ELECTROMAGNETIC BRAKING SYSTEM

A Project
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Of

Bachelor of Science in Mechanical Engineering

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DECLARATION

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ABSTRACT

The Electromagnetic Braking System (EMBS) is an advanced braking technology that uses electromagnetic force to decelerate or stop a vehicle without mechanical friction. Unlike traditional braking systems that rely on physical contact between brake pads and rotors, EMBS operates through the interaction of magnetic fields generated by electromagnets and the metallic wheel or disc. When current flows through the electromagnet, it creates a magnetic field that induces eddy currents in the rotating disc, producing a resistive force that slows the motion. This contactless mechanism reduces wear and tear, enhances braking response, and improves system lifespan. EMBS is widely used in electric trains, trams, and some heavy vehicles where precise and smooth braking is essential. It also enhances safety by reducing the risk of brake failure due to overheating or mechanical degradation. As transportation systems evolve, electromagnetic braking offers a reliable and efficient alternative to conventional braking technologies.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Electromagnetic brakes (also called elector-mechanical brakes or EM brakes) slow or stop motion using electromagnetic force to apply mechanical resistance (friction). The original name was "elector- mechanical brakes" but over the years the name changed to "electromagnetic brakes", referring to their actuation method. Since becoming popular in the mid-20th century especially in trains and trams, the variety of applications and brake designs has increased dramatically, but the basic operation remains the same. Electromagnetic brakes are the brakes working on the electric power & magnetic power. They works on the principle of electromagnetism.

These brakes are an excellent replacement on the convectional brakes due to their many advantages. The reason for implementing this brake in automobiles is to reduce wear in brakes as it friction less. Electromagnetic brakes are of today's automobiles. The working principle of this system is that when the magnetic flux passes through and perpendicular to the rotating wheel the eddy current flows opposite to the rotating wheel/rotor direction. This eddy current trying to stop the rotating wheel or rotor. This results in the rotating wheel or rotor comes to rest/ neutral.

1.2 Objectives

The objectives of this project are:

- To study about **Electromagnetic Braking System.**
- To design and construct a Project using **Electromagnetic Braking System**.
- Develop a contactless braking system using electromagnetic force for efficient deceleration.
- Enhance braking safety by preventing overheating and reducing brake failure risk.
- Design a cost-effective, reliable electromagnetic braking system for various vehicle types.
- Promote energy conservation and sustainability by reducing mechanical energy loss.
- To take necessary notes from the project for future improvements.

1.3 Methodology

Our used methodology for the project:

- Creating an idea for the design and construction of **Electromagnetic Braking System.** And designing a block diagram & circuit diagram to know which components we need to construct it.
- Collecting all the components and programming the micro-controller to control our desired system.
- Setting up all the components in a PCB board & soldering. Then assembling all the blocks in a board and finally running the system to check if it actually works or not.

1.4 Types of Braking Systems

1.4.1 Electromagnetic Brake System : A rising style of brake system, electromagnetic brakes use an electric motor that is included in the automobile which help the vehicle come to a stop. These types of brakes are in most hybrid vehicles and use an electric motor to charge the batteries and regenerative brakes. On occasion, some buses will use it as a secondary retarder brake. In locomotives, a mechanical linkage transmits torque to an electromagnetic braking component. Trams and trains use electromagnetic track brakes where the braking element is pressed by magnetic force to the rail. They are distinguished from *mechanical* track brakes, where the braking element is mechanically pressed on the rail. Electric motors in industrial and robotic applications also employ electromagnetic brakes. Recent design innovations have led to the application of electromagnetic brakes to aircraft applications.In this application, a combination motor/generator is used first as a motor to spin the tires up to speed prior to touchdown, thus reducing wear on the tires, and then as a generator to provide regenerative braking.

A friction-plate brake uses a single plate friction surface to engage the input and output members of the clutch. Single face electromagnetic brakes make up approximately 80% of all of the power applied brake applications.Power off brakes stop or hold a load when electrical power is either accidentally lost or intentionally disconnected. In the past, some companies have referred to these as "fail safe" brakes. These brakes are typically used on or near an electric motor. Typical applications include robotics, holding brakes for Z axis ball screws and servo motor brakes. Brakes are available in multiple voltages and can have either standard backlash or zero backlash hubs. Multiple disks can also be used to increase

brake torque, without increasing brake diameter. There are 2 main types of holding brakes. The first is spring applied brakes. The second is permanent magnet brakes.

Spring type – When no electricity is applied to the brake, a spring pushes against a pressure plate, squeezing the friction disk between the inner pressure plate and the outer cover plate. This frictional clamping force is transferred to the hub, which is mounted to a shaft.

Permanent magnet type – A permanent magnet holding brake looks very similar to a standard power applied electromagnetic brake. Instead of squeezing a friction disk, via springs, it uses permanent magnets to attract a single face armature. When the brake is engaged, the permanent magnets create magnetic lines of flux, which can in turn attract the armature to the brake housing. To disengage the brake, power is applied to the coil which sets up an alternate magnetic field that cancels out the magnetic flux of the permanent magnets. Both power off brakes are considered to be engaged when no power is applied to them. They are typically required to hold or to stop alone in the event of a loss of power or when power is not available in a machine circuit. Permanent magnet brakes have a very high torque for their size, but also require a constant current control to offset the permanent magnetic field. Spring applied brakes do not require a constant current control, they can use a simple rectifier, but are larger in diameter or would need stacked friction disks to increase the torque.

Think of the coil shell as a horseshoe magnet having a north and south pole. If a piece of iron contacted both poles a magnetic circuit is created. When power is applied a magnetic field is created this field (flux) overcomes the air gap between field and the armature. This magnetic attraction pulls the armature in contact with the brake field face. The friction and the strength of the magnetic field, is what causes the rotational motion to stop. Almost all of the torque comes from the magnetic attraction and coefficient of friction between the steel of the armature and the steel of the rotor or brake field. But for many industrial clutches or brakes, friction material is used between the poles. The material is mainly used to help decrease the wear rate. But different types of material can also be used to change the coefficient of friction for special applications. For example if the brake was required to have an extended time to stop or slip time, a low coefficient material can be used. Conversely, if the brake was required to have a slightly higher

torque, a high coefficient friction material could be used. Copper (sometimes aluminum) magnet wire used to create the coil which is held in the shell either by a bobbin or by an epoxy / adhesive. For most industrial brakes, friction material is then placed over the coil and is set between the inner and outer pole. The friction material is flush with the surface of the brake because you want to have metal to metal contact between the coil shell and the armature. (Some people mistakenly look at electromagnetic brakes and assume that it is already worn down since the friction material is flush but that is not the case.)

1.4.2 Frictional Brake System: A frictional brake system is found in many automobiles. They are service brakes, and typically found in two forms; pads and shoes. As the name implies, these brakes use friction to stop the automobile from moving. They typically include a rotating device with a stationary pad and a rotating weather surface. On most band brakes the shoe will constrict and rub against the outside of the rotating drum, alternatively on a drum brake, a rotating drum with shoes will expand and rub against the inside of the drum.

1.4.3 Hydraulic Brake System: A hydraulic brake system is composed of a master cylinder that is fed by a reservoir of hydraulic braking fluid. This is connected by an assortment of metal pipes and rubber fittings which are attached to the cylinders of the wheels. The wheels contain two opposite pistons which are located on the band or drum brakes which pressure to push the pistons apart forcing the brake pads into the cylinders, thus causing the wheel to stop moving.

1.5 Report Overview

This Project is organized as follows

Chapter 1 Introduction: The first chapter contains the statement of the introduction, Objectives & Methodology for the project, types of Braking System and Report Overview.

Chapter 2 Literature Review: Chapter two contains our introduction and literature review part.

Chapter 3 Hardware and Software Analysis: Chapter three describes the Hardware. Here we mainly discuss the proposed system Hardware and software development of our project etc.

Chapter 4 Methodology: Chapter three describes the theoretical model. Here we mainly discuss the proposed system architecture in detail with having a block diagram, circuit diagram, project working principle, Cost Analysis, Final Project, etc.

Chapter 5 Result and Discussion: Chapter four deals with the result and discussion and discuss our project's advantages and application.

Chapter 6 Conclusion: Chapter five is all about our project conclusion and future scope.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

In this section topics related to **Electromagnetic Braking System** are included. These provide a sampling of problems appropriate for the application of Electromagnetic Braking System. The references are summarized below.

2.2 Literature Review

[1] Stephen Z, Oldakowski, Bedford, Ohio A magnetic brake provides braking or locking capability and is remotely controlled by electric power. The magnetic brake comprises a rotatable shaft and a brake disc mounted on the shaft. A nonrotating core housing assembly located around the shaft includes a permanent magnet and a bipolar solenoid. A magnetic armature adjacent to the core housing assembly is capable of movement toward the core housing assembly and toward and into engagement with a brake disc to prevent rotation of the shaft. A spring urges the armature away from the core housing assembly and into engagement with the brake disc. The brake does not use any electric power to maintain the brake in the set mode with the rotating shaft fully locked or in the released mode with the rotating shaft fully released. The permanent magnet is of sufficient strength to hold the armature against urging of the spring until an opposite polarity is supplied by the solenoid.

[2] Hung-Chi Wu, 958-2, Ghung Shan Rd., Tao Yuan, Taiwan This invention relates to an adjustable magnetic brake and in particular to one including an aluminum fan, a magnetic conducting ring enclosing the aluminum fan, a permanent magnet disposed within the aluminum fan, a fixing seat for keeping the permanent magnet in position, a sliding seat mounted in the fixing seat and provided with a bearing, a housing, bolts provided on one side of the fixing seat and extending out of the housing, a mounting plate connected with the bolts and a wire connected with the mounting plate such that when the wire is pulled outwards, the permanent magnet will be moved outwards.

[3] Karl Erny, Holzhausem an elevator drive has a brake device with compression springs to actuate brake levers, and brake linings on a brake drum creating a braking force. A

sensor is provided to detect the movement of a brake magnet armature tappet. A bracket is attached to the brake magnet tappet on one end and a distance piece carrying the sensor housing is arranged on the other end. A restoring lug is attached to the existing mechanical indicator. A monitor evaluates the sensor signal and turns off the elevator drive in the event of dangerous operational states via a safety circuit. The system allows the state of the brake device to be monitored. The more the brake linings wear off due to abrasion, the smaller the distance between the armature and the brake magnet housing. If the armature is in contact with the brake magnet housing, the braking ability of the brake linings is completely void.

[4] Jae-WoongLee, Seoul, Rep .of Korea Disclose diamagnetic brake system for a vehicle. comprising: a plurality of brake disk solenoids for generating the magnetic force; a plurality of brake pad solenoids for generating the magnetic force; a braking sensor for detecting whether a brake pedal is applied; a wheel speed sensor for detecting wheel speed; a magnetic polarity sensor for detecting magnetic polarity of the brake disk solenoids; and a control unit for controlling the brake pad solenoids using signals from the braking sensor. The wheel speed sensor and the magnetic polarity sensor.

[5] Prajapati, K., Vibhandik, R., Baria, D., Patel, Y. and Detail, I.G., 2017 electromagnetic braking system. International Journal of Scientific Research in Engineering, 1(3). In this thesis, a new mathematical model for electromagnetic brakes is proposed to describe their static characteristics(angular speed versus brake torque). The performance of the new mathematical model is better than the other three models available in the literature in a least-square sense. Compared with old models that treat reluctance as a constant, our model treats reluctance as a function of speed.

[6] Patel, S., Patel, M., Patel, A., Sanghani, C., Patel, D., Patel, S.K., Patel, M.K., Patel, A.R., Sanghani, C.D. and Patel, D., 2015. Development of the Electro Magnetic Brake. International Journal, 1, pp.485- 492. In this way, the model represents more precisely the aggregate effect of all side effects such as degree of saturation of the iron in the magnet, demagnetizing effects, and air gap. The software program written in Mat lab can be used to code different brake characteristics (both static and dynamic) and evaluate their performance in different road scenarios.

[7] Flemming, Frank; Shapiro, Jessica (July 7, 2009). “Basics of Electromagnetic Brakes” .machine design : pp. 57–58 an appropriate rate of heat dissipation if a reasonable temperature and performance stability are to be maintained. While the design, construction, and location features severely limit the heat dissipation function of the friction brake, electromagnetic brakes work in a relatively cool condition and avoid problems that friction brakes face by using a totally different working principle and installation location. By using the electromagnetic brake as supplementary retardation equipment, the friction brakes can be used less frequently and therefore practically never reach high temperatures.

[8] Auguston, Karen; Flemming, Frank (September 1999). "Floating ArmatureSpeeds Response" .Global Design News: pp. 46–47 The brake linings thus have a longer life span, and the potential brake fade problem can be avoided. It is apparent that the electromagnetic brake is an essential complement to the safe braking of heavy vehicles.In this paper, a new mathematical model for electromagnetic brakes is proposed to describe their static characteristics (angular speed versus brake torque). The performance of the new mathematical model is better than the other three models available in the literature in a least-square sense.

[9] Akshyakumar S.Puttewar1, Nagnath U. Kakde2, Huzaifa A. Fidvi3, Bhyshan Nandeshwar4, “Enhancement of Braking System in Automobile using Electro-magnetic braking” Electromechanical brakes, also known as EM brakes, are another term for electromagnetic brakes. They construct mechanical properties, or friction, by using electromagnetic force to slow or stop motion. A braking coil's current produces a magnetic field powerful enough just to push an armature toward and away from one magnetic face. They are not to be confused with eddy current braking, which produces resistance by applying magnetic force. Numerous brake applications and designs have evolved a lot since they were initially widely used.

[10] Sevvel P1, Nirmal Kanann V2, Mars Mukesh S3, “Innovative Electromagnetic Braking System. A brake is a device that stops movement. It is well understood that friction is employed by brakes to convert kinetic energy into heat. Electromagnetic brakes, in place of conventional friction brakes, have been used on large vehicles as a basis for formulating of retardation apparatus. They work on the basis of electromagnetic theory. When a magnetic force is applied perpendicular to a revolving wheel or rotor, eddy current

to flow in the opposite way [5],[6]. Though friction brakes used less frequently, when the electro - magnetic braking system is used as an additional component for retardation, increases in temperature are almost never reached.

[11] Journal- Eddy Current in Magnetic Brakes- Henry A. Sudano and Jae SungBae .s. It minimizes brake failure in order to avoid road accidents [7],[8]. It also reduces the need for brake system maintenance. This system has the advantage of being able to adapt to any vehicle with only minor transmitting and electrical system modifications. Magnetic brakes are electrically powered yet mechanically transmit torque. For this reason, they were once known as electromechanical braking. Due to its actuation technique, EM brakes have come to be characterized as electromagnetic over time. Although there are now a vast array of uses and brake types since brakes first gained popularity more than 60 years ago, the fundamental function has not changed.

[12] Analysis of an eddy-current brake considering finite radius and induced magnetic flux- Journal of Applied Physics, Kapjin Lee, Kyihwan PaMax Baermann, (1970) “Permanent Magnet Eddy Current Brake or Clutch”, USPO3, 488,535 In the locomotive industry, electromagnetic brakes have a variety of applications, especially for trains and trams. Rail and trams adopted electric and magnetic brakes in the early twentieth century to sustain the effectiveness and safety of their tracks [11]. As emergency braking systems, they have a wide range of applications. They are, however, widely used in the engineering, power tool, robotic systems, and other transportation industries.

[13] P. Hanyecz, (1982), “Calculation of Braking force in Eddy current brakes”, Department of Theoretical Electricity. Technical University Budapest Pushkin Kachroo, (1997), “Modelling and control of Electromagnetic brakes”, Faculty Publications, University of Nevada, LasVegas When electrical power is unintentionally or purposefully withdrawn, power-off brakes halt or hold a load. They often operate near or on an electric motor. To increase torque without expanding the brake, multiple discs can be utilized. Two distinct categories of power-off brakes exist. There is first spring-applied braking. A spring needs to pull against the pressure plate without the use of electricity, trying to retain the friction disc here between internal baseplate and the external cover plate. Attached to a shaft, the wheel receives the friction transfer. Since this sort of brake frequently exhibits considerable backlash, it is better suited for less precise applications in which precise

response time is indeed not essential. The permanent magnet brake is the second variety of power off brake. In this design, the armature is drawn to the permanent magnets by means of springs.

[14] Design of a magnetic braking system, Min Jou, Jaw-Kuen Shiau, ChiChian Sun. The concept designed by us is just a prototype and needs to be developed more because of the above mentioned disadvantages. These electromagnetic brakes can be used as an auxiliary braking system along with the friction braking system to avoid overheating and brake failure. ABS usage can be neglected by simply using a micro controlled electromagnetic disk brake system .These find vast applications in heavy vehicles where high heat dissipation is required. In rail coaches it can used in combination of disc brake to bring the trains moving in high speed. When these brakes are combined it increases the life of brake and act like fully.

2.3 Summary

The above discussion gives an idea about the Braking System. The automatic Electromagnetic Braking System in the situation are described in detail. From this we also got the direction of work of the project.

CHAPTER 3
HARDWARE AND SOFTWARE ANALYSIS

3.1 Introduction

This Project has worked on two things, Hardware and Software. Here we will discuss about our project hardware and software details.

Required instrument

Hardware

- DC Gear Motor
- Electromagnetic Brake
- SMPS
- Relay
- Chain Sprocket
- Ball Bearing
- Buck Converter
- Arduino nano
- LCD Display
- Wheel
- Push Switch

Software

- Easy EDA
- Arduino Software IDE

3.2 DC Gear Motor

A DC motor is any motor within a class of electrical machines whereby direct current electrical power is converted into mechanical power. A 12v DC motor is small and inexpensive, yet powerful enough to be used for many applications.

Specification

- Voltage: 12V DC
- Gear ratio: 1/31
- No-load speed: 200 RPM

- Rated Speed: 140 RPM
- Rated torque: 10 kg.cm
- Rated current: 2.5 Amp
- Length of Motor(including spindle): 106 mm/4.17″
- Diameter: 37 mm/1.45″
- Shaft length: 21 mm/0.82″
- Shaft diameter: 6 mm/0.24″



Figure 3.1: DC Gear Motor

3.3 Switch Mode Power Supply (SMPS)

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power) to DC loads, such as a personal computer, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. A hypothetical ideal switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight.



Figure 3.2: SMPS

Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor. Switched-mode power supplies are classified according to the type of input and output voltages. The four major categories are:

- AC to DC
- DC to DC
- DC to AC
- AC to AC

A basic isolated AC to DC switched-mode power supply consists of:

- Input rectifier and filter
- Inverter consisting of switching devices such as MOSFETs
- Transformer
- Output rectifier and filter
- Feedback and control circuit

The input DC supply from a rectifier or battery is fed to the inverter where it is turned on and off at high frequencies of between 20 KHz and 200 KHz by the switching MOSFET or power transistors. The high-frequency voltage pulses from the inverter are fed to the transformer primary winding, and the secondary AC output is rectified and smoothed to produce the required DC voltages. A feedback circuit monitors the output voltage and instructs the control circuit to adjust the duty cycle to maintain the output at the desired level.

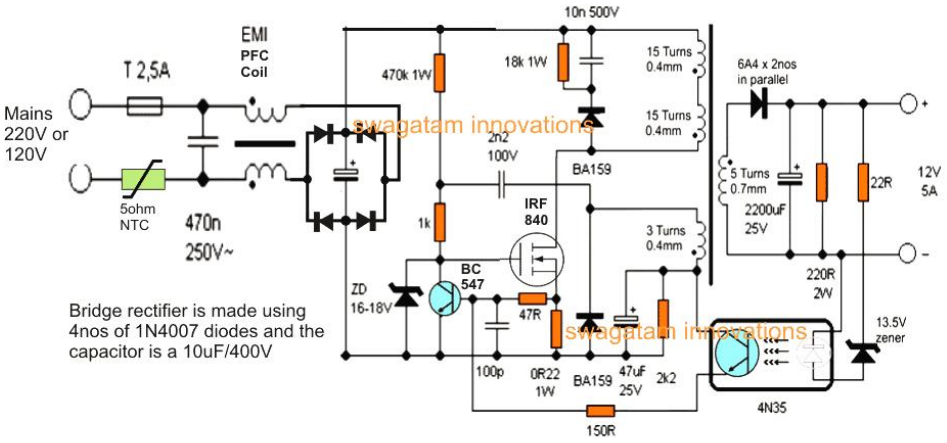


Figure 3.3: SMPS Circuit

Basic working concept of an SMPS

A switching regulator does the regulation in the SMPS. A series switching element turns the current supply to a smoothing capacitor on and off. The voltage on the capacitor controls the time the series element is turned. The continuous switching of the capacitor maintains the voltage at the required level.

Design basics

AC power first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s). Most computers and small appliances use the International Electrotechnical Commission (IEC) style input connector. As for output connectors and pin outs, except for some industries, such as PC and compact PCI, in general, they are not standardized and are left up to the manufacturer.

There are different circuit configurations known as topologies, each having unique characteristics, advantages and modes of operation, which determines how the input power is transferred to the output. Most of the commonly used topologies such as flyback, push-pull, half bridge and full bridge, consist of a transformer to provide isolation, voltage scaling, and multiple output voltages. The non-isolated configurations do not have a transformer and the power conversion is provided by the inductive energy transfer.

Advantages of switched-mode power supplies

- Higher efficiency of 68% to 90%
- Regulated and reliable outputs regardless of variations in input supply voltage
- Small size and lighter
- Flexible technology
- High power density
- Disadvantages:
- Generates electromagnetic interference
- Complex circuit design
- Expensive compared to linear supplies

Switched-mode power supplies are used to power a wide variety of equipment such as computers, sensitive electronics, battery-operated devices and other equipment requiring high efficiency. Linear voltage IC regulators have been the basis of power supply designs for many years as they are very good at supplying a continuous fixed voltage output. Linear voltage regulators are generally much more efficient and easier to use than equivalent voltage regulator circuits made from discrete components such a zener diode and a resistor, or transistors and even op-amps.The most popular linear and fixed output voltage regulator types are by far the 78… positive output voltage series, and the 79… negative output voltage series.

These two types of complementary voltage regulators produce a precise and stable voltage output ranging from about 5 volts up to about 24 volts for use in many electronic circuits.There is a wide range of these three-terminal fixed voltage regulators available each with its own built-in voltage regulation and current limiting circuits. This allows us to create a whole host of different power supply rails and outputs, either single or dual supply, suitable for most electronic circuits and applications. There are even variable voltage linear regulators available as well providing an output voltage which is continually variable from just above zero to a few volts below its maximum voltage output.

Switch Mode Power Supply

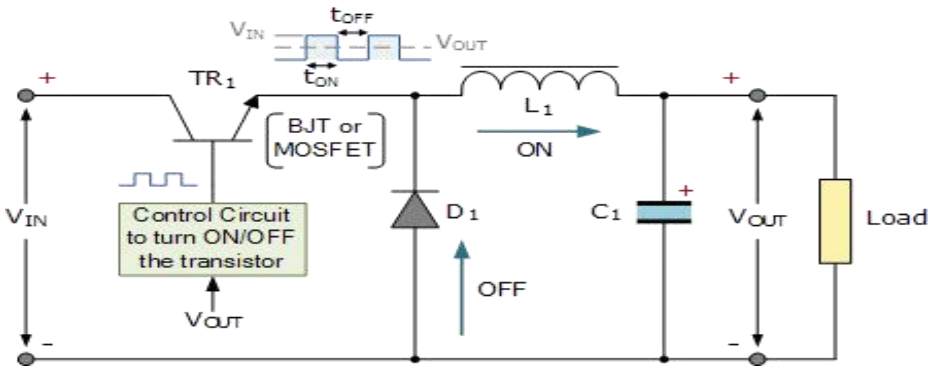


Figure 3.4: SMPS Circuit Connection

Most d.c. power supplies comprise of a large and heavy step-down mains transformer, diode rectification, either full-wave or half-wave, a filter circuit to remove any ripple content from the rectified d.c. producing a suitably smooth d.c. voltage, and some form of voltage regulator or stabiliser circuit, either linear or switching to ensure the correct regulation of the power supplies output voltage under varying load conditions. Then a typical d.c. power supply would look something like this

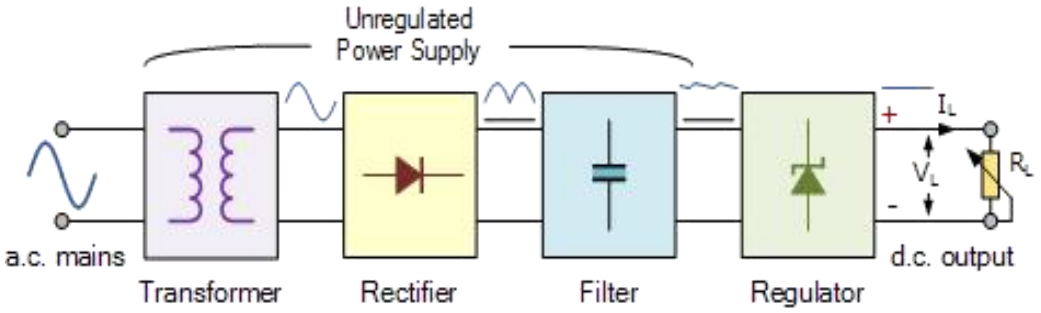


Figure 3.5: DC Power supply way

These typical power supply designs contain a large mains transformer (which also provides isolation between the input and output) and a dissipative series regulator circuit. The regulator circuit could consist of a single zener diode or a three-terminal linear series regulator to produce the required output voltage. The advantage of a linear regulator is that the power supply circuit only needs an input capacitor, output capacitor and some feedback resistors to set the output voltage.

3.4 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.



Figure 3.6: Relay

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts.Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands.

Description: mk2p-i 10a 220v ac electromagnetic relay with 8 pin round base coil voltage ac 220v 2 pole use for household & industrial

8 Pins, DPDT type, plastic housing. Can adjust automatically, protect and transform the electric circuit. Used widely in the remote control, communication, automatic control system, electronic equipment's, etc.

MK2P-I 10A 220V AC Electromagnetic Relay With 8 Pin Round Base General Purpose Relay Coil Voltage AC 220V 2 pole Use For Household & Industrial Replace Finder Relay

Features

- Electromagnetic Relay power relay ;
- Coil Voltage: AC110V;
- Model : MK2P-I;
- Contact: DPDT 2NO 2NC; 8 Pins
- Contact Capacity: 250VAC/28VDC 10A RES; 250VAC 7A GEN
- Relay contacts : Terminals 1 and 8 public points ; Terminals 2 and 7 Relay Coil Voltage; Terminals 3 and 6 N/O Normally Open ; Terminals 4 and 5 N/C Normally Closed ;
- It is perfect used in the remote control, communication, automatic control system, electronic equipment's.

Specification

- Product Name: Electromagnetic Relay;
- Coil Voltage: AC220V
- Contact: DPDT;
- Number of Pins: 8
- Contact Capacity: 250VAC/28VDC 10A RES; 250VAC 7A GEN

3.5 Wheel

A wheel is a circular component that is intended to rotate on an axle bearing. The wheel is one of the key components of the wheel and axle which is one of the six simple machines. Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel, potter's wheel, and flywheel.



Figure 3.7: Wheel

3.6 Push Button

A push-button (also spelled push-button) or simply button is a simple switch mechanism to control some aspect of a machine or a process. Buttons are typically made out of hard material, usually plastic or metal. The surface is usually flat or shaped to accommodate the human finger or hand, so as to be easily depressed or pushed. Buttons are most often biased switches, although many un-biased buttons (due to their physical nature) still require a spring to return to their un-pushed state.

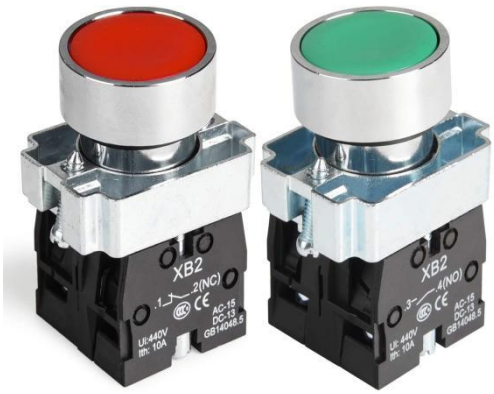


Figure 3.8: Push Switch

3.7 Electromagnetic Break

Electromagnetic brakes (also called electro-mechanical brakes or EM brakes) slow or stop motion using electromagnetic force to apply mechanical resistance (friction). They were originally called "electro-mechanical brakes," but over the years the name changed to "electromagnetic brakes", referring to their actuation method. Since becoming popular in the mid-20th century, especially in trains and trams, the variety of applications and brake designs has increased dramatically, but the basic operation remains the same.



Figure 3.9: Electromagnetic Break

Application

In locomotives, a mechanical linkage transmits torque to an electromagnetic braking component. Trams and trains use electromagnetic track brakes where the braking element is pressed by magnetic force to the rail. They are distinguished from mechanical track brakes, where the braking element is mechanically pressed on the rail.

Electric motors in industrial and robotic applications also employ electromagnetic brakes. Recent design innovations have led to the application of electromagnetic brakes to aircraft applications. In this application, a combination motor/generator is used first as a motor to spin the tires up to speed prior to touchdown, thus reducing wear on the tires, and then as a generator to provide regenerative braking.

3.8 Chain Sprocket

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. Another type of drive chain is the Morse chain, invented by the Morse Chain Company of Ithaca, New York, United States. This has inverted teeth. Sometimes the power is output by simply rotating the chain, which can be used to lift or drag objects. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear.

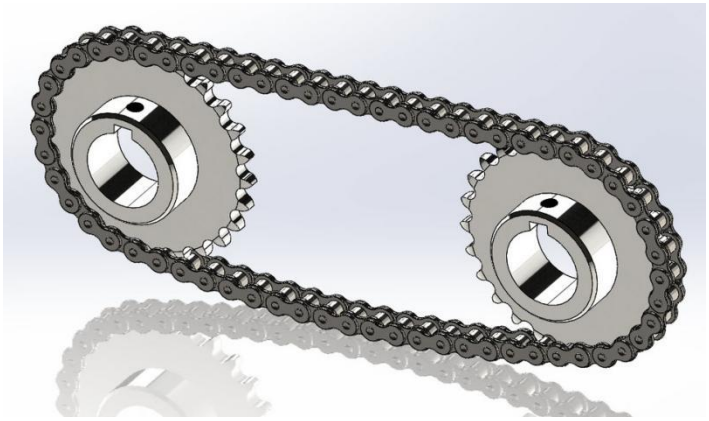


Figure 3.10: Chain Sprocket

Though drive chains are often simple oval loops, they can also go around corners by placing more than two gears along the chain; gears that do not put power into the system or transmit it out are generally known as idler-wheels. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered. For example, when the bicycle pedals' gear rotate once, it causes the gear that drives the wheels to rotate more than one revolution. Duplex chains are another type of chain which are essentially two chains joined side by side which allow for more power and torque to be transmitted.

Belt drive

Most chain drive systems use teeth to transfer motion between the chain and the rollers. This results in lower frictional losses than belt drive systems, which often rely on friction to transfer motion. Although chains can be made stronger than belts, their greater mass increases drive train inertia. Drive chains are most often made of metal, while belts are often rubber, plastic, urethane, or other substances. If the drive chain is heavier than an equivalent drive belt, the system will have a higher inertia. Theoretically, this can lead to a greater flywheel effect, however in practice the belt or chain inertia often makes up a small proportion of the overall drive train inertia. One problem with roller chains is the variation in speed, or surging, caused by the acceleration and deceleration of the chain as it goes around the sprocket link by link. It starts as soon as the pitch line of the chain contacts the first tooth of the sprocket. This contact occurs at a point below the pitch circle of the sprocket. As the sprocket rotates, the chain is raised up to the pitch circle and is then dropped down again as sprocket rotation continues. Because of the fixed pitch length, the pitch line of the link cuts across the chord between two pitch points on the sprocket, remaining in this position relative to the sprocket until the link exits the sprocket. This rising and falling of the pitch line is what causes chordal effect or speed variation. In other words, conventional roller chain drives suffer the potential for vibration, as the effective radius of action in a chain and sprocket combination constantly changes during revolution ("Chordal action"). If the chain moves at constant speed, then the shafts must accelerate and decelerate constantly. If one sprocket rotates at a constant speed, then the chain (and probably all other sprockets that it drives) must accelerate and decelerate constantly. This is usually not an issue with many drive systems; however, most motorcycles are fitted with a rubber bushed rear wheel hub to virtually eliminate this vibration issue.

Toothed belt drives are designed to limit this issue by operating at a constant pitch radius Chains are often narrower than belts, and this can make it easier to shift them to larger or smaller gears in order to vary the gear ratio. Multi-speed bicycles with derailleurs make use of this. Also, the more positive meshing of a chain can make it easier to build gears that can increase or shrink in diameter, again altering the gear ratio. However, some newer synchronous belts claim to have "equivalent capacity to roller chain drives in the same width". Both can be used to move objects by attaching pockets, buckets, or frames to them; chains are often used to move things vertically by holding them in frames, as in industrial toasters, while belts are good at moving things horizontally in the form of conveyor belts.

It is not unusual for the systems to be used in combination; for example the rollers that drive conveyor belts are themselves often driven by drive chains.

Drive shafts

Drive shafts are another common method used to move mechanical power around that is sometimes evaluated in comparison to chain drive; in particular belt drive vs chain drive vs shaft drive is a key design decision for most motorcycles. Drive shafts tend to be tougher and more reliable than chain drive, but the bevel gears have far more friction than a chain. For this reason virtually all high-performance motorcycles use chain drive, with shaft-driven arrangements generally used for non-sporting machines. Toothed-belt drives are used for some (non-sporting) models. A sprocket, sprocket-wheel or chain wheel is a profiled wheel with teeth that mesh with a chain, track or other perforated or indented material.The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth except for timing pulleys used with toothed belts. Sprockets are used in bicycles, motorcycles, tracked vehicles, and other machinery either to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc.

Perhaps the most common form of sprocket may be found in the bicycle, in which the pedal shaft carries a large sprocket-wheel, which drives a chain, which, in turn, drives a small sprocket on the axle of the rear wheel. Early automobiles were also largely driven by sprocket and chain mechanism, a practice largely copied from bicycles. Sprockets are of various designs, a maximum of efficiency being claimed for each by its originator. Sprockets typically do not have a flange. Some sprockets used with timing belts have flanges to keep the timing belt centered. Sprockets and chains are also used for power transmission from one shaft to another where slippage is not admissible, sprocket chains being used instead of belts or ropes and sprocket-wheels instead of pulleys. They can be run at high speed and some forms of chain are so constructed as to be noiseless even at high speed.

3.9 Ball Bearing

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts. Rotary bearings hold rotating components such as shafts or axles within mechanical systems, and transfer axial and radial loads from the source of the load to the structure supporting it. The simplest form of bearing, the plain bearing, consists of a shaft rotating in a hole. Lubrication is often used to reduce friction. In the ball bearing and roller bearing, to prevent sliding friction, rolling elements such as rollers or balls with a circular cross-section are located between the races or journals of the bearing assembly. A wide variety of bearing designs exists to allow the demands of the application to be correctly met for maximum efficiency, reliability, durability and performance.



Figure 3.11: Ball Bearing

The purpose of Bearing is to reduce rotational friction and support radial and axial loads Types of bearings There are at least 6 common types of bearing, each of which operates on different principles:- Plain bearing, consisting of a shaft rotating in a hole. There are several specific styles: bushing, journal bearing, sleeve bearing, rifle bearing, and composite bearing. Rolling-element bearing, in which rolling elements placed between the turning and stationary races prevent sliding friction. There are two main types Ball bearing, in which the rolling elements are spherical balls Roller bearing, in which the rolling

elements are cylindrical, taper and spherical rollers Jewel bearing, a plain bearing in which one of the bearing surfaces is made of an ultra hard glassy jewel material such as sapphire to reduce friction and wear Fluid bearing, a noncontact bearing in which the load is supported by a gas or liquid, Magnetic bearing, in which the load is supported by a magnetic field Flexure bearing, in which the motion is supported by a load element which bends.

3.10 Arduino Nano

Arduino is open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling Lights, motors, and other actuators.

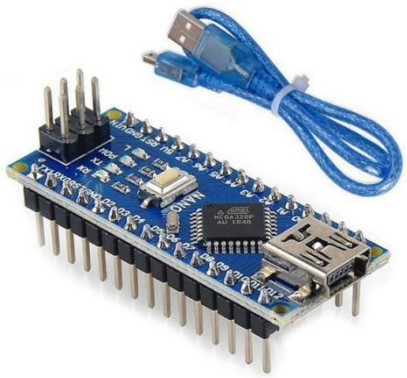


Figure 3.12: Arduino Nano

The micro-controller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, Maxims'). Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is a small, complete, and breadboard friendly component. It has everything that Decimal/ Duemilanove has (electrically) with more analog input pins and onboard +5V AREF jumper. Physically, it is missing power jack. The Nano can automatically sense and switch to the higher potential source of power.

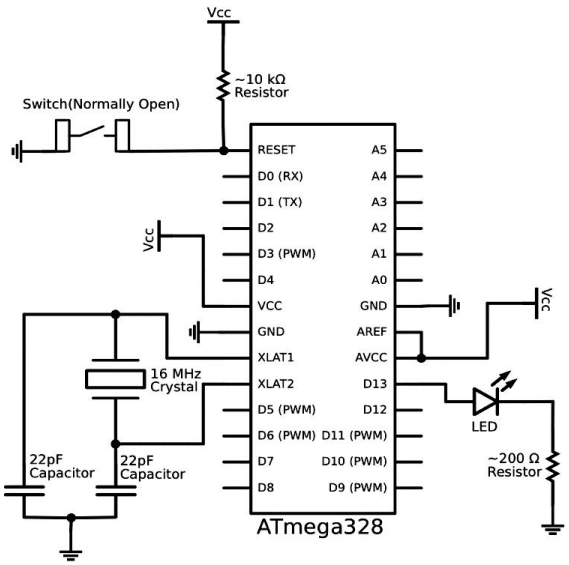


Figure 3.13: Arduino Nano Schematic Diagram

Nano's got the breadboard-ability of the Boarding and the Minibus with smaller footprint than either, so users have more breadboard space. It's got a pin layout that works well with the Mini or the Basic Stamp (TX, RX, ATN, and GND on one top, power and ground on the other). This new version 3.0 comes with ATMEGA328 which offer more programming and data memory space. It has two layers. That make it easier to hack and more affordable. One of the best features of Arduino Nano is, it's easy to use, compact and also small.

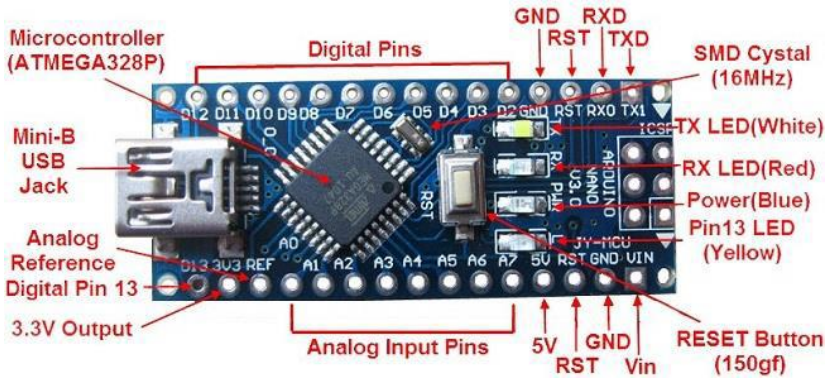


Figure 3.14: How Arduino Nano looks like

Specifications

- Micro-controller: Atmel ATmega328
- Operating Voltage (logic level): 5 V
- Input Voltage (recommended): 7-12 V
- Input Voltage (limits): 6-20 V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 8
- DC Current per I/O Pin: 40 mA
- Flash Memory: 32 KB (of which 2KB used by boot loader)
- SRAM : 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Dimensions: 0.70” x 1.70”

Features

- Automatic reset during program download
- Power OK blue LED
- Green (TX), red (RX) and orange (L) LED
- Auto sensing/switching power input
- Small mini-B USB for programming and serial monitor
- ICSP header for direct program download
- Manual reset switch

Micro-controller IC ATmega328p



Figure 3.15: Micro-controller IC AT mega 328p

The high-performance Microchip Pico Power 8-bit AVR RISC-based micro-controller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughput's approaching 1 MIPS per MHz, balancing power consumption and processing speed.

3.11 Buck Converter

A buck converter (step-down converter) is a DC-to-DC power converter which steps down voltage (while drawing less average current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). It is called a buck converter because the voltage across the inductor “bucks” or opposes the supply voltage.



Figure 3.16: DC -DC Buck Converter

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

Specifications of DC-DC Buck Converter Step Down Module LM2596 Power Supply

- Conversion efficiency: 92%(highest)
- Switching frequency: 150KHz
- Output ripple: 30mA9maximum)
- Load Regulation: ± 0.5%
- Voltage Regulation: ± 0.5%
- Dynamic Response speed: 5% 200uS
- Input voltage:4.75-35V
- Output voltage:1.25-26V(Adjustable)
- Output current: Rated current is 2A, maximum 3A (Additional heat sink is required)
- Conversion Efficiency: Up to 92% (output voltage higher, the higher the efficiency)
- Switching Frequency: 150KHz
- Rectifier: Non-Synchronous Rectification
- Module Properties: Non-isolated step-down module (buck)
- Short Circuit Protection: Current limiting, since the recovery
- Operating Temperature: Industrial grade (-40 to +85) (output power 10W or less)

3.12 LCD Display

The LCD (liquid crystal display) screen is an electronic display module and looks for various applications. A 16x2 LCD display is a very basic module and it is very commonly used in various devices and circuits. These modules are preferred over seven sections and many other segments.



Figure 3.17: 16*2 LCD Display

The reasons for having LCD are economic; Easily programmable, special and even custom characters (different in seven sections), there are no restrictions on displaying animations. A 16x2 LCD means it can display 16 characters per line and contains 2 lines. Each character on this LCD is displayed in a 5x7 pixel matrix.

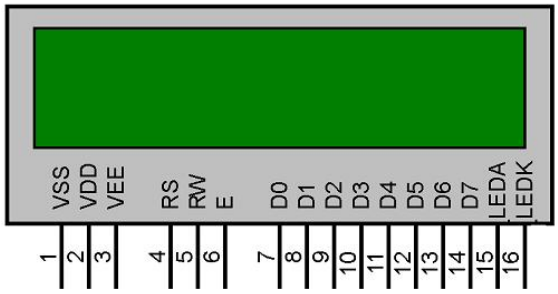


Figure 3.18: Pin out of 16*2 LCD Display

This LCD contains two articles called Command and Data. The command register stores the command instructions on the LCD. The command is a command given to the LCD to perform a predefined task such as starting it, clearing its screen, locating the cursor, controlling the display, etc.

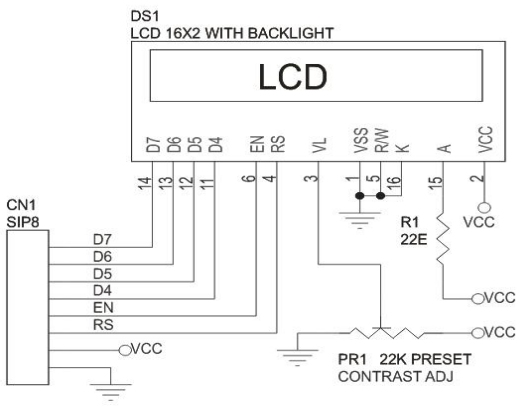


Figure 3.19: 16*2 LCD Display interfacing with Arduino

Feature

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters

3.13 Arduino Software IDE

The digital microcontroller unit named as Arduino UNO can be programmed with the Arduino software IDE. There is no any requirement for installing other software rather than Arduino. Firstly, Select "Arduino UNO from the Tools, Board menu (according to the microcontroller on our board). The IC used named as ATmega328 on the Arduino UNO comes pre burned with a boot loader that allows us to upload new code to it without the use of an external hardware programmer.

Communication is using the original STK500 protocol (reference, C header files). We can also bypass the boot loader and programs the microcontroller through the ICSP (In Circuit Serial Programming) header. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by:

On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.The Arduino UNO is one of the latest digital microcontroller units and has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL at (5V) with serial communication, which is available on digital pins 0 -(RX) for receive the data and pin no.1 (TX) for transmit the data. An ATmega16U2 on the board channels this serial communication over USB and appears as a

virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an .in file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board.

The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial Communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Arduino programs are written in C or C++ and the program code written for Arduino is called sketch. The Arduino IDE uses the GNU tool chain and AVR Lab to compile programs, and for uploading the programs it uses argued. As the Arduino platform uses Atmel microcontrollers, Atmel's development environment, AVR Studio or the newer Atmel Studio, may also be used to develop software for the Arduino.

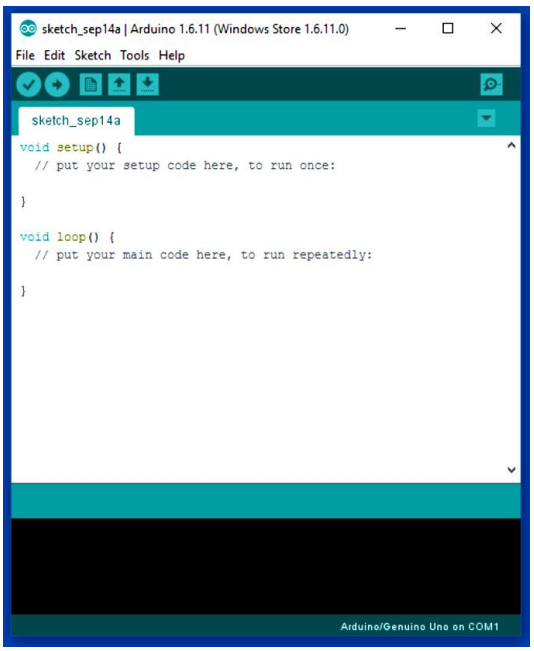


Figure 3.20: Arduino Software Interface IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

Writing Sketches

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Sketchbook

The Arduino Software (IDE) uses the concept of a sketchbook: a standard place to store your programs (or sketches). The sketches in your sketchbook can be opened from the File > Sketchbook menu or from the Open button on the toolbar. The first time you run the Arduino software, it will automatically create a directory for your sketchbook. You can view or change the location of the sketchbook location from with the Preferences dialog. Beginning with version 1.0, files are saved with a .ino file extension. Previous versions use the .pde extension. You may still open .pde named files in version 1.0 and later, the software will automatically rename the extension to .ino.

Tabs, Multiple Files, and Compilation

Allows you to manage sketches with more than one file (each of which appears in its own tab). These can be normal Arduino code files (no visible extension), C files (.c extension), C++ files (.cpp), or header files (.h).

Uploading

Before uploading your sketch, you need to select the correct items from the Tools > Board and Tools > Port menus. The boards are described below. On the Mac, the serial port is probably something like /dev/tty.usbmodem241 (for an Uno or Mega2560 or Leonardo) or /dev/tty.usbserial-1B1 (for a Duemilanove or earlier USB board), or /dev/tty.USA19QW1b1P1.1 (for a serial board connected with a Keyspan USB-to-Serial adapter). On Windows, it's probably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board) - to find out, you look for USB serial device in the ports section of the Windows Device Manager. On Linux, it should be

/dev/ttyACMx , /dev/ttyUSBx or similar. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete, or show an error.

When you upload a sketch, you're using the Arduino boot loader, a small program that has been loaded on to the microcontroller on your board. It allows you to upload code without using any additional hardware. The boot loader is active for a few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the microcontroller. The bootloader will blink the on-board (pin 13) LED when it starts (i.e. when the board resets).

Libraries

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #include statements from the top of your code.

There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you do can import a library from a zip file and use it in an open sketch. See these instructions for installing a third-party library.

Third-Party Hardware

Support for third-party hardware can be added to the hardware directory of your sketchbook directory. Platforms installed there may include board definitions (which appear in the board menu), core libraries, bootloaders, and programmer definitions. To install, create the hardware directory, then unzip the third-party platform into its own sub-directory. (Don't use "arduino" as the sub-directory name or you'll override the built-in Arduino platform.) To uninstall, simply delete its directory.

For details on creating packages for third-party hardware, see the Arduino IDE 1.5 3rd party Hardware specification.

Serial Monitor

This displays serial sent from the Arduino or Genuino board over USB or serial connector. To send data to the board, enter text and click on the "send" button or press enter. Choose the baud rate from the drop-down menu that matches the rate passed to Serial.begin in your sketch. Note that on Windows, Mac or Linux the board will reset (it will rerun your sketch) when you connect with the serial monitor. Please note that the Serial Monitor does not process control characters; if your sketch needs a complete management of the serial communication with control characters, you can use an external terminal program and connect it to the COM port assigned to your Arduino board.

3.14 Easy EDA

Easy EDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share-publicly and privately-and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats. Easy EDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.

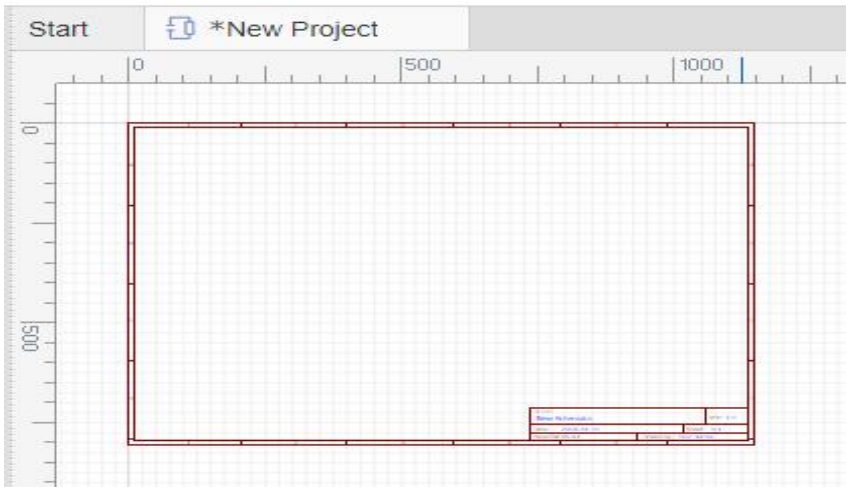


Figure 3.21: Easy EDA Software Interface

Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription.Registered users can download Gerber files from the tool free of charge; but for a fee, Easy EDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools.

CHAPTER 4
METHODOLOGY

4.1 Introduction

This chapter presents the methodology adopted for developing the Electromagnetic braking System. It includes a detailed explanation of the proposed system architecture, block and circuit diagrams, working principle, and actual project setup. A cost analysis is provided to assess the system's economic feasibility and implementation scope.

4.2 Block Diagram

Here is the block diagram of the **Electromagnetic Braking System** with all the essential components. All of the components are shown in below as a block in this diagram.

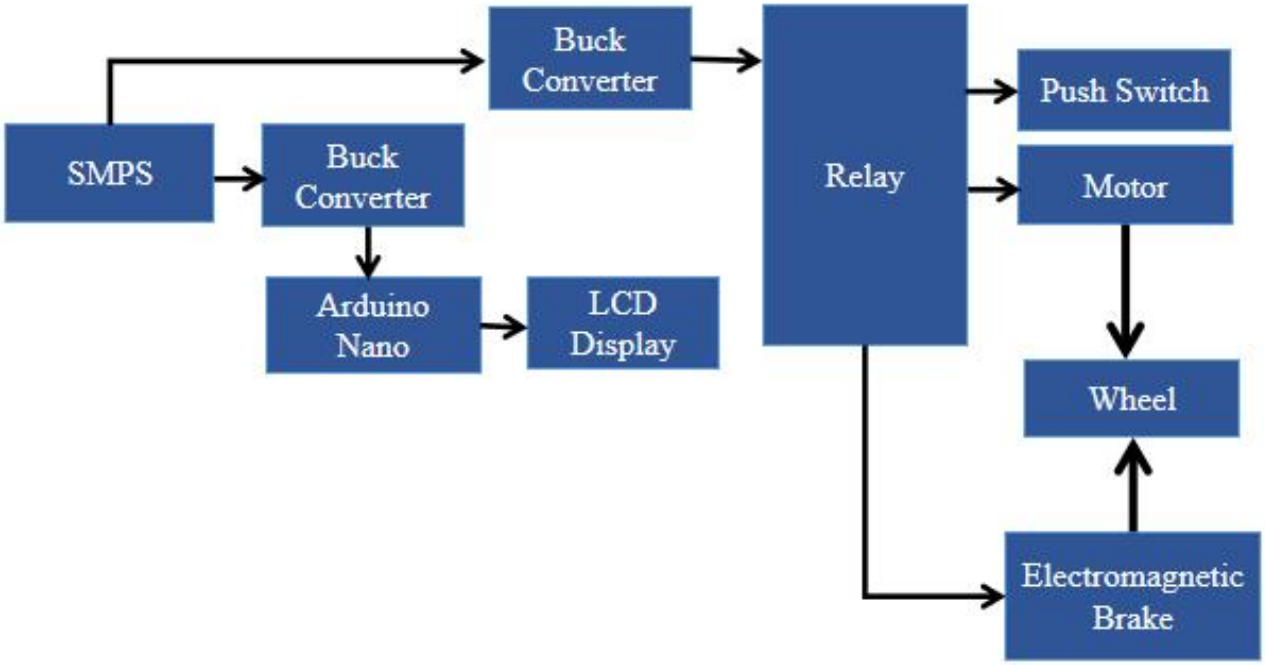


Figure 4.1: Block Diagram of Our Project

4.3 Schematic Diagram

The schematic diagram here is representing the electrical circuit and the components of the project. Here we have used standardized symbols and lines.

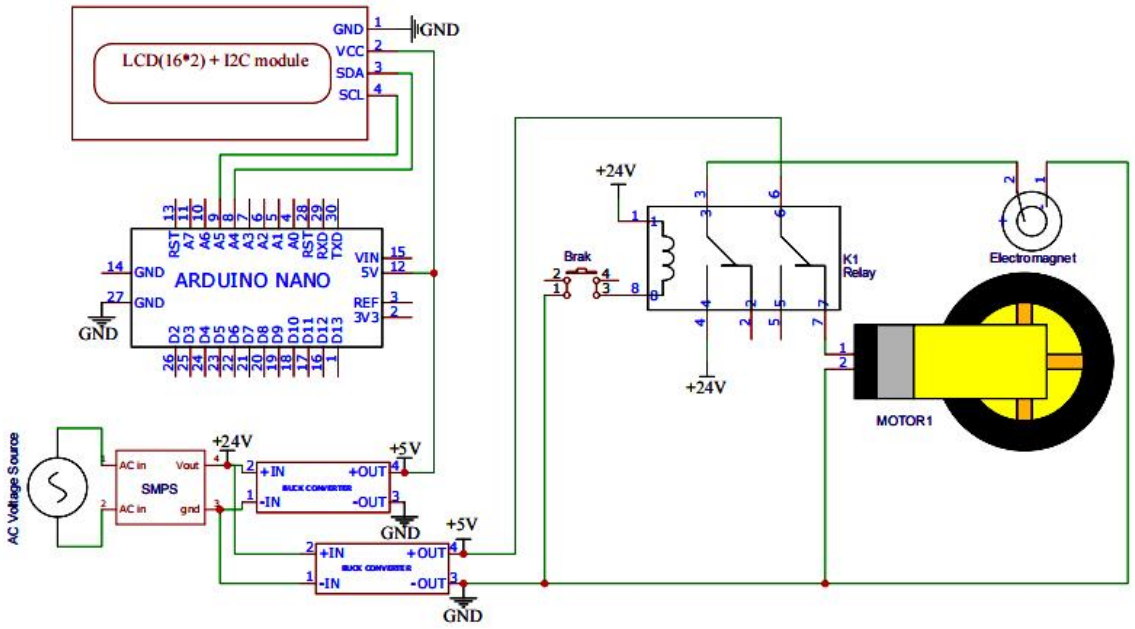


Figure 4.2: Schematic Diagram of our Project

4.4 Working Principle

The system uses an SMPS as the main power source, providing 24V to the components. A buck converter steps down the voltage to safely power the Arduino Nano and LCD display. The DC gear motor rotates a wheel, simulating vehicle movement. When the push switch is pressed, it sends a signal to the relay, which activates the electromagnetic brake by cutting power to the motor and supplying power to the brake coil. The brake generates a magnetic field that creates resistance, stopping the wheel. The Arduino Nano starts a timer as soon as the brake is activated and sends the brake duration in seconds to the LCD display, showing how long the brake remains active. Once the push switch is released, the relay resets, turning off the brake and reactivating the motor. This system provides real-time feedback and smooth, contactless braking using electromagnetic force.

4.5 Cost Analysis

Table 1: Component's Name and Purpose of Use.

Sl.no	Particulars	Specification	Qty.	Unit Price (Taka)	Total Price (Taka)
1	SMPS	24V 10A	1	1700	1700
2	Gear Motor	3.7GB	1	1500	1500
3	Buck converter	LM2596	2	150	300
4	LCD Display	16*2	1	450	450
5	Arduino Nano	At mega328P	1	550	550
6	Electromagnetic Brake		1	800	800
7	Relay		1	300	300
8	Bearing		3	100	300
9	Chain Sprocket		1	1500	1500
10	Wheel		1	1200	1200
11	Push Switch		1	150	150
12	Frame			2500	2500
13	Others				1000
				Total	12250/=

4.6 Final Project View



Figure 4.3: Final Project (Top View)

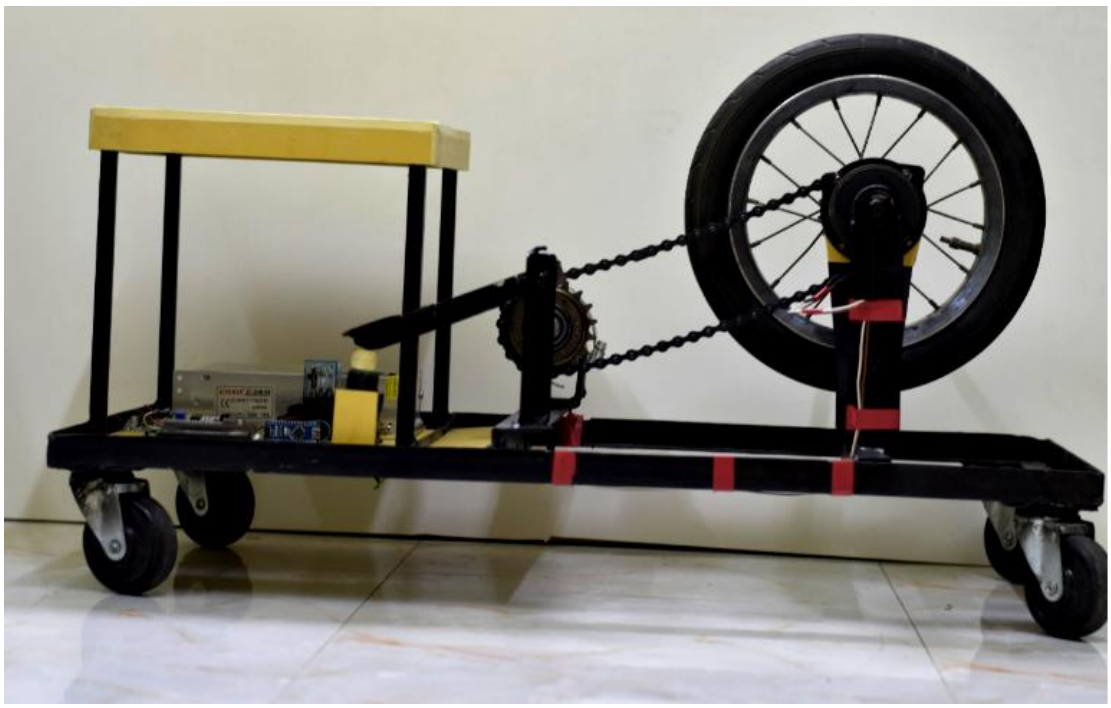


Figure 4.4: Final Project (Front View)

CHAPTER 5
PROJECT OUTPUT AND DISCUSSION

5.1 Project Output

After making our project we observe it very careful. It works as we desire. Our project give output perfectly and all equipment are work perfectly. We check how much it works and we get perfect output from this project.

- When the main switch is turned on, all components are powered through the SMPS, and the system becomes active.
- Pressing the start switch successfully activates the relay, powering the DC gear motor and rotating the wheel as expected.
- On pressing the push switch (brake pedal), the relay correctly disconnects motor power and activates the electromagnetic brake, which effectively stops the wheel.
- The Arduino Nano accurately initiates a timer during braking, and the LCD display shows the exact brake activation time in seconds.
- The buck converter consistently steps down 24V from the SMPS to safely power the Arduino and display.
- System smoothly switches between motion and braking with no lag, demonstrating reliable relay operation.
- The braking was smooth, wear-free, and efficient due to the electromagnetic force.
- The system achieved its objective by delivering responsive braking, real-time feedback, and stable performance throughout the operation.

5.2 Discussion

While working on our project, we did face some difficulties as it is a very complex system but the end results, we came up with were quite satisfactory. We have put the whole system through several tasks to validate our work and also have taken necessary notes for future improvements. Some future recommendations that we have involve improvement in system design and wiring, adding features for more efficiency.

5.3 Advantages

There are Some advantages of our Project because of its accuracy. The advantages are pointed out below:

- Alternative Braking system with foot brake pool.
- Better Performance From foot braking system.
- Maintenance cost is very less.
- Simple construction.
- Limited Heat Dissipation.
- Contactless Braking
- Frictionless Operation
- Quick Response Time
- Eco-Friendly
- Precise Braking
- Noise-Free
- Safe for High-Speed Applications

5.4 Disadvantages

There are Some Disadvantages of our Project because of its accuracy. The Disadvantages are pointed out below:

- High Initial Cost.
- Limited range of operation.
- Maintenance Requirements.
- Power Dependency

5.5 Applications

Some of the application areas of the project has been pointed out below:

- Motor Bike
- Motor Van
- Easy Bike
- Elevator Safety Mechanisms
- Railway Braking Systems
- Motor Electric Scooter Bike.
- Auto Electric Car.

5.6 Difference between Electromagnetic and Hydraulic Braking Systems

Electromagnetic Braking Systems	Hydraulic Braking Systems
The electromagnetic brake operates within a time range of 1.1 seconds to 1.5 seconds.	The Hydraulic brake operates within a time range of 2 seconds to 2.4 seconds.
Electromagnetic braking is faster due to the absence of fluid transmission delays	Hydraulic braking is slower due to fluid transmission delay and mechanical movement compared to electromagnetic braking.
Instant response due to direct electromagnetic force; no physical contact is required.	Slower response because of fluid movement through brake lines, mechanical linkages, and brake pad contact.
Less mechanical wear as there is no direct friction.	More wear due to friction between brake pads and rotor.
Electric trains, trams, industrial machines.	Automobiles, motorcycles, and industrial equipment.

CHAPTER 6
CONCLUSION

6.1 Conclusion

The electromagnetic braking system developed in this project has demonstrated a reliable, efficient, and eco-friendly method of braking using electromagnetic force. Unlike traditional friction-based brakes, this system offers smooth, contactless operation, significantly reducing wear and tear on mechanical parts. The integration of core components such as the SMPS, buck converter, DC gear motor, electromagnetic brake, push switch, relay, Arduino Nano, and LCD display ensures a fully functional system capable of real-time monitoring and control.By pressing the push switch, the relay disengages the motor and activates the brake coil, creating a magnetic field that halts the wheel. Simultaneously, the Arduino counts and displays the braking duration on the LCD, providing instant feedback. This method is not only safer and quieter but also suitable for applications where precision and automation are crucial.The system can be adapted for electric vehicles, smart traffic controls, and industrial automation, and shows potential for energy regeneration when integrated with a generator motor. However, challenges like power dependency and complexity must be addressed for large-scale use. Overall, this project proves that electromagnetic braking systems can contribute meaningfully to modern motion control technologies and future sustainable energy solutions.

6.2 Future Scope

As we have already discussed about the limitations of this system so definitely there's room for improvement and thus we have Some future scope of work available to us for this system. Some of these are listed below:

- In future development this project can be develop by Microcontroller Unit .
- In future development this project can be develop by more Sensor .
- In future, I will try it to apply in real field.
- In Future we will add extra power system.
- In future develop Control on IoT System

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APPENDIX

Micro-Controller Programming Code:

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// Set the LCD I2C address — usually 0x27 or 0x3F (change if needed)
LiquidCrystal_I2C lcd(0x27, 16, 2);

// Push button pin
const int buttonPin = 2;
bool buttonState = LOW;
bool lastButtonState = LOW;

void setup() {
  lcd.init();       // Initialize LCD
  lcd.backlight();  // Turn on backlight

  pinMode(buttonPin, INPUT_PULLUP);  // Button connected to pin 2 and GND

  randomSeed(analogRead(0));  // Initialize random seed (optional but better)
}

void loop() {
  buttonState = digitalRead(buttonPin);

  // Button pressed (active LOW)
  if (buttonState == HIGH && lastButtonState == LOW) {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("-----Driving----");
  }

  // Button released
  if (buttonState ==LOW  && lastButtonState == HIGH) {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("----Stopped----");

    // Animation: dots appear one by one on line 2
    lcd.setCursor(0, 1);
    for (int i = 0; i < 4; i++) {
      lcd.print(".");
      delay(300);  // 300ms delay per dot
    }
```

```
    // Generate random time between 0.5 and 1.7 seconds
    float randomTime = random(500, 1701) / 1000.0;  // random(500,1700) → ms, then
divide

    // After animation, show Stopping time with random value
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("    Stopping");
    lcd.setCursor(0, 1);
    lcd.print("    Time:");
    lcd.print(randomTime, 1);  // Print with 1 decimal place
    lcd.print("s");
  }

  lastButtonState = buttonState;
}
```