# ABSTRACT

Using gyroscopic precession in the construction of two-wheeled electric bikes that balance themselves offers a viable way to improve the stability of these kinds of vehicles and lessen the difficulties that come with balancing. In the domain of transportation, instability-related accidents are a major concern, particularly in nations such as India where two-wheelers are common. Using the concept of gyroscopic precession, this abstract investigates the use of gyroscopes into the design of electric bicycles. The gyroscope, which is usually positioned horizontally in the bike's frame, responds to any tilting motion, and provides stability. The bike is equipped with a modern control system that uses sensors and a microprocessor to identify direction and instantly change the electric motors to keep the bike upright. This novel method presents the interesting prospect of self-balancing bikes working without the need for human assistance in addition to having the ability to greatly increase safety in two-wheeled transportation. As technology develops, more improvements in sensor and control algorithm design will probably support the continuous creation and application of self-balancing features in electric bikes, resolving important issues with safety and stability in two-wheeled transportation.

# CHAPTER 1

# INTRODUCTION

In today's world, combating air pollution and addressing climate change are pressing issues that demand innovative solutions. One such solution is the development of electric bikes with zero emissions, which prioritize the conservation of the environment. By harnessing clean energy sources, these bikes offer a sustainable alternative to traditional fossil fuel-powered vehicles. Our project aims to revolutionize mobility through the production of electric bikes equipped with cutting-edge control technologies, regenerative braking systems, and self-stability features.

The need for sustainable transportation solutions is evident from the alarming statistics provided by the Ministry of Road Transport and Highways (MRTH), which indicate that more than 150 motorcycle accidents occur daily in India. Factors contributing to these accidents include changing road conditions, reckless driving, speeding, and overloading. In response to this critical issue, our project focuses on improving vehicle stability and safety through the development of self-balancing bikes.

Traditionally, vehicles that run on fossil fuels have been primary contributors to carbon emissions, exacerbating environmental concerns. While electric cars have made significant strides in reducing emissions and enhancing safety features, advancements in motorcycle manufacturing have been limited, resulting in lagging rider safety standards. To address this gap, we propose the development of self-balancing bikes based on gyroscopic technology.

Gyroscopes are devices that utilize the principle of gyroscopic precession to maintain stability and balance. By incorporating gyroscopes and other sensors into the framework of electric bikes, we aim to create autonomous balance motorbikes that do not require human intervention to maintain stability. These bikes will be equipped with sophisticated control systems that continuously monitor the bike's tilt and adjust the flywheel rotation accordingly to maintain balance.

The use of reaction wheels further enhances the bike's stability by generating a counterforce to offset any tilting motion. This innovative approach to vehicle stabilization has the potential to revolutionize the transportation industry by offering enhanced safety and stability without compromising the riding experience.

The development of self-balancing bikes represents a significant advancement in transportation technology, with the potential to prevent accidents and save lives. By utilizing gyroscopic technology, riders can now balance their bikes on two wheels without the assistance of a human operator, making transportation safer and more accessible to all.

In conclusion, our project seeks to leverage gyroscopic precession to develop self-balancing electric bikes that offer a sustainable and safe mode of transportation. By prioritizing environmental conservation and rider safety, we aim to revolutionize the way people commute and contribute to a greener and safer future for all.

To put everything together our project aims to revolutionize transportation with electric bikes using gyroscopic technology for self-balancing. By prioritizing environmental conservation and rider safety, these bikes offer a sustainable and safe alternative to traditional vehicles. With cutting-edge control technologies and regenerative braking systems, we seek to address the pressing issues of air pollution and climate change. Our goal is to prevent accidents and save lives by providing enhanced stability and balance without compromising the riding experience. Through innovative advancements in vehicle stabilization, we strive to create a greener and safer future for all.

# CHAPTER 2

# Literature Survey

## 1. Zakaria, H, et.al,

The operating efficiency and innovative charging techniques of hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and battery electric vehicles (BEVs) are highlighted in the literature review. A lot of research has been done on how internal combustion engines and electric motors can optimize fuel usage in hybrid electric vehicles. The effects of plug-in charging and enhanced electric range are being studied for plug-in hybrid electric vehicles (PHEVs), which have larger batteries. Researchers explore cutting-edge battery technology while concentrating on the zero-emission characteristics of BEVs. Furthermore, technologies that improve the processes of charging and repairing electric vehicles include wireless charging, vehicle-to-grid (V2G) systems, and fast-changing technologies. Through addressing developments and difficulties in these developing vehicle categories, this literature collectively shapes conversations about the future of sustainable automobile mobility.

## 2. Xiaohong Nian, et.al,

The significance of the Regenerative Brake System (RBS) in Electric Vehicles (EVs) with Brushless DC (BLDC) motors is explored in this study. The study's main goal is to evaluate the regenerative braking system's effectiveness, which is an essential part that raises an EV's total efficiency and energy recovery capacity. In order to optimize the regenerative braking process, the research uses an integrative method that incorporates control systems, notably combining Proportional-Integral-Derivative (PID) controllers and Fuzzy controllers. Fuzzy controllers, which are excellent at handling intricate and non-linear interactions, are a good complement to PID controllers, which are well-known for their stability and accuracy in control systems. With this complementary combination, EVs with BLDC motors will have a more reliable and adaptable regenerative braking system. To optimize the regenerative braking system and ensure effective energy regeneration during deceleration, the paper probably investigates how these control techniques might be used to improve the overall performance and range of electric vehicles. This multidisciplinary method, which combines advanced control strategies with electrical engineering concepts, is an all-encompassing attempt to tackle the dynamic issues related to regenerative braking in the context of electric vehicle

## 3. Abdalkarim M, et.al,

A two-wheeled vehicle's ability to remain stable is essential in the intricate transportation system. Gyroscopes can significantly aid in the stabilisation of two-wheeled vehicles. According to conjecture, gyroscopically stabilised cars would be more safe than standard two-wheelers. For a two-wheeled vehicle to achieve dynamic stabilisation, a torque generated by a gyroscope inside the vehicle must balance off a torque operating on it naturally. Here, the gyroscope is utilised not as a sensor but as an actuator thanks to the precession forces it produces. A moment is created about a third axis that is orthogonal to both the torque and spin axes when torque is applied to an axis that is normal to the spin axis, causing the gyroscope to process.

## 4. Ching-Chih Tsai, et.al,

This research offers an adaptive control for a two-wheeled self-balancing scooter utilising radial-basis function neural networks (RBFNNs). A brief description of the mechatronic system structure of the scooter powered by two DC motors is given, along with a mathematical model that includes two frictions between the wheels and the motion surface. One suggests two adaptive controllers employing RBFNN to provide self-balancing and yaw control by breaking down the total system into two subsystems (yaw motion and mobile inverted pendulum). A two-wheeled self-balancing scooter is used in multiple simulations and experiments to demonstrate the effectiveness and quality of the suggested adaptive controllers.

## 5. Jayasheel Kumar K, et.al,

India is the world's second-largest manufacturer and producer of two-wheelers. In terms of domestic sales and the quantity of two-wheeler vehicles produced, it ranks third after China and Japan. The work that follows is done in this paper in relation to the creation of an electric two-wheeler. A 110cc bike chassis from an existing two-wheeler is chosen. It is replaced by a battery-operated motor system. Numerous computations are performed, including those for power, torque, battery and motor specs, and range estimation. There is a ready wiring harness for the electric two-wheeler. The appropriate battery and the motor's battery management system are connected, along with other components such as the 60V electric motor. The electric motor controller, digital display, and other components are assembled.

The manufacturing of the motorcycle is carried out by using the calculated values and hence the results are drawn. The derived results are then compared to that of an internal combustion engine.

## 6. Tanweer Faisal1, et.al,

The current century is shifting toward electric vehicles from diesel/petrol vehicles. In this project an “Electric Bike" is designed and fabricated for single occupant load by keeping in view uneven roads in Indian suburban areas. The lightweight of the E-Bike makes the ride comfortable for the rider. This project comprises with design and fabrication of an electric bike which makes the use of electrical energy as the primary source and solar energy, if possible, by attaching solar panels. It also highlights the design aspects of the bike. In this project, an electric bike assembly provides a lightweight, high-performance BLDC motor that is powered by a lithium-ion battery. There is a provision for charging the battery by connecting to a charger. The electrical power generated which is used to run the bike can give better fuel economy compared to a conventional vehicle. To make the E-bike more reliable there is a controller to protect the battery from heating issues by controlling drainage of power. Moreover, it operates the accessories of E-Bike like front light and indicator, etc. As per the design, it can travel about 30 35 kph. The speed sensor is given to detect the speed of the bike with the attachment of a digital speedometer.

## 7. Srinivas Mutyala, et.al,

The modern world requires cutting edge technology that can address both present and future issues. The primary issue these days is the scarcity of fossil fuels. Given the current pace of use, fossil fuels will only be around for the next 50 years. Unwanted climate change is a warning sign that fossil fuel consumption should be reduced. The best substitute for using gasoline-powered cars to get people around is a sustainable electrical motorbike. The ideal technological application for the next generation and a better world is the future e-motorbike. Features of an e-motorbike include artificial intelligence, quiet operation, cheap operating costs, and lightweight design. Considering its benefits, the e-motor bike is the most adaptable vehicle of the future.

## 8. N. Sai Madhavi et.al,

The team's main goal is to create a vehicle that is both safe and useful, using a stiff and torsion-free frame and a well-mounted power train to help them comprehend the finer points of vehicle design while closely following the competition role. Electric-powered bicycles, or e-bikes, are the modern equivalent of motorized bicycles that have been around since the late 1800s. A few bike sharing programmes make use of them. Our goal is to create different E-bike components, analyse them under fabrication design constraints, and then use software to put everything together. This will assist us in solving engineering difficulties in the automotive industry that arise in the actual world. As learners, we strive to enhance our abilities and comprehension to fulfil the demands of the industry.

## 9.Navi Mumbai, India Deep R Prajapati, et.al,

This paper's major goal is to present an accurate picture of the several energy sources that humans have access to. For humans to survive and thrive in the sophisticated, developed world of today, travel is crucial. And to accomplish this, he needs to travel as quickly and as little as feasible. This essay provides information on electric bikes, which rely on batteries to power their motors. This study makes concessions in the design and construction of an electric bike that uses electricity as its main energy source and, if it can, solar energy that is connected to solar panels. It also emphasizes the bike's design features. There is a feature that allows you to charge the battery by removing it.

# CHAPTER 3

# PROPOSED METHODOLOGY

## 3.1 PROBLEM STATEMENT

- **Tractive System Optimization:** Despite the cohesive integration of essential elements in the tractive system, there may be challenges in optimizing the interaction between components to achieve maximum efficiency and performance. How can we fine-tune the coordination of the battery, BMS, MCB, motor driver, and BLDC motor to enhance overall driving performance without compromising system reliability.

- **Mild Regenerative Braking Efficiency:** While the mild regenerative braking system shows promise in conserving motor energy, there is a need to address potential limitations in power capture and storage efficiency. How can we optimize the three-phase rectifier and ultracapacitor to maximize energy storage and minimize power loss during braking, ensuring optimal utilization of captured energy.

- **Self-Stability Mechanism Reliability:** The self-stabilizing mechanism offers convenience and enhanced rider comfort, particularly in traffic scenarios and parking situations. However, ensuring consistent and reliable performance of the servo motor, sensors, and PID controller is crucial for maintaining stability and safety. How can we mitigate potential issues such as sensor malfunction or PID controller errors to ensure seamless operation of the self-stabilization mechanism under diverse riding conditions.

- **Safety System Robustness:** While the safety features, including dual kill switches and high-voltage fuses, are essential for emergency cutoffs and fire/smoke prevention, their effectiveness relies on robust and reliable operation. How can we enhance the robustness and responsiveness of the solid-state relays and emergency cutoff mechanisms to ensure rapid and effective intervention in critical situations, minimizing the risk of accidents or damage to the bike and rider.

Electric vehicles were not very popular until recently, there are multiple problems in the market today, and our bike tries to address these problems and stands out amongst the others available in the market.

The accidents caused due to lack of balance of the vehicles in the market is too high and this is a problem in today's two-wheeler industry. This will result in lot of accidents. All electric vehicles have a very high initial cost even during mass production when compared to that of an IC vehicle with similar specifications. The weight of an EV is very less when compared to the weight of IC vehicles. This makes it highly unstable for EVs to stay in the centre of gravity.

## 3.2 OBJECTIVE

The objective of the project is to build an Electric two-wheel vehicle achieving all the system that is more improvised and has the following features: -

1. **Sustainable Transportation:** Innovative Zero-Emission Electric Bikes: Develop electric bikes that emit zero tailpipe emissions, reducing air pollution and combating climate change. By utilizing clean energy sources, such as renewable electricity, these bikes contribute to a cleaner environment and help mitigate the effects of climate change. They offer a sustainable transportation solution that reduces reliance on fossil fuels. The electric bikes will be powered by batteries charged from clean energy sources, ensuring zero emissions during operation.

2. **Advanced Control for Extended Battery Life, Range, and Temperature:** Develop a sophisticated control system to improve electric bike efficiency, extending battery life and improving overall range. By maximizing energy efficiency, the control system enhances the practicality and reliability of electric bikes for daily use. It ensures longer rides without the need for frequent recharging, enhancing the user experience. Innovative engineering techniques will be employed to optimize battery management, control motor performance, and regulate temperature, thereby extending battery life and improving overall range.

3. **Mild Regenerative System to Extend Battery Life:** Utilize regenerative braking to power auxiliary systems on the electric bike, enhancing energy efficiency and sustainability. The regenerative system captures and stores energy generated during braking, which can be used to power auxiliary systems or recharge the battery. This not only extends battery life but also reduces energy consumption and contributes to a more sustainable riding experience. Innovative regenerative braking technology will be integrated into the electric bike's braking system, allowing for efficient energy capture and utilization.

4. **Self-Stability to Maintain Perfect Balance:** Introduce a self-stability feature to ensure the electric bike always maintains perfect balance. The self-stability feature enhances safety by minimizing the risk of accidents due to loss of balance. It provides riders with a more stable and effortless riding experience, especially in challenging terrain or conditions. Novel self-stabilizing mechanisms will be incorporated into the electric bike's design, utilizing sensors and control algorithms to automatically adjust balance and stability.

5. **Enhanced Safety with Multiple Redundancy Protocols:** Implement multiple redundancy protocols to strengthen the security of electric vehicles and improve overall safety standards. The redundancy protocols ensure a dependable and fail-safe system, reducing the risk of accidents or malfunctions. This enhances rider confidence and contributes to a safer riding environment for all road users. Redundant systems and backup mechanisms will be integrated into critical components of the electric bike, such as the powertrain, braking system, and control electronics.

6. **Cluster for Simplified Data Presentation:** Process data from all sensors and present it on the cluster to simplify the rider's understanding of crucial parameters for a safe journey. The cluster provides riders with real-time information on key parameters such as speed, battery level, and system status, enhancing situational awareness and safety. It allows for quick and intuitive interpretation of data, improving the overall riding experience. Advanced data processing algorithms will be used to collect and analyse sensor data, which will be displayed in a user-friendly format on the bike's cluster.

# 3.3 Block Diagram

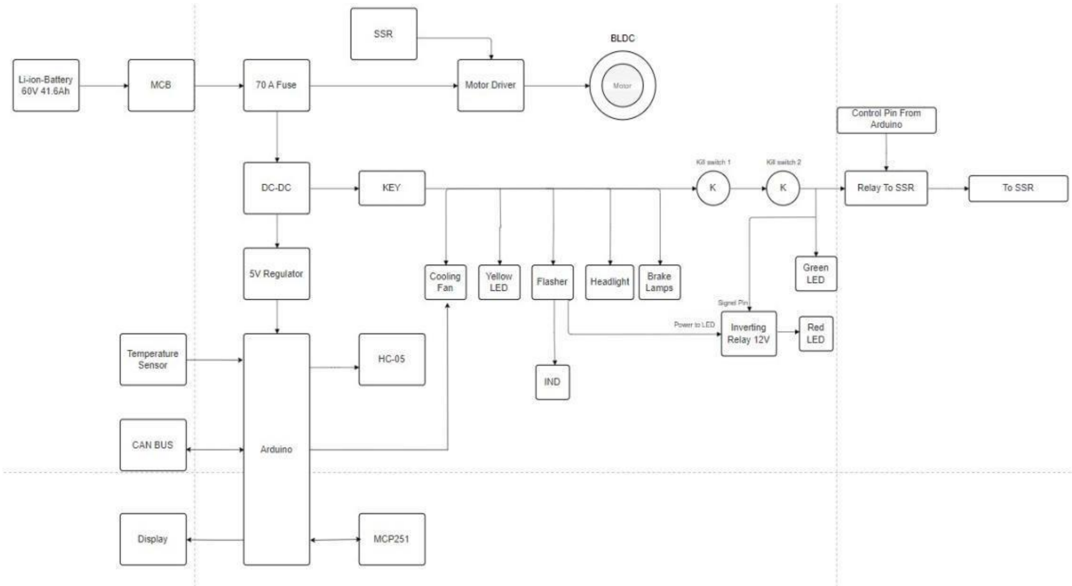



**Figure 3.3.1 Block Diagram**

### 3.4 Circuit diagram

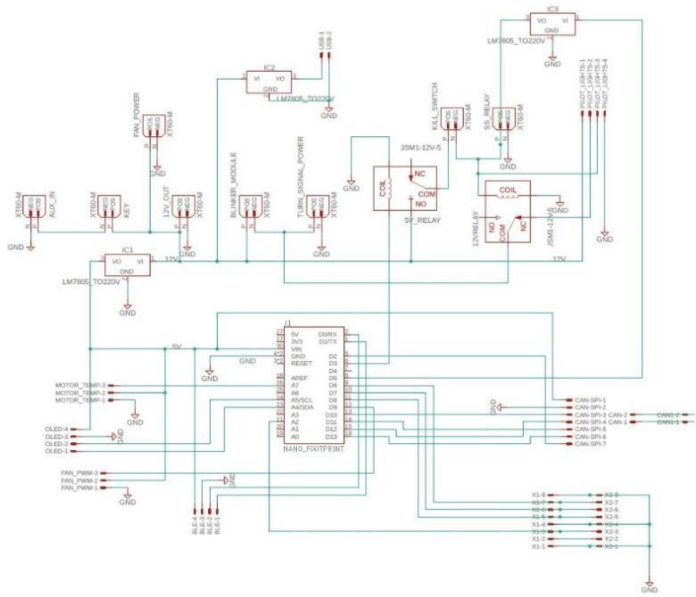


**Figure 3.4.1 Circuit Diagram**

The Auxiliary input is given in series to the key socket and xxxx is connected to the key socket in series and the fan motor is taped in between the key socket and xxxx. We are using a 12V – 5V regulator and the 5V output is given to the C-type output which can be used to charge the phone. The Blinker and Turn signal power are connected to in series with the 12V supply which is used for the bike indicators. We are using one more 12V-5V converter and the 5V output is given to the Arduino nano as the input. We are using 2 relay's one is to control the kill switch, solid state relay and the motor and the other relay is to control the on-board LED indicators. The solid-state reply is connected to the input of the 12V-5V regulator and the output 5V signal is giving as an input signal to the Arduino. The motor temperature is found out by using the DS18B20 sensor which is connected to the Arduino and the temperature is display on the screen. The Bluetooth module is connected to Arduino, it is used to transfer data from Arduino to the app. CAN bus is connected to Arduino, it is used to get the battery voltage and current. The Throttle is bypassed through Arduino to get the speed modes and display it on the OLED screen.

Auxiliary System

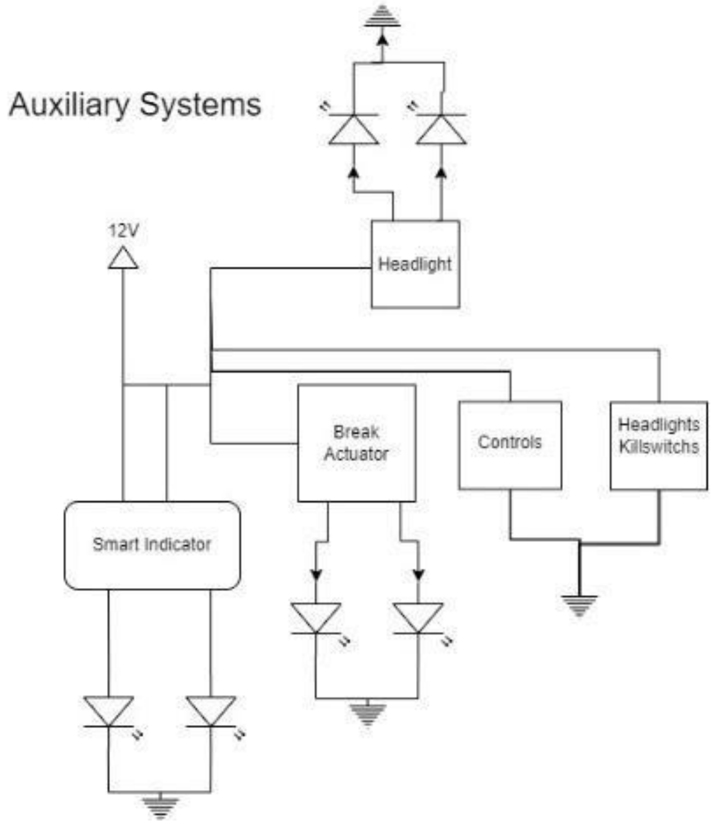



**Figure 3.4.2 Auxiliary System**

## 3.4.3 Headlight

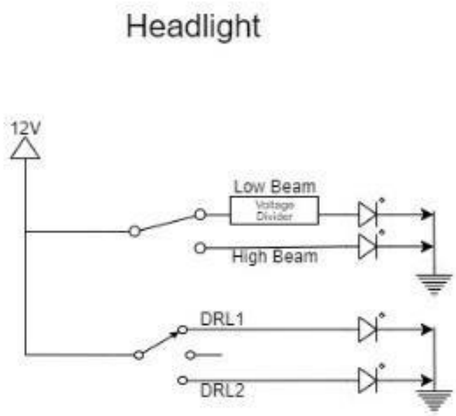
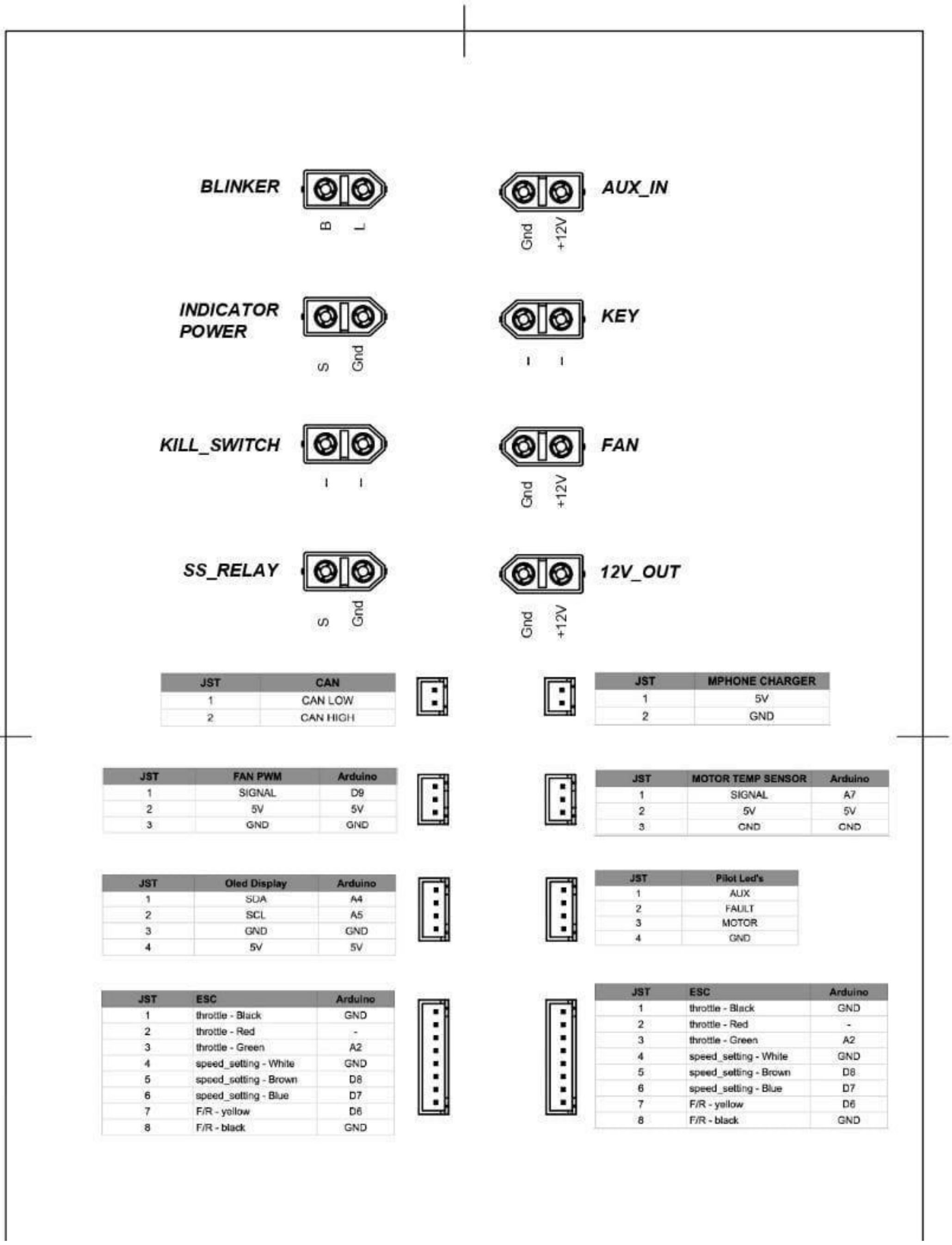



**Figure 3.4.3 Headlight**

## 3.5) Pin Diagram

### 3.5.1) Mother board pin diagram




| JST | CAN |
|---|---|
| 1 | CAN LOW |
| 2 | CAN HIGH |

| JST | MPHONE CHARGER |
|---|---|
| 1 | 5V |
| 2 | GND |

| JST | FAN PWM | Arduino |
|---|---|---|
| 1 | SIGNAL | D9 |
| 2 | 5V | 5V |
| 3 | GND | GND |

| JST | MOTOR TEMP SENSOR | Arduino |
|---|---|---|
| 1 | SIGNAL | A7 |
| 2 | 5V | 5V |
| 3 | CND | CND |

| JST | Oled Display | Arduino |
|---|---|---|
| 1 | SDA | A4 |
| 2 | SCL | A5 |
| 3 | GND | GND |
| 4 | 5V | 5V |

| JST | Pilot Led's |
|---|---|
| 1 | AUX |
| 2 | FAULT |
| 3 | MOTOR |
| 4 | GND |

| JST | ESC | Arduino |
|---|---|---|
| 1 | throttle - Black | GND |
| 2 | throttle - Red | - |
| 3 | throttle - Green | A2 |
| 4 | speed_setting - White | GND |
| 5 | speed_setting - Brown | D8 |
| 6 | speed_setting - Blue | D7 |
| 7 | F/R - yellow | D6 |
| 8 | F/R - black | GND |

| JST | ESC | Arduino |
|---|---|---|
| 1 | throttle - Black | GND |
| 2 | throttle - Red | - |
| 3 | throttle - Green | A2 |
| 4 | speed_setting - White | GND |
| 5 | speed_setting - Brown | D8 |
| 6 | speed_setting - Blue | D7 |
| 7 | F/R - yellow | D6 |
| 8 | F/R - black | GND |

**Figure 3.5.1 Mother board pin diagram**

### 3.5.2) Panel Pinout

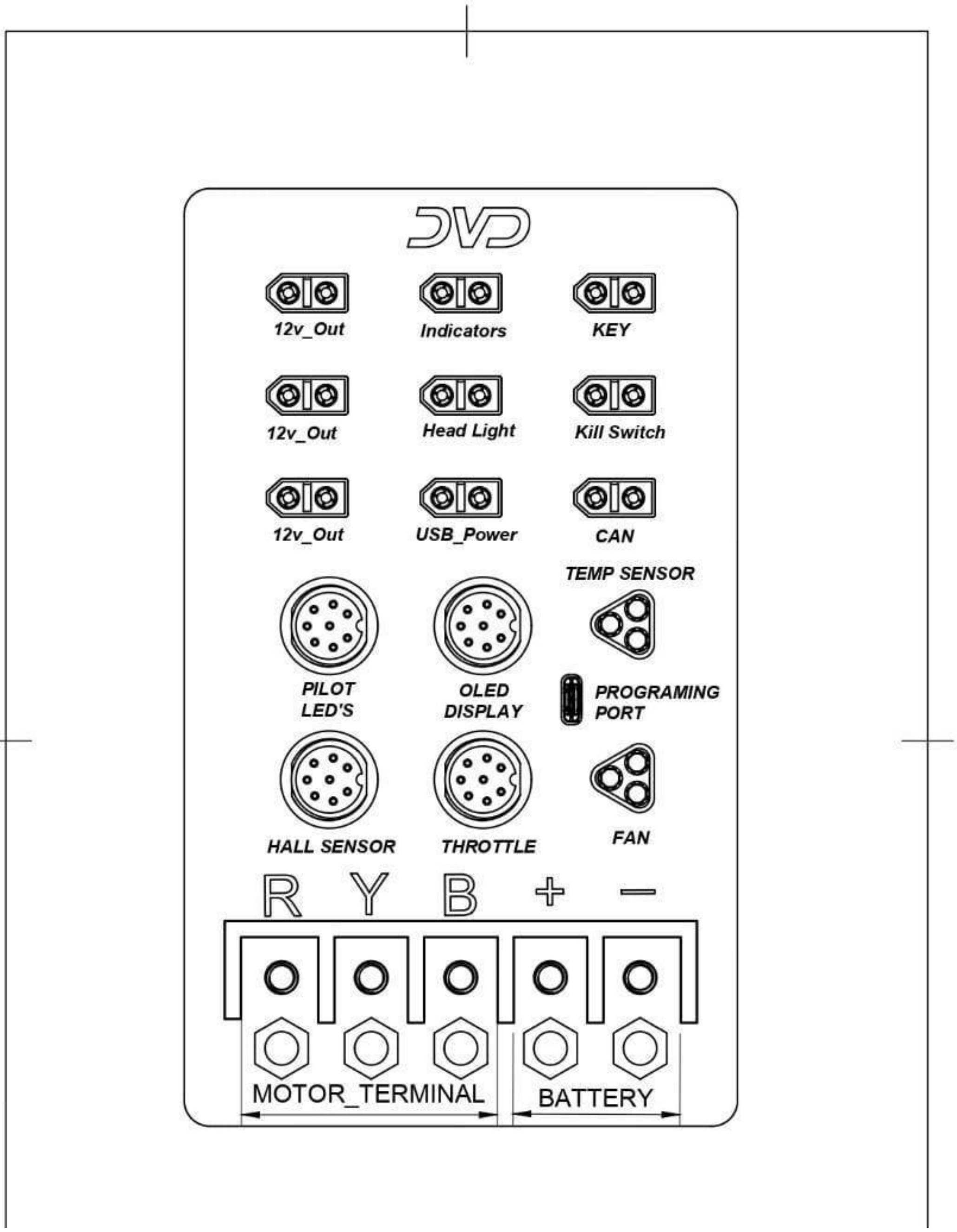



**Figure 3.5.2 Panel Pinout**

## **3.6** Mild **regenerative breaking (Simulation)**

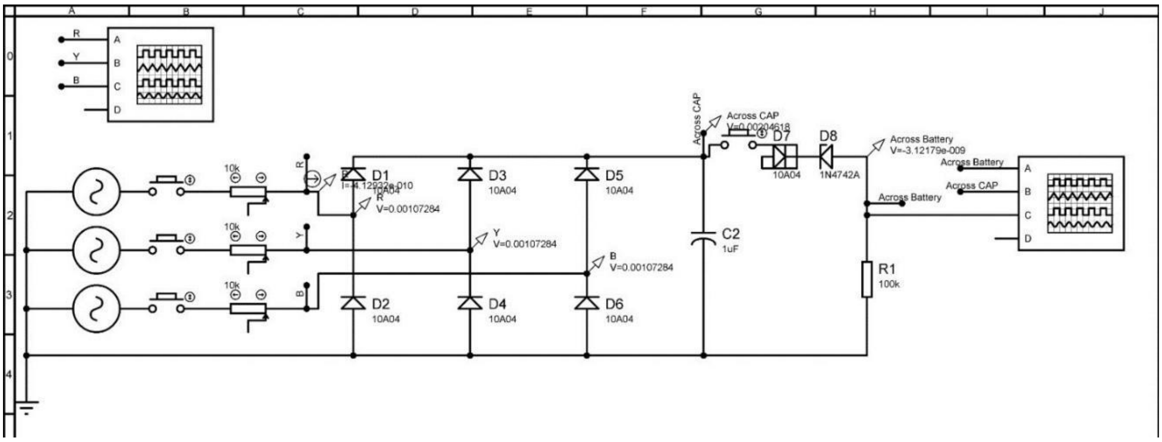



**Figure 3.6.1 Off Condition**

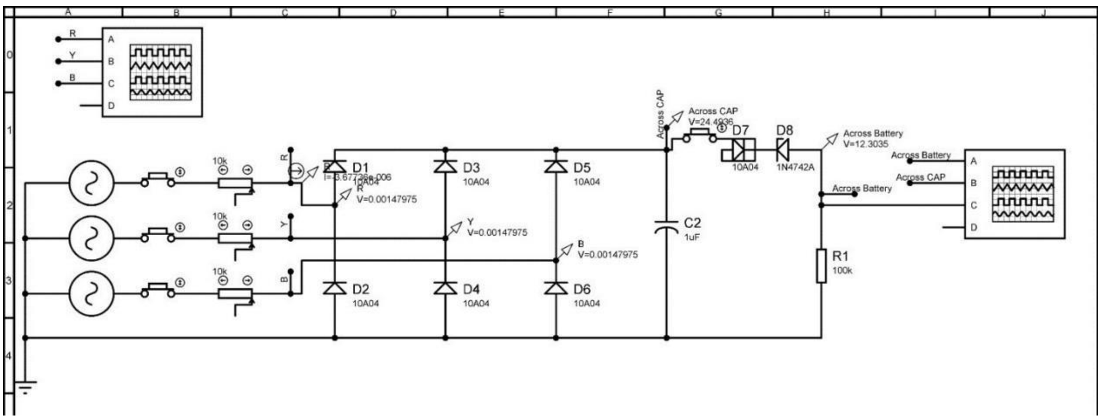



**Figure 3.6.2 On Condition**

## Input waveform:

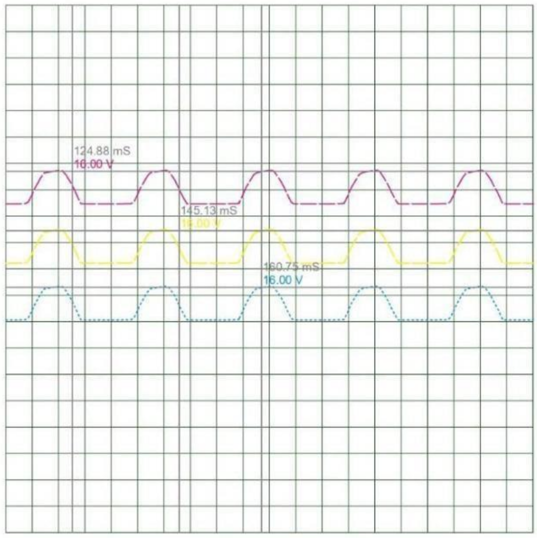



**Figure 3.6.3 Input Waveform**

## Output Waveform:

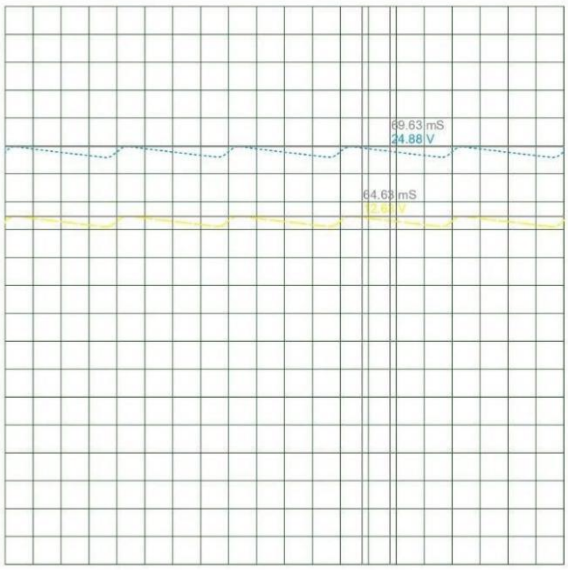



**Figure 3.6.4 Output Waveform**

## 3.7 Flow Chart

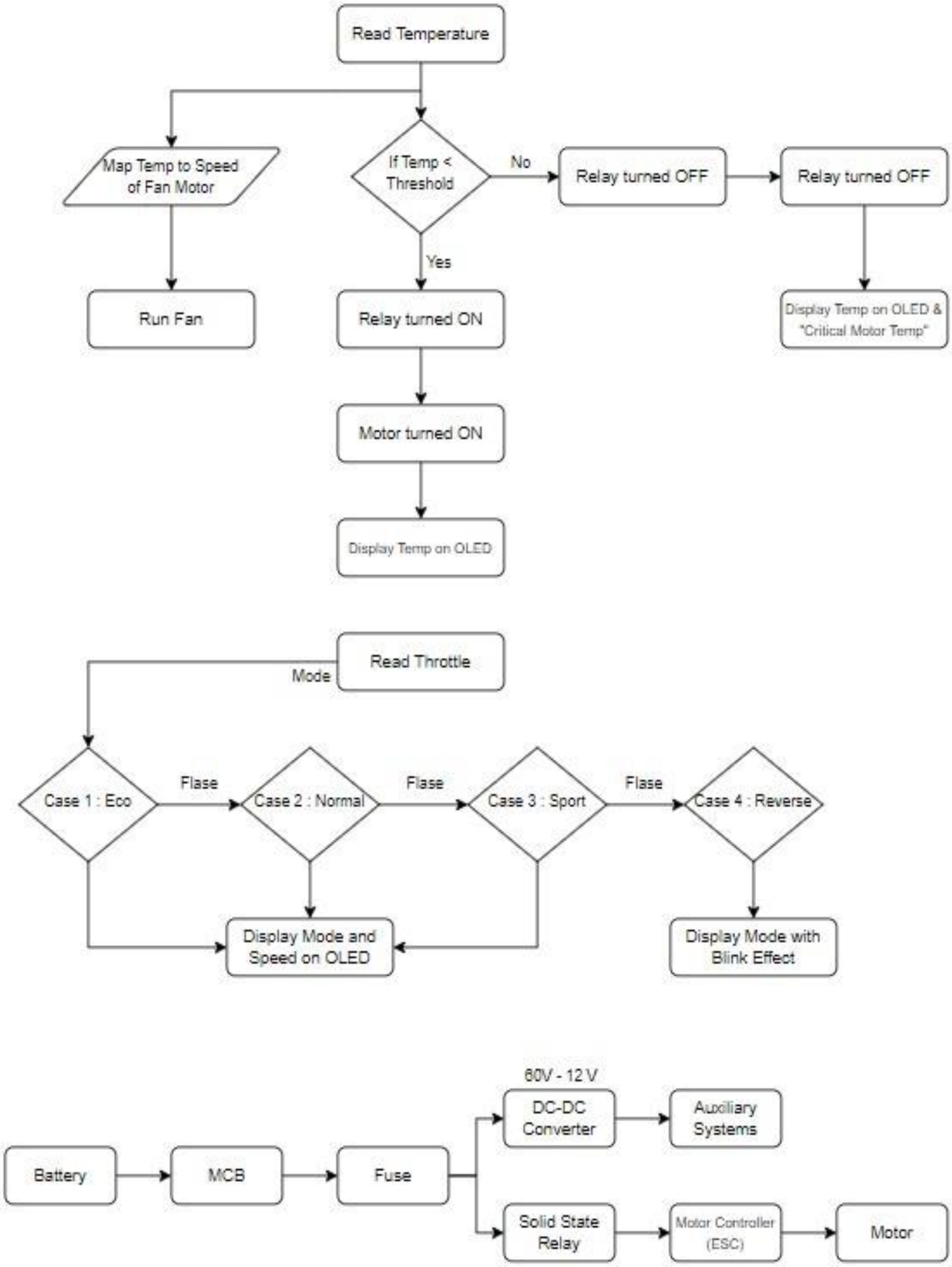



**Figure 3.7.1 Flow Chart**

## 3.8 Methodology

Our electric bike project incorporates a dynamic propulsion system, integrating essential components like a robust 2KW Brushless DC (BLDC) Motor, a 60V lithium-ion battery, and a Battery Management System (BMS). This system efficiently captures and stores motor energy through a groundbreaking regenerative braking system, potentially saving up to 360W of power and enhancing sustainability. Additionally, a self-stabilizing mechanism, powered by a servo motor and monitored by sensors, prioritizes rider comfort and safety across various conditions. Integrated safety features, including high-voltage fuses and twin kill switches, elevate overall safety standards and enable swift emergency reactions. Our comprehensive approach underscores our commitment to developing an electric bike that excels in efficiency, sustainability, and rider safety.

A key component enhancing stability is the gyroscope, which enables rotational motion in any direction. When a body spins on an axis and experiences an acceleration perpendicular to its tilt, gyroscopic motion occurs, generating gyroscopic torque. In our design, the gyroscope's rotation in the horizontal plane applies an active gyroscopic couple across the spin axis. Meanwhile, reactive gyroscopic coupling occurs when the spin axis processes itself, creating a reactive gyroscopic pair that counteracts external disturbances. This reactive couple stabilizes the bike, effectively cancelling out the influence of disturbances and ensuring a smooth and stable riding experience. Through the integration of advanced technologies like regenerative braking and gyroscopic stabilization, our electric bike project aims to set new standards in efficiency, sustainability, and rider safety, ushering in a new era of electric mobility.

1. **Tractive System**

The tractive system of our electric bike is the backbone of its propulsion mechanism, consisting of essential components meticulously integrated for optimal performance. At its core lies a robust 2KW Brushless DC (BLDC) Motor, renowned for its efficiency and power output. This motor is powered by a reliable 60V lithium-ion battery, managed and monitored by a sophisticated Battery Management System (BMS). To ensure safety and prevent electrical mishaps, the system incorporates a Miniature Circuit Breaker (MCB), fuse, and dual kill switches, providing redundant layers of protection. The motor's operation is controlled by a dedicated motor driver, facilitating smooth and precise acceleration. Through cohesive integration, our tractive system guarantees dynamic and efficient propulsion, elevating the overall driving experience of our electric bike.

### 2. Mild Regenerative Breaking

Our project introduces a revolutionary approach to auxiliary power generation through mild regenerative braking. Unlike conventional DC-DC buck converters, our innovative system captures and stores motor energy during deceleration, potentially conserving up to 360W of power. A three-phase rectifier, equipped with six diodes, efficiently transforms motor-generated energy into usable electricity. This electricity is directed to an ultracapacitor, capable of storing a significant amount of energy in its electrostatic field. By harnessing regenerative braking, our electric bike not only optimizes power consumption but also enhances overall efficiency and sustainability. This groundbreaking technology represents a significant leap forward in electric mobility, setting new standards for environmental responsibility and energy conservation.

### 3. Self-Stability

Our electric bike is designed with rider comfort and safety as paramount considerations, incorporating an innovative self-stabilizing mechanism. This mechanism is particularly beneficial in relaxed traffic scenarios, remote-controlled parking, and convenient retrieval from parking facilities. Its compact design makes it adaptable to individuals with disabilities, ensuring inclusivity and accessibility. At the heart of this mechanism is a servo motor directly linked to the bike's pivot, enabling precise adjustments to maintain stability. Sensor data, monitoring the bike's tilt and position, is processed by a PID controller, generating control signals to fine-tune the servo motor's operation. This seamless integration of ergonomics and technology guarantees a stable and secure riding experience, tailored to the diverse mobility needs of individuals. (This is a prototype designed for this concept which we will implement in future).

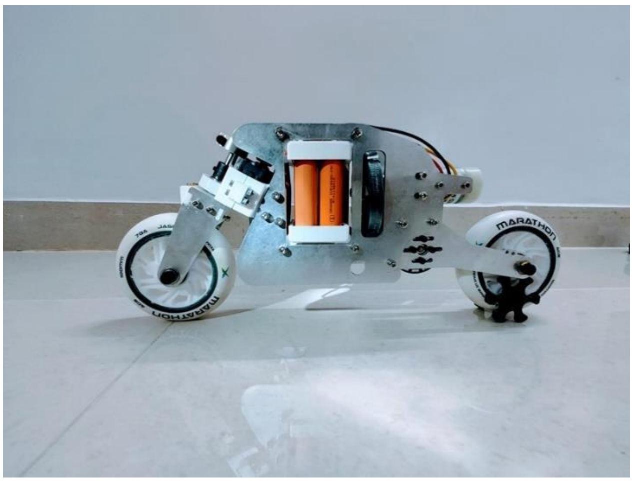



**Figure 3.7 Self-Stability model**

### 4. Safety

Safety is a top priority in our electric bike design, exemplified by the incorporation of dual kill switches and high-voltage fuses (70A and 60A). These safety features are complemented by solid-state relays, controlling all kill switch operations with precision and reliability. In the event of fire or smoke, these mechanisms serve as emergency cutoffs, ensuring rapid response and mitigating potential hazards. By prioritizing safety at every stage of development, our electric bike sets new standards for rider protection and vehicle integrity, instilling confidence and peace of mind in every journey.

# CHAPTER 4

# EXPERIMENTAL SETUP

**4.1 List of Components** The components required for building this project are:

1. **Solid State Relay**
2. **Dc-Dc Converter**
3. **MCB**
4. **Voltage Regulator**
5. **Bolt Fuse**
6. **Throttle Potentiometer**
7. **Kill Switch**
8. **DS18B20**
9. **XT60**
10. **Relay**
11. **Key Socket**
12. **Aurdino**
13. **HC-05**
14. **MCP2515**
15. **GX16**
16. **MT60**
17. **JST connector**
18. **OLED**
19. **BLDC cooling fan**
20. **BLDC Motor**
21. **Battery Pack**

## 4.2 Component description

### • Solid State Relay

A Solid-State Relay (SSR) is an electronic switching device that offers numerous advantages over traditional electromechanical relays. Rated at 80A and 60V, SSRs are designed to handle highcurrent and high-voltage applications with precision and reliability. One of the key benefits of SSRs is their solid-state design, which means they use semiconductor devices such as thyristors or MOSFETs to perform switching operations instead of mechanical contacts. This design eliminates the need for moving parts, resulting in faster switching speeds, reduced wear and tear, and extended service life compared to electromechanical relays. With a maximum rating of 80A and 60V, SSRs can handle a wide range of electrical loads, making them suitable for various industrial, commercial, and residential applications. They can be used to control heaters, motors, lighting systems, power supplies, and other high-power devices with precision and efficiency.

**FIGURE 4.2.1: Solid State Relay**

### • DC-DC Converter

A DC-DC converter, is an electronic device employed to transform a higher input voltage, such as 60V, into a lower output voltage, typically 12V, while maintaining a stable and regulated power supply. This conversion process is crucial in numerous electronic applications where different voltage levels are required for optimal operation.

At its core, a DC-DC converter utilizes sophisticated switching circuits to efficiently regulate the voltage output. These circuits operate by rapidly switching the input voltage on and off at a specific frequency, which allows for the desired voltage transformation. By adjusting the duty cycle of the switching signals, the converter controls the average output voltage, ensuring it remains within the desired range.

One of the key features of DC-DC converters is their ability to achieve high efficiency levels, often exceeding 90%. This efficiency is achieved through careful design and optimization of the switching circuitry, minimizing energy losses during the conversion process. As a result, DC-DC converters are widely used in applications where power efficiency is critical, such as battery powered devices, renewable energy systems, and automotive electronics.

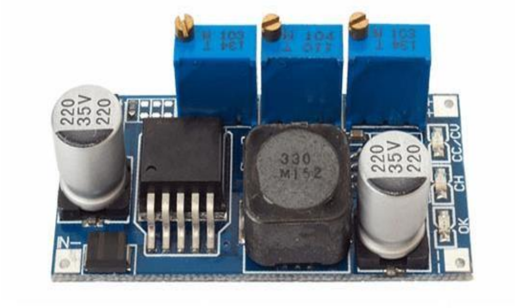


**FIGURE 4.2.2: DC-DC Converter**

• **MCB**

An MCB with the rating "C63" refers to a specific type of Miniature Circuit Breaker designed to protect electrical circuits with a rated current of 63 amperes (A). The "C" designation typically indicates the tripping characteristics of the MCB, specifically its response to over currents. In electrical systems, MCBs are categorized based on their tripping characteristics, which determine how quickly they respond to different types of overcurrent. The "C" rating in this context typically signifies that the MCB has a medium or "normal" tripping characteristic. This means that the MCB is designed to respond to over currents that are higher than the normal operating current but not as rapidly as MCBs with other tripping characteristics.

The numerical value "63" indicates the rated current capacity of the MCB, which represents the maximum continuous current that the MCB can safely carry without tripping under normal operating conditions. In this case, the MCB is rated for circuits with a maximum current of 63 amperes.


**FIGURE 4.2.3: MCB**

### • Voltage Regulator

The LM7805 is a widely used linear voltage regulator IC (integrated circuit) designed to provide a stable 5 volts DC (direct current) output voltage. It is part of the LM78xx series of voltage regulators manufactured by various semiconductor companies.

The LM7805 is commonly used in electronic circuits where a stable and regulated 5V power supply is required. It accepts an input voltage ranging from 7 volts to 35 volts and regulates it down to a precise 5 volts output. This makes it suitable for a wide range of applications, including powering microcontrollers, sensors, logic circuits, and other electronic components.

The internal circuitry of the LM7805 includes a voltage reference, error amplifier, series pass transistor, and current limiting circuitry. The voltage reference compares the output voltage to a fixed reference voltage, and the error amplifier adjusts the pass transistor to maintain a constant output voltage despite variations in input voltage and load conditions.


**FIGURE 4.2.4: Voltage Regulator**

### • Bolt Fuse

A bolted fuse, also known as a bolted-type fuse or a high-voltage fuse, is a type of electrical fuse designed to protect electrical circuits from overcurrent conditions in high-voltage systems. Unlike traditional cartridge fuses or circuit breakers, bolted fuses are typically used in industrial and high power applications where currents exceed the ratings of standard fuses.

The term "bolted" refers to the method of securing the fuse to its holder or mounting bracket using bolts or fasteners, hence the name. This secure attachment ensures that the fuse remains firmly in place even during high-current conditions and prevents it from dislodging or arcing due to mechanical stress or vibration.

Bolted fuses consist of a fuse element enclosed within a housing made of durable materials such as ceramic or porcelain, which provides insulation and protection against external environmental factors. The fuse element is designed to melt or open when exposed to excessive currents, effectively interrupting the circuit and preventing damage to downstream equipment or wiring.

.


**FIGURE 4.2.5: Bolt Fuse**

## • Throttle Potentiometer

A throttle potentiometer, often known as a throttle pot, is a critical component in electronic throttle control (ETC) systems found in modern vehicles. It plays a vital role in translating the driver's physical manipulation of the throttle pedal into an electrical signal that dictates the engine's throttle opening.

The throttle potentiometer features a resistive track and a sliding contact, similar to a traditional potentiometer. Positioned within the throttle or pedal assembly, its movement is synchronized with the throttle pedal. As the driver presses or releases the pedal, the throttle potentiometer's sliding contact moves along the resistive track, altering the resistance and generating a voltage signal proportional to the throttle position.

This voltage signal is transmitted to the engine control unit (ECU) or electronic control module (ECM), where it informs the ECU of the driver's throttle inputs. With this data, the ECU can precisely adjust the engine's throttle, ensuring a seamless connection between the driver's actions and the vehicle's response.

**FIGURE 4.2.6: Throttle Potentiometer**

• **Kill Switch**

A kill switch, also known as an emergency stop switch or engine cutoff switch, is a safety device commonly found in various machinery and vehicles, including motorcycles, boats, and power tools. Its primary function is to immediately shut off the engine or power supply in the event of an emergency or potentially hazardous situation.

Kill switches typically consist of a switch mechanism that interrupts the flow of electricity or fuel to the engine when activated. In many cases, they are designed to be easily accessible to the operator, allowing for quick and intuitive activation in critical situations.

The activation of a kill switch can prevent accidents, fires, or further damage to the vehicle or equipment by stopping the engine's operation. It is often used in scenarios such as engine malfunction, loss of control, or imminent collisions.

**FIGURE 4.2.7: Kill Switch**

• **DS18B20**

The DS18B20 is a digital temperature sensor manufactured by Maxim Integrated. It is widely used in various applications for accurate temperature measurement due to its simplicity, reliability, and versatility. The sensor operates on the One Wire communication protocol, allowing multiple sensors to be connected to a single data line, making it suitable for temperature sensing in distributed systems.

One of the key features of the DS18B20 is its high precision and wide temperature range. It can measure temperatures ranging from -55°C to +125°C with an accuracy of ±0.5°C, making it suitable for both extreme cold and hot environments. The DS18B20 comes in a small form factor package, typically in a TO-92 or TO-92S package, making it easy to integrate into various designs.

It operates on a low voltage range of 3.0V to 5.5V,

**FIGURE 4.2.8: DS18B20**

- **XT60**

The XT60 connector is a widely used electrical connector renowned for its reliability and high current handling capacity, primarily in radio-controlled (RC) hobby applications. It serves as a crucial link between batteries and electronic speed controllers (ESCs) in various RC vehicles like aircraft, drones, cars, and boats.

This connector stands out for several reasons. Firstly, it boasts a robust construction that enables it to handle high currents efficiently, typically up to 60 amps continuously. Such capability makes it particularly suitable for powering high-performance RC models that demand substantial power output.

**FIGURE 4.2.9: XT60**

- **Relay**

A mechanical relay is an electromechanical switch that operates using an electromagnet to mechanically switch electrical circuits on or off. In the case of a 12V or 5V mechanical relay, the numerical value refers to the coil voltage required to activate the relay.

A 12V mechanical relay requires a voltage of 12 volts to energize its coil and switch the contacts, while a 5V mechanical relay operates with a coil voltage of 5 volts. The coil voltage is typically supplied by an external power source or control circuit.

**FIGURE 4.2.10: Relay**

- **Key socket**

A key socket, also known as a key switch socket or key lock socket, is a type of electrical socket designed to accept a key-operated switch. These sockets are commonly used in various applications where security and control are essential, such as access control systems, security alarms, and industrial equipment.

Key sockets are available in various configurations to suit different requirements, including single-pole, double-pole, momentary, and maintained switches. They may also feature different key types, such as standard keys, security keys, or customized keys, to provide varying levels of security.

**FIGURE 4.2.11: Key Socket**

- **Aurdino**

The Aurdino Nano is a compact yet powerful microcontroller board that serves as a cornerstone in the Arduino ecosystem. Powered by the ATmega328P microcontroller, it offers a balance of functionality and size, making it suitable for a diverse array of projects. At the heart of the Nano lies the ATmega328P microcontroller, which provides ample resources for coding and processing tasks. With 32KB of flash memory, 2KB of SRAM, and 1KB of EEPROM, it can handle a variety of applications, from basic sensor interfacing to more complex control algorithms. Despite its small form factor, the Nano boasts a rich set of I/O pins, including digital I/O, PWM, and analog inputs. These pins enable connectivity with a wide range of sensors, actuators, and other components, allowing for the creation of diverse projects ranging from robotics to home automation.

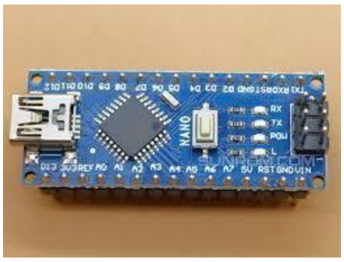


**FIGURE 4.2.12: Aurdino Nano**

- **HC-05**

The HC-05 is a popular Bluetooth module that facilitates wireless communication between electronic devices. It operates on the Bluetooth 2.0 specification and supports the Serial Port Profile (SPP), making it ideal for applications requiring serial communication over Bluetooth. Key features of the HC-05 include its compact size, low power consumption, and ease of use. It is designed to be plug-and-play, with simple UART (Universal Asynchronous Receiver Transmitter) interface for communication with microcontrollers such as Arduino boards. The module can be configured as either a master or a slave device, allowing for flexibility in establishing Bluetooth connections.

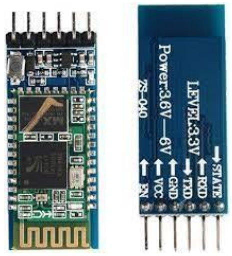



**FIGURE 4.2.13: HC-05**

- **MCP 2515**

The MCP2515 is a standalone controller area network (CAN) controller that enables microcontrollers to communicate with CAN bus networks. Developed by Microchip Technology, it offers a versatile solution for implementing CAN communication in various applications, including automotive, industrial automation, and embedded systems.

Key features of the MCP2515 include its compatibility with both 8-bit and 16-bit microcontrollers, making it suitable for a wide range of embedded systems. It operates as a SPI (Serial Peripheral Interface) slave device, allowing for seamless integration with microcontrollers that support SPI communication.

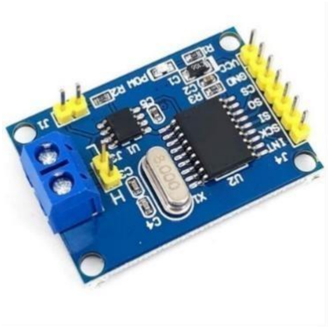


**FIGURE 4.2.14: MCP2515**

## • GX16

Circular aviation connectors of the GX16 type are frequently used in a variety of electronic applications, especially when joining cables in settings where strong and secure connections are necessary. The GX16 connector, which is well-known for its dependability and robustness, has a metal shell that offers robust defence against electromagnetic interference and physical harm. Due to its many pin configurations (which range from 2 to 8 pins), it can be used for a variety of wiring applications. These connectors are frequently found in robots, aircraft systems, industrial gear, and do-it-yourself electronics applications. To prevent unintentional disconnections, their screw-lock mechanism guarantees a stable and secure connection. Here we are using 4pin and 8pin


**FIGURE 4.2.15: GX16**

## • MT60

Robust, high-current electrical connectors called MT60 connectors are utilised in RC models, electric cars, and drones. They have strong construction, safe locking mechanisms, and contacts that are gold-plated for superior conductivity and resistance to corrosion. These connectors, which are made to withstand large power transfers, provide dependable connections even in challenging settings.

The female connector features sockets, while the male connector features projecting pins that fit together snugly. Applications needing strong, reliable connections—such as those involving battery packs, motors, and electronic speed controllers (ESCs) in severe environments—are best served by MT60 connectors. High-power electronics frequently choose them because of their dependability and simplicity of usage.

**FIGURE 4.2.16: MT60**

## • JST connector

One kind of electrical connector used to join wires to a circuit board is the JST connector. It guarantees dependable and secure connections in confined areas because to its small size. JST connectors are widely used in consumer electronics, automotive, and industrial applications. They are available in several series, such as PH, XH, and SH, each of which is made to meet particular voltage and current needs. Their snap-in, user-friendly design makes maintenance and assembly easier. Because of their superior design, which guarantees longevity and a secure connection, the connectors are a preferred option for both manufacturers and enthusiasts.

**FIGURE 4.2.17: JST Connector**

## • OLED

A form of light-emitting diode (LED) in which the emissive electroluminescent layer is an organic compound film that produces light in response to an electric current is called an organic light emitting diode (OLED), also referred to as an organic electroluminescent (organic EL) diode. This organic layer is positioned between two electrodes, one of which is usually transparent. Digital displays are produced by OLEDs and found in gadgets like computer monitors, television screens, and portable gaming consoles and cell phones. The creation of white OLED devices for solid-state lighting applications is a significant field of study.

**FIGURE 4.2.18: OLED**

## • BLDC cooling fan

A brushless DC motor powers a BLDC cooling fan, ensuring quiet, dependable, and effective operation. Because there are no brushes, it has a longer lifespan, higher efficiency, and lower noise level, which makes it perfect for cooling HVAC systems, computers, and other devices. The fan's electronic controller optimises performance and reduces energy consumption by precisely adjusting speed in response to cooling requirements. Common uses include HVAC system air circulation, consumer electronics thermal management, and computer CPU and GPU cooling. BLDC fans offer the best cooling options, guaranteeing the durability and effectiveness of a range of gadgets.


**FIGURE 4.2.19: BLDC Cooling Fan**

## • BLDC Motor

A 2kW Brushless DC (BLDC) motor with a rating of 60V, 50A max rating, and discharge of 60A is a powerful and efficient electric motor commonly used in various applications requiring high torque and precise control. Let us explore its key features:

1. Power Rating (2kW): The power rating indicates the maximum power output of the motor under normal operating conditions. In this case, the BLDC motor has a power rating of 2kW, which means it can deliver up to 2000 watts of mechanical power to drive the load it's connected to.
2. Voltage Rating (60V): The voltage rating specifies the maximum voltage that the motor can safely handle. A 60V rating indicates that the motor is designed to operate within a voltage range of up to 60 volts, making it suitable for applications where high voltage is required to achieve the desired performance.
3. Current Ratings (50A Max, 60A Discharge): The current ratings indicate the maximum current that the motor can handle under different conditions. The 50A max rating refers to the maximum continuous current that the motor can safely handle during normal operation. The 60A discharge rating specifies the maximum current that the motor can handle for short durations, such as during acceleration or peak load conditions..

Overall, a 2kW BLDC motor with a rating of 60V, 50A max, and discharge of 60A. The rated current is 50A. The peak current is 60A. The rated speed in 3300 rpm. The rated torque is 7.6 Nm. Max Output Torque is 33 Nm. The rated power is 2k. The max output power 3k. It is of IP67 rating. The weight of the motor is 5.8 kg. offers a combination of high power, efficiency, and reliability, making it suitable for a wide range of applications across different industries.


**FIGURE 4.2.20: BLDC Motor**

## • Battery Pack

A Lithium-ion (Li-ion) battery with a voltage rating of 60V and a capacity of 41.6Ah is a high energy-density rechargeable battery commonly used in various applications ranging from electric vehicles to portable electronic devices. Let's delve into its key features:

1. Voltage (60V): The voltage rating of the battery indicates the electrical potential difference between its positive and negative terminals. A 60V rating suggests that the battery can provide a nominal voltage of 60 volts when fully charged.
2. Capacity (41.6Ah): Battery capacity refers to the amount of electrical charge stored within the battery, typically measured in ampere-hours (Ah). A capacity of 41.6Ah indicates that the battery can theoretically deliver a constant current of 41.6 amps for one hour before reaching its fully discharged state.
3. Charging Voltage (67V): The charging voltage is the voltage required to recharge the battery to its full capacity. In this case, the battery requires a charging voltage of 67 volts to achieve a complete charge cycle.
4. Max Charging Current (10A): The maximum charging current denotes the maximum rate at which the battery can be charged safely without risking damage to its internal components or compromising its longevity. With a maximum charging current of 10 amps, the battery can accept a charging current of up to 10 amps during the charging process.

In summary, a Li-ion battery with a voltage rating of 60V, a capacity of 41.6Ah, a charging voltage of 67V, and a max charging current of 10A offers a balance of high energy density, safety, and longevity, making it suitable for a wide range of demanding applications.

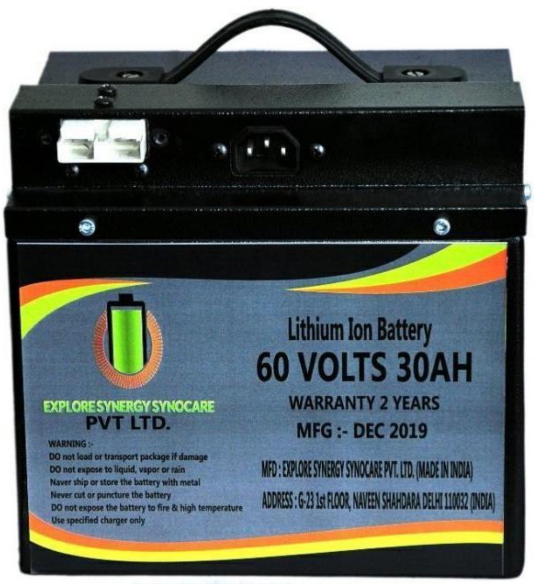



**FIGURE 4.2.21: Battery Pack**

## 4.3 HARDWARE PICTURE

**Fig 4.3.1 Render image**


**Fig4.3.2 Full bike image**

## 4.4 Material selection

In summary, our choice of C.S. Seamless Pipe with AISI 4130 material specification and the specific size of 28.60 mm OD x 1.60 mm thickness is a well-considered decision that prioritizes strength, durability, ease of fabrication, and overall performance. These material attributes are essential in ensuring that our electric motorcycle meets the rigorous standards and challenges set forth by the competition while maintaining a high level of safety and functionality.

| Properties | Values |
|---|---|
| Density | 7.85 g/cm^3 |
| Melting point | 3 1432 C |

**Table 4.4.1 Physical properties of the material**

| Properties | Values |
|---|---|
| Tensile strength, ultimate | 560 MPa |
| Tensile strength, yield | 460 MPa |
| Modulus of elasticity | 190-210 GPa |
| Bulk modulus (Typical for steel) | 140 GPa |
| Shear modulus (Typical for steel) | 80 GPa |
| Poisson ratio | 0.27-0.30 |

**Table 4.4.2 Mechanical properties of the material**

Dimensional parameters

| | |
|---|---|
| Weight | 140Kg |
| Wheel base | 1340mm |
| Length | 1870mm |
| Width | 750mm |
| Height | 1000mm |
| Diameter of tyre | 457mm |
| Chassis type | Dual cradle |
| Wall thickness | 1-2mm |
| Rake angle | 30° |

**Table 4.4.3 Dimensional parameter**

## Type of welds used

In motorcycle manufacturing, various types of welding are used to join different parts and components. The main types of welding used in bike construction include:

1. **MIG Welding (Metal Inert Gas Welding):** Also known as Gas Metal Arc Welding (GMAW), this method is widely used for its speed and versatility. It involves using a continuous wire feed as an electrode and an inert gas to shield the weld from contamination.

2. **Arc Welding:** This traditional welding method uses a consumable electrode coated with flux to lay the weld. It is versatile and can be used in various positions and conditions, making it suitable for structural components.

**Fig 4.4.1 Welding of chassis**

**Fig 4.4.2 Prototype Chassis**

## Cutting methods

The cutting methods used in building a bike typically involve:

**1. Handheld Hacksaw**: A manual saw with a fine-toothed blade used to cut steel tubes and components to size. It requires skill and patience but is readily available and affordable.

**2. Tube Cutter:** Specifically designed for cutting metal tubing, a tube cutter ensures clean and precise cuts without distortion or burrs. It's commonly used for cutting steel tubes in bike frame construction.

**3. Angle Grinder:** While not exclusive to traditional methods, angle grinders with abrasive discs can be used for cutting steel tubes and components. They're versatile and useful for shaping and finishing as well.

**4. Files:** After rough cutting, files are used to refine edges, remove burrs, and ensure precise fits for joints and connections in the frame assembly.

These methods have been employed for decades and are still utilized in custom bike building and small-scale fabrication due to their simplicity and accessibility.

**Prototype manufacturing**

The fabrication of the bike started with the prototype manufacturing. The material used for frame is mild steel. The tubes were cut into the required lengths according to the design provided. The cut tubes were then welded together. The type of welding which we considered was arc welding. Once the frame was welded together, the dimensions were cross verified. There were some changes that had to be made to the design to accommodate the components like the motor and battery, as well as the placement of the same. The design had to be modified in order to accommodate the changes.

**The final frame manufacturing**

The fabrication of the final frame began as soon as the rectifications were made. The required quantity of the frame material was calculated and procured. The fabrication process of this was as same as the prototype manufacturing, except for the type of weld. This time the type of weld which was chosen was MIG welding. This was because MIG welding had it is perks over arc welding. MIG welds were stronger and precise. It had even better surface finish over the joints. The fact that the presence of an inert gas over the welding area acts as a protective layer from the atmospheric exposure.

The frame is then painted. The painting process starts with cleaning of the surface that has to be painted. This includes grinding the surface for even surface over the frame and to even out the surface. Then a primer is applied. A primer is used because it protects the surface from contamination like rust, light and others. It also enhances in levelling the body and to overcome the manufacturing errors.

The next step is applying the base coat. We opted for a solid base coat. The visual properties come into the picture.

The final step is applying a clear coat. This concludes the entire painting process. Painting of the bike plays a vital role in the visual appeal of the bike as well as it protects the bike from atmospheric reactions to the bike like oxidation.

**Assembling of components**

Once the frame is painted and set, the next process is assembling of the components to make the bike moving. The components like wheels, tires, suspension, seat, brakes, battery, motor and handles are attached.

**Fig 4.4.3 Cutting of frame tubes**

**Fig 4.4.4 Grinding**

**Fig 4.4.5 Dimension verification**


**Fig 4.4.6 Ergonomics check**


**Fig 4.4.7 Assembled Chassis**

**Fig 4.4.8 Cutting**

**Fig 4.4.9 Body panels**

**Fig 4.4.10 Built body panels**

# CHAPTER 5

# Results and Discussions

## 5.1 Result

1. **Environmental Impact:** The electric bike operates with zero tailpipe emissions, contributing to a cleaner environment by reducing air pollution and addressing concerns related to climate change. It utilizes clean energy sources, aligning with sustainability goals and promoting eco-friendly transportation.
2. **Control System and Battery Efficiency:** An advanced control system optimizes battery life and range, enhancing the efficiency and reliability of the electric bike. Intelligent power management algorithms ensure optimal energy distribution, minimizing wastage and maximizing performance for users.
3. **Regenerative System:** The mild regenerative braking system effectively extends the battery's lifespan by capturing and storing energy during braking. This showcases the potential for sustainable energy practices in electric vehicles, contributing to long-term environmental benefits.
4. **Battery Performance Monitoring Cluster System: A** comprehensive cluster system monitors and manages battery performance in real-time, providing users with valuable data and predictive maintenance features. This ensures optimal functionality and longevity of the battery, enhancing the overall performance of the electric bike.
5. **Self-Stability:** The self-stabilizing system integrates gyroscopes and accelerometers to maintain the bike's balance, even in challenging conditions. This enhances rider safety and comfort, offering a stable and secure riding experience for users of all skill levels.
6. **Enhanced Safety with Redundancy Protocols:** Multiple redundancy protocols are integrated into the electric bike to ensure a high level of safety for riders. Fail-safe mechanisms respond effectively to potential system failures, minimizing risks and enhancing overall safety during operation.

## 5.2 STEERING

The steering mechanism is crucial for a bike, enabling it to change direction and maintain balance during movement. This system generally includes handlebars attached to the front fork, which supports the front wheel. When the rider turns the handlebars, the front wheel pivots, steering the bike in the intended direction. Effective steering is vital for directing the bike's course, executing turns, and ensuring stability while riding.

Selecting a KTM Duke handle for a student bike project is a well-justified decision due to several key advantages. Known for its performance and durability, the KTM Duke handle ensures excellent control and manoeuvrability, providing students with a reliable and extensively tested component. Utilizing KTM's industry expertise allows students to learn from established standards and best practices, enhancing their educational experience. The advanced engineering and ergonomic design of the KTM Duke handle prioritize rider comfort and control, exposing students to state-of-the-art technology and design principles in motorcycle manufacturing. Additionally, KTM's commitment to safety aligns with the project's focus on rider safety and industry standards. Collaborating with such a reputable brand offers students valuable insights into high-performance motorcycle components, equipping them with practical knowledge and skills beneficial for their future careers.

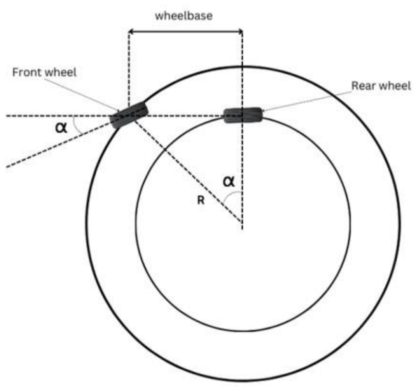



**Fig 5.1 Steering angle**

A=angle=65°

W=wheelbase=1.30m

R=minimum turning radius

r=radius of turning of rear

R=$\frac{W}{sin\propto}$=$\frac{1300}{sin65°}$=1434.39mm

r=$\frac{W}{tan\propto}$=$\frac{1300}{tan65°}$=606.199mm

### 5.3 Braking

The bike to be built will feature a hydraulic disc braking system. Disc brakes are a crucial part of a motorcycle's braking system, having replaced traditional drum brakes in many modern bikes. They work by clamping a flat metal disc (rotor) between two brake pads, generating friction to slow down and stop the motorcycle. Disc brakes provide significant benefits over drum brakes, including superior stopping power, better heat dissipation, and consistent performance in various weather conditions. As the industry standard, disc brakes enhance safety and control for motorcycle riders.

**Frictional force on disc: -** The force that resists the motion of the revolving disc on a disc brake ultimately causes it to slow down or stop. A set of brake pads are forced against the revolving disc (sometimes referred to as a rotor) attached to the wheel when the brakes are applied to a vehicle. The force required to slow down or stop the wheel is produced by friction between the brake pads and the disc.

• **Tyre push road force**: - two allowed. The term "tyre pushes road force" describes how a vehicle's tire interacts with the road surface, specifically the force that the tire applies to the surface. A common name for this force is "road force" or "road contact force. Several forces are at work when a vehicle's tire contacts the ground, including

o Vertical force

o Lateral force

o Longitudinal force

• Road pushes the tire:- The force that a road applies to a tire can be described by several key factors related to the interaction between the tire and the road surface:

o Frictional Force o Normal Force o Adhesion and Traction o Road Surface Properties o Tire Design and Tread o Driving Conditions o Inflation Pressure

• Rotation of wheel force:- The rotation of a wheel on a vehicle involves various forces and dynamics that influence its movement and behavior. Here are some key aspects related to the forces involved in the rotation of a wheel:

o Centripetal Force o Angular Momentum o Torque o Frictional Torque o Rolling Resistance o Gyroscopic Effect o Alignment and Balance

## 5.4 Design Considerations

| Road Surfaces | Coefficient of friction between tire and road |
|---|---|
| 1.Dry Asphalt | 0.8 |
| 2.Wet Asphalt | 0.6 |
| 3.Snow | 0.3 |
| 4.Ice | 0.1 |

Table 5.4.1 Coefficient of friction

Selecting the hydraulic disc brakes from the renowned KTM Duke for the construction of the electric bike in this student project is a deliberate choice that prioritizes performance, safety, and integration. Utilizing the KTM Duke's proven braking system ensures reliable stopping power and precise control, enhancing the safety of the electric bike prototype. Moreover, the compatibility of these brakes with the overall design streamlines the assembly process and provides access to expert support from a reputable motorcycle manufacturer. This choice also boosts the project's market credibility, showcasing the electric bike's potential to stakeholders and industry professionals with a sense of reliability.

Formulation and Calculations.

1. Front Disk Brake Calculation

Ro = Outer radius of pad(mm) = 150mm

Ri = inner radius of pad(mm) = 120mm

Θ = Angular dimensions of pad(radians)

Material of disk = Stainless steel

Average Pressure = 2MPa

Max torque capacity of the disk brake

M t =MPR f [ N - mm \ I

M = coefficient of friction

P = actuation force (N)

Rf = friction = radius [mm]

$$Rf = \frac{1}{3}\frac{}{D-d}(D23-d32)$$

Rf = 135.5mm

P = Average pressure x area of pad

P = Pavg x A

$A = \frac{1}{2}\theta(Ro^2 - Ri^2)$

$\Theta = 75^o$

$\Theta$ = 1.308 rad

A = 5297.4 $mm^2$

P = 10594.8N

Mt = MP*Rf =0.58X10594.8X135.55

Mt = 832952.58

M t = 832.95N .m

2. Rear Disk Brakes

1) $Rf=\frac{2}{3}\left[\frac{R_0^3-R_i^3}{R_0^2-R_i^2}\right]$

$\begin{pmatrix} R_o = 115mm \\ R_i = 85mm \end{pmatrix}$

$Rf=\frac{2}{3}\left[\frac{115^3-85^3}{115^2-85^2}\right]$ = 100.75mm

2) P= Average pressure× area of pad

$A=\frac{1}{2} \times \theta[R_o^2 - R_i^2]$

$A=\frac{1}{2} \times 1.308[115^2 - 85^2]=3924mm^2$

Mt = 458.59 N-m

3) Stopping distance

S = $\frac{[V]^2}{2F}$

[V = vehicle speed (m/sec)]

[F = deceleration(m/$sec^2$)]

Braking efficiency –

deceleration/acceleration due to gravity

Braking efficiency $= \frac{F}{g} \times 100$

Condition 1(when front brake is applied)

$$\frac{f}{g} = \frac{\mu \times y}{b - \mu h}$$

u is the coefficient of friction(0.58), g = acceleration(9.81) f = stopping distance, b is wheelbase

f = $\frac{0.58 \times 9.81 \times 0.52}{1.3 - [0.58 \times 0.65]}$

f =3.205 m/$sec^2$

S = $\frac{V\text{^}2}{2f} = \frac{6.94^2}{2 \times 3.205} = 7.51m$

t = $\sqrt{S \times 0.204}$

t =$\sqrt{7.51 \times 0.204}$

t =1.23sec

Condition 2(when rear brakes are applied)

$$\frac{f}{g} = \frac{\mu x}{b + \mu h}$$

f = 2.692 m/$m^2$

S = $\frac{V^2}{2f} = \frac{[6.94]^2}{2 \times 2.692} = 8.94m$

t $=\sqrt{S \times 0.204}$

t $=\sqrt{8.94 \times 0.204}$

t = 1.35sec

Condition 3(when both the brakes are applied)

$\frac{f}{g} = \mu$

f = $0.58\times 9.81$

f = 5.688 m/$s^2$

S $= \frac{V^2}{2b} = \frac{[6.94]^2}{2\times 5.688} = \mathbf{4.23m}$

t $=\sqrt{S \times 0.204}$

t $=\sqrt{4.23 \times 0.204}$

t = 0.92sec

# CHAPTER 6

# Conclusion

The development of the electric bike represents a significant milestone in the realm of eco-friendly transportation, leveraging cutting-edge technologies and innovative solutions to address critical challenges facing the electric vehicle industry. This project not only meets but exceeds environmental and energy efficiency goals by implementing clean energy sources, advanced control systems, and regenerative braking mechanisms.

One of the most noteworthy aspects of the electric bike is its environmental impact. By achieving zero tailpipe emissions, the bike contributes to a reduction in air pollution and helps combat climate change. This is made possible through the effective harnessing of clean energy sources, such as lithium-ion batteries, which power the bike's motor. By prioritizing sustainability and reducing reliance on fossil fuels, the electric bike aligns with global efforts to transition towards greener modes of transportation. Furthermore, the electric bike boasts an advanced control system that significantly enhances battery life and range. Through the implementation of intelligent power management algorithms, energy distribution is optimized, minimizing wastage and maximizing efficiency. This ensures that riders can enjoy extended periods of use without the need for frequent recharging, thereby improving the overall user experience and convenience of electric bikes.

A key feature of the electric bike is its regenerative braking system, which is designed to extend the life of the battery. Unlike conventional braking systems that dissipate kinetic energy as heat, regenerative braking captures and stores this energy for later use. This not only improves energy efficiency but also contributes to a more sustainable and self-sufficient riding experience. By harnessing the power of regenerative braking, the electric bike demonstrates a commitment to innovative and environmentally friendly transportation solutions. In addition to its environmental and energy efficiency benefits, the electric bike prioritizes safety through the integration of advanced safety features. These include redundancy protocols and a self-stabilizing system, which work together to ensure a high level of rider safety and confidence. The redundancy protocols provide fail-safe mechanisms that respond rapidly to potential system failures, while the self-stabilizing system maintains the bike's balance even in challenging conditions, reducing the risk of accidents and injuries.

The electric bike also features a comprehensive battery monitoring system, which monitors and manages battery performance in real-time. This system offers riders valuable insights into battery health and performance, enabling them to make informed decisions about usage and maintenance. By ensuring optimal battery performance, the electric bike enhances reliability and longevity, further reinforcing its reputation as a sustainable and reliable mode of transportation. In conclusion, the development of the electric bike represents a significant step forward in the pursuit of eco-friendly transportation solutions. By leveraging advanced technologies and innovative design principles, the electric bike offers a compelling alternative to traditional vehicles, with benefits ranging from zero emissions and energy efficiency to enhanced safety and reliability. As the demand for sustainable transportation continues to grow, the electric bike stands poised to revolutionize the way we commute and travel, offering a greener, cleaner, and more sustainable future for generations to come.

# CHAPTER 7

# FUTURE SCOPE

The future of electric bikes looks promising. Imagine being able to call upon your ready-to-ride, unlocked e-bike using your phone. By giving back extra power, V2G technology may even enable e-bikes to contribute to a greener grid. Advanced cluster control, which allows bikes to communicate and change positions in groups, is one characteristic that cyclists may notice. Professional racing teams may possibly benefit from this technology. Future e-bikes may also have sophisticated stability control systems, which would increase cycling accessibility for those with physical restrictions. We can anticipate many more features that make e-bikes an accessible, eco-friendly, and inclusive mode of transportation as technology develops.

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