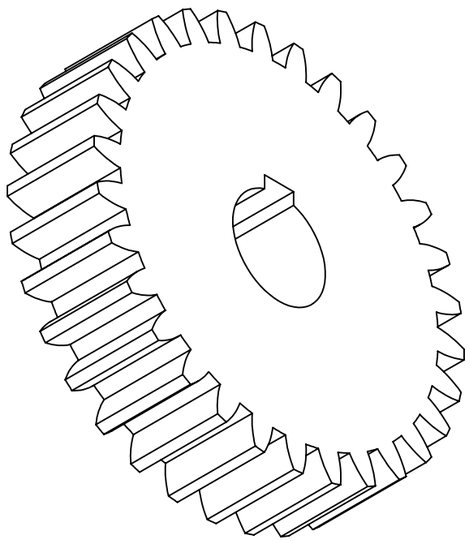
SCALE:1:1.5

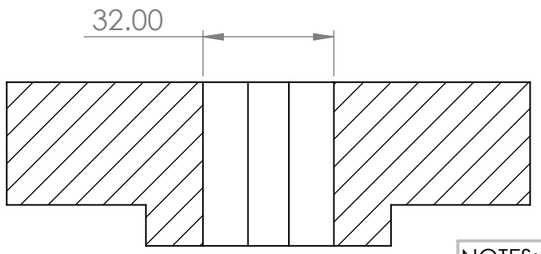
DWG NO. 1013






SECTION A-A

SCALE 1 : 1.5

NOTES:
DIMENSION IN MM
GENERAL TOLERANCE:
+/- 0.2

TITLE:

# SPROCKET_ENGINE

Sprocket_ Engine Part Drawing

MATERIALS:AISI 304

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

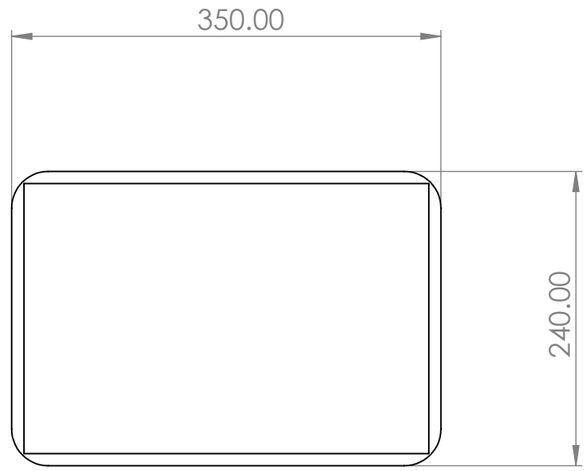
DRN BY: Adriel Sebastian

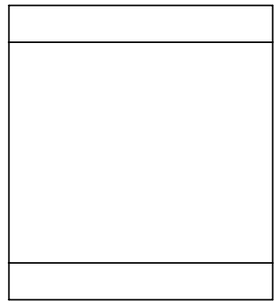
DATE:17/10/2021

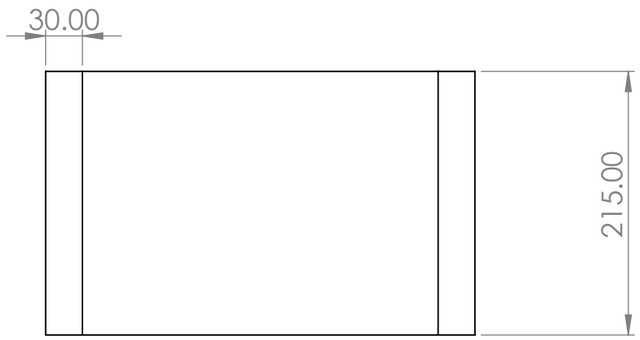
A3

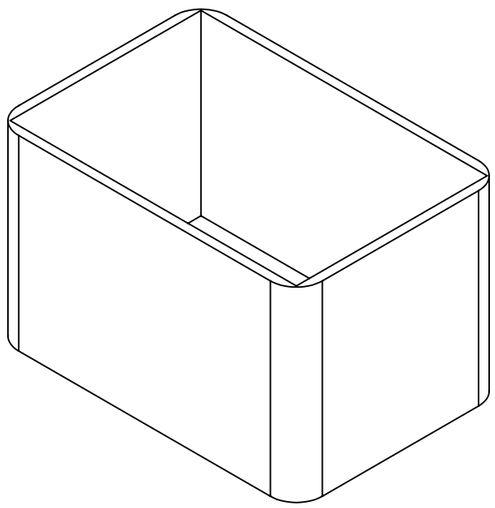
SCALE:1:1.5

DWG NO. 1014

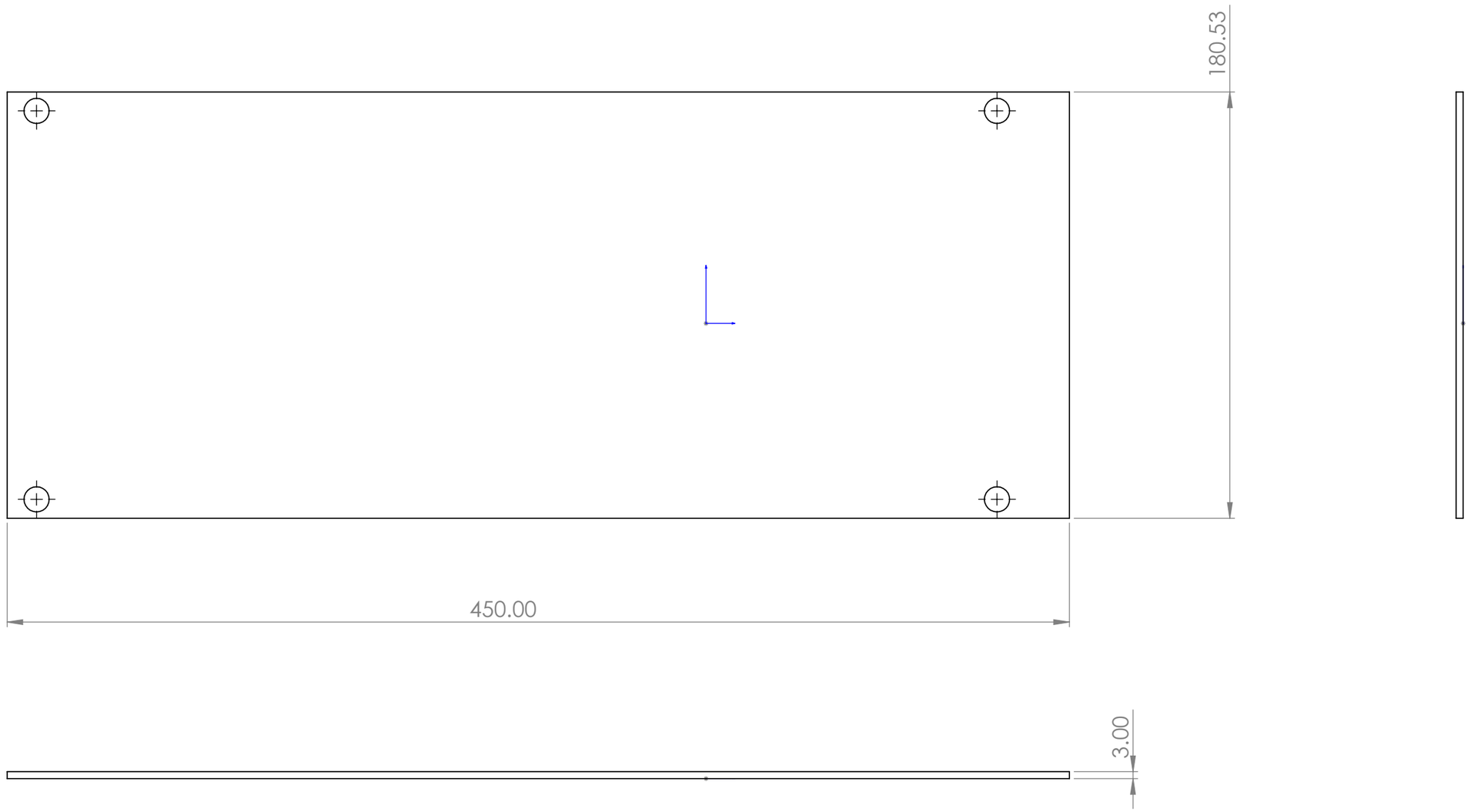


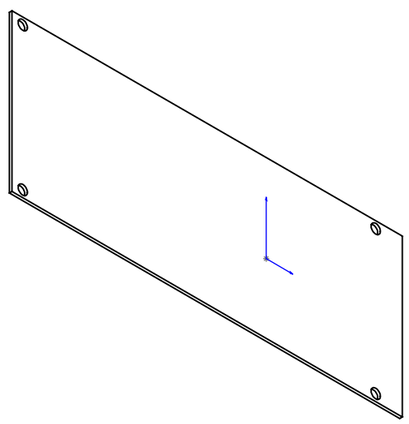





| | | | | |
|---|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE:<br>+/- 0.2 | TITLE:<br>BOX_ENGINE | | | Box_<br>Engine<br>Part<br>Drawing |
| | MATERIALS: AISI 304 | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING | DATE:17/10/2021 | A3 |
| | | DRN BY: Adriel Sebastian | | SCALE:1:5 |
| | | | | DWG NO.1015 |



NOTES:
DIMENSION IN MM
GENERAL TOLERANCE:
+/- 0.2

TITLE:

# GEAR HOUSING COVER

Gear Housing Cover Part Drawing

MATERIALS:AISI 304

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

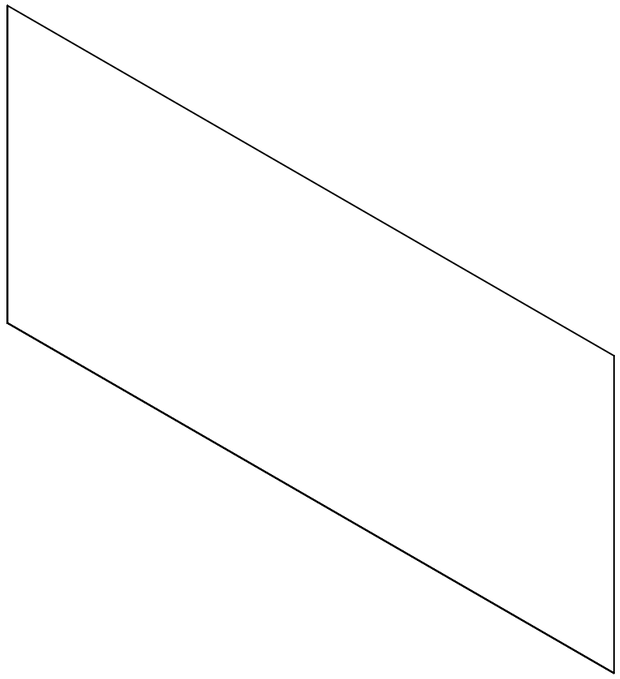
DRN BY: Adriel Sebastian

DATE:17/10/2021

A3

SCALE:1:1

DWG NO.1016

NOTES:
DIMENSION IN MM
GENERAL TOLERANCE
+/- 0.2

TITLE:

# CHASSIS FLOOR

Chassis Floor Part Drawing

MATERIALS:AISI 304

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

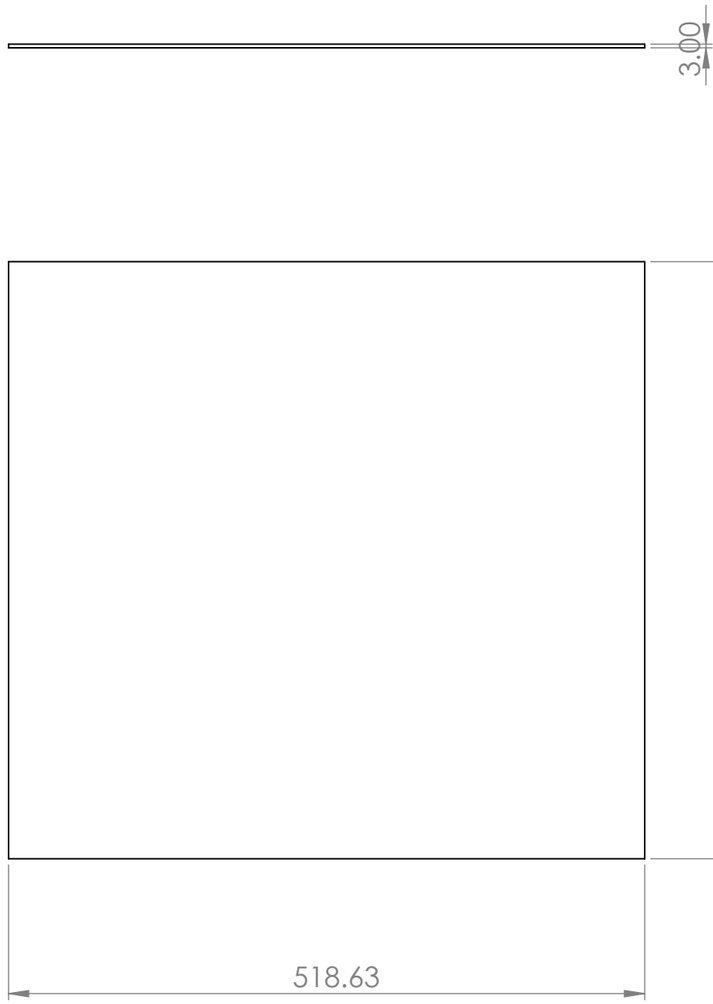
DRN BY: Adriel Sebastian

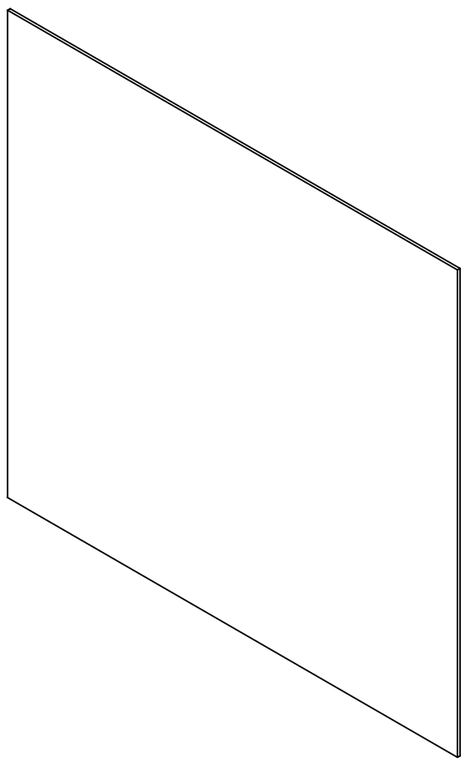
DATE:17/10/201

A3

SCALE:1:1

DWG NO. 1017



NOTES:
DIMENSION IN MM
GENERAL TOLERANCE:
+/- 0.2

TITLE:

# CHASSIS FLOOR 2

Chassis Floor 2 Part Drawing

MATERIALS:AISI 304

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

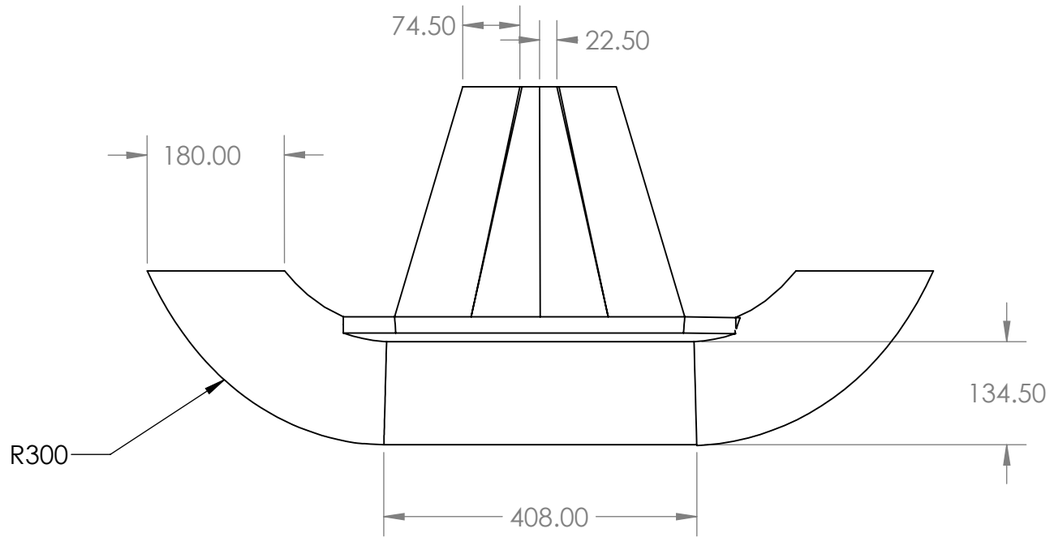
DRN BY: Adriel Sebastian

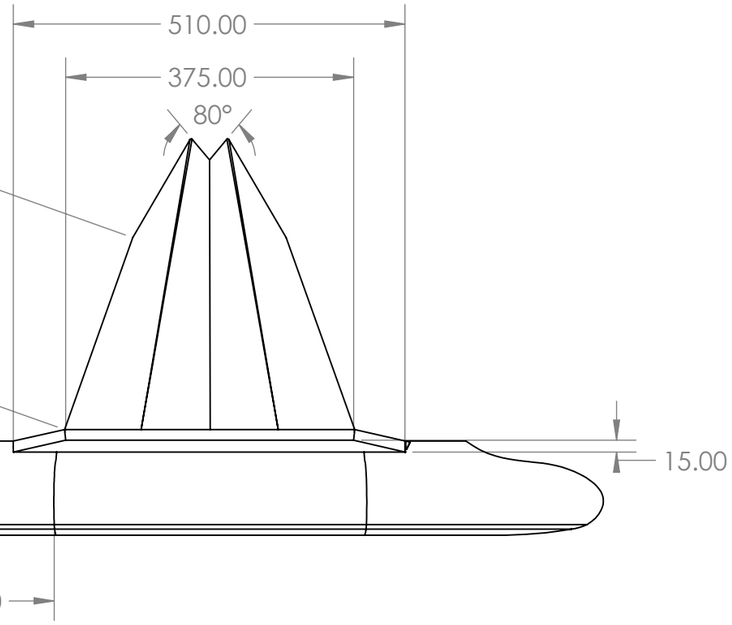
DATE:17/10/2021

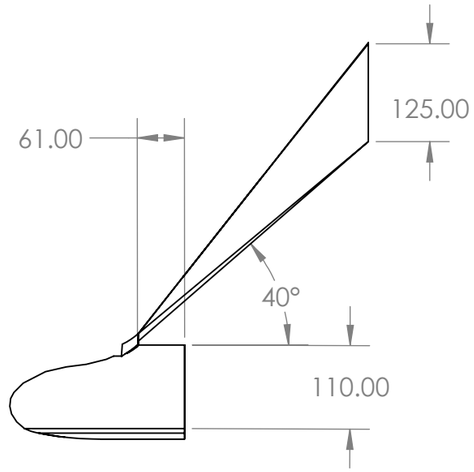
A3

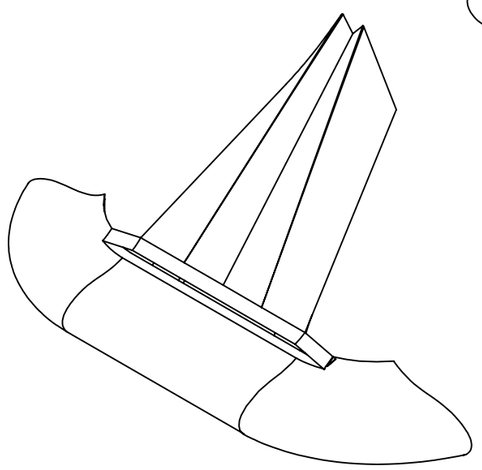
SCALE:1:1

DWG NO. 1018

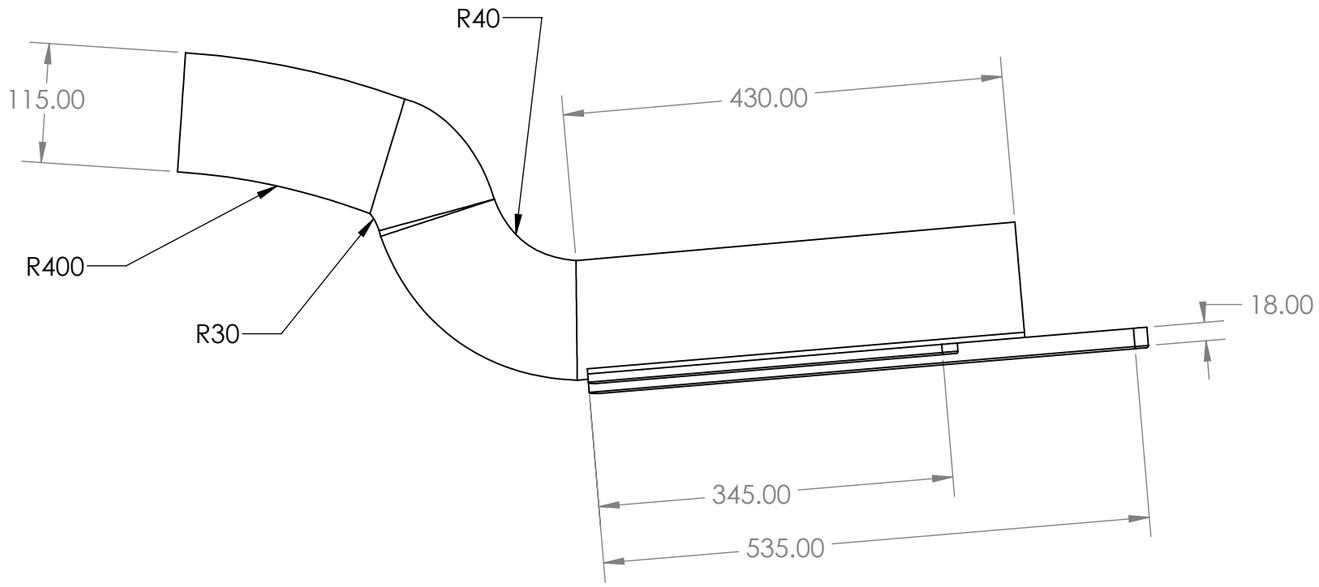


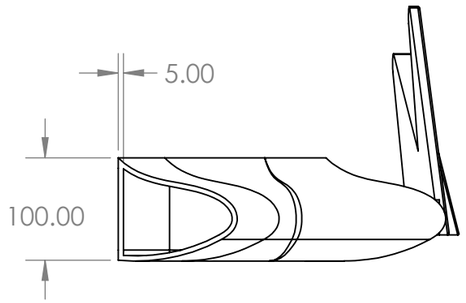



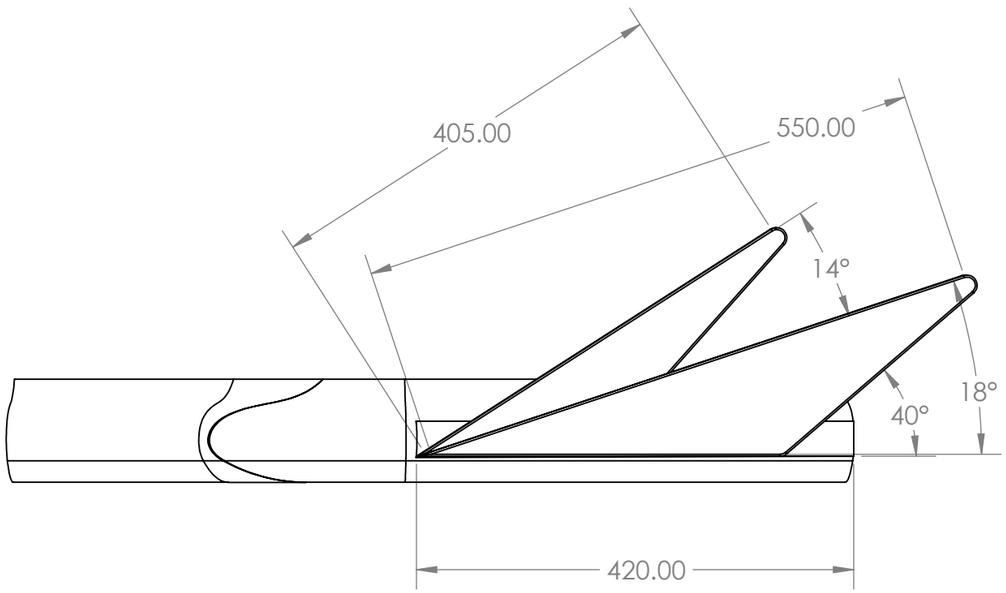



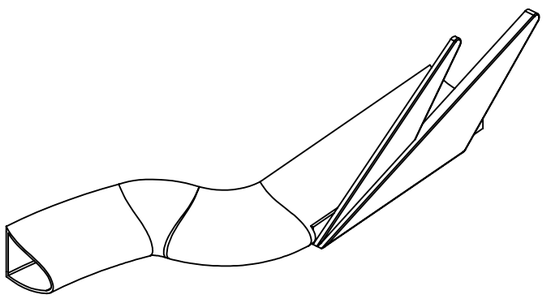



| | | | | |
|---|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>FRONT BUMPER 1 | | | FRONT BUMPER DETAIL DRAWING |
| | MATERIALS:<br>POLYPROPENE (PP) | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING | DATE: 13/10/202 | A3 |
| | | DRN BY: TAN EE WERN | | SCALE: 1.8 |
| | | | | DWG NO. 1019 |

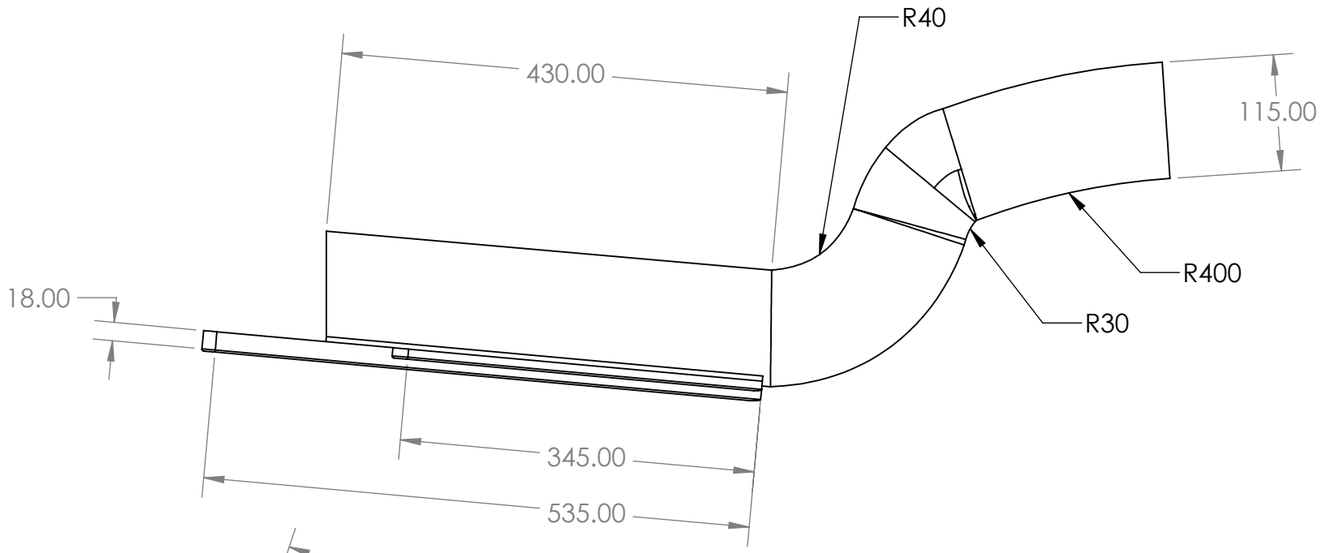


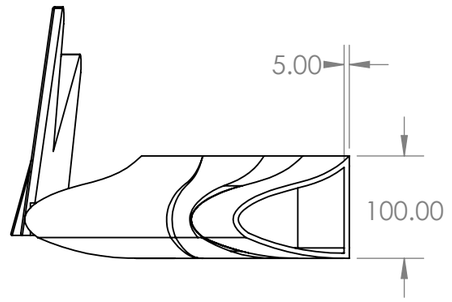



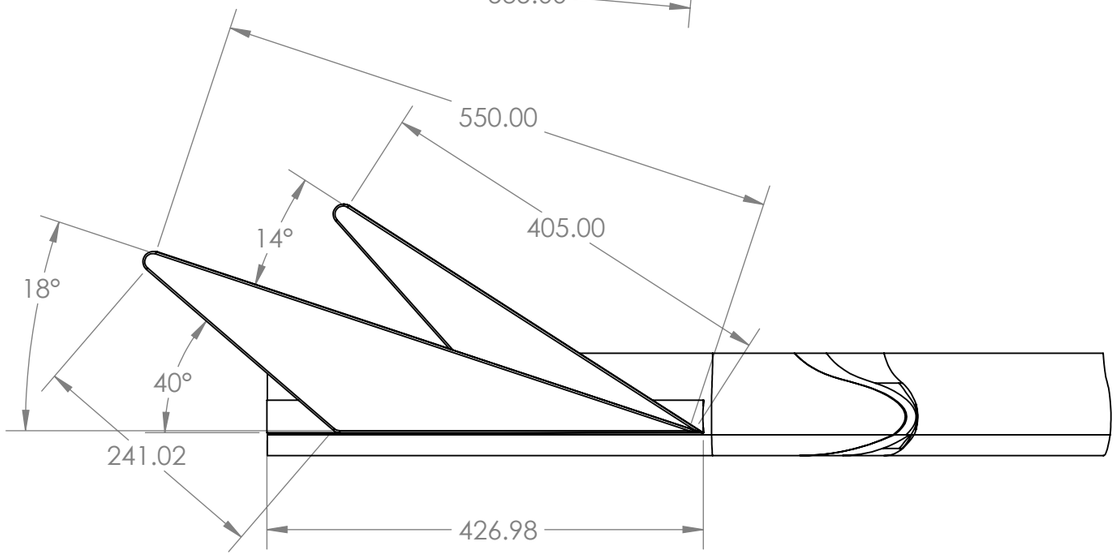



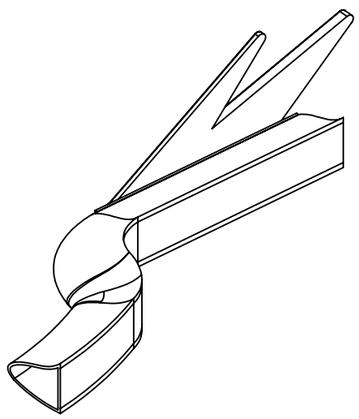



| | | | | |
|---|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>LEFT BUMPER 1 | | | LEFT BUMPER DETAIL DRAWING |
| | MATERIALS:<br>POLYPROPENE (PP) | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING | DATE: 13/10/2021 | A3 |
| | | DRN BY: TAN EE WERN | | SCALE: 1.6 |
| | | | | DWG NO. 1020 |



NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
+/- 0.2

TITLE:
RIGHT BUMPER 1

RIGHT BUMPER DETAIL DRAWING

MATERIALS:
POLYPROPENE (PP)

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

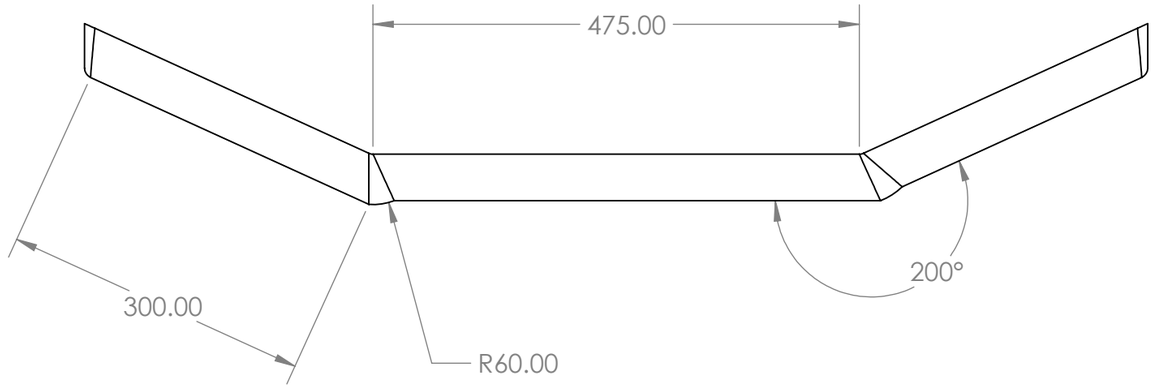
DRN BY: TAN EE WERN

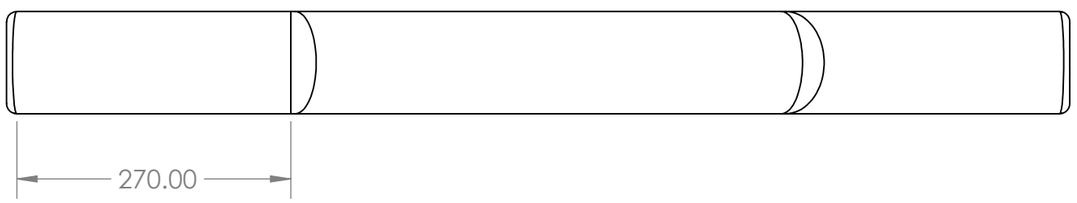
DATE: 13/10/2021

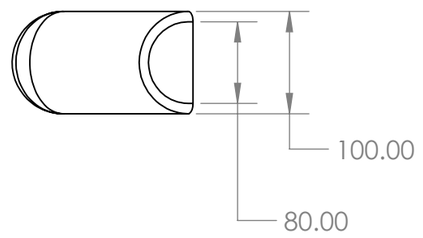
A3

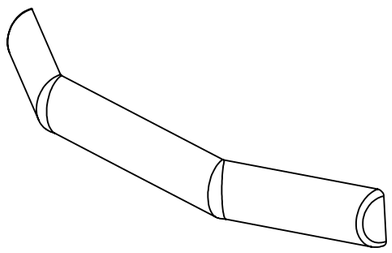
SCALE: 1.6

DWG NO. 1021

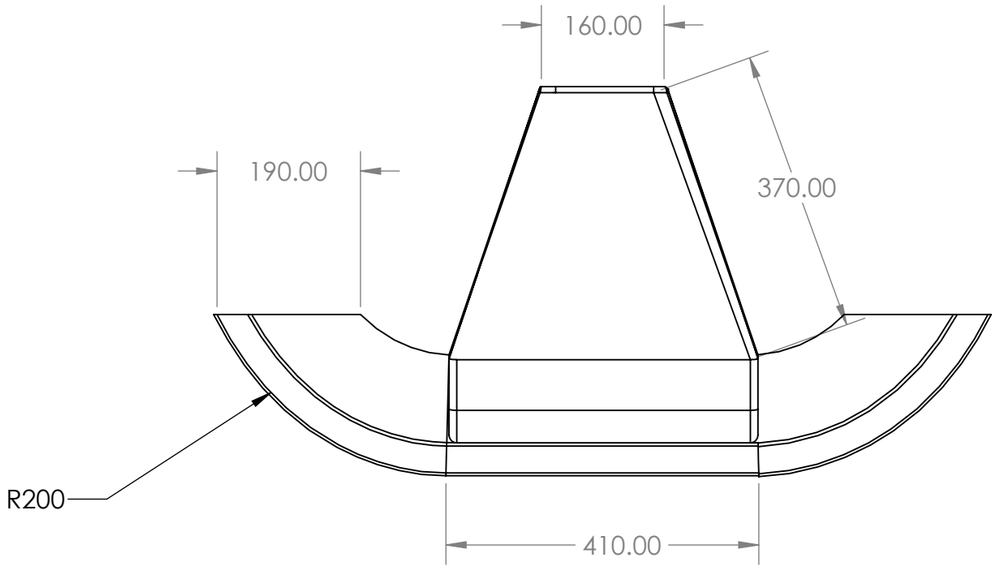


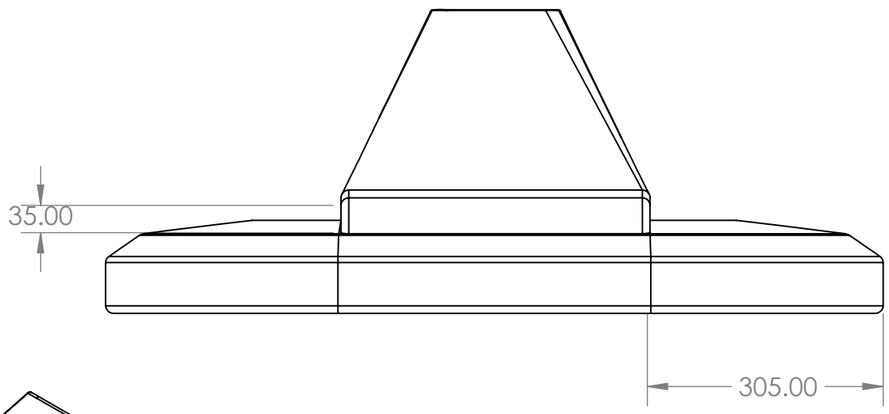



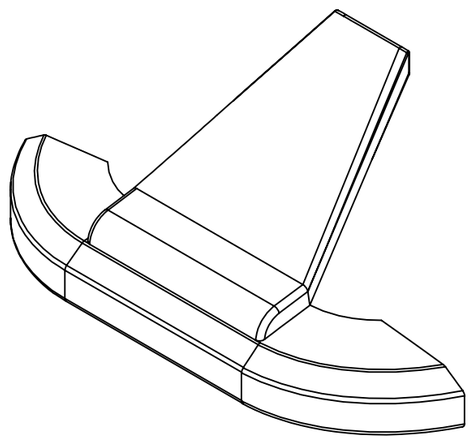



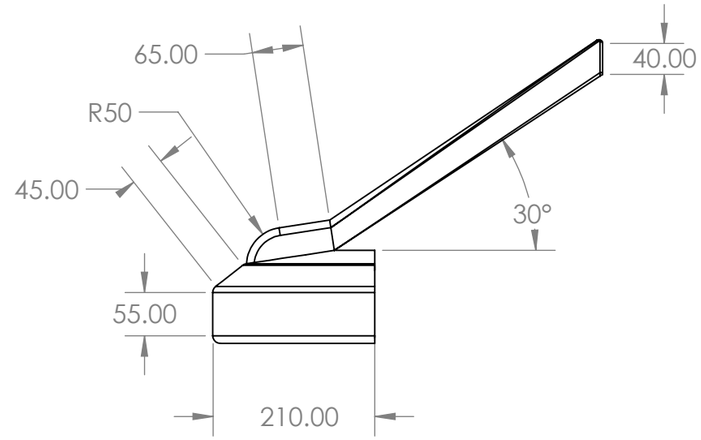



| | | | |
|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>REAR BUMPER 1 | | REAR BUMPER DETAIL DRAWING |
| | MATERIALS:<br>POLYPROPENE (PP) | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING<br>DRN BY: TAN EE WERN | DATE: 13/10/2021<br>A3<br>SCALE: 1.8<br>DWG NO. 1022 |

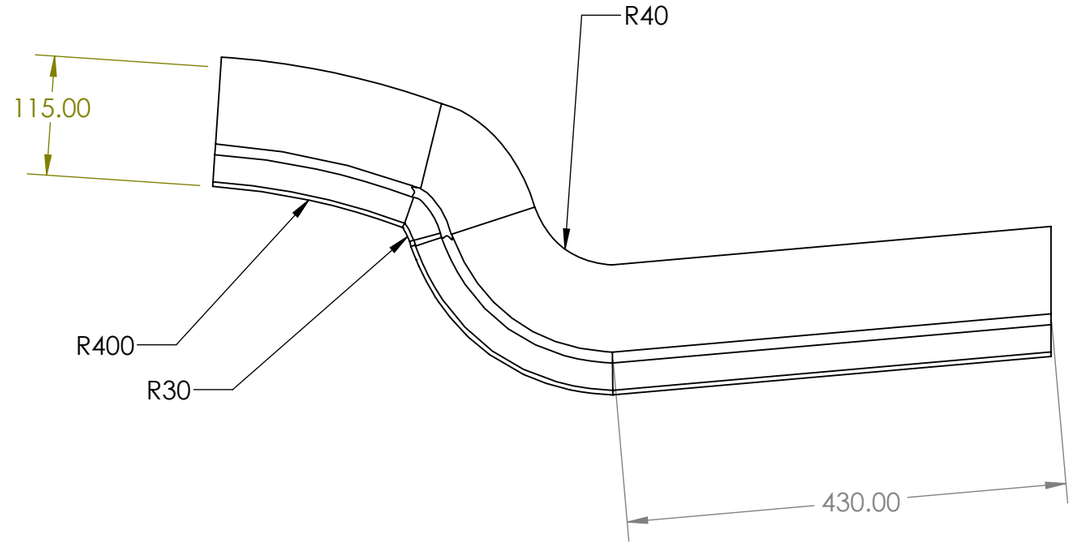


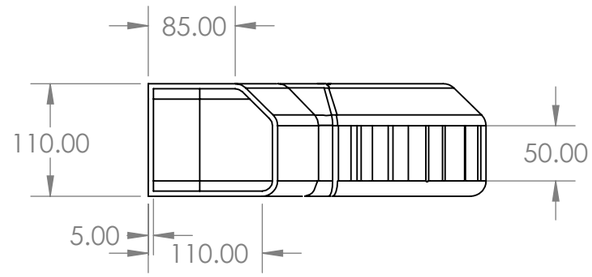



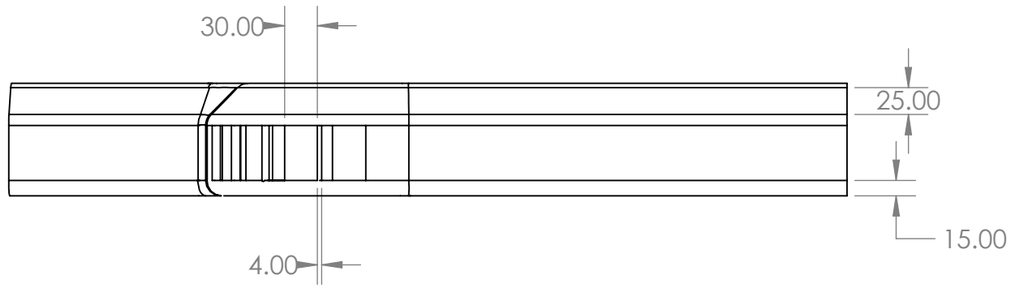



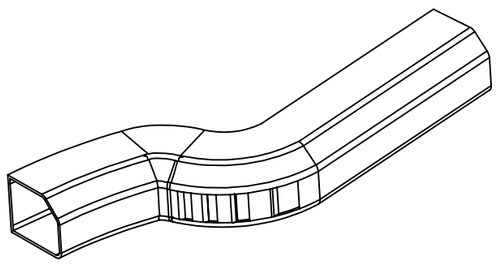



| | | | |
|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>FRONT BUMPER 2 | | RIGHT BUMPER 2<br>DETAIL<br>DRAWING |
| | MATERIALS:<br>POLYPROPENE (PP) | MONASH UNIVERSITY DEPARTMENT<br>OF MECHANICAL ENGINEERING | DATE: 13/10/202 A3 |
| | | DRN BY: TAN EE WERN | SCALE: 1.8 |
| | | | DWG NO. 1023 |

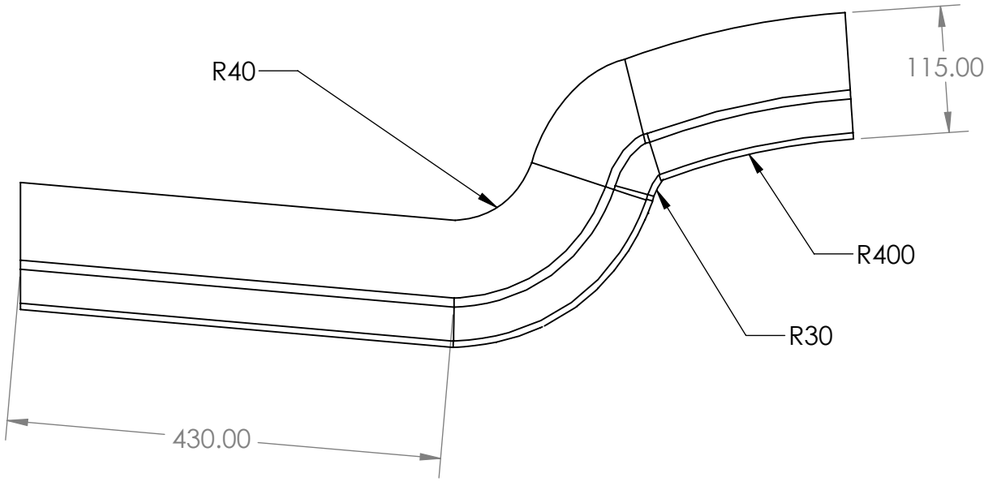


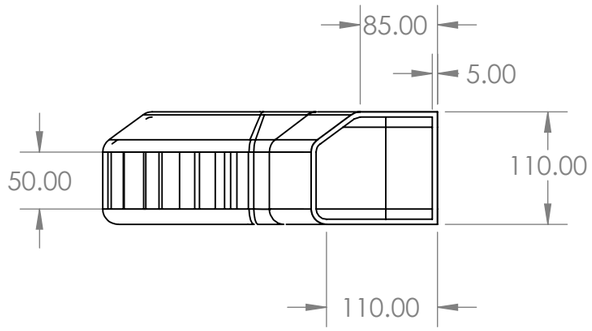



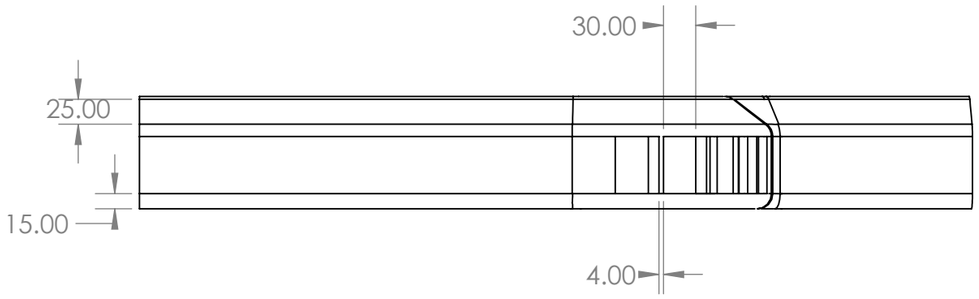



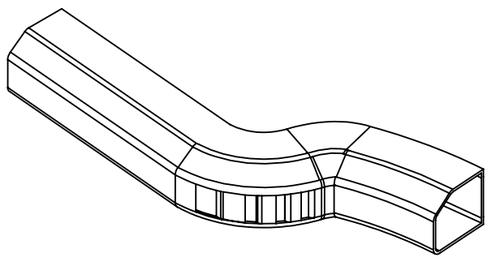



| | | | |
|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>LEFT BUMPER 2 | | LEFT BUMPER 2<br>DETAIL<br>DRAWING |
| | MATERIALS:<br>POLYPROPENE (PP) | MONASH UNIVERSITY DEPARTMENT<br>OF MECHANICAL ENGINEERING | DATE: 13/10/2021 A3 |
| | | DRN BY: TAN EE WERN | SCALE: 1.6 |
| | | | DWG NO. 1024 |



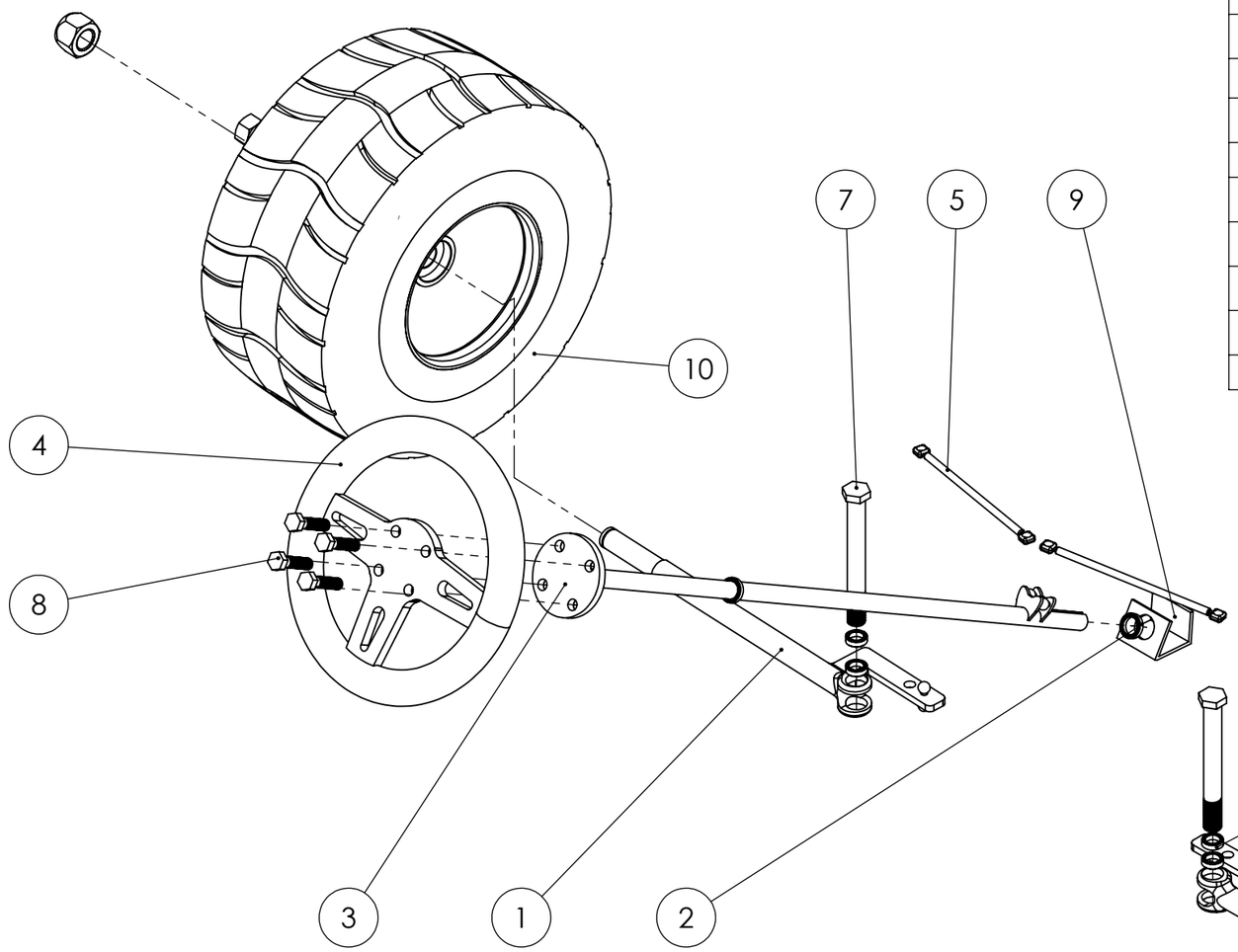



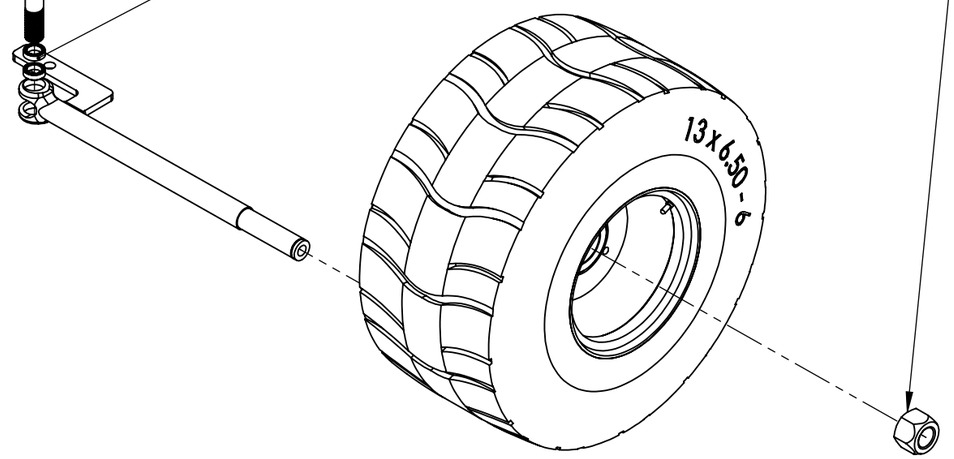



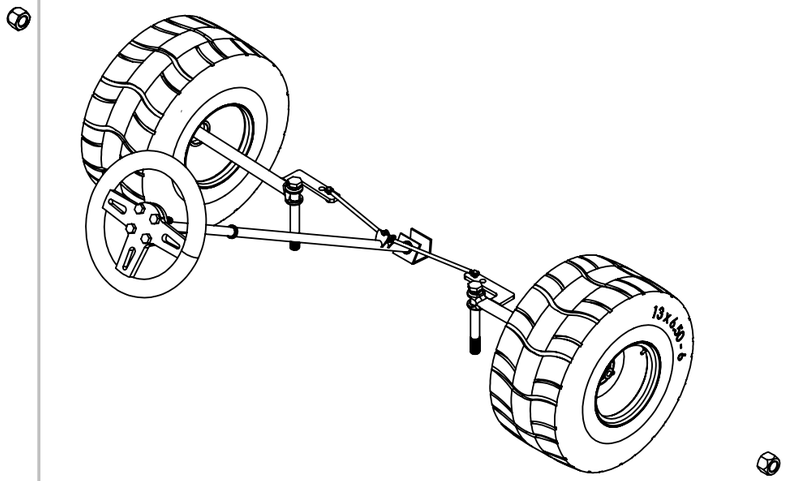



| | | | |
|---|---|---|---|
| NOTES:<br>DIMENSION IN MM<br>GENERAL TOLERANCE :<br>+/- 0.2 | TITLE:<br>RIGHT BUMPER 2 | | RIGHT BUMPER 2<br>DETAIL<br>DRAWING |
| | MATERIALS:<br>POLYPROPENE (PP) | MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING | DATE: 13/10/2021 A3 |
| | | DRN BY: TAN EE WERN | SCALE: 1.6 |
| | | | DWG NO. 1025 |

| ITEM NO. | PART NUMBER | DESCRIPTION | QTY. |
|---|---|---|---|
| 1 | - | SPINDLE | 2 |
| 2 | 6804JR | BEARING | 2 |
| 3 | - | STEERING SHAFT | 1 |
| 4 | - | STEERING WHEEL | 1 |
| 5 | - | TIE ROD | 2 |
| 6 | 6704 | BEARING | 4 |
| 7 | M12 X 16 X 80 | SOCKET HEAD SHOULDER SCREW | 2 |
| 8 | M6 X 30 | HEX BOLT | 4 |
| 9 | 1013 | STEERING HOLDER | 1 |
| 10 | - | RIM AND TYRE | 2 |
| 11 | M25 | NUT | 1 |




NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
+/- 0.2

TITLE:

# STEERING ASSEMBLY

STEERING ASSEMBLY DRAWING

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

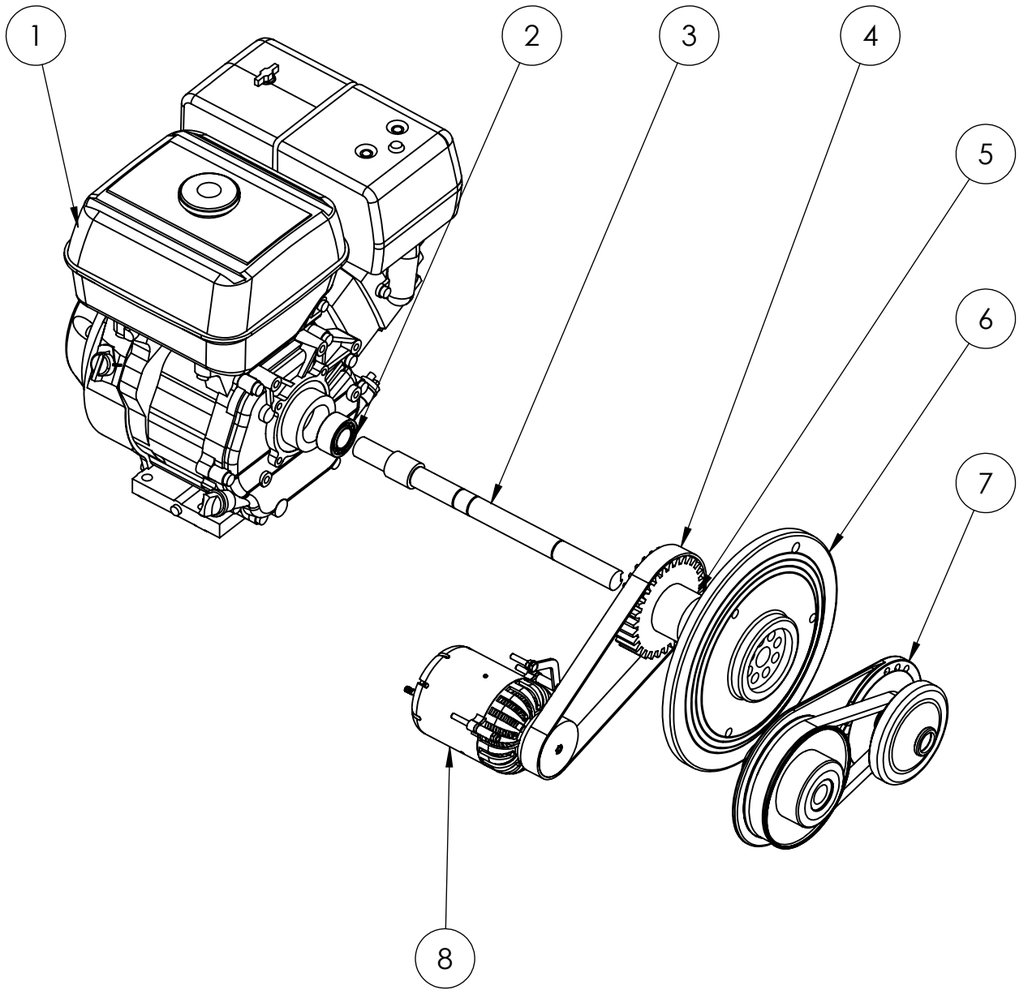
DRN BY: TAN EE WERN

DATE:13/10/2021

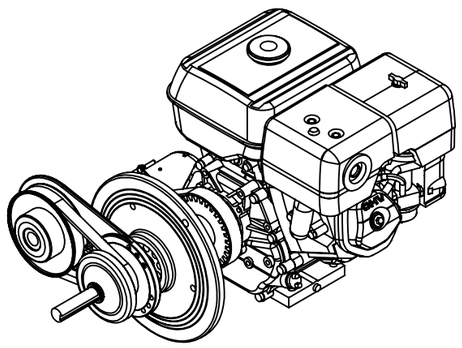
A3

SCALE:1:5

DWG NO.2000




| ITEM NO. | PART NUMBER | DESCRIPTION | QTY. |
|---|---|---|---|
| 1 | PREDATOR 13HP 420CC | ENGINE | 1 |
| 2 | 7005 | BEARING | 1 |
| 3 | 1002 | ENGINE SHAFT | 1 |
| 4 | ROLLER CHAINS ANSI B29. 40 | ROLLER CHAIN | 1 |
| 5 | 1014 | SPROCKET ENGINE | 1 |
| 6 | - | FLYWHEEL | 1 |
| 7 | - | TORQUE CONVERTER | 1 |
| 8 | - | ALTERNATOR | 1 |



NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
$^{+}/_{-}$ 0.2

TITLE:

# ENGINE TRANSMISSION ASSEMBLY

ENGINE TRASMISSION ASSEMBLY DRAWING

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

DATE:13/10/2021

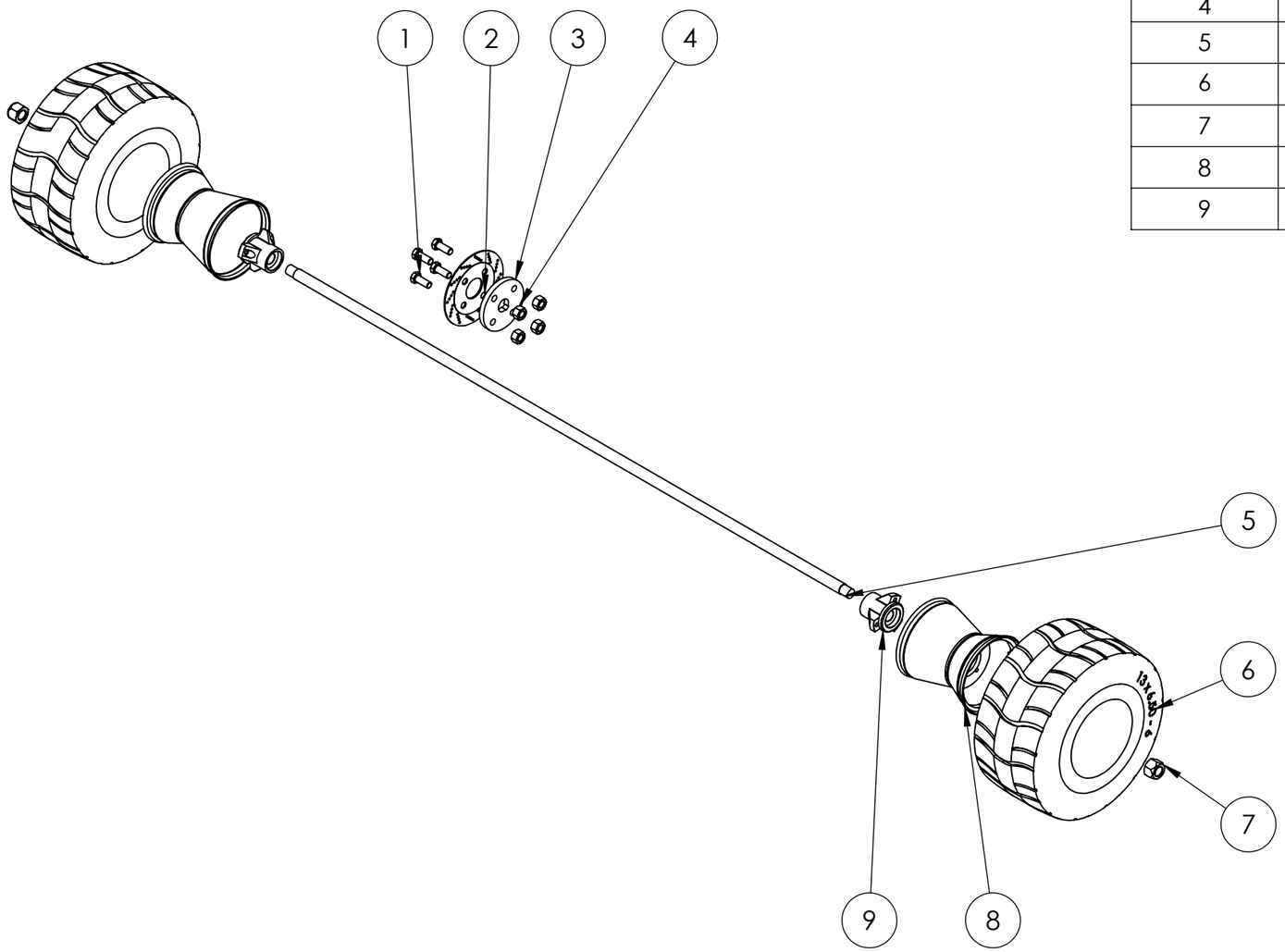
A3

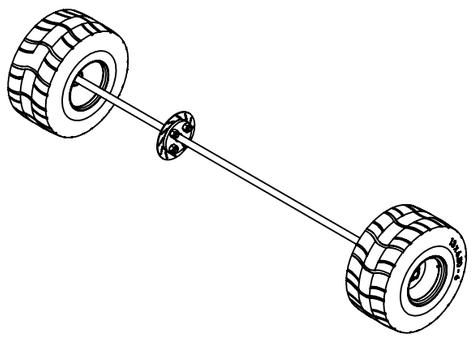
SCALE:1:10

DRN BY: TAN EE WERN

DWG NO.2001

| ITEM NO. | PART NUMBER | DESCRIPTION | QTY. |
|---|---|---|---|
| 1 | M12 x 1.75 x 30 | HEX SCREW | 4 |
| 2 | - | BRAKE ROTOR | 1 |
| 3 | - | ROTOR HUB | 1 |
| 4 | M14 x 2 | HEX BOLT | 4 |
| 5 | 1004 | WHEEL SHAFT | 1 |
| 6 | - | TYRE | 2 |
| 7 | M20 | NUT | 2 |
| 8 | - | RIM | 2 |
| 9 | - | WHEEL HUB | 2 |



NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
$^{+}/_{-}$ 0.2

TITLE:

# WHEELS ASSEMBLY

WHEELS ASSEMBLY DRAWING

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

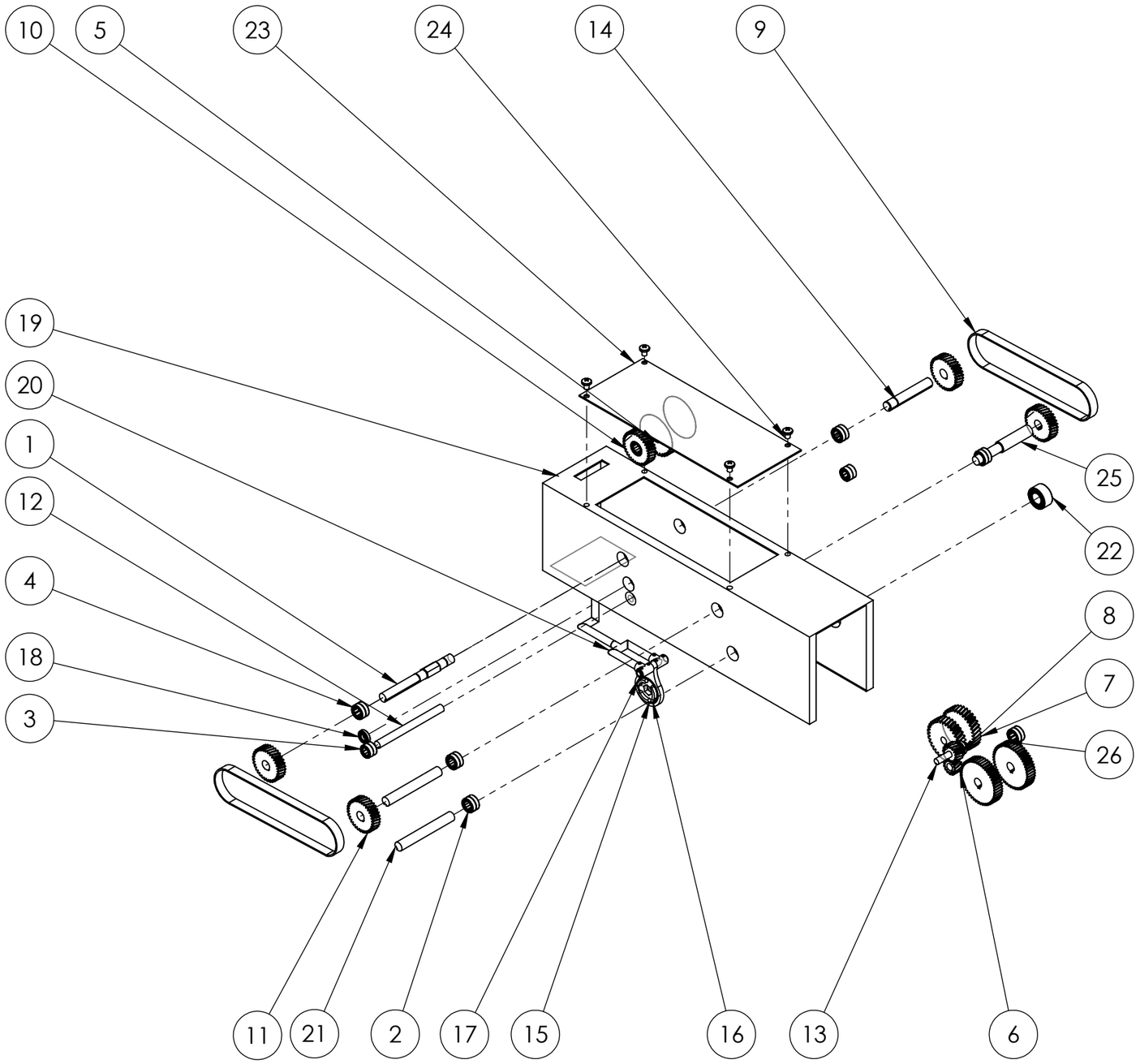
DRN BY: TAN EE WERN

DATE:13/10/2021

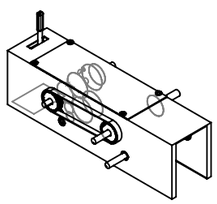
A3

SCALE:1:10

DWG NO.2002




| ITEM NO. | PART NUMBER | DESCRIPTION | QTY. |
|---|---|---|---|
| 1 | 1002 | ENGINE SHAFT | 1 |
| 2 | 6804FR | BEARING | 5 |
| 3 | 6903JRN | BEARING | 2 |
| 4 | 6000 | BEARING | 3 |
| 5 | - | MAIN FORWARD GEAR | 1 |
| 6 | - | COUNTER REVERSE GEAR | 1 |
| 7 | - | COUNTER GEARS | 2 |
| 8 | - | IDLE REVERSE GEAR | 1 |
| 9 | ROLLER CHAINS ANSI B29. 40 | ROLLER CHAIN | 1 |
| 10 | - | REVERSE GEAR | 1 |
| 11 | - | CHAIN DRIVE SPROCKET | 4 |
| 12 | 1011 | COUNTERSHAFT | 1 |
| 13 | 1010 | REVERSE IDLE SHAFT | 1 |
| 14 | 1009 | INPUT GEARBOX SHAFT | 1 |
| 15 | - | SELECTOR RING | 1 |
| 16 | - | SYNCHRONOUS RING | 1 |
| 17 | - | LEVER ADJUSTER | 1 |
| 18 | 6902 | BEARING | 2 |
| 19 | 1003 | GEAR HOUSING | 1 |
| 20 | 1007 | LEVER JOINT | 1 |
| 21 | 1012 | CHAIN DRIVE INPUT SHAFT | 1 |
| 22 | 7005 | BEARING | 1 |
| 23 | - | GEAR HOUSING COVER | 1 |
| 24 | M10 X 1.5 X 13 | PAN HEAD SCREW | 4 |
| 25 | 1001 | TOEQUE CONVERTER OUTPUT SHAFT | 1 |
| 26 | - | GEARBOX TO WHEELS GEAR | 2 |



NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
$^{+}/_{-}$0.2

TITLE:

# GEARBOX ASSEMBLY

GEARBOX ASSEMBLY DRAWING

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

DRN BY: TAN EE WERN

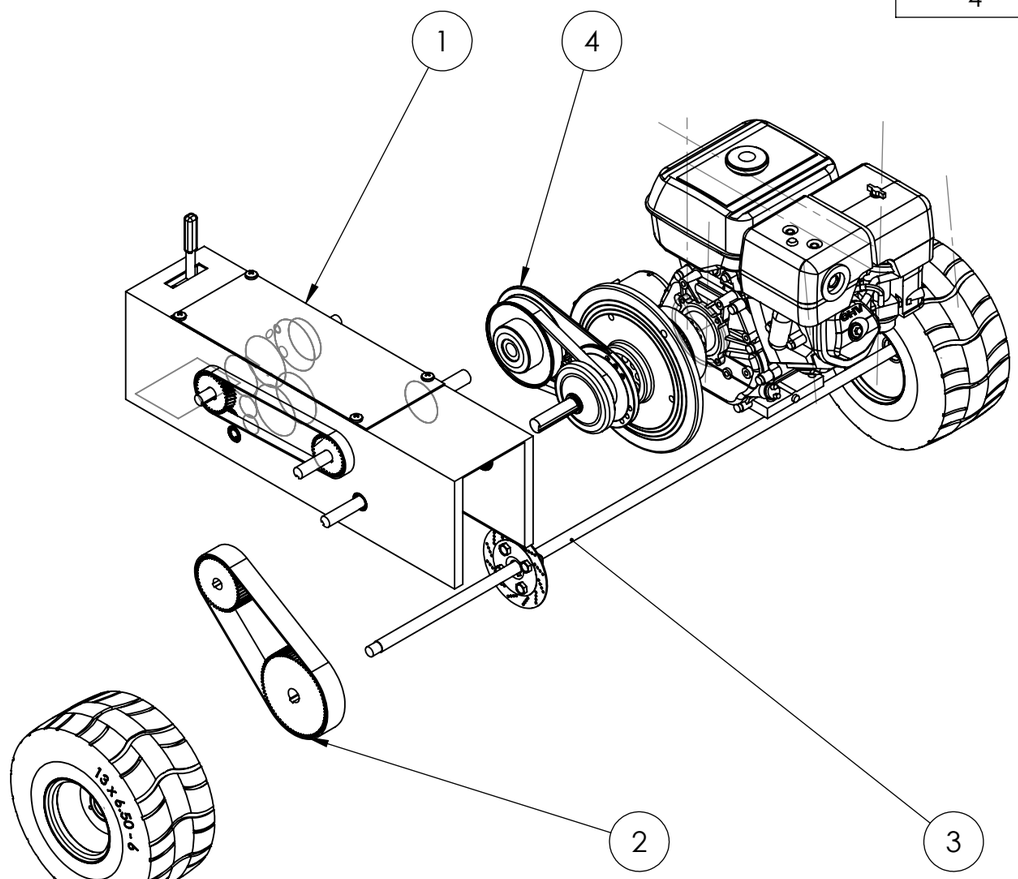
DATE:13/10/2021

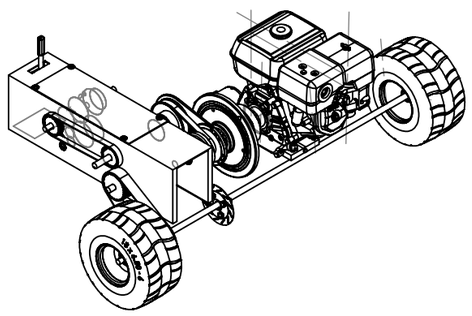
A3

SCALE:1:10

DWG NO.2003

| ITEM NO. | PART NUMBER | DESCRIPTION | QTY. |
|---|---|---|---|
| 1 | 2003 | GEARBOX ASSEMBLY | 1 |
| 2 | 2006 | CHAIN DRIVE ASSEMBLY | 1 |
| 3 | 2002 | WHEEL ASSEMBLY | 1 |
| 4 | 2001 | ENGINE ASSEMBLY | 1 |



NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
+/- 0.2

TITLE:

# TRANMISSION ASSEMBLY

TRANMISSION ASSEMBLY DRAWING

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

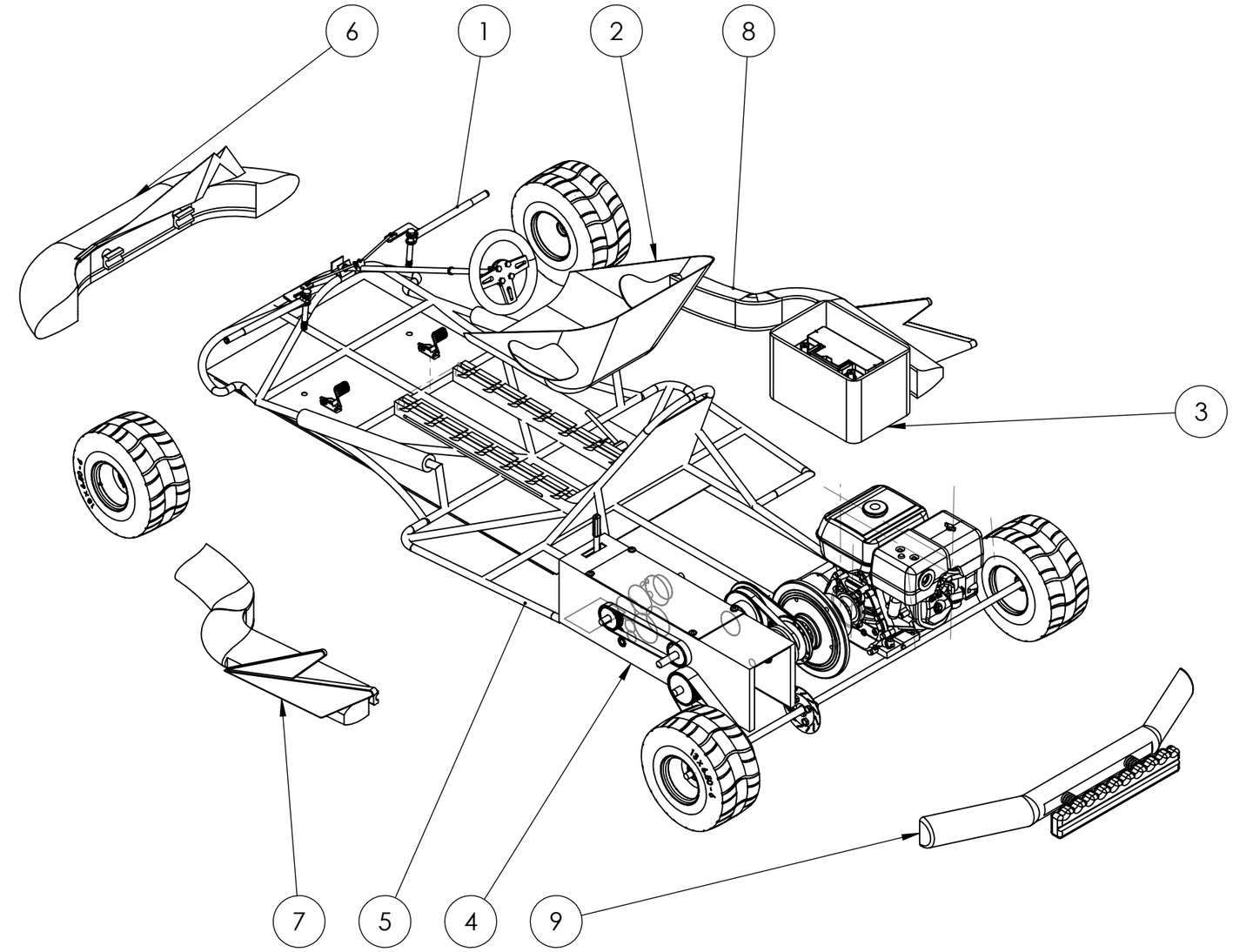
DRN BY: TAN EE WERN

DATE:13/10/2021

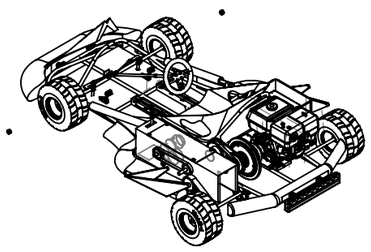
A3

SCALE:1:10

DWG NO.2004




| ITEM NO. | ASSEMBLY NUMBER | DESCRIPTION | QTY. |
|---|---|---|---|
| 1 | 2000 | STEERING ASSEMBLY | 1 |
| 2 | - | SEAT | 1 |
| 3 | - | BATTERY HOLDER | 1 |
| 4 | 2004 | POWER TRANSMISSION ASSEMBLY | 1 |
| 5 | - | CHASSIS ASSEMBLY | 2 |
| 6 | 1019 | FRONT BUMPER 1 | 1 |
| 7 | 1020 | LEFT BUMPER 1 | 1 |
| 8 | 1021 | RIGHT BUMPER 1 | 1 |
| 9 | 1022 | REAR BUMPER 1 | 1 |



NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
$\pm$ 0.2

TITLE:

# GO-KART ASSEMBLY

GO-KART ASSEMBLY DRAWING

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

DRN BY: TAN EE WERN

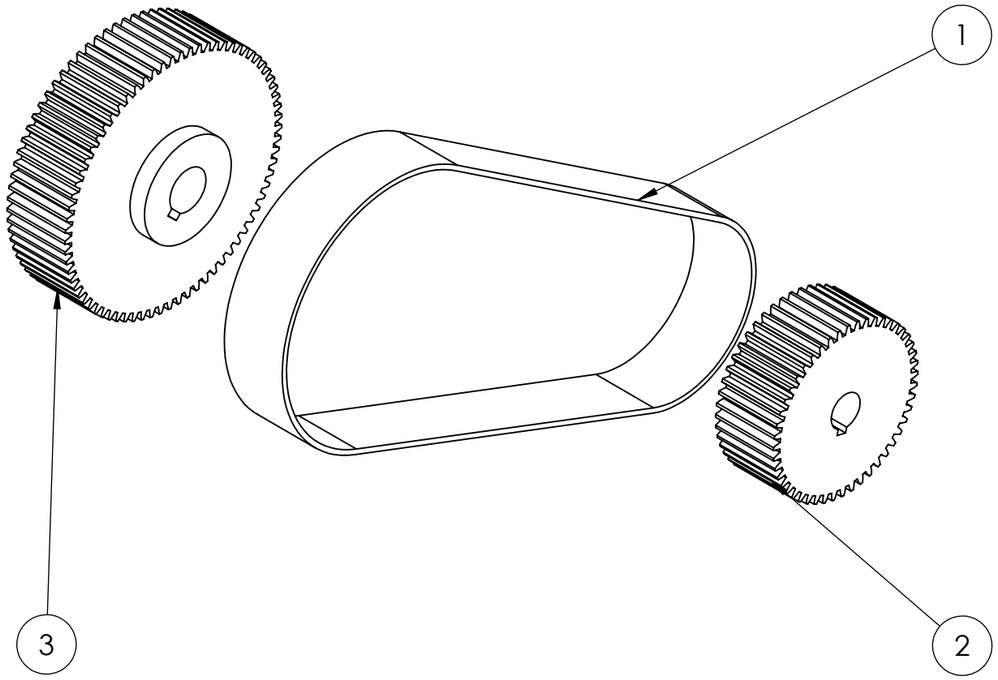
DATE:13/10/202

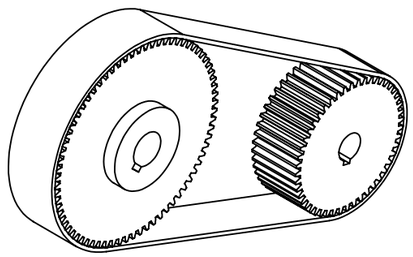
A3

SCALE:1:15

DWG NO.2005

| ITEM NO. | PART NUMBER | DESCRIPTION | QTY. |
|---|---|---|---|
| 1 | ROLLER CHAINS ANSI B29. 40 | ROLLER CHAINS | 1 |
| 2 | - | SPROCKET GEARBOX | 1 |
| 3 | - | SPROCKET WHEELS | 1 |



NOTES:
DIMENSION IN MM
GENERAL TOLERANCE :
+/- 0.2

TITLE:

# CHAIN DRIVE ASSEMBLY

CHAIN DRIVE ASSEMBLY DRAWING

MONASH UNIVERSITY DEPARTMENT OF MECHANICAL ENGINEERING

DRN BY: TAN EE WERN

DATE:13/10/2021

A3

SCALE:1:10

DWG NO.2006

# KART-MOBIL

## 1. Power Transmission

### 1.1 Engine
- 1.1.1 Engine Analysis RM1693.16
- 1.1.2 CAD Model
- 1.1.3 Engine Cooling System
- 1.1.4 Engine Mount
- 1.1.5 Engine Reassessment
- 1.1.6 Engine Cooling Analysis

### 1.2 Transmission
- 1.2.1 Torque Converter Analysis RM450.00
- 1.2.2 Gear Ratio Selection
- 1.2.3 Power Tranmission Analysis
- 1.2.4 CAD Model
- 1.2.5 Steering Mechanism
- 1.2.6 Mounting of transmission system

### 1.3 Acceleration
- 1.3.1 Accelerator Research RM28.25
- 1.3.2 Accelerator design
- 1.3.3 CAD Model

## 2. Wheels and Brakes

### 2.1 Wheels
- 2.1.1 Rim Profiles Research
- 2.1.2 Rim Materials Research
- 2.1.3 Tyre Compound Research
- 2.1.4 Rim and Tyre Selection RM629.32
- 2.1.5 CAD Model
- 2.1.6 Wheel Shaft Structure Analysis

### 2.2 Brakes
- 2.2.1 Brake Types Research
- 2.2.2 Rotor/Caliper Selection RM82.44
- 2.2.3 Master Cylinder Selection RM63.75
- 2.2.4 Brake Pedal Selection RM28.25
- 2.2.5 CAD Model

## 3. Body

### 3.1 Chassis
- 3.1.1 Chassis Research RM351.7
- 3.1.2 Structural Design
- 3.1.3 Engine Placement Analysis
- 3.1.4 CAD Model
- 3.1.5 Ansys Simulation
- 3.1.6 Structural Analysis
- 3.1.7 Material Analysis
- 3.1.8 Chassis Structure Analysis
- 3.1.9 Computational Fluid Dynamics

### 3.2 Exterior Body Frame
- 3.2.1 Body Design
- 3.2.2 Safety Features
- 3.2.3 Body Kits RM180
- 3.2.4 Integration with Chassis
- 3.2.5 CAD Model
- 3.2.6 Aerodynamics Analysis

### 3.3 Interior and Driver
- 3.3.1 Driver seat position
- 3.3.2 Steering Wheel RM455
- 3.3.3 Pedals positioning
- 3.3.4 Seatbelt RM38.76
- 3.3.5 Helmet RM49.90
- 3.3.6 Gloves RM28.80
- 3.3.7 CAD
- 3.3.9 Mounting of seat position

## 4. Electronics
- 4.1 Alternator RM138.00
- 4.2 Brake Lights RM21.51
- 4.3 Data logger RM128.54
- 4.4 Speedometer RM83.00
- 4.5 Integration within vehicle **RM 60.00**
- 4.6 Checkpoint System **RM13.48**
- 4.7 Accessories **RM39.10**
- 4.8 Programming

**LEGEND**

| |
|---|
| Everyone |
| Adriel |
| Andrew |
| Ashton |
| Dhaan |
| Ee Wern |

Budget: RM5000

## 5. Racing Track

### 5.1 Track Layout
- 5.1.1 Track Research
- 5.1.2 Safety Features
- 5.1.3 CAD Model
- 5.1.4 Redesign Track
- 5.1.5 Draft Track Facilities
- 5.1.6 Model Track Facilities
- 5.1.7 Add Track Details
- 5.1.8 Kinematic of Track

## 6. Business plan
- 5.1 Offered packages
- 5.2 Marketing
- 5.3 Revenue and cost analysis
- 5.4 Business concept

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 1.1.1 | **WBS Level** | Level 3 |
| **WBD Title** | Engine Analysis | | |
| **Date Change** | 2021-08-12 | **Authorisation** | Ee Wern |
| **Revision No** | 13 | **Approval** | |
| **Date** | 2021-08-12 | | |
| **Key Person** | Adriel Sebastian | | |

**Description of Task**

- Identify Engine Model, Specs and Performance
- Determined Power and Torque curve, Calculated the Torque Curve
- Determined the gear ratio to be used (For single drive gear ratio)
- Identify engine dimension
- CAD of the selected engine
- Analyzing the components in the cooling system in the engine

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Engine Model | 1. 2021-08-03 | 1. 2021-08-07 |
| 2. Maximum power and Torque requirement | 2. 2021-08-03 | 2. 2021-08-07 |
| 3. Price of engine | 3. 2021-08-03 | 3. 2021-08-07 |
| 4. CAD and estimated space for engine | 4. 2021-08-03 | 4. 2021-08-10 |

**Assumptions**

- The teeth on the gears to calculate the gear ratio and maximum speed
- The engine can be mounted on the vehicle

**Constraints**

Vehicle Structure may affect the engine

**Resources**

**Cost:** RM2,247.20
**Labour:** 1 member
**Duration:** 1-2 week(s)

**Interdependencies**

**Higher Level:** 1.0Engine
**Lower Level:** 1.2 Power Transmission

| **Project Manager** | Dr. Chiew | **Date** | 2021-08-12 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| | | | |
|---|---|---|---|
| **Project:** Go-Kart | | **Project/ Contract No:** 0001 | |
| **WBS Element** | 3.1.1, 3.1.2, 3.1.4 | **WBS Level** | Level 3 |
| **WBD Title** | Chassis Research, Structural Design, CAD Model | | |
| **Date Change** | 2021 – 08 - 12 | **Authorisation** | Ee Wern |
| **Revision No** | 1 | **Approval** | Ee Wern |
| **Date** | 2021 – 08 - 12 | | |
| **Key Person** | Andrew Setiawan | | |

**Description of Task**

- Researched about the general chassis design
- Designed the estimated dimension for the chassis
- Produced the chassis design with SOLIDWORKS
- Designed the prototype for the chassis and these two designs should be reviewed

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Two documents about the chassis design | 1. 2021-08-03 | 1. 2021-08-07 |
| 2. The estimated dimension for two chassis | 2. 2021-08-05 | 2. 2021-08-12 |
| 3. The two CAD design from SOLIDWORKS | 3. 2021-08-05 | 3. 2021-08-12 |
| 4. | 4. | 4. |

**Assumptions**

- The whole component without passenger weigh below 100 kg
- The placement of the component's installation is still tentative
- The first design for chassis is lighter, but has weaker structure compared to the second design

**Constraints**

- The design is not fixed yet since the placing of the components might affect the design
- The simulation can not be done yet due to software problem

**Resources**
**Cost:** RM0
**Labour:** 1 member
**Duration:** 2 weeks

**Interdependencies**
**Higher Level:** 3.1 Chassis
**Lower Level:** 3.1.1 Chassis Research, 3.1.2 Structural Design, 3.1.4 CAD Model

| | | | |
|---|---|---|---|
| **Project Manager** | Dr. Chiew | **Date** | 2021-08-12 |

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 2.1.1, 2.1.2, 2.1.3, 2.1.4 | **WBS Level** | Level 3 |
| **WBD Title** | Rim Profiles Research, Rim Materials Research, Tyre Research, Rim and Tyre Selection | | |
| **Date Change** | 2021-08-13 | **Authorisation** | Ee Wern |
| **Revision No** | 1 | **Approval** | Ee Wern |
| **Date** | 2021-08-13 | | |
| **Key Person** | Ashton Kam Ting Yao | | |

**Description of Task**

Identify advantages and disadvantages of different rim profiles and materials.
Compare all rim profiles, materials and sizes
Identify the most suitable rim and tyre combination.

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. One rim type and size selected for use.<br>2. One tyre type and size selected for use.<br>3. Comparison table charted out. | 1. 2021-08-03<br>2. 2021-08-03 | 1. 2021-08-06<br>2. 2021-08-06 |

**Assumptions**

Vehicle frame and chassis has enough clearance for the rim, along with the tyre, to fit the assembly at all 4 corners.

**Constraints**

Manufacturers in Malaysia may not sell exact, or close, rim profiles due to variety between all manufacturers (rim profiles are not standard).

**Resources**
**Cost:** RM629.32
**Labour:** 1 members
**Duration:** 1 day

**Interdependencies**
**Higher Level:** 2.1 Wheels
**Lower Level:** 2.1.5 CAD Model

| **Project Manager** | Dr. Chiew | **Date** | 2021-08-11 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 1.2.1 | **WBS Level** | Level 1 |
| **WBD Title** | Torque Converter Analysis | | |
| **Date Change** | 2021-08-11 | **Authorisation** | Ee Wern |
| **Revision No** | 1 | **Approval** | Ee Wern |
| **Date** | 2021-08-11 | | |
| **Key Person** | Dhaan Raaj Chanda Kumar Singh | | |

**Description of Task**

- Identify the components in a power transmission.
- Research on the working principle of torque converters.
- Identify the various types of torque converters.
- Do a CAD model of torque converter to present in the engineering analysis.

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Identified power transmission component | 1.2021-08-07 | 1. 2021-08-07 |
| 2. Torque converter model chosen | 2. 2021-08-07 | 2. 2021-08-07 |
| 3. Torque Converter CAD model | 3. 2021-08-11 | 3. 2021-08-11 |

**Assumptions**

-Components of power transmission able to fit into the chassis design

**Constraints**

-Power transmission components included may be too expensive as its yet to be researched

**Resources**

**Cost:**RM400

**Labour:** 2 members (for first deliverables), 1 member for the rest of the deliverables

**Duration:** 1 weeks

**Interdependencies**

**Higher Level:** 1.2 Transmission

**Lower Level:** 1.2.3 CAD Model

| **Project Manager** | Dr. Chiew | **Date** | 2021-08-11 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go- Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 1.2.3, 1.3.1 | **WBS Level** | Level 1 |
| **WBD Title** | Transmission, Acceleration | | |
| **Date Change** | 2021-08-11 | **Authorisation** | Ee Wern |
| **Revision No** | 1 | **Approval** | Ee Wern |
| **Date** | 2021-08-11 | | |
| **Key Person** | Tan Ee Wern | | |

**Description of Task**

- Identify the components required for power transmission
- Design a reverse gear box
- Do a CAD model to present in the engineering aspects together with calculation
- Research on the function of an accelerator
- Design accelerator pedal

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Identified power transmission component | 1. 2021-08-03 | 1. 2021-08-03 |
| 2. Gear box design | 2. 2021-08-03 | 2. 2021-08-03 |
| 3. Power transmission CAD model | 3. 2021-08-07 | 3. 2021-08-07 |
| 4. Researchaccelerator | 4. 2021-08-07 | 4. 2021-08-07 |
| 5. Design accelerator | 5. 2021-08-07 | 5. 2021-08-07 |

**Assumptions**

- Components of power transmission able to fit into the chassis design
- Chassis is able to mount accelerator

**Constraints**

- Power transmission components included may be too expensive as cost is yet to be researched

**Resources**

**Cost:** RM500.00
**Labour:** 2 members (for first deliverables), 1 member for the rest of the deliverables
**Duration:** 1 weeks

**Interdependencies**

**Higher Level:** 1.2 Transmission, 1.3 Acceleration
**Lower Level:** 1.2.3 CAD Model, 1.3.1 Accelerator research, 1.3.2 Accelerator design

| **Project Manager** | Dr. Chiew | **Date** | 2021-08-11 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| | | | |
|---|---|---|---|
| **Project:**<br><br>Go-Kart Project | | **Project/ Contract No:**<br><br>0001 | |
| **WBS Element** | 1.1.3,1.1.4,3.1.3,3.1.2,3.1.4,3.1.5,3.2.4 | **WBS Level** | Level 3 |
| **WBD Title** | Engine Cooling System, Engine Placement Analysis, Chassis CAD Model, ANSYS Simulation, Integration with Chassis | | |
| **Date Change** | 2021-08-24 | **Authorisation** | Dhaan Raj |
| **Revision No** | 13 | **Approval** | Dhaan Raj |
| **Date** | 2021-08-24 | | |
| **Key Person** | Adriel Sebastian Joseph | | |

**Description of Task**

- Designed and CAD the final chassis of the Go-Kart using Solidworks
- Done the 3 Finite Element Analysis of the Go-Kart chassis in ANSYS 2019 version R2
- Done a research on the engine cooling system as an analysis of Thermodynamic application
- Finalized the position to mount the engine and the adjustable seat with proper research
- and analysis
- Done a CAD of the adjustable seat with proper research

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. CAD model of the chassis<br>2. Results of the Total Deformation and von-Mises using ANSYS Simulation<br>3. The mounting positions of the engine and the adjustable seat<br>4. CAD of a seat with correct incline angle<br>5. Analysis on the components of the cooling system embedded in the engine | 1. 2021-08-16<br>2. 2021-08-17<br>3. 2021-08-16<br>4. 2021-08-16<br>5. 2021-08- 13 | 1. 2021-08-17<br>2. 2021-08-18<br>3. 2021-08-16<br>4. 2021-08-16<br>5. 2021-08- 13 |

**Assumptions**

-No defects on the pipe of the original final chassis otherwise FEA is not useful
-No defects in the components of Cooling system in Engine otherwise not functional

**Constraints**

-A detail study on the chassis using Method of Joints, Method of Sections and Energy Method cannot be done due to the constraints of time and information

**Resources**

**Cost:** -
**Labour:** 1 Member
**Duration:** 1 week

**Interdependencies**

**Higher Level:** 1.1 Engine, 3.1 Chassis, 3.2 Exterior Body Frame, 3.3 Interior and Driver

| | | | |
|---|---|---|---|
| **Lower Level:** 1.1.3 Engine cooling system,1.1.4 Engine Mounting, 3.1.2 Chassis Structural Design, 3.1.3 Engine placement analysis, 3.1.4 Chassis CAD Model ,3.1.5 ANSYS Simulation, 3.2.4 Integration with chassis | | | |
| **Project Manager** | Dr. Chiew | **Date** | 2021-08-24 |

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go - Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 3.2.2, 3.3.4, 3.3.5, 3.3.6, 3.3.8, 4.2, 4.3, 4.4 | **WBS Level** | Level 3 |
| **WBD Title** | Safety Features, Seatbelt, Helmet, Gloves, Ergonomics Analysis, Brake Lights, Data Logger, and Speedometer | | |
| **Date Change** | 2021-08-07 | **Authorisation** | Dhaan |
| **Revision No** | 1 | **Approval** | Dhaan |
| **Date** | 2021-08-24 | | |
| **Key Person** | Andrew Setiawan | | |

**Description of Task**

3.2.2:
- Researched about the possible safety features and estimate the price

3.3.4, 3.3.5, 3.3.6:
- Looked up about the common Go-Kart Equipment that provide extra protection

3.3.8:
- Researched on components that might increase the ergonomics features on the vehicle

4.2, 4.3, 4.4:
- Looked up about extra features to be put in the vehicle

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. (3.2.2) Kill switch might be required for the vehicle<br>2. (3.3.4, 3.3.5, 3.3.6) The equipment is available online and price estimation is RM117.46<br>3. (3.3.8) The component that can improve the ergonomic features is adjustable seat and steering hub<br>4. (4.2, 4.3, 4.4) These components are possible to be installed to increase the performance and safety but assumed to require 20V DC power supply, the price estimation is RM115.85 | 1. 2021 – 08 - 13<br>2. 2021 – 08 - 15<br>3. 2021 – 08 - 14<br>4. 2021 – 08 - 14 | 1. 2021 – 08 - 19<br>2. 2021 – 08 - 19<br>3. 2021 – 08 - 19<br>4. 2021 – 08 - 19 |

**Assumptions**

- The price for the equipment and extra features is still tentative
- The power needed for extra features is around 30V
- The person height for adjustable seat is 170-180cm

| |
|---|
| **Constraints**<br>- The extra features such as brake lights, data logger and speedometer require power supply |
| **Resources**<br>**Cost:** RM 0<br>**Labour:** 1 member<br>**Duration:** 7-9 days |
| **Interdependencies**<br>**Higher Level:** 3.2 Exterior Body Frame, 3.3 Interior and Driver, 4.0 Electronics<br>**Lower Level:** 3.3.8 Ergonomics Analysis, 4.4 Speedometer |

| | | | |
|---|---|---|---|
| **Project Manager** | Dr. Chiew | **Date** | 2021-08-24 |

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5, 4.1, 5.1.1, 5.1.2, 5.1.3 | **WBS Level** | Level 3 |
| **WBD Title** | Brake Types Research, Rotor/Caliper Selection, Master Cylinder Selection, Brake Pedal Selection, CAD Model, Alternator, Track Research, Safety Features, CAD Model | | |
| **Date Change** | 2021-08-24 | **Authorisation** | Dhaan Raaj |
| **Revision No** | 1 | **Approval** | Dhaan Raaj |
| **Date** | 2021-08-20 | | |
| **Key Person** | Ashton Kam Ting Yao | | |

**Description of Task**

- Identify brake types
- Compare rotor and caliper materials
- Identify function of master cylinder in braking system
- Identify an ergonomic and safe size of brake pedal
- Identify function of alternator
- Identify common track characteristics
- Identify track safety features
- Obtain or design CAD Model of brakes, brake rotor and caliper, master cylinder, pedal, alternator and track

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. One brake type selected | 1. 2021-08-12 | 1. 2021-08-13 |
| 2. Comparison chart of rotor and caliper materials crafted | 2. 2021-08-12 | 2. 2021-08-13 |
| 3. Indicate use of master cylinder in system | 3. 2021-08-14 | 3. 2021-08-14 |
| 4. Identify appropriate size of brake pedal | 4. 2021-08-14 | 4. 2021-08-14 |
| 5. Design track, along with safety features on SolidWorks | 5. 2021-08-17 | 5. 2021-08-18 |
| 6. Assemble designed models into full vehicle assembly | 6. 2021-08-18 | 6. 2021-08-19 |

**Assumptions**

One brake rotor sufficient to stop wheel axle
Rotor material selected, Aluminium, can withstand braking force and heat
Alternator provides sufficient power to switch on the electrical components
Brake pedal works well with master cylinder
Battery not included in design
Good quality hydraulic fluid used
Track design not included in budget

**Constraints**

Track design is limited to 50x50x4m
Rotor width fits caliper gap

| | | | |
|---|---|---|---|
| Friction material on caliper is of high quality material | | | |
| **Resources**<br>**Cost:** RM970.76<br>**Labour:** 2 members<br>**Duration:** 12weeks | | | |
| **Interdependencies**<br>**Higher Level:** 2.2 Brakes, 4.0 Electronics, 5.1 Layout<br>**Lower Level:** 2.2.5 CAD Model, 4.2 Brake Lights, 5.1.3 CAD Model | | | |
| **Project Manager** | Dr. Chiew | **Date** | 2021-08-24 |

**2WORK BREAKDOWN DICTIONARY**

| | | | |
|---|---|---|---|
| **Project:**<br><br>Go- Kart Project | | **Project/ Contract No:**<br><br>0001 | |
| **WBS Element** | 1.2.2,1.2.4,3.1.7,3.2.3 | **WBS Level** | Level 3 |
| **WBD Title** | Gear Ratio Selection, Steering Mechanism, Material Analysis, Body Kits | | |
| **Date Change** | 2021-08-20 | **Authorisation** | Dhaan Raaj |
| **Revision No** | 1 | **Approval** | Dhaan Raaj |
| **Date** | 2021-08-20 | | |
| **Key Person** | Dhaan Raaj Chanda Kumar Singh | | |

**Description of Task**

- Determine gear ratio required based on maximum speed of Go-kart.
- Carry out calculation to determine gear ratio.
- Identified the different mechanisms of steering and decide which to use.
- Carry out calculation on steering mechanism.
- CAD model of steering mechanism.
- Material research for chassis and bumper.
- CAD model for bumper design.

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Carry out gear ratio calculation | 1.2021-08-13 | 1. 2021-08-14 |
| 2. Basic mechanical linkage steering based on Ackermann's steering | 2. 2021-08-14 | 2. 2021-08-15 |
| 3. Calculation of Ackermann's percentage and turning radius | 3. 2021-08-15 | 3. 2021-08-15 |
| 4. Steering Mechanism and bumper CAD model | 4. 2021-08-17 | 4. 2021-08-18 |
| 5. Decide best material (AISI1018) for chassis. | 5. 2021-08-17 | 5. 2021-08-16 |

**Assumptions**

- Total weight of Go- Kart with driver is assumed and various resistance acting on Go- Kart are not taken into account.

**Constraints**

-Gear ratio may be not suitable as a full analysis on the various resistance acting on the Go- kart has not been carried out.

**Resources**

**Cost:**RM870
**Labour:** 1 member
**Duration:** 1 week

**Interdependencies**

**Higher Level:** 1.2 Transmission, 3.1 Chassis, 3.2 Exterior Body Frame, 3.3 Interior and Driver
**Lower Level:** 1.2.1 Torque Converter Analysis, 1.2.3 CAD model, 3.2.3 Body kit, 3.3.2 Steering Wheel

| | | | |
|---|---|---|---|
| **Project Manager** | Dr. Chiew | **Date** | 2021-08-24 |

**2WORK BREAKDOWN DICTIONARY**

| **Project:** Go- Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 1.2.3, 1.3.3,3.1.4,3.1.6,3.2.1,3.2.3,3.2.4,3.2.5,3.3.3, 5.1.1,5.1.3 | **WBS Level** | Level 3 |
| **WBD Title** | Transmission CAD Model, Acceleration CAD Model, Structural analysis,Body Design, Body Kits, Integration with Chassis, Exterior Body Frame CAD Model, Pedals positioning, Track Research, Racing Track CAD Model | | |
| **Date Change** | 2021-08-24 | **Authorisation** | Dhaan Raj |
| **Revision No** | 1 | **Approval** | Dhaan Raj |
| **Date** | 2021-08-24 | | |
| **Key Person** | Tan Ee Wern | | |

**Description of Task**

- Build CAD Models for Transmission, Accelerator, Chassis, Exterior Body Frame and race track for proposal purposes
- Assemble the subsystems on the chassis for an overview of the vehicle
- Design customizable spoiler as a part of the exterior body frame
- Research on the track layout
- Perform structural analysis on the chassis

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Build CAD Models | 1.2021-08-19 | 1. 2021-08-19 |
| 2. Assemble the subsystems | 2. 2021-08-19 | 2. 2021-08-19 |
| 3. Design customizable spoilers and body kit | 3. 2021-08-19 | 3. 2021-08-19 |
| 4. Research on track layout | 4. 2021-08-17 | 4. 2021-08-18 |
| 5. Perform structural analysis on chassis | 5. 2021-08-19 | 5. 2021-08-19 |

**Assumptions**

- All subsystems are dimensioned accurately
- Spoiler mounting design is able to support the spoiler

**Constraints**

- The adjustable spoiler mount concept has yet been tested out so it might not work in reality

**Resources**
**Cost:**
RM1000
**Labour:** 1 member, 2 members ( Research on track layout )
**Duration:** 1 week + 3 days

**Interdependencies**
**Higher Level:** 1.2 Transmission, 1.3 Acceleration 3.1 Chassis, 3.2 Exterior Body Frame, 3.3 Interior and Driver, 5.1 Layout
**Lower Level:** 1.2.3 CAD Model, 1.3.3 CAD Model, 3.1.4 CAD Model, 3.1.6 Structural Analysis, 3.2.1 Body Design, 3.2.3 Body Kits, 3.2.4 Integration with Chassis, 3.2.5 CAD Mode, 3.3.3 Pedal positioning, 5.1.1 Track Research, 5.1.3 CAD Model

| | | | |
|---|---|---|---|
| **Project Manager** | Dr. Chiew | **Date** | 2021-08-24 |

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 001 | |
|---|---|---|---|
| **WBS Element** | 3.1.8 | **WBS Level** | Level 3 |
| **WBD Title** | Chassis Structure Analysis | | |
| **Date Change** | 2021-09-07 | **Authorisation** | Ashton Kam |
| **Revision No** | 1 | **Approval** | Ashton Kam |
| **Date** | 2021-09-07 | | |
| **Key Person** | Adriel Sebastian Joseph | | |

**Description of Task**

- Analysis and research done to enhance the strength of the chassis to withstand shock, vibration and other stress.
- Analysis in the area of chassis with the constraints of maximum stress, deflection and critical regions under loading conditions.
- Simulation technique was adopted in design optimization for weight reduction, better material utilization and suitable cross section.
- Height and thickness was changed to check their effect on weight.

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. CAD of the chassis<br>2. Research of the materials<br>3. Maximum von-Mises and deflection of the chassis under loading condition | 1. 2021-09-06<br>2. 2021-09-06<br>3. 2021-09-06 | 1. 2021-09-06<br>2. 2021-09-06<br>3. 2021-09-06 |

**Assumptions**

- No defects on the pipe of the original final chassis otherwise FEA is not useful

**Constraints**

-The budget is RM5000 thus cannot choose an expensive material which gives better physical property

**Resources**

**Cost:** RM0
**Labour:** 1 member
**Duration:** 1 week

**Interdependencies**

**Higher Level:** 3.1 Chassis
**Lower Level:** 3.1.2 Structural Design , 3.1.7 Material Analysis

| **Project Manager** | Dr Chiew | **Date** | 2021-09-07 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 4.5 | **WBS Level** | Level 2 |
| **WBD Title** | Integration Within Vehicle | | |
| **Date Change** | 2021-09-07 | **Authorisation** | Ashton Kam |
| **Revision No** | 1 | **Approval** | Ashton Kam |
| **Date** | 2021-09-07 | | |
| **Key Person** | Andrew Setiawan | | |

**Description of Task**

- The battery was introduced to start the engine and power up the cooling system through alternators
- Making the flow chart of the electrical components within the vehicle

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. The schematic view of electricity flow from the battery to the other electrical components | 1. 31-08-2021 | 1. 07-09-2021 |

**Assumptions**

- The electricity is not fluctuating
- The alternator provides stable energy
- The alternator provides enough electricity for the other electrical components

**Constraints**

- The electricity in actual case might be fluctuating within the vehicle

**Resources**
**Cost:** RM 0
**Labour:** 1 member
**Duration:** 2-3 days

**Interdependencies**
**Higher Level:** 4.0 Electronics
**Lower Level:** -

| | | | |
|---|---|---|---|
| **Project Manager** | Dr. Chiew | **Date** | 2021-09-2021 |

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 5.1.4 | **WBS Level** | Level 3 |
| **WBD Title** | Redesign Track | | |
| **Date Change** | 2021-06-09 | **Authorisation** | Ashton Kam |
| **Revision No** | 1 | **Approval** | Ashton Kam |
| **Date** | 2021-05-09 | | |
| **Key Person** | Ashton Kam Ting Yao | | |

| **Description of Task** |
|---|
| - Redesign track after feedback from client<br>- Implement tyre barricade, traffic lights and lamp posts at high-risk areas |

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Corners width extended to 4.5m<br>2. CAD tyre barricades at high risk area<br>3. CAD traffic lights at corner entrances<br>4. CAD lamp posts at corners | 1. 2021-09-06<br>2. 2021-09-06<br>3. 2021-09-06 | 1. 2021-09-06<br>2. 2021-09-06<br>3. 2021-09-06 |

**Assumptions**
1. Recycled tyres can be easily obtained for a very low price
2. Wiring of lamp posts will not interfere or overlap with track
3. Corners are the only areas of high risk

**Constraints**
Track design is limited to 50x50x4m

**Resources**
**Cost:** RM0.00 (not included in vehicle budget)
**Labour:** 1 member
**Duration:** 1 week

**Interdependencies**
**Higher Level:** 5.1 Layout
**Lower Level:** 5.1.3 CAD Model

| **Project Manager** | Dr. Chiew | **Date** | 2021-09-07 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 1.2.4,2.1.6 | **WBS Level** | Level 3 |
| **WBD Title** | Steering Mechanism, Wheel Shaft Sructure Analysis | | |
| **Date Change** | 2021-06-09 | **Authorisation** | Ashton Kam |
| **Revision No** | 1 | **Approval** | Ashton Kam |
| **Date** | 2021-05-09 | | |
| **Key Person** | Dhaan Raaj Chanda Kumar Singh | | |

**Description of Task**

- Redesign of wheel shaft to accommodate turning radius.
- CAD Model of wheel shaft.
- Recalculation to improve turning radius.

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1.CAD Model.<br>2. Calculation to improve turning radius. | 1. 2021-09-04<br>2. 2021-09-05 | 1. 2021-09-04<br>2. 2021-09-05 |

**Assumptions**

1. Turning force is not taken into account.

**Constraints**

**Resources**
**Cost:** RM60.00
**Labour:** 1 member
**Duration:** 3 days

**Interdependencies**
**Higher Level:** 2.1 Wheels
**Lower Level:** 2.1.6 Wheel Shaft Structure Analysis,1.2.4 Steering Mechanism

| **Project Manager** | Dr. Chiew | **Date** | 2021-09-07 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 3.3.4, 3.3.5 | **WBS Level** | Level 3 |
| **WBD Title** | Seatbelt, Helmet | | |
| **Date Change** | 2021-06-09 | **Authorisation** | Ashton Kam |
| **Revision No** | 1 | **Approval** | Ashton Kam |
| **Date** | 2021-05-09 | | |
| **Key Person** | Tan Ee Wern | | |

**Description of Task**

- Research on appropriate seat belts to be installed on the go kart
- Design a helmet for drivers

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Research seatbelts | 1. 2021-09-06 | 1. 2021-09-06 |
| 2. CAD seatbelt on the seat with appropriate dimensions | 2. 2021-09-06 | 2. 2021-09-06 |
| 3. CAD drivers helmet | 3. 2021-09-06 | 3. 2021-09-06 |

**Assumptions**

1. Seatbelts dimensions are available in the market

**Constraints**

**Resources**
**Cost:** RM100.00 (not included in vehicle budget)
**Labour:** 1 members
**Duration:** 1 week

**Interdependencies**
**Higher Level:** 3.3 Interior and Driver
**Lower Level:** 3.3.4 Seatbelt, 3.3.5 Helmet

| **Project Manager** | Dr. Chiew | **Date** | 2021-09-07 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 1.2.6, 3.1.9, 3.3.9 | **WBS Level** | Level 3 |
| **WBD Title** | Mounting of transmission system, Computational Fluid Dynamics (CFD), Mounting of seat position | | |
| **Date Change** | 2021-09-21 | **Authorisation** | Andrew Setiawan |
| **Revision No** | 1 | **Approval** | Andrew Setiawan |
| **Date** | 2021-09-21 | | |
| **Key Person** | Adriel Sebastian Joseph | | |

**Description of Task**

- Mounting the power transmission system correctly on the chassis
- Mounting the adjustable seat on the chassis according to the measurement set
- Started on the test run on CFD

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Mounting of the adjustable seat | 1. 2021-09-19 | 1. 2021-09-20 |
| 2. Mounting of the power transmission | 2. 2021-09-19 | 2. 2021-09-20 |
| 3. Research on the CFD | 3. 2021-09-20 | 3. 2021-09-20 |

**Assumptions**

1. No defects on the pipe of the original final chassis otherwise CFD is not be useful
2. The fasteners used have no defects otherwise mounting will not be useful

**Constraints**

-The budget is RM5000 thus cannot choose an expensive material of fastener which gives better physical property

**Resources**

**Cost:** RM0.00
**Labour:** 1 member
**Duration:** 2 weeks

**Interdependencies**

**Higher Level:** 1.2 Transmission, 3.1 Chassis , 3.3 Interior and Driver
**Lower Level:** 1.2.6 Mounting of transmission system, 3.1.9 Computational Fluid Dynamics (CFD), 3.3.9 Mounting of seat position

| **Project Manager** | Dr. Chiew | **Date** | 2021-09-21 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 4.5 | **WBS Level** | Level 2 |
| **WBD Title** | Integration Within Vehicle | | |
| **Date Change** | 2021-09-18 | **Authorisation** | Andrew Setiawan |
| **Revision No** | 1 | **Approval** | Andrew Setiawan |
| **Date** | 2021-09-21 | | |
| **Key Person** | Andrew Setiawan | | |

**Description of Task**

- Determine the data logger to be used
- List out the options for the brake lights
- Research on how the alternators discharge the electricity and its components
- Research on the battery to be used

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. A list of brake lights available | 1. 2021-16-09 | 1. 2021-09-18 |
| 2. A data logger to be used | 2. 2021-16-09 | 2. 2021-09-18 |
| 3. A written document of an alternator's information | 3. 2021-16-09 | 3. 2021-09-18 |
| | | 4. |

**Assumptions**

- The alternators discharge rate is always above 12V
- The electricity components will be assembled parallelly

**Constraints**

- More information is needed for the radiator electricity consumption
- The cost of the electrical components needs to be kept as cheap, but as effective as possible. Planned below RM500

**Resources**
**Cost:** RM 0
**Labour:** 1 member
**Duration:** 2-3 days

**Interdependencies**
**Higher Level:** 4.0 Electronics
**Lower Level:** -

| | | | |
|---|---|---|---|
| **Project Manager** | Dr. Chiew | **Date** | 2021-09-21 |

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 5.1.5, 5.1.6 | **WBS Level** | Level 3 |
| **WBD Title** | Draft Track Facilities, Model Track Facilities | | |
| **Date Change** | 2021-09-21 | **Authorisation** | Andrew Setiawan |
| **Revision No** | 1 | **Approval** | Andrew Setiawan |
| **Date** | 2021-09-21 | | |
| **Key Person** | Ashton Kam Ting Yao | | |

| **Description of Task** | | |
|---|---|---|
| - Draft a rough estimate of where extra facilities will be on track area<br>- Make a CAD model out track facilities | | |
| **Deliverables** | **Delivery Date** | |
| | **Planned** | **Actual** |
| 1. Add toilet for both genders<br>2. Add 2nd floor for observers<br>3. Add PA system<br>4. Add railing for 2nd floor<br>5. Add conference room | 1. 2021-09-20<br>2. 2021-09-20<br>3. 2021-09-20<br>4. 2021-09-21<br>5. 2021-09-21 | 1. 2021-09-20<br>2. 2021-09-20<br>3. 2021-09-20<br>4. 2021-09-21<br>5. 2021-09-21 |
| **Assumptions**<br>1. Malaysia maintains law on binary genders<br>2. A total of 50 people will be on the 2nd floor at one go<br>3. Echo from PA system is non-disruptive for audio<br>4. Conference room can hold up to 20 people at one go<br>5. Electrical outlets are situated at sufficient spots | | |
| **Constraints**<br>Track design is limited to 40x40x5m | | |
| **Resources**<br>**Cost:** RM0.00 (not included in vehicle budget)<br>**Labour:** 1 member<br>**Duration:** 2 weeks | | |
| **Interdependencies**<br>**Higher Level:** 5.1 Track Layout<br>**Lower Level:** 5.1.7 Add Track Details | | |
| **Project Manager** | Dr. Chiew | **Date** 2021-09-21 |

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 1.2.3, 1.2.4 | **WBS Level** | Level 3 |
| **WBD Title** | Power Transmission Analysis, CAD Model | | |
| **Date Change** | 2021-09-21 | **Authorisation** | Andrew Setiawan |
| **Revision No** | 1 | **Approval** | Andrew Setiawan |
| **Date** | 2021-09-21 | | |
| **Key Person** | Dhaan Raaj Chanda Kumar Singh | | |

**Description of Task**

- Prepare calculation on the required transmitted torque to the wheels for dry and wet condition for a specific weight.
- Redesign of bumper for extra safety.
- Researh on torque converter for cheaper model.

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Calculate torque required at wheels for dry and wet condition. | 1. 2021-09-15 | 1. 2021-09-16 |
| 2. Produced CAD for bumper. | 2. 2021-09-18 | 2. 2021-09-19 |
| 3. Decided on a cheaper torque converter with equivalent specifications. | 3. 2021-09-20 | 3. 2021-09-20 |

**Assumptions**

1. Air resistance is negligible.
2. Coefficient of static friction for torque calculation is based on common dry and wet data.

**Constraints**

Cannot determine the actual static friction of track surface.

**Resources**

**Cost:** RM 0
**Labour:** 1 member
**Duration:** 1 week

**Interdependencies**

**Higher Level:** 1.2 Transmission
**Lower Level:** 1.2.3 Power Transmission Analysis, 1.2.4 CAD Model

| **Project Manager** | Dr. Chiew | **Date** | 2021-09-21 |
|---|---|---|---|

# WORK BREAKDOWN DICTIONARY

| | | | |
|---|---|---|---|
| **Project:**<br><br>Go-Kart Project | | **Project/ Contract No:**<br><br>0001 | |
| **WBS Element** | 1.2.3, 1.2.4 | **WBS Level** | Level 3 |
| **WBD Title** | Power Transmission Analysis, CAD Model | | |
| **Date Change** | 2021-09-21 | **Authorisation** | Andrew Setiawan |
| **Revision No** | 1 | **Approval** | Andrew Setiawan |
| **Date** | 2021-09-21 | | |
| **Key Person** | Tan Ee Wern | | |

**Description of Task**

- Provide detail calculation on the stress and safety of factor of the power transmission components
- Provide sizing for the design components from the result of the calculation.
- Find suitable purchase parts through various catalogues.
- Decide on the materials used for each designed transmission component.

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Calculate the stress and safety factor for designed components | 1. 2021-09-17 | 1. 2021-09-18 |
| 2. Size the designed components from the calculations | 2. 2021-09-20 | 2. 2021-09-21 |
| 3. Find purchase parts with the correct sizing | 3. 2021-09-20 | 3. 2021-09-20 |
| 4. Decide on materials used for designed components | 4. 2021-09-21 | 4. 2021-09-21 |

**Assumptions**

1. Components with self weight below 0.1kg will not be taken into consideration during calculation
2. All purchase parts are available in the catalogue
3. Safety factor above 5 is acceptable.

**Constraints**

Cannot test the practicality of the design due to the pandemic.

**Resources**

**Cost:** RM 500
**Labour:** 1 member
**Duration:** 2 weeks

**Interdependencies**

**Higher Level:** 1.2 Transmission
**Lower Level:** 1.2.3 Power Transmission Analysis, 1.2.4 CAD Model

| | | | |
|---|---|---|---|
| **Project Manager** | Dr. Chiew | **Date** | 2021-09-21 |

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 3.1.9,3.2.6, 5.1.8 | **WBS Level** | Level 3 |
| **WBD Title** | Computational Fluid Dynamics (CFD),Aerodynamic Analysis, Kinematic of Track | | |
| **Date Change** | 2021-10-05 | **Authorisation** | Adriel Sebastian |
| **Revision No** | 1 | **Approval** | Adriel Sebastian |
| **Date** | 2021-10-05 | | |
| **Key Person** | Adriel Sebastian | | |

**Description of Task**

- Done the detail calculation for the Tag-game timing using the track
- Research on the CFD simulation and the governing equation
- Research on simulation in ANSYS Fluent
- Helped on the calculation for the shaft

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. The exact time for each lapse<br>2. Governing equation for drag and lift coefficient<br>3. Ideas on modifying the Go-Kart model to reduce the drag | 1. 2021-10-03<br>2. 2021-10-03<br>3. 2021-10-04 | 1. 2021-10-04<br>2. 2021-10-04<br>3. 2021-10-04 |

**Assumptions**

1. Static coefficient of friction of the road is for dry surface
2. Wear and tear of the tire is neglected
3. The material of the chassis for now during simulation

**Constraints**

- Following the design of the track
- Using ANSYS Fluent for simulation

**Resources**

**Cost:** RM0.00
**Labour:** 1 member
**Duration:** 2 weeks

**Interdependencies**

**Higher Level:** 3.1 Chassis, 3.2 Exterior Body Frame, 5.1 Track Layout
**Lower Level:** 3.1.9 Computational Fluid Dynamics (CFD),3.2.6 Aerodynamic Analysis, 5.1.8 Kinematic of Track

| **Project Manager** | Dr. Chiew Yeong Shiong | **Date** | 2021-10-05 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 4.1, 4.3, 4.4, 4.5, 4.6 | **WBS Level** | Level 2 |
| **WBD Title** | Alternator, Data logger, Speedometer, Integration within vehicle, Checkpoint system | | |
| **Date Change** | 2021-10-05 | **Authorisation** | Adriel Joseph |
| **Revision No** | 1 | **Approval** | Adriel Joseph |
| **Date** | 2021-10-05 | | |
| **Key Person** | Andrew Setiawan | | |

**Description of Task**

- Researching about the LED indicator
- Researching for the speedometer
- Revising the RFID system since it is not viable
- Revising the data logger system
- Changing the alternator to be used

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. An LED supplier for the indicator system has been found with the specification available<br>2. The shield for Arduino nano is changed<br>3. The alternator to be used is the new alternator with 12V/75A<br>4. The RFID system is replaced with laser sensor | 1. 2021-09-28<br>2. 2021-09-28<br>3. 2021-09-28 | 1. 2021-10-03<br>2. 2021-10-03<br>3. 2021-10-03<br>4. |

**Assumptions**

- The Arduino nano and shield is one entity
- The power used for the whole data logging system is 5W

**Constraints**

- The battery is used, but need to be integrated with the alternator
- The cost of the RFID checkpoint system was changed due to the budget limit
- More research is needed to integrate the battery with the alternator

**Resources**
**Cost:** RM 0
**Labour:** 1 member
**Duration:** 4-5 days

**Interdependencies**
**Higher Level:** 4.0 Electronics
**Lower Level:** -

| | | | |
|---|---|---|---|
| **Project Manager** | Dr. Chiew  | **Date** | 2021-10-05 |

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 1.1.6, 5.1.7 | **WBS Level** | Level 3 |
| **WBD Title** | Engine Cooling Analysis, Add Track Details | | |
| **Date Change** | 2021-10-03 | **Authorisation** | Adriel Sebastian |
| **Revision No** | 1 | **Approval** | Adriel Sebastian |
| **Date** | 2021-10-04 | | |
| **Key Person** | Ashton Kam Ting Yao | | |

**Description of Task**

- Perform calculations on engine cooling
- Perform simulations on engine cooling
- Compare calculations and simulations
- CAD track facilities

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Add surau | 1. 2021-10-03 | 1. 2021-10-04 |
| 2. Add fire extinguishers | 2. 2021-10-03 | 2. 2021-10-04 |
| 3. Add fire staircase | 3. 2021-10-04 | 3. 2021-10-04 |
| 4. Add KELUAR signs | 4. 2021-10-04 | 4. 2021-10-04 |
| 5. Add fire alarm triggers | 5. 2021-10-04 | 5. 2021-10-04 |
| 6. Add garage door | 6. 2021-10-04 | 6. 2021-10-04 |

**Assumptions**

1. Engine coolant used is perfectly composed and without defect
2. Corrosion and mechanical defects in engine cooling system does not affect performance
3. Malaysian guidelines in government website are of the latest updates and standards
4. Firetruck requirements are met outside the building boundaries

**Constraints**

Radiator size is limited by engine size
Track design is limited to 40x40x5m

**Resources**

**Cost:** RM0.00 (Analysis not counted in budget/Track not included in vehicle budget)
**Labour:** 1 member
**Duration:** 2 weeks

**Interdependencies**

**Higher Level:** 1.1 Engine, 5.1 Track Layout
**Lower Level:** 1.1.6 Engine Cooling Anaylsis, 5.1.7 Add Track Details

| **Project Manager** | Dr. Chiew | **Date** | 2021-10-05 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 1.2.3,1.2.4,1.2.5 | **WBS Level** | Level 3 |
| **WBD Title** | Power Transmission Analysis, CAD Model, Steering Mechanism | | |
| **Date Change** | 2021-10-03 | **Authorisation** | Adriel Sebastian |
| **Revision No** | 1 | **Approval** | Adriel Sebastian |
| **Date** | 2021-10-04 | | |
| **Key Person** | Dhaan Raaj Chanda Kumar Singh | | |

| **Description of Task** | | |
|---|---|---|
| -Finalise calculation regarding power transmission.<br>- Alteration and assembly of design components in power transmission.<br>- Finalize calculation of steering mechanism.<br>- Research and redesign of bumpers. | | |
| **Deliverables** | **Delivery Date** | |
| | **Planned** | **Actual** |
| 1. Confirmed torque at wheels is sufficient.<br>2. Finalised size and no. of teeths of gears in gearbox.<br>3. Fitting of gear box in CAD drawing.<br>4. Finalised turning radius based on Ackermann Principle.<br>5. Designed bumpers with increased crumple zone. | 1. 2021-10-03<br>2. 2021-10-03<br>3. 2021-10-04<br>4. 2021-10-04<br>5. 2021-10-04 | 1. 2021-10-04<br>2. 2021-10-04<br>3. 2021-10-04<br>4. 2021-10-04<br>5. 2021-10-04 |
| **Assumptions**<br>1. There are no power loss in the chain drives. | | |
| **Constraints** | | |
| **Resources**<br>**Cost:** -<br>**Labour:** 1 member<br>**Duration:** 1 week | | |
| **Interdependencies**<br>**Higher Level:** 1.2 Transmission,<br>**Lower Level:** 1.2.3 Power Transmission Analysis ,1.2.4 CAD Model, 1.2.5 Steering Mechanism | | |

| **Project Manager** | Dr. Chiew | **Date** | 2021-10-04 |
|---|---|---|---|

**WORK BREAKDOWN DICTIONARY**

| **Project:** Go-Kart Project | | **Project/ Contract No:** 0001 | |
|---|---|---|---|
| **WBS Element** | 1.2.3,1.2.4, 5.1,5.3 | **WBS Level** | Level 2, Level 3 |
| **WBD Title** | Power Transmission Analysis, CAD Model, Offered packages, Revenue and cost analysis | | |
| **Date Change** | 2021-10-03 | **Authorisation** | Adriel Sebastian |
| **Revision No** | 1 | **Approval** | Adriel Sebastian |
| **Date** | 2021-10-04 | | |
| **Key Person** | Tan Ee Wern | | |

**Description of Task**

-Perform static structural analysis through simulations on power transmission components
- Finalize CAD Model dimensions for designed components in power transmission
- Finalize materials used for each designed component
- Search for suppliers for purchase parts
- Calculate cost of packages to be market for go kart business
- Research on the aerodynamics of bumpers to integrate as customization option

| **Deliverables** | **Delivery Date** | |
|---|---|---|
| | **Planned** | **Actual** |
| 1. Simulate designed components | 1. 2021-10-03 | 1. 2021-10-04 |
| 2. Build finalize CAD Model | 2. 2021-10-03 | 2. 2021-10-04 |
| 3. Finalize dimensions for power transmission | 3. 2021-10-04 | 3. 2021-10-04 |
| 4. Find suitable materials for design components | 4. 2021-10-04 | 4. 2021-10-04 |
| 5. Find suppliers for purchase parts with exact dimensions | 5. 2021-10-04 | 5. 2021-10-04 |
| 6. Calculate the cost of packages | 6. 2021-10-04 | 6. 2021-10-04 |

**Assumptions**

1. There are no power loss in the chain drives
2. Gearbox lever design is applicable in reality
3. Supplier contains the stocks for purchased parts

**Constraints**

-Cost of packages cannot be finalised yet as the cost of the whole car is only roughly estimated

**Resources**

**Cost:** RM500 ( for materials of design components and purchase parts )
**Labour:** 1 member
**Duration:** 2 weeks

**Interdependencies**

**Higher Level:** 1.2 Transmission, 6 Business Plan
**Lower Level:** 1.2.3 Power Transmission Analysis ,1.2.4 CAD Model, 5.1 Offered packages,5.3 Revenue and cost analysis

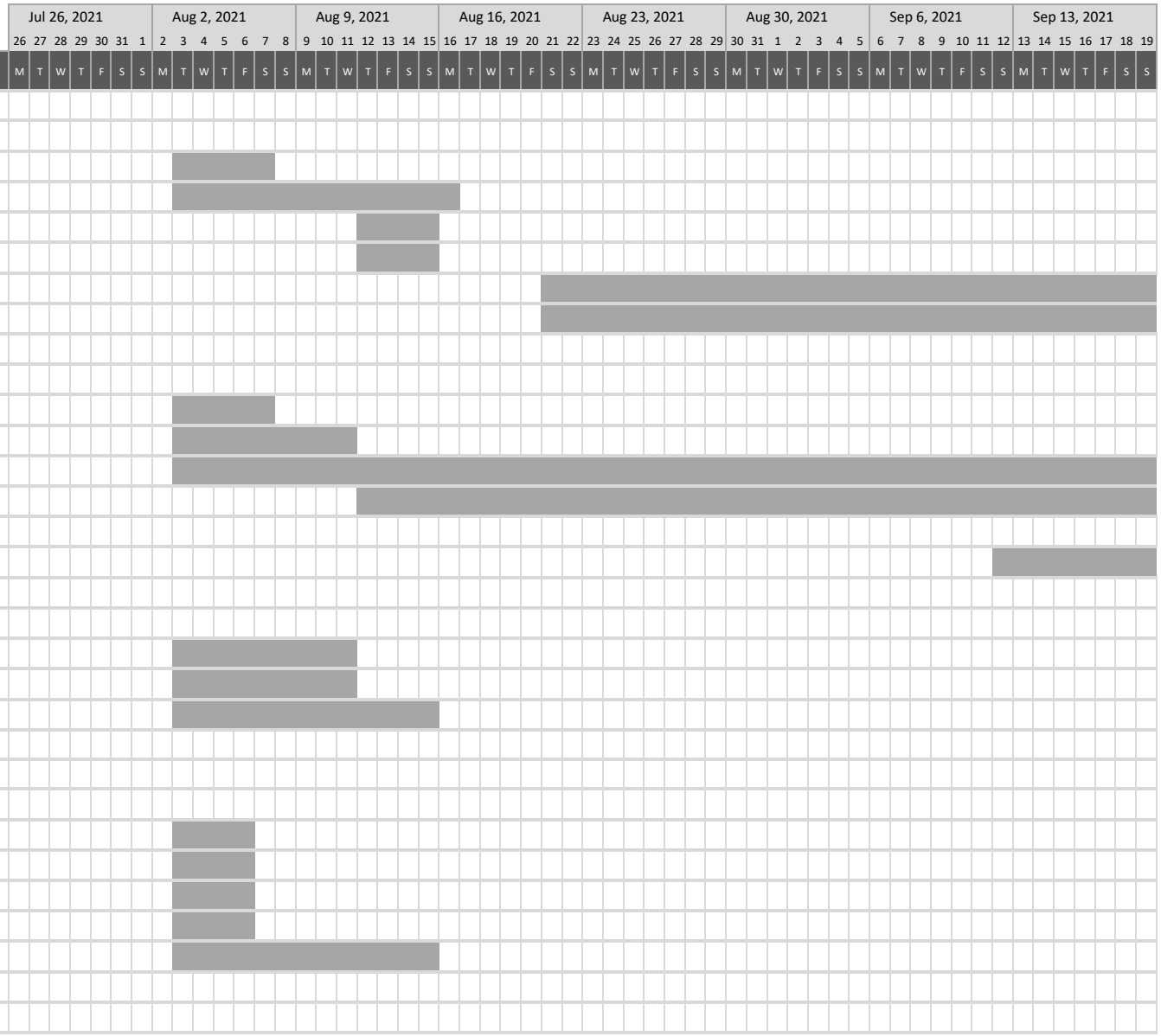
| | | | |
|---|---|---|---|
| **Project Manager** | Dr. Chiew | **Date** | 2021-10-04 |

# Go-Kart Project

Kart-mobil

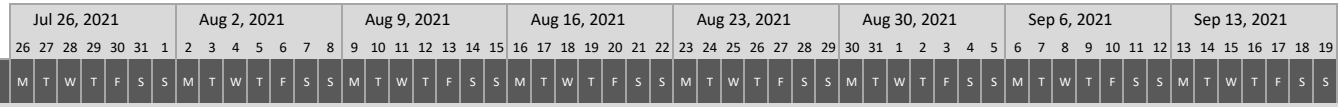
| | |
|---|---|
| Project Start: | Tue, 7/27/2021 |
| Today: | Thurs, 8/12/2021 |
| Display Week: | 1 |

| TASK | ASSIGNED TO | PROGRESS | START | END |
|---|---|---|---|---|
| 1. POWER TRANSMISSION | | | ( month/ day/year ) | |
| **1.1 Engine** | | | | |
| 1.1.1 Engine Analysis | Adriel | 100% | 8/3/21 | 8/7/21 |
| 1.1.2 CAD Model | Adriel | 100% | 8/3/21 | 8/16/21 |
| 1.1.3 Engine Cooling System | Adriel | 100% | 8/12/21 | 8/15/21 |
| 1.1.4 Engine Mount | Adriel | 100% | 8/12/21 | 8/15/21 |
| 1.1.5 Engine Reassessment | Adriel | 100% | 8/21/21 | 10/3/21 |
| 1.1.6 Engine Cooling Analysis | Ashton | 100% | 8/21/21 | 10/3/21 |
| **1.2 Tranmission** | | | | |
| 1.2.1 Torque Converter Analysis | Dhaan Raj | 100% | 8/3/21 | 8/7/21 |
| 1.2.2 Gear Ratio Selection | Dhaan Raj | 100% | 8/3/21 | 8/11/21 |
| 1.2.3 Power Transmission | Dhaan, Ee Wern | 100% | 8/3/21 | 9/20/21 |
| 1.2.4 CAD Model | Dhaan, Ee Wern | 100% | 8/12/21 | 9/20/21 |
| 1.2.5 Steering Mechanism | Dhaan Raj | 100% | 9/27/21 | 10/4/21 |
| 1.2.6 Mounting of Transmission System | Adriel | 100% | 9/12/21 | 9/20/21 |
| **1.3 Acceleration** | | | | |
| 1.3.1 Accelerator Research | Ee Wern | 100% | 8/3/21 | 8/11/21 |
| 1.3.2 Accelerator design | Ee Wern | 100% | 8/3/21 | 8/11/21 |
| 1.3.3 CAD Model | Ee Wern | 100% | 8/3/21 | 8/15/21 |
| 2. WHEEL AND BRAKES | | | | |
| **2.1 Wheels** | | | | |
| 2.1.1 Rim Profiles Research | Ashton | 100% | 8/3/21 | 8/6/21 |
| 2.1.2 Rim Materials Research | Ashton | 100% | 8/3/21 | 8/6/21 |
| 2.1.3 Tyre Compound Research | Ashton | 100% | 8/3/21 | 8/6/21 |
| 2.1.4 Rim and Tyre Selection | Ashton | 100% | 8/3/21 | 8/6/21 |
| 2.1.5 CAD Model | Ashton | 100% | 8/3/21 | 8/15/21 |
| 2.1.6 Wheel Shaft Structure Analysis | Ashton | 100% | | |



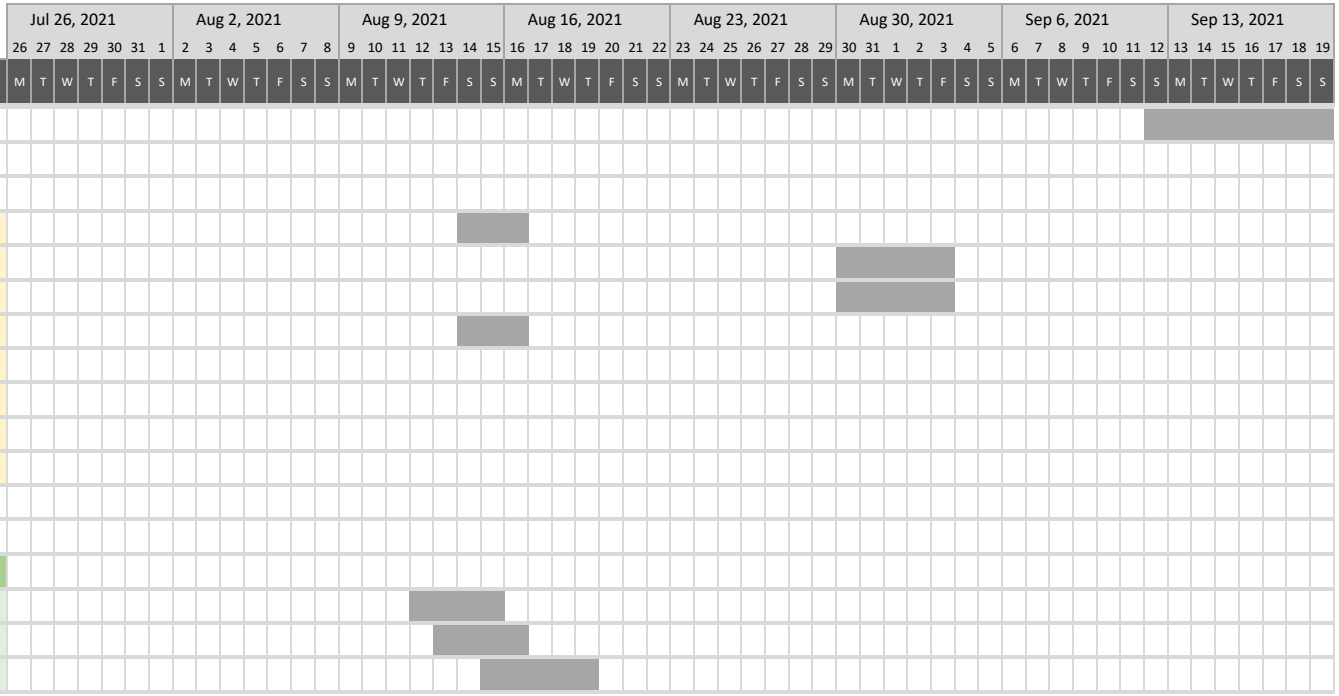
Display Week: 1

| TASK | ASSIGNED TO | PROGRESS | START | END |
|---|---|---|---|---|
| **2.2 Brakes** | | | | |
| 2.2.1 Brakes Types Research | Ashton | 100% | 8/12/21 | 8/16/21 |
| 2.2.2 Rotor/Caliper Selection | Ashton | 100% | 8/12/21 | 8/16/21 |
| 2.2.3 Master Cylinder Selection | Ashton | 100% | 8/12/21 | 8/16/21 |
| 2.2.4 Brake Type Selection | Ashton | 100% | 8/12/21 | 8/18/21 |
| 2.2.5 CAD Model | Ashton | 100% | 8/14/21 | 8/18/21 |
| 3. BODY | | | | |
| **3.1 Chassis** | | | | |
| 3.1.1 Chassis Research | Andrew | 100% | 8/3/21 | 8/7/21 |
| 3.1.2 Structural Design | Adriel, Ee Wern | 100% | 8/3/21 | 8/7/21 |
| 3.1.3 Engine Placement Analysis | Adriel | 100% | 8/8/21 | 8/14/21 |
| 3.1.4 CAD Model | Andrew, Adriel, Ee | 100% | 8/3/21 | 9/5/21 |
| 3.1.5 Ansys Simulation | Adriel | 100% | 8/14/21 | 8/16/21 |
| 3.1.6 Structural Analysis | Ee Wern | 100% | 8/21/21 | 10/3/21 |
| 3.1.7 Material Analysis | Dhaan | 100% | 8/21/21 | 10/3/21 |
| 3.1.8 Chassis Structure Analysis | Adriel | 100% | 8/31/21 | 9/6/21 |
| 3.1.9 Computational Fluid Dynamics | Adriel | 100% | 9/27/21 | 10/3/21 |
| **3.2 Exterior Body Frame** | | | | |
| 3.2.1 Body Design | Ee Wern | 100% | 8/12/21 | 8/15/21 |
| 3.2.2 Safety Features | Andrew | 100% | 8/12/21 | 8/15/21 |
| 3.2.3 Body Kits | Ee Wern, Dhaan | 100% | 8/12/21 | 8/15/21 |
| 3.2.4 Integration with Chassis | Ee Wern, Dhaan, Adriel | 100% | 8/12/21 | 8/15/21 |
| 3.2.5 CAD Model | Ee Wern | 100% | 8/12/21 | 8/15/21 |
| 3.2.6 Aerodynamics Analysis | Adriel | 100% | 8/21/21 | 10/3/21 |
| **3.3 Interior and Driver** | | | | |
| 3.3.1 Driver Seat Position | Ee Wern | 100% | 8/15/21 | 8/17/21 |
| 3.3.2 Steering Wheel | Dhaan, Ee Wern | 100% | 8/15/21 | 8/17/21 |
| 3.3.3 Pedals Positioning | Ee Wern | 100% | 8/15/21 | 8/17/21 |
| 3.3.4 Seatbelt | Andrew, Ee Wern | 100% | 8/15/21 | 8/17/21 |
| 3.3.5 Helmet | Andrew | 100% | 8/15/21 | 8/17/21 |
| 3.3.6 Gloves | Andrew | 100% | 8/15/21 | 8/17/21 |
| 3.3.7 CAD | Ee Wern | 100% | 8/15/21 | 9/8/21 |



Display Week: 1

| TASK | ASSIGNED TO | PROGRESS | START | END |
|---|---|---|---|---|
| 3.3.8 Mounting of Seat Position | Adriel | 100% | 9/12/21 | 9/20/21 |
| | | | | |
| 4. ELECTRONICS | | | | |
| 4.1 Alternator | Ashton | 100% | 8/14/21 | 8/16/21 |
| 4.2 Brake Lights | Andrew | 100% | 8/30/21 | 9/3/21 |
| 4.3 Data Logger | Andrew | 100% | 8/30/21 | 9/3/21 |
| 4.4 Speedometer | Andrew | 100% | 8/14/21 | 8/16/21 |
| 4.5 Integration within vehicle | Andrew | 100% | 8/21/21 | 9/18/21 |
| 4.6 Checkpoint System | Andrew | 100% | 8/21/21 | 10/3/21 |
| 4.7 Accessories | Andrew | 100% | 10/11/21 | 10/15/21 |
| 4.8 Programming | Ashton | 100% | 10/10/21 | 10/15/21 |
| | | | | |
| 5. RACING TRACK | | | | |
| **5.1 Layout** | | | | |
| 5.1.1 Track Research | Ashton, Ee Wern | 100% | 8/12/21 | 8/15/21 |
| 5.1.2 Safety Features | Ashton | 100% | 8/13/21 | 8/16/21 |
| 5.1.3 CAD Model | Ashton, Ee Wern | 100% | 8/15/21 | 8/19/21 |

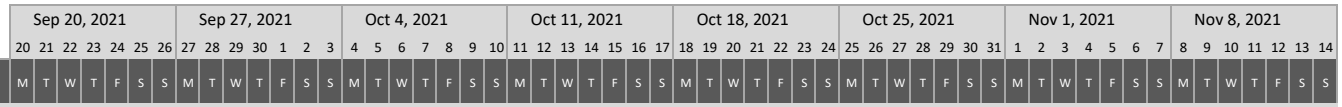


# Go-Kart Project

Kart-mobil

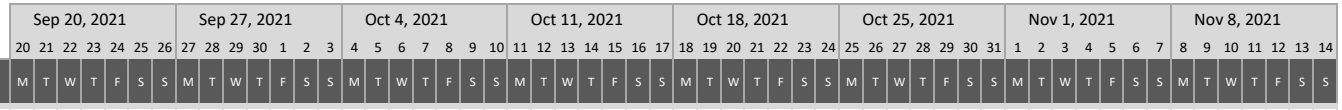
| | |
|---|---|
| Project Start: | Tue, 7/27/2021 |
| Today: | Thurs, 8/12/2021 |
| Display Week: | 9 |

| TASK | ASSIGNED TO | PROGRESS | START | END |
|---|---|---|---|---|
| 1. POWER TRANSMISSION | | | ( month/ day/year ) | |
| **1.1 Engine** | | | | |
| 1.1.1 Engine Analysis | Adriel | 100% | 8/3/21 | 8/7/21 |
| 1.1.2 CAD Model | Adriel | 100% | 8/3/21 | 8/16/21 |
| 1.1.3 Engine Cooling System | Adriel | 100% | 8/12/21 | 8/15/21 |
| 1.1.4 Engine Mount | Adriel | 100% | 8/12/21 | 8/15/21 |
| 1.1.5 Engine Reassessment | Adriel | 100% | 8/21/21 | 10/3/21 |
| 1.1.6 Engine Cooling Analysis | Ashton | 100% | 8/21/21 | 10/3/21 |
| **1.2 Tranmission** | | | | |
| 1.2.1 Torque Converter Analysis | Dhaan Raj | 100% | 8/3/21 | 8/7/21 |
| 1.2.2 Gear Ratio Selection | Dhaan Raj | 100% | 8/3/21 | 8/11/21 |
| 1.2.3 Power Transmission | Dhaan, Ee Wern | 100% | 8/3/21 | 9/20/21 |
| 1.2.4 CAD Model | Dhaan, Ee Wern | 100% | 8/12/21 | 9/20/21 |
| 1.2.5 Steering Mechanism | Dhaan Raj | 100% | 9/27/21 | 10/4/21 |
| 1.2.6 Mounting of Transmission System | Adriel | 100% | 9/12/21 | 9/20/21 |
| **1.3 Acceleration** | | | | |
| 1.3.1 Accelerator Research | Ee Wern | 100% | 8/3/21 | 8/11/21 |
| 1.3.2 Accelerator design | Ee Wern | 100% | 8/3/21 | 8/11/21 |
| 1.3.3 CAD Model | Ee Wern | 100% | 8/3/21 | 8/15/21 |
| 2. WHEEL AND BRAKES | | | | |
| **2.1 Wheels** | | | | |
| 2.1.1 Rim Profiles Research | Ashton | 100% | 8/3/21 | 8/6/21 |
| 2.1.2 Rim Materials Research | Ashton | 100% | 8/3/21 | 8/6/21 |
| 2.1.3 Tyre Compound Research | Ashton | 100% | 8/3/21 | 8/6/21 |
| 2.1.4 Rim and Tyre Selection | Ashton | 100% | 8/3/21 | 8/6/21 |
| 2.1.5 CAD Model | Ashton | 100% | 8/3/21 | 8/15/21 |
| 2.1.6 Wheel Shaft Structure Analysis | Ashton | 100% | | |



Display Week: 9

| TASK | ASSIGNED TO | PROGRESS | START | END |
|---|---|---|---|---|
| **2.2 Brakes** | | | | |
| 2.2.1 Brakes Types Research | Ashton | 100% | 8/12/21 | 8/16/21 |
| 2.2.2 Rotor/Caliper Selection | Ashton | 100% | 8/12/21 | 8/16/21 |
| 2.2.3 Master Cylinder Selection | Ashton | 100% | 8/12/21 | 8/16/21 |
| 2.2.4 Brake Type Selection | Ashton | 100% | 8/12/21 | 8/18/21 |
| 2.2.5 CAD Model | Ashton | 100% | 8/14/21 | 8/18/21 |
| 3. BODY | | | | |
| **3.1 Chassis** | | | | |
| 3.1.1 Chassis Research | Andrew | 100% | 8/3/21 | 8/7/21 |
| 3.1.2 Structural Design | Adriel, Ee Wern | 100% | 8/3/21 | 8/7/21 |
| 3.1.3 Engine Placement Analysis | Adriel | 100% | 8/8/21 | 8/14/21 |
| 3.1.4 CAD Model | Andrew, Adriel, Ee | 100% | 8/3/21 | 9/5/21 |
| 3.1.5 Ansys Simulation | Adriel | 100% | 8/14/21 | 8/16/21 |
| 3.1.6 Structural Analysis | Ee Wern | 100% | 8/21/21 | 10/3/21 |
| 3.1.7 Material Analysis | Dhaan | 100% | 8/21/21 | 10/3/21 |
| 3.1.8 Chassis Structure Analysis | Adriel | 100% | 8/31/21 | 9/6/21 |
| 3.1.9 Computational Fluid Dynamics | Adriel | 100% | 9/27/21 | 10/3/21 |
| **3.2 Exterior Body Frame** | | | | |
| 3.2.1 Body Design | Ee Wern | 100% | 8/12/21 | 8/15/21 |
| 3.2.2 Safety Features | Andrew | 100% | 8/12/21 | 8/15/21 |
| 3.2.3 Body Kits | Ee Wern, Dhaan | 100% | 8/12/21 | 8/15/21 |
| 3.2.4 Integration with Chassis | Ee Wern, Dhaan, Adriel | 100% | 8/12/21 | 8/15/21 |
| 3.2.5 CAD Model | Ee Wern | 100% | 8/12/21 | 8/15/21 |
| 3.2.6 Aerodynamics Analysis | Adriel | 100% | 8/21/21 | 10/3/21 |
| **3.3 Interior and Driver** | | | | |
| 3.3.1 Driver Seat Position | Ee Wern | 100% | 8/15/21 | 8/17/21 |
| 3.3.2 Steering Wheel | Dhaan, Ee Wern | 100% | 8/15/21 | 8/17/21 |
| 3.3.3 Pedals Positioning | Ee Wern | 100% | 8/15/21 | 8/17/21 |
| 3.3.4 Seatbelt | Andrew, Ee Wern | 100% | 8/15/21 | 8/17/21 |
| 3.3.5 Helmet | Andrew | 100% | 8/15/21 | 8/17/21 |
| 3.3.6 Gloves | Andrew | 100% | 8/15/21 | 8/17/21 |
| 3.3.7 CAD | Ee Wern | 100% | 8/15/21 | 9/8/21 |



Display Week: 9

| TASK | ASSIGNED TO | PROGRESS | START | END |
|---|---|---|---|---|
| 3.3.8 Mounting of Seat Position | Adriel | 100% | 9/12/21 | 9/20/21 |
| | | | | |
| 4. ELECTRONICS | | | | |
| 4.1 Alternator | Ashton | 100% | 8/14/21 | 8/16/21 |
| 4.2 Brake Lights | Andrew | 100% | 8/30/21 | 9/3/21 |
| 4.3 Data Logger | Andrew | 100% | 8/30/21 | 9/3/21 |
| 4.4 Speedometer | Andrew | 100% | 8/14/21 | 8/16/21 |
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| 4.7 Accessories | Andrew | 100% | 10/11/21 | 10/15/21 |
| 4.8 Programming | Ashton | 100% | 10/10/21 | 10/15/21 |
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| 5. RACING TRACK | | | | |
| **5.1 Layout** | | | | |
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| 5.1.2 Safety Features | Ashton | 100% | 8/13/21 | 8/16/21 |
| 5.1.3 CAD Model | Ashton, Ee Wern | 100% | 8/15/21 | 8/19/21 |