REACTION BEAM CALIPER BRAKE PAD WEAR WARNING USING INTERNET OF THINGS (IoT)

MT6811 PROJECT

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

One of the major technological development is the invention of motor vehicles. The vehicles used nowadays are for transportation purposes like movement of people, goods, etc., The safety has become one of the major concern while traveling in these vehicles. Many companies strive to improve the safety of their vehicle and boast them in their advertisements. The brakes are one of the important safety component that need to be taken into consideration for the improvement of safety in a vehicle.

The wear of the brake pad is often ignored by many drivers which may be fatal as the stopping distance would get increased if the brake shoe is completely worn out. The indication is present on the dashboard which is the major reason for its ignorance.

Thus, the major aim of this project is to provide an easy solution to notify the concerned person through text messages and mobile application about the brake pad wear on a caliper brake. This is implemented using the pad wear sensor that is attached alongside the brake shoe lining that senses the wear of the brake pad and transmits a signal to the microcontroller which is in turn connected to the GSM and IoT modules to send the warning to the concerned person.

TABLE OF CONTENT

LIST OF FIGURES

CHAPTER - 01

INTRODUCTION

1. OVERVIEW

Technology, in its recent days, has been showing a rising trend in all its relevant areas of indulgence. One such area in which the development is very much appreciable and clearly noticeable is the field of automobiles.

In automobiles, the classified field of interest in technological improvement is mainly the heavy and light passenger vehicles. In these vehicles, many consideration is made on the parameters and the ultimatum is to enhance the comfort and safety. To achieve these factors, the firms do a lot of enhancements and upgrade their system of working when required.

The braking system is the major component of the safety unit in an automobile. It must be maintained in a proper condition and should be checked regularly in order to assure the safety of the vehicle as well as the travellers. Majority of the heavy vehicle accidents are fatal and they take place mainly due to the negligence of the driver regarding the brake pad wear.

The brake pads are the major component in a brake system that is responsible for sharp braking and stopping of the vehicle. If the brake pads are worn out, and it is left unnoticed or not taken care, then the brakes of the vehicle may not perform as expected and may lead to fatal accidents.

In order to provide a solution that is feasible to alert the driver and other responsible people, we had developed a project that gives warning about the condition of the brake pad through text messages. This solution is considered to be effective as every one of us use mobile phones and check it regularly.

When there is a text message on our mobile phone about the condition of the brake pad wear, then it can trigger the people to take action by changing the brake pads as soon as possible.

1.2 PROBLEM STATEMENT

- ➢ The accidents caused due to brake failure contributes around 22% of the total accidents that takes place worldwide. It is the second highest contributor for automobile accidents.
- ➢ The brake pads and discs in your car wear out a little bit more with each and every use. Over time, this wear makes it harder to stop your vehicle, resulting in longer stop distances and increased accident risks.
- ➢ Preventing this issue takes regular maintenance and inspection of your vehicle's brake systems. Have a thorough inspection done at least once every 30,000 miles—this is the typical minimum lifetime of brake pads.

3. OBJECTIVES

- ➢ To provide an easy solution to indicate the brake pad wear of the vehicle that you travel through text messages to the registered mobile number.
- ➢ To alert the driver in an effective way through his mobile phones rather than a dashboard indication.
- ➢ To provide seamless connection between the vehicle's brake condition and the person who is responsible to take corresponding actions to change the brake pad of the vehicle on time.

1.4 EXISTING MODEL

- ➢ The current version of brake pad wear alerting system is incorporated on the dashboard of the vehicle and the warning indicator glows whenever the brake pad of the vehicle is worn out.
- ➢ The brake pad thickness sensing element is simple in its construction and it consists of conducting wire enclosed in a protective jacket.
- ➢ This indication is ignored for most of the time by the drivers which may lead to some serious consequences.

5. PROPOSED MODEL

- ➢ The proposed model is designed in a way that the person is notified through his mobile phone which can be effective as each and every one will be having their mobile phones with them most of the time.
- ➢ During long distance travel, it is mandatory to check the brake system and its working in order to ensure safety.
- ➢ If the brake pads are worn for a particular amount, then there would be a warning message sent to the respected person about the brake's condition and the necessity to change the brake pad immediately at the nearest service station.

CHAPTER-02

LITERATURE REVIEW

David Willey and David G. Williams invented the Brake pad wear detection system (1978) that comprises a brake having a brake pad and a conductive braking face, the brake pad and the conductive braking face engaging during braking, a sensor loop embedded in the brake pad and positioned so as to be broken when the wear to the brake pad exceeds the working limited, an indicator means, and a detecting means, characterised in that the detecting means detects contact between the sensor loop and the braking face and also breakage of the sensor loop. By providing a detecting means which detects contact between the sensor loop and the braking face as well as the breakage of the sensor loop, it is ensured that warning will be given when wear to the pad is approaching the working limit.

Katsuya Ito and Hitoshi Takanashi developed Pad Wear indicator probe (1993) that contains a plurality of terminals turned or bent into a U-shape with their tip positions offset from each other. The terminals are cut in stages according to the wear development degree of the brake pad. It comprises of a core element disposed near a tip of the probe, the core element having first and second diameter portions, said first diameter portion being larger than said second diameter portion; and a plurality of U-shaped electric wire paths having a turn part extending toward said tip of the probe, the turn part of each of said plurality of U-shaped electric wire paths wrapped around one of said first diameter portion and said second diameter portion, said plurality of electric wire paths being different in a length measured between the turn part of each of said plurality of electric wire paths and said tip of the probe.

William Gronowicz Jr. proposed a Brake pad wear sensor (2001) that is attached to a backing plate of a brake pad. The sensor comprises a metal arm

extending to one side of the brake pad. The metal arm is electrically insulated from the backing plate. A tab made from a dielectric material projects from a free end of the arm in the same direction that the brake pad extends from the backing plate. The tab has a wear face spaced from the backing plate, the same distance as a brake surface of the brake pad. When a brake is applied by a vehicle operator, both the brake pad brake surface and the tab wear face frictionally engage a brake rotor fixed to a wheel hub. The dielectric material is selected so the tab wears at the same rate as the brake pad. The capacitance changes as the dielectric material wears away. The capacitance is used to indicate the remaining amount of brake pad life on a digital readout.

Daniel Philpott introduced a Brake Pad Wear Monitoring System (2014) that may include a brake pad wear sensor module that may be configured to detect wear of a friction material of a brake pad assembly. The brake pad wear sensor module may transmit a signal that may be indicative of a wear condition of the friction material. It comprises of a brake pad wear sensor module for detecting wear of a friction material of a brake pad assembly, the brake pad wear sensor module having a terminal and a diagnostic device that communicates with the brake pad wear sensor module via the terminal, the diagnostic device having a user interface; wherein the diagnostic device receives a signal from the brake pad wear sensor module indicative of a wear condition of the friction material and wherein the diagnostic device provides a first output via the user interface when the signal indicates a first brake pad wear level and provides a second output via the user interface when the signal indicates a second brake pad wear level.

CHAPTER – 03

METHODOLOGY

3.1 DESCRIPTION

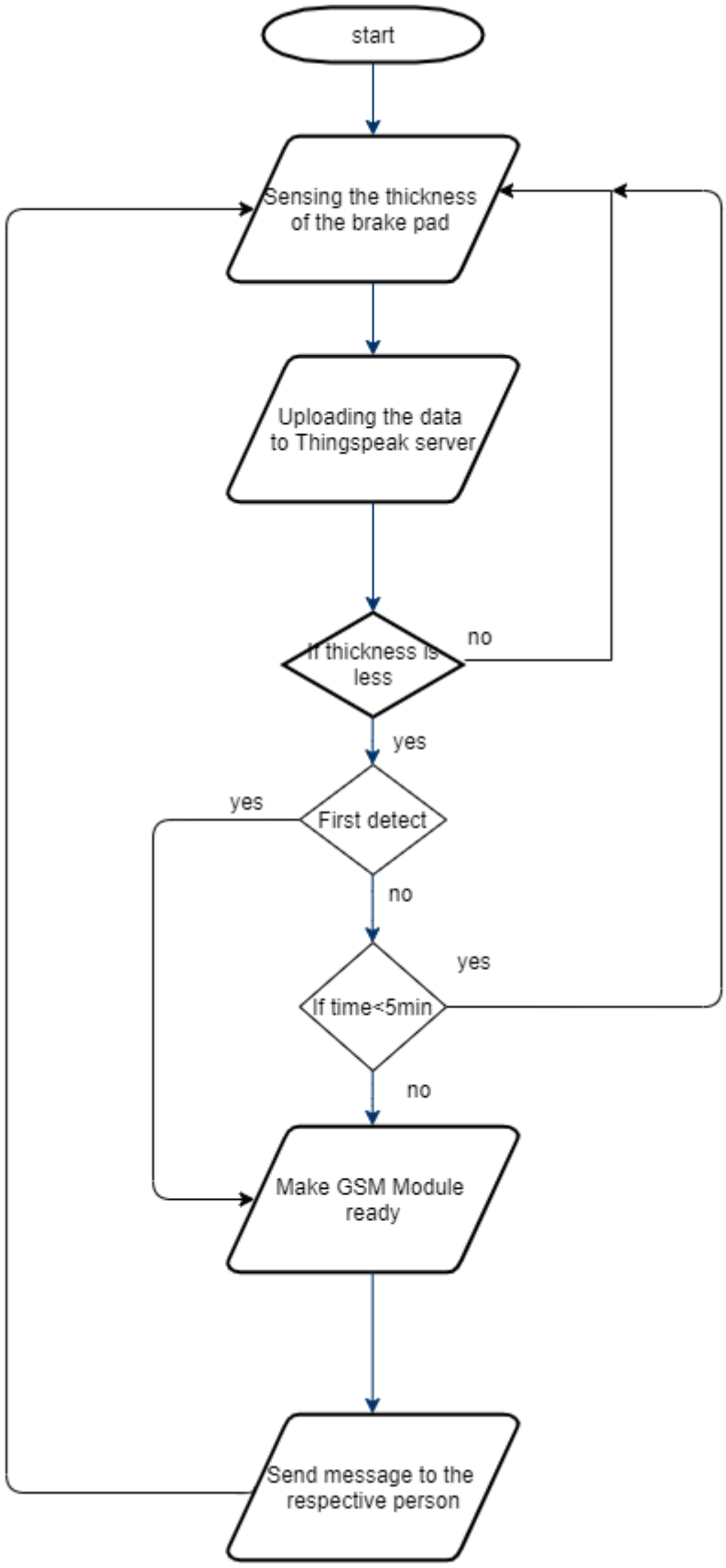
The methodology incorporated to overcome all the setbacks in the given problem statement are given below:

The preliminary communication with the personnel of the vehicle is achieved by using the GSM (Global System for Mobile Communication) module. With the help of this module simple text messages stating the condition of the brake pad have been sent to the user in order to warn them about the deteriorated condition of the brake pads that may lead to some fatal accidents. The GSM requires an active Sim Card to be inserted in the given slot for the communication, between the vehicle and the responsible person, to take place. The type of GSM module used in this project is compatible with 4G network (SIM900A). Hence, both text messages and activities like server updating can be done. The module operates on four bands of frequencies which are 850 / 900 / 1800 and 1900 MHz.

The connection between the module and the server is provided by the internet and the data from the module is updated on the server with the help of IoT technology. The server used here for data tracking and plotting is ThingSpeak, an open source server by MathWorks. It mainly focuses on IoT analytics. The real time data from the brake pad wear sensor is sent to the server for maintain the database for the rate in which the pad wears. These data can be useful for future reference and can also be useful in drawing interpretations about the quality and the performance of the brake pad.

3.2 BLOCK DIAGRAM AND FLOWCHART

3.2.1 Block Diagram



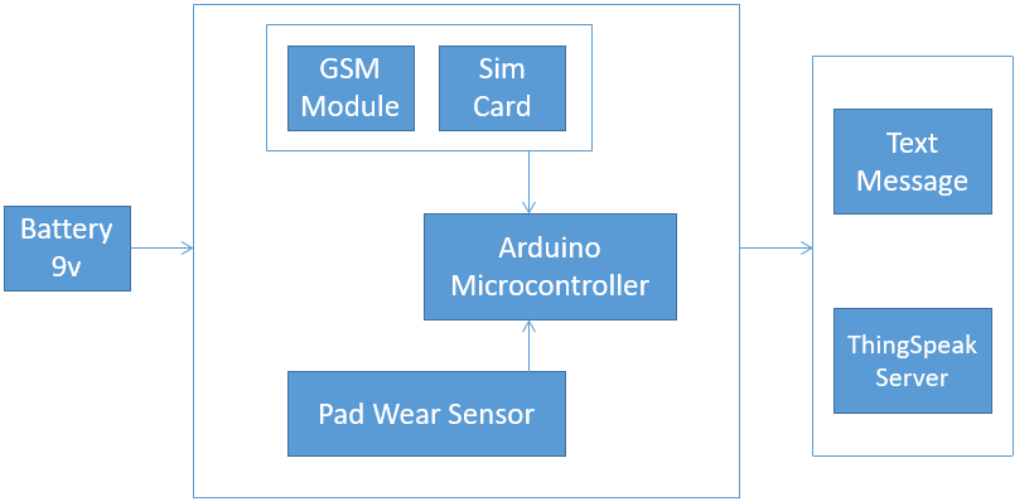


Fig.3.2.1 Block Diagram

The existing brakes are attached with a pad wear sensor which is connected to an Arduino microcontroller. The GSM module is inserted with a sim card that can relay texts and update graph in the ThingSpeak server. All these operations are controlled using the microcontroller which has a separate 9V power supply from a battery.

3.2.2 Flowchart

Fig.3.2.2 Flowchart

3.2.3 Algorithm

STEP 1: Start.

STEP 2: The thickness of the brake pad is sensed using the pad wear sensor.

STEP 3: The thickness data is uploaded to the ThingSpeak server.

STEP 4: Check whether the thickness of brake pad is critical or not.

If yes, then go to STEP 5 else go to STEP 2.

STEP 5: Detect the thickness of the brake pad once again to get the wear data.

If yes, go to STEP 7 else go to STEP 6.

STEP 6: Check whether the time between each detections is less than 5 minutes.

If yes, go to STEP 2 else continue with STEP 7.

STEP 7: Make the GSM module ready for transmission by enabling the internet.

STEP 8: Send an SMS to the respective person regarding the condition of the Brake

Pads and also update the graph on the ThingSpeak Server immediately.

3.2.4 Circuit Diagram

The circuit diagram given, depicts the real time connection of the circuit required. It consists of components such as a Microcontroller, GSM Module, Brake Pad wear indicator, Battery. The microcontroller acts as the primary control centre for the overall functioning of the setup. The microcontroller used in this system is Arduino Nano and the interfacing of all the other components are made with this microcontroller. The control instruction and the respective code is fed to the microcontroller in order to perform the required operation.

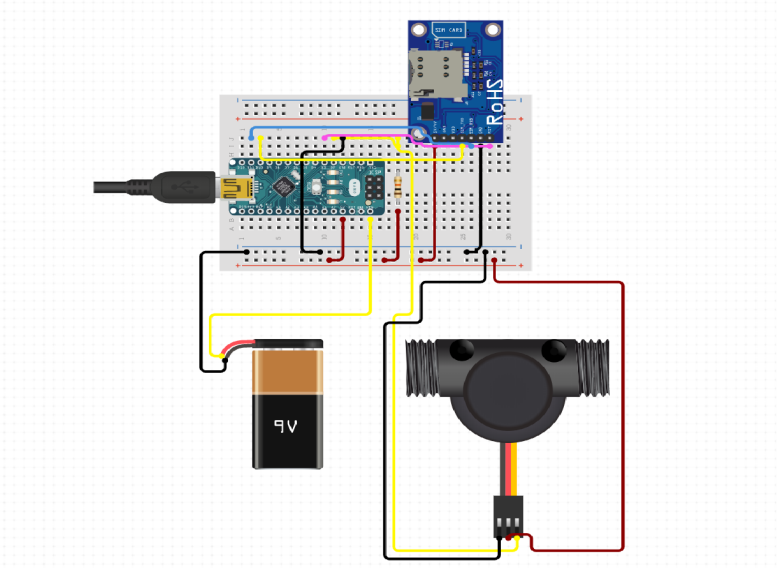


Fig.3.2.3 Circuit Diagram

The GSM module is used to establish the network connection between the user and the system. The connection is made with the Arduino microcontroller. The transmission pin TXD of the GSM module is connected with the Digital 10 pin of Arduino microcontroller. The receiving pin RXD of the GSM module is connected with the Digital 11 pin of Arduino microcontroller. The power to the GSM module is provided by connecting the Vin and Gnd pin of the module with the 5v and Gnd pin of the microcontroller.

The brake pad wear sensor is a thick copper wire which starts conducting over a predetermined wear rate. The connection is made with the microcontroller through the Analog pin A1.

The power to the entire circuit is provided through a 9v battery. This enables the system to operate in a standalone manner. The battery is connected to the adapter port of the microcontroller.

The signal from the brake pad wear sensor is used to drive the GSM module to send the messages to the user and the connection with the internet will enable the data to be uploaded to the ThingSpeak server.

3.3. Hardware Description

3.3.1 Wear Indicator

The brake pad wear indicator is used to sense the thickness of the brake pad in the vehicle and it is accountable for the indication of the state of the brake pad as bad when the thickness of the brake pad wears and reduces below the safer size. The construction of the brake pad wear indicator is very simple to interpret. The indication of the bad state of the brake pad is given by glowing a light in the dashboard of the vehicle.

Fig.3.3.1 Wear Indicator

The brake pad wear indicator consists of a connector and a wire with protective covering. The connection is of NO (Normally Open) type and the signal is passed through the connector once the brake pad wears below the permissible limit and the connection is closed. This signal is the one which is used to glow the light in the dashboard.

3.3.2 Arduino Nano

Arduino Nano is a small, compatible, flexible and breadboard friendly Microcontroller board, developed by Arduino.cc in Italy, based on ATmega328p (Arduino Nano V3.x) / Atmega168 (Arduino Nano V3.x). It comes with an operating voltage of 5V; however, the input voltage can vary from 7 to 12V. Arduino Nano Pinout contains 14 digital pins, 8 analog Pins, 2 Reset Pins & 6 Power Pins. Each of these Digital & Analog Pins are assigned with multiple functions but their main function is to be configured as input or output.

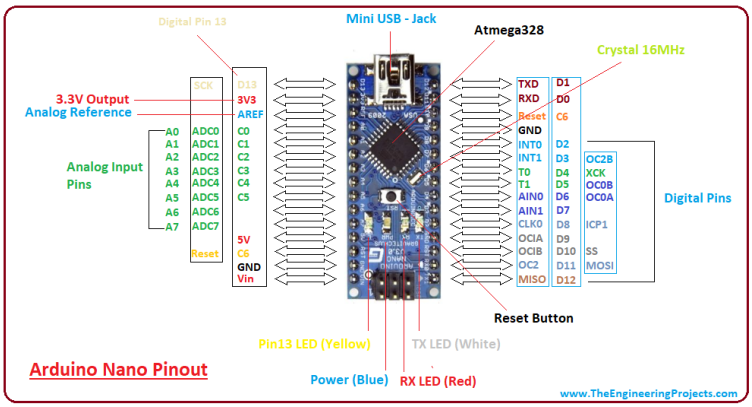


Fig.3.3.2 Arduino Nano

We use this microcontroller mainly because of the size and the functionalities it carries out. This microcontroller is used to digitalize the working of the brake pad wear indicator and also to interface the brake pad wear indicator with the GSM module.

3.3.3 GSM Module

The SIM900 is a complete Quad-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. Featuring an

industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption.

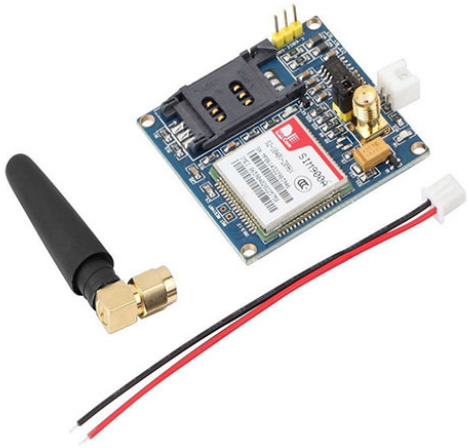


Fig.3.3.3 GSM Module

We use the SIM 900A GSM Module along with a sim card to indicate the condition of the brake pad through SMS and also to upload the data to a server. With the uploaded data, we can indicate the number of kilometres remaining with a safe thickness of the brake pad.

3.4 Software Description

3.4.1 Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the

programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public Licence, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main () into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

3.4.2 ThingSpeak

ThingSpeak™ is an IoT analytics platform service that allows you to aggregate, visualize and analyse live data streams in the cloud. ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak. With the ability to execute MATLAB® code in ThingSpeak you can perform online analysis and processing of the data as it comes in. ThingSpeak is often used for prototyping and proof of concept IoT systems that require analytics.

Internet of Things (IoT) describes an emerging trend where a large number of embedded devices (things) are connected to the Internet. These connected devices communicate with people and other things and often provide sensor data to cloud storage and cloud computing resources where the data is

processed and analyzed to gain important insights. Cheap cloud computing power and increased device connectivity is enabling this trend.

IoT solutions are built for many vertical applications such as environmental monitoring and control, health monitoring, vehicle fleet monitoring, industrial monitoring and control, and home automation.

An IoT system includes all these elements. ThingSpeak fits in the cloud part of the diagram and provides a platform to quickly collect and analyze data from internet connected sensors.

ThingSpeak allows you to aggregate, visualize and analyze live data streams in the cloud. Some of the key capabilities of ThingSpeak include the ability to:

- Easily configure devices to send data to ThingSpeak using popular IoT protocols.
- Visualize your sensor data in real-time.
- Aggregate data on-demand from third-party sources.
- Use the power of MATLAB to make sense of your IoT data.
- Run your IoT analytics automatically based on schedules or events.
- Prototype and build IoT systems without setting up servers or developing web software.
- Automatically act on your data and communicate using third-party services like Twilio® or Twitter®.

Chapter – 04

WORKING OF CALIPER BRAKES

At their most basic, brake calipers are force-multiplication devices. Step on the brake pedal and a small piston compresses brake fluid in the master

cylinder. Because brake fluid doesn't compress, this force is transmitted instantly to the brake calipers. Inside the brake caliper, large pistons multiply the force exerted, pushing the brake pads into the brake rotor.

In the case of fixed brake calipers, the pistons compress from both sides. In the case of floating brake calipers, the piston pushes first on the inboard brake pad, pushing the caliper away from the rotor, causing the outboard brake pad to contact the rotor. The caliper slides allow for this movement.

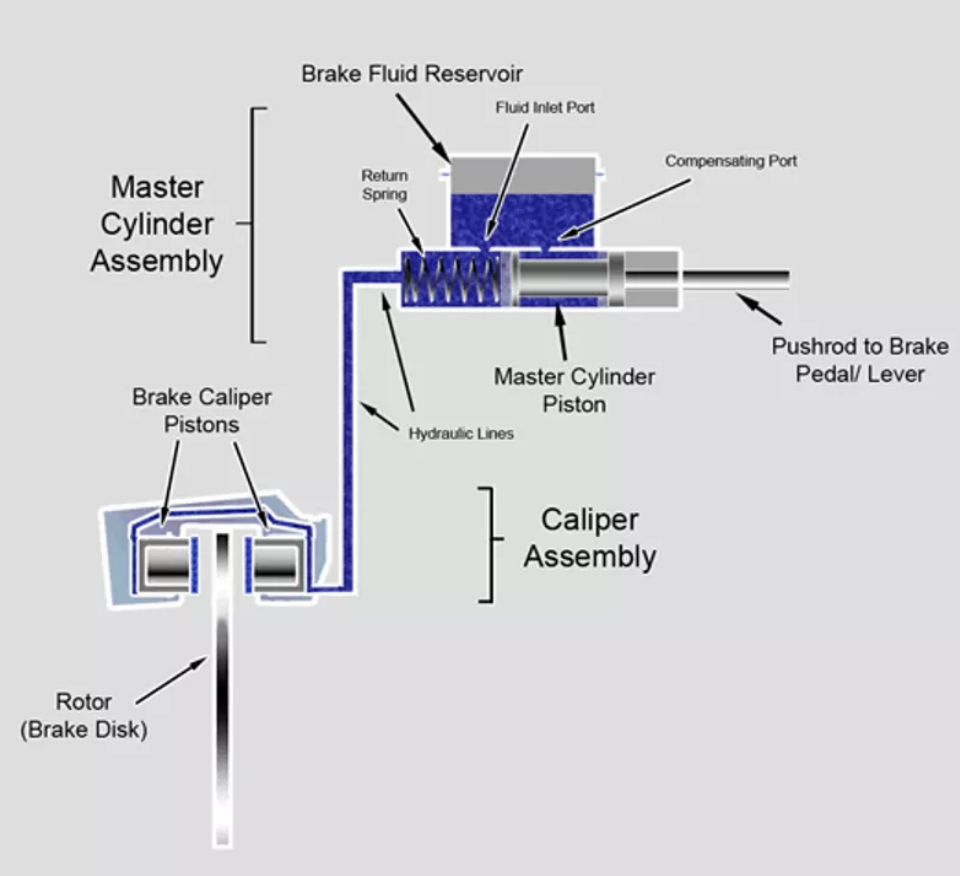


Fig.4.1 Caliper Working

A floating caliper typically uses one piston to move the inboard pad into contact with the inner side of the rotor. The force of the inboard pad contacting the inside surface of the rotor causes the caliper to slide or float on the pins mounted to the bracket or steering knuckle. This forces the outboard pad, mounted inside the caliper housing to contact the outer side of the rotor. This clamping force on the spinning rotor is what causes the wheel to slow and stop.

Cheese slide pins can stick in their bores, preventing sufficient braking force and causing the inboard pad to wear prematurely.

A fixed caliper has pistons on both sides of the rotor. These pistons squeeze both the inboard and outboard pads with equal force causing the vehicle to stop. Light and medium trucks and luxury cars have fixed calipers. Brake caliper pistons are either chrome-plated steel or phenolic plastic. Both of these are hollow to save weight. The phenolic pistons are excellent heat insulators and thus help prevent heat from degrading or boiling the brake fluid.

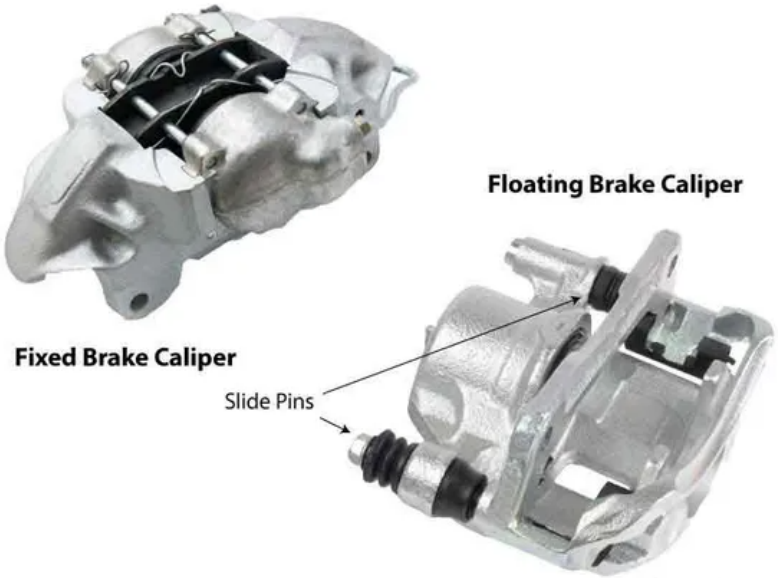


Fig.4.2 Types of Caliper Brakes

Brake calipers are essential to your car's ability to stop and are arguably one of the most important automobile brake parts. Most cars today have disc brakes, at least for the front wheels, anyway. But a lot of cars and trucks are now using disc brakes in the rear, too. In a disc-braking system the car's wheels are attached to metal discs, or rotors, that spin along with the wheels. The job of the caliper is to slow the car's wheels by creating friction with the rotors.

The brake caliper fits over the rotor like a clamp. Inside each caliper is a pair of metal plates bonded with friction material -- these are called brake pads. The outboard brake pads are on the outside of the rotors (toward the curb) and the inboard brake pads on the inside (toward the vehicle). When you step on the

brake, brake fluid from the master cylinder creates hydraulic pressure on one or more pistons in the brake caliper, forcing the pads against the rotor. The brake pads have high-friction surfaces and serve to slow the rotor down or even bring it to a complete halt. When the rotor slows or stops, so does the wheel, because they're attached to one another.

Older cars and trucks used drum brakes, where the motion of the wheels is slowed by friction between a rotating drum and brake shoes mounted inside the drum. This friction caused heat and gases to build up inside the drum, which often resulted in a loss of braking power known as brake fade. Because the brake pads in disc brake systems are external to the disc rather than contained within a drum, they are more easily ventilated and heat doesn't tend to build up quite as fast. For this reason, drum brakes have been largely replaced in modern vehicles by disc brakes; however, some less expensive cars still use drum brakes for the rear wheels, where less stopping power is required.

There are two main types of calipers: floating (or sliding) calipers and fixed calipers. Floating calipers move in and out relative to the rotor and have one or two pistons only on the inboard side of the rotor. This piston pushes the entire caliper when the brakes are applied, creating friction from the brake pads on both sides of the rotor. Fixed calipers, as the name implies, don't move, but rather have pistons arranged on opposing sides of the rotor. Fixed calipers are generally preferred for their performance, but are more expensive than the floating kind. Some high-performance fixed calipers have two or more pairs of pistons (or "pots") arranged on each side of the rotor -- some have as many as six pairs total.

Brake pads don't last forever. Every time the pads in a disc brake system come in contact with the spinning rotor, they wear down a little. Gradually, these brake parts (the pads) become thinner and thinner. To compensate for this, the piston in the caliper emerges from the hollow cylinder where it resides inside the caliper. As it does so, it pushes the worn-down brake pads further and

further inward toward the rotor. Eventually, the brake pads will need to be replaced with fresh, unworn pads. Unfortunately, the caliper piston (which is now nearly fully extended) makes it difficult to remove and replace the pads. The piston needs to be pushed back into the caliper.

This is where special brake pad tools come in. The job of a brake caliper tool is to retract the piston or pistons back into the caliper so that the brake pads can be easily removed and replaced. The piston can't simply be pushed back into the caliper because it's threaded, like a screw, and needs to be wound back in. While it is possible to use, say, a pair of pliers to do this, it isn't recommended. You can damage the piston, the caliper and your hands, too. The brake caliper tool typically fits over the piston at one end and has a handle at the opposite end that allows it to be rotated. As it rotates, the piston is wound back into the caliper.

Floating calipers also need to be serviced if the pins that they slide on begin to stick. This is usually caused by dirt or rust. When this happens, the caliper cannot fully retract the brake pad from the rotor and friction continues, even when the brake pedal isn't being pushed. This can cause excessive wear on the pad, inefficiency in fuel use, and even warping of the rotor if enough heat builds up.

CHAPTER – 05

THINGSPEAK SERVER DATA

5.1. Data before criticality

The data of brake pad thickness is taken into account by using the in-house pad wear sensor that is being produced by the company itself. This sensor utilises a switch based connection in order to obtain the thickness data. The data are uploaded to the ThingSpeak server with the help of internet from the GSM module.

The pad wear data is uploaded to the website with kilometre left vs timeline as graph references.

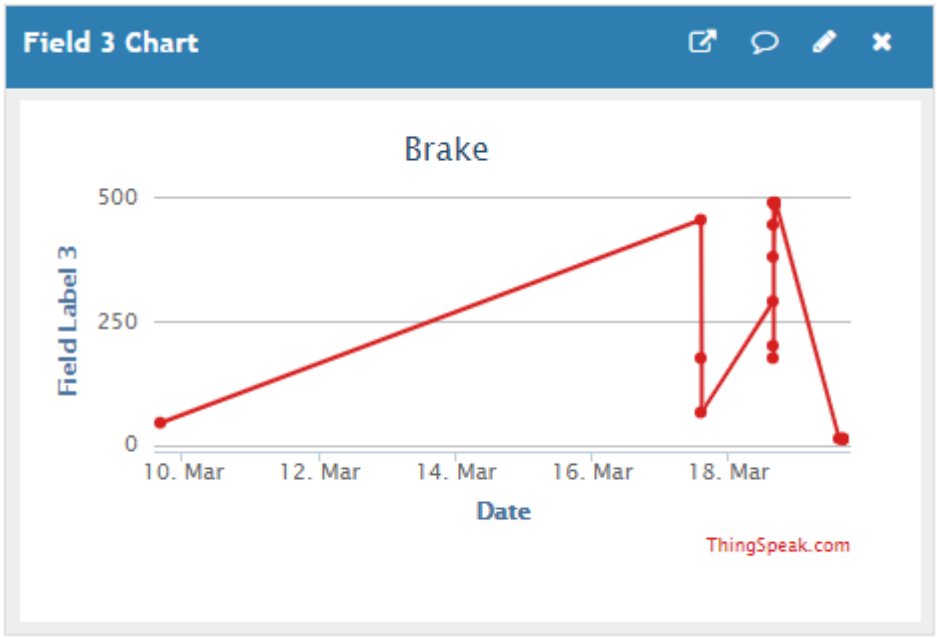


Fig.5.1 Kilometre vs Timeline Graph

5.2. Data after criticality

Once the brake pad wear has reached the limit after which it is advisable to change the pad in order to ensure safety, the pad wear sensor becomes active

and records the data of the kilometre left by using the microcontroller and GSM module.

These data are represented in a graphical format that can be easily understood by a layman and there is a clear mentioning of the kilometres that the vehicle can travel safely without any brake failure issues.

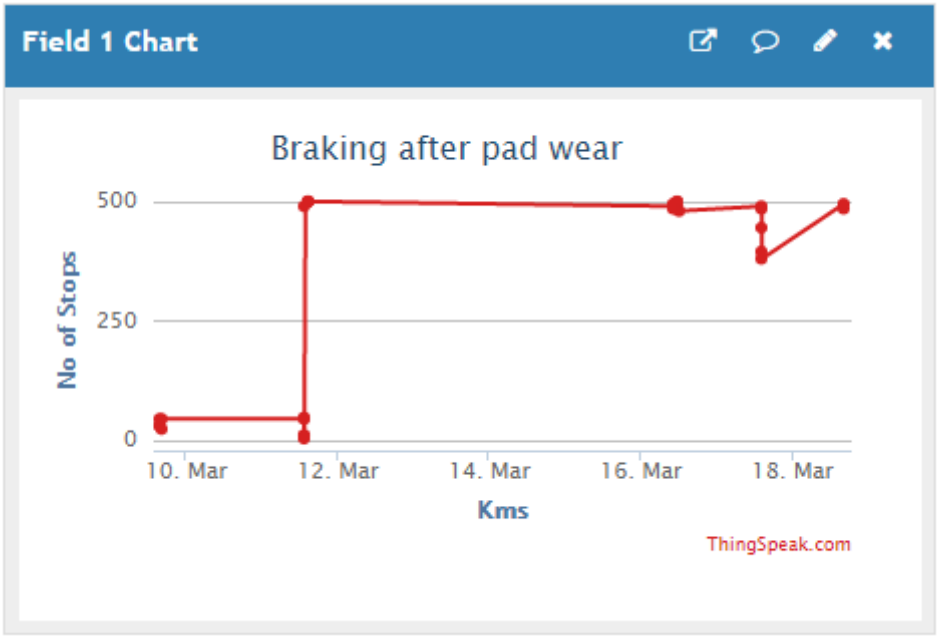


Fig.5.2 Chart 1

We can clearly notice the decrease in the number of kilometres after a few days in the timeline. This is a pin point notification that can be deciphered to represent the amount of kilometres that the vehicle can travel after the brake pad wear criticality has been reached.

Once the severity of the brake failure issue is increased, the data represented would be in the format of time that helps the respective person to identify the amount of braking power left in the vehicle.

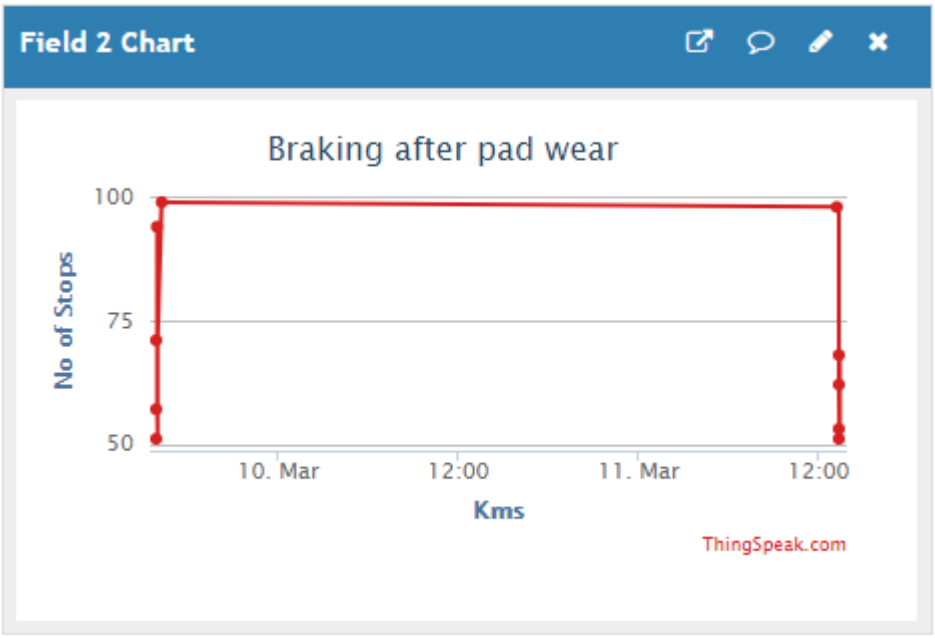


Fig.5.3 Chart 2

In the above chart, we can clearly get an idea that the pad wear has exceeded the limit and the graph shows exactly the deformation of the pad by reducing the kilometre that the vehicle can travel further in a safe manner. At the end of the graph, we can notice that there is a sharp decrease in the kilometre section of the graph. This is because of the severity of the issue and the probability of the failure can be high due to carelessness.

CHAPTER – 06

ADVANTAGES AND DISADVANTAGES

6.1 Advantages

- The system incorporates an electronic circuitry in a complete mechanical model which adds to the future scope of the automobile industry.
- The data can be viewed anywhere by anybody who have the authorisation to view it.
- It can reduce the number of accidents that take place due to brake failure especially in heavy vehicle sector.
- The system can co-exist with the existing mechanism without any major modifications to the design of the brake callipers.
- It can be useful to a manufacturer because, if at all a brake failure happens, the recorded data can be taken from the server and analysed to concentrate on the particular reason for failure.
- Failure mode analysis is made easier for the manufacturer as the system itself records the reasons for brake failure if the brake pad hasn't been changed even after prior warning.
- It stands as an initiative that helps incorporation of electronics and automation into pure mechanical components.
- All the components that are used in this semi-automation system are cheap and easily available in the market which helps in quick mass production.

6.1 Disadvantages

- There is a requirement of continuous service that is needed to be provided in order for the message to reach the respective person.

- Internet connectivity is mandatory for the data to be uploaded to the server for further analysis.
- The circuit must always be protected from the various factors such as heat when the vehicle is running.

CHAPTER - 07
RESULT AND CONCLUSION

7.1 Result

- ➢ The caliper brake pad wear data was obtained using the pad wear sensor and given as input to the microcontroller.
- ➢ The microcontroller processes the given information from the code and decides whether it is in the state of criticality.
- ➢ Once all the processing is over, the GSM module is made ready to transmit the SMS and data over internet onto the ThingSpeak server.
- ➢ The graph and SMS are easily understood by anyone who have the authorisation to view it.
- ➢ Finally, the data are used to change the brake pad of the vehicle since the one used have worn out.

7.2 Conclusion

Thus, the incorporation of digital and new age techniques such as IoT (Internet of Things) in the brake pad wear warning of reaction beam caliper will assure to deliver the user the facility of real time data monitoring, track the data, analysis of the data provided, and also to have an enhanced control over the monitoring of the vehicle's performance.

7.3 Future Scope

The incorporation of the above said digital techniques will be carried out to most of the other braking components required to monitor the braking characteristics and a common control unit will be designed to centralize the working of the components used for monitoring and data transfer.

REFERENCES

1. David Willey and David G. Williams (1978) ‘Brake pad wear detection system (Patent No: 4204190)
2. Katsuya Ito and Hitoshi Takanashi (1993) ‘Pad wear and pad wear indicator probe (Patent No: US5608376A)’.
3. William Gronowicz Jr. (2001) ‘Brake pad wear sensor (Patent No: 6302241)
4. Daniel Philpott (2014) ‘Brake Pad Wear Monitoring System (Patent No: 20160146279)’.

APPENDIX

Arduino Code

```
#include <SoftwareSerial.h>
int MyValue1=500;
SoftwareSerial Serial1(10, 11);
boolean toggle = false;
int check = 0;
int checkout = 0;
int ana = A1;
int counter = 0;
void setup() {
  pinMode(4, OUTPUT);
  pinMode(12, INPUT);
  pinMode(LED_BUILTIN, OUTPUT);
  Serial.begin(9600);
  Serial1.begin(9600);
  delay(100);
}
void loop()
{
  toggle = !toggle;
  digitalWrite(4,toggle);
```

```
checkout  = digitalRead(4);
Serial.println(checkout);
check=0;
Serial.println(check);
check = analogRead(ana);
Serial.println(check);
if((check > 1000) && (counter==0||counter==5))
{
  Serial.println("Enter1");
  digitalWrite(LED_BUILTIN, HIGH);
  delay(2000);
  counter = counter+1;
   Serial1.println("AT+CMGF=1");
   delay(1000);  // Delay of 1 second
   Serial1.println("AT+CMGS=\"+919941839994\"\r");
   delay(1000);
   Serial1.println("SAFETY WARNING!!! WORN BRAKE PAD. Kindly
   change your brake pads at our nearest service centre.");
   delay(100);
   Serial1.println((char)26);
   delay(1000);
}
```

```
  else if((check > 1000) && (counter!=0||counter!=5))
  {
    Serial.println("Enter2");
    counter = counter + 1;
  }
  else
  {
    Serial.println("Enter3");
    digitalWrite(LED_BUILTIN, LOW);
    delay(2000);
  }
  MyValue1 = MyValue1 - counter;
  if(MyValue1==495 || MyValue1==490 || MyValue1==485)
{
    Serial.println("Enter4");
    Connect2Server();
    Field1(MyValue1);
    EndConnection();
}
}
void Connect2Server()
{
```

```
Serial1.println("AT");
delay(200);
Serial1.println("AT+CPIN?");
delay(200);
Serial1.println("AT+CREG?");
delay(200);
Serial1.println("AT+CGATT?");
delay(200);
Serial1.println("AT+CIPSHUT");
delay(200);
Serial1.println("AT+CIPSTATUS");
delay(1000);
Serial1.println("AT+CIPMUX=0");
delay(1000);
ShowSerialData();
Serial1.println("AT+CSTT=\"internet\"");
delay(200);
ShowSerialData();
Serial1.println("AT+CIICR");
delay(2000);
ShowSerialData();
Serial1.println("AT+CIFSR");
```

```
  delay(2000);
  ShowSerialData();
  Serial1.println("AT+CIPSPRT=0");
  delay(1000);
  ShowSerialData();
  Serial1.println("AT+CIPSTART=\"TCP\",\"api.thingspeak.com\",\"80\"");//
  start up the connection
  delay(2000);
  ShowSerialData();
  Serial1.println("AT+CIPSEND");
  delay(2000);
  ShowSerialData();
}
void Field1(int data)
{
  String str = "GET http://api.thingspeak.com/update?
  api_key=BZ9N7GAXNC0TDKAC&field1=" + String (data);
  Serial1.println(str);
  delay(2000);
  ShowSerialData();
  Serial1.println((char)26);
  delay(4000);
  Serial1.println();
```

```
  ShowSerialData();
}
void Field2(int data)
{
   String str = "GET http://api.thingspeak.com/update?
   api_key=BZ9N7GAXNC0TDKAC&field2=" + String (data);
  Serial1.println(str);
  delay(2000);
  ShowSerialData();
  Serial1.println((char)26);
   delay(4000);
  Serial1.println();
  ShowSerialData();
}
void EndConnection()
{
  Serial1.println("AT+CIPSHUT");
  delay(100);
  ShowSerialData();
}
void ShowSerialData()
{
```

```
  if(Serial1.available()!=0)
     Serial.write(Serial1.read());
  if(Serial.available()!=0)
          Serial1.write(Serial.read());
}
```

MATLAB CODE

```
fieldID1 = 2;
fieldID2 = 3;
readAPIKey = 'QNPRE47A7SYCCFI6';
[data1, time1] = thingSpeakRead(readChannelID, 'Field', fieldID1, 'NumPoints',
30, 'ReadKey', readAPIKey);
[data2, time2] = thingSpeakRead(readChannelID, 'Field', fieldID2, 'NumPoints',
30, 'ReadKey', readAPIKey);
yyaxis left;
plot(time1, data1)
yyaxis right;
plot(time2, data2);
```

RAJALAKSHMI ENGINEERING COLLEGE

DEPARTMENT OF MECHATRONICS ENGINEERING

VISION

To attain excellence in academics, research and technological advancement in Mechatronics Engineering with a concern for society.

MISSION

To impart high quality professional education and produce Mechatronics Engineers with all round knowledge of multi-disciplinary branches of engineering and technology. To foster skill sets required to be a global professional in the areas of automation, intelligent systems, robotics, research for technology management and to fulfil the expectations of industry and needs of the society. To inculcate entrepreneurial qualities for creating, developing and managing global engineering ventures.

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

PEO1:

Graduates will have a comprehensive knowledge in the analytical, scientific and engineering fundamentals necessary to model, analyse and solve engineering problems and to prepare them for graduate studies and for successful careers in industry.

PEO2:

Graduates will effectively design and develop products in areas such as manufacturing, motion control, machine vision, system simulation, intelligent systems, automotive systems and robotics.

PEO3:

Graduates will acquire Technical expertise, Leadership skills, Ethical practices and Team spirit with a concern towards greener society.

PROGRAMME OUTCOMES(PO)

Engineering Graduates will be able to:

- **Engineering knowledge:** Apply knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

- **Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

- **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations.

- **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

- **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

    - **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

- **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

- **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

- **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES(PSO)

PSO1:
To innovate a Mechatronics system to meet the requirements and specifications.
PSO2:
To analyse and improve the performance of a Mechatronics system and enhance the intellectual capabilities of the system.
PSO3:
To lead professional career in industries or an entrepreneur by applying Engineering and Management principles and practices.