DESIGN AND CONSTRUCTION OF PORTABLE WIRELESS CHARGER

A Project report is submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

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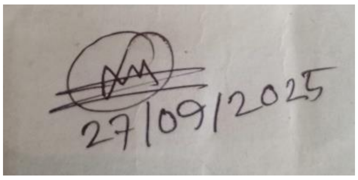
DECLARATION

The title name of my project is, **"Design and Construction of a Wireless Mobile Charger"** and it has been done with a big aim of improving and modifying the mobile charging system to reduce public trouble. This project is designed and decorated in a way that it will be made at low cost, more than one device can be charged at a time and also portable. I also announce that it is the result of my own honest and earnest efforts which was carried out at the laboratories of EEE under engineering facility of DIU. This project has been prepared by me which is a part of the conditions for completing the Bachelor of Science in Electrical and Electronic Engineering program. This work was not submitted in the past according to the best of my knowledge in full or in part for any academic qualification at this university or any other institution in the world. I have taken all kind of necessary protection regarding safety while I made the research process, handled any kind of possible risks included, with that I also respected and thankful from my depth of my heart for the rights and responsibilities of all people who connected to this study.

Signature of the candidates



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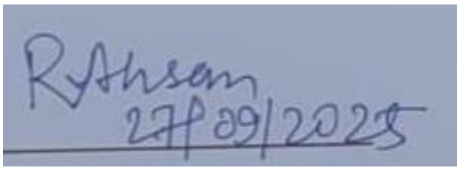
APPROVAL

It is to certify that the project titled **"Design and Construction of a Portable Wireless Charger"** submitted by Md. Moniuruzzaman**, ID: 172-33-4138**, has been completed under my direct supervision and direction. He has completed his project activities with hard work, commitment persistence and focus which really appreciable. This project has been accepted as a partial fulfillment of the requirements for the Bachelor of Science (B.Sc. in EEE) degree from the Department of Electrical and Electronic Engineering, Daffodil International University in 2025 and has been considered acceptable. I pray to Allah for him and wish him all the best for his future success and achievement.



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Dr. Md. Rezwanul Ahsan

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Dedicated

To

MY PARENTS AND SON

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LIST OF ABBREVIATIONS

BAETE	Board of Accreditation for Engineering and Technical Education
DC	Direct Current
AC	Alternating Current
MOSFET	Metal—Oxide-Semiconductor Field –Effect Transistor
LED	Light Emitting Diode
LCD	Liquid- Crystal Display
IC	Integrated Circuit
NASA	National Aeronautics and Space Administration
SHARP	Stationary High Height Relay Platform
EM	Electromagnetic
WPT	Wireless Power Transformer
RF	Radio Frequency
EVK	Evaluation Kit
EVM	Earned Value Management
EMF	Electromotive Force

LIST OF SYMBOLS

Symbol	Name of symbol
μ	Coefficient Of Friction
φ	Angular separation or rotational angle
ε	Lowercase epsilon
ω	Omega
η	Lowercase eta

ACKNOWLEDGEMENT

First and foremost, I want to express my deepest, endless and heartfelt praise to Almighty Allah cause with his want I can complete my project and His blessings and support is not only in my academic journey but also throughout my life. I am always thankful to my family from depth of my heart for emotional and financial support, encouragement, and true love. I specially feel grateful for my parents sacrifice and they always pray for my success and proud for my achievement which boost me to do better. I am thankful and horned to my honorable supervisor **Dr. Md. Rezwanul Ahsan Associate Professor of the Department of EEE, DIU,** for his effective direction and inspiration during the whole project, it is my great pleasure and fortune to have the scope to work under his supervision, shelter of affection, with love and in the light of his wise direction and pathways which is a memory too precious to forget and impossible to describe. Gratitude to all the lecturers, lab technologists of the EEE Department, who have influenced my knowledge and helped myself all the time when i needed. With that i also send love to my department head teacher for his help and confidence building. Finally, thanks and deepest love to my collegians and companion in the department and specially all of those honorable teachers under whose guidance I have learned.

ABSTRACT

The biggest concern for the mobile charger manufacturers always face a problem with Mobile battery performance. There are many Users always raised a complain regarding their mobile battery life that Users said that the devices do not last long and need to be charged many times a day which is a big suffer for them and also time killing. To solve this problem, in this paper shown that our mobile phone is charged automatically using a micro controller circuit. By this project we give a knowledge about how your mobile is charged without any damage in your mobile phones battery life and condition which increase efficiency. Here the primary coil is connected with a secondary coil in the transmitter, from AC to DC Bridge Circuit and a micro controller with the timer circuit is used to prevent the swelling of the battery which worked nicely for charging. Although with lots of advantage it has little bit of cons also which hopefully it will be solved in near future cause technology are developed day by day by solving rising problem.

Keywords: *Electricity generator, Power transformer, Wireless Power Transfer (WPT) Inductive Coupling, Resonant Coupling, Magnetic Resonance, Electromagnetic Field, Near-field Communication, Efficiency Measurement, Green Technology, Portable Devices, Thermal Management, Printed Circuit Board (PCB).*

CHAPTER 1
INTRODUCTION

1.1 Background

A source of electrical energy from natural and artificial sources for operating devices such a distance using a wireless or cable is called Wireless power transmission. while using this our life is getting easier day by day. We can see a better future by taking charging by using resonance. It will be one of the upcoming technologies. It has been illustrate by this project, that low-power devices will be charged wirelessly adding the inductive coupling system. It could be decreased the complications growing from the use of available old cable charging systems. However, the project also showed to us that there are new and huge possibilities of wireless systems in our daily routine. More ever We are live in era of technological advances. Where upcoming technology are growing gradually day by day to give comfortable lifer. Although we use low power devices in our life like phones, cameras not only those but also mid-power devices like laptops, on the old and more formal cable systems. This type of cable system creates lots of untidiness when it comes to charging different kind of devices at a time. Main problems is it takes many electric sockets and different device has differed kind design for charging port for themself. with a clear abidance a straight question might arise in a while. If One device can charge all of these devices at a time without cable then we can get relief from this problem. We take the question and work on it. Here I came up with an idea. In the modern era it is a very simple and more effective way of made the solution to these problem Where wireless way of transmitting electricity is available. It is a system that transfers energy from one point to another without using any wire, cable, vacuum, or other material. we can transmit Electric energy in the atmosphere by WPT means Wireless Power Transmission. it will be used in those places where we need to supply of energy continuously, but where conventional cables are failed. They are not only unreasonable but also inconvenient, expensive, dangerous, unwanted or impossible. In a small range and medium range, we can use inductive coupling and also in A large amount of power can be transmitted through resonant induction and electromagnetic wave power transfer. Wireless Power Transfer (WPT) is a technology which can carry electricity in one place to another places and that is otherwise impossible or is inadequate to transmit. By charging low power devices, Mid Power Devices could be taking a part in the upcoming big thing. The main aim of this project is to design and form a method to transmit wireless electrical power through space and charge a mobile phone which is a low power device. This system will transmit a resisting load power from an AC line by using resonator coils. The study explored various kind of geometric and physical structure factors are carefully to develop and grow connectivity between transmitters and receivers. After getting successful in this way charging process will stop the use of chair while charging, now it becomes more easier to charge a low power device. However, it will also ensure that the devices are free from risk and have too much protection which eliminates the trouble of short circuits. Use a single power outlet, which is most likely to charge multiple devices at a same time using single source was the main purpose.

1.2 Problem Statement and Proposed Solutions

Every day to improve in daily routine work people use devices. For their power supply all the devices are using the power socket. when they use lots of devices in their daily life, then it’s could may be the main reason for huge unavailability of power socket. Nowadays All the Individuals are making their living easier by using smart mobile phones. Here the problem truly rise that they are experiencing and feel is the quickly soluble smartphones using multi-applications on standby time or standby batteries. It is known to all that firstly in1839 sir Nikola Tesla was invented the wireless power transfer. He ensure a Vacuum bulbs without using any type of cable. Wireless power transfer resonance is used for power exchange through coil. By Figure 1.1 we can illustrate the comparison of using between the wire charging and the wireless power transfer charging.

Fig. 1.1 Illustration of wireless charger

The main difference between them that a wireless power transfer charging is more organized and easier to handle, not only that it also makes a feel to user that it is more comfortable to using smartphone without a single wire. More luckily few problems needs to be highlighted and solved in this project, where it transfers can be transferred to a long range or where it transfers in for a short range. after getting that the power of it can be effective from the which components are basically need to use in the coil. It will be making each induvial user use device for better life. A test might be used logical and evidence based wireless power transfer and gain wireless power transfer capabilities. Otherwise, we must need to think about such things like the health conditions and radio radiation.

1.3 Objectives

Such purpose of this project is how to get in various objectives Successfully those are given in the below.

1. firstly, we needed to inquiry of a wireless power transfer system where we use a resonant coil to developed it.
2. Secondly, to make and study the whole system and research it to increase its effectiveness.
3. Finally, we need to verify the wireless power transfer coil and we Use the LabVIEW software to do it.

1.4 Brief Procedures

1. Project flow chart
2. Case study wireless power transfer using magnetic resonance coupled.
3. Experiment on wireless power transfer coils
4. Develop the system and validate the performance.
5. Analyze result
6. Result and analysis

1.4.1 Project Flow Chart

Figure 1.2 show the project flow chart used to make sure this project is successfully done before the due date of this project.

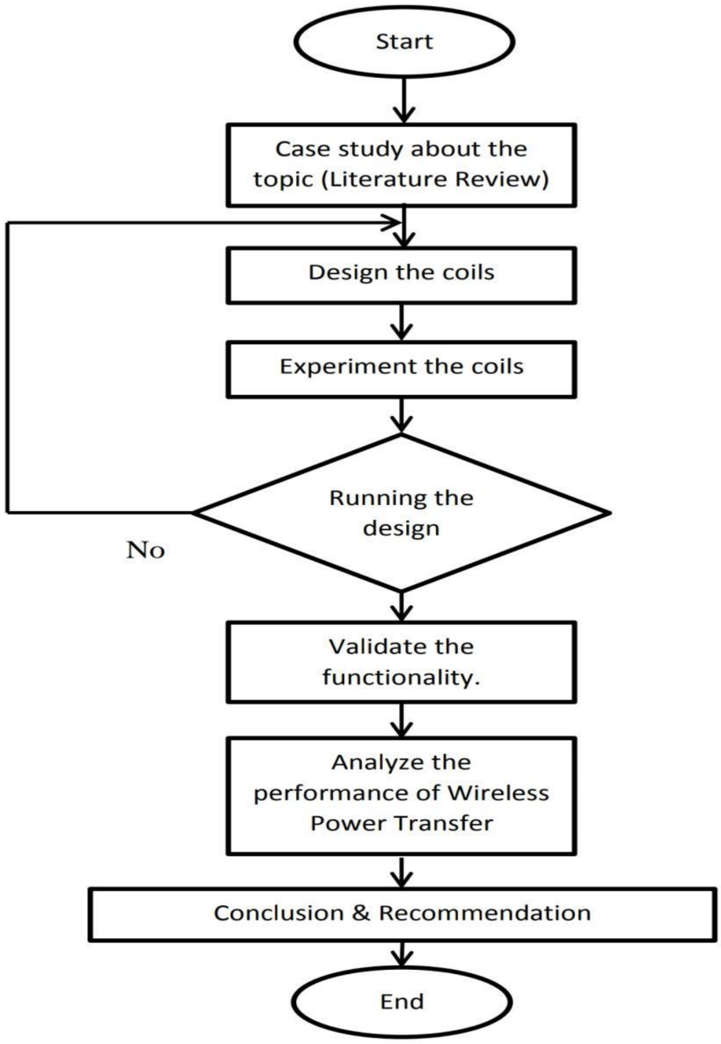


Figure 1.2: Flow chart for the methodology of the Project

1.4.2 Operating Principles

Operation principles of wireless power transfer system are similar to the surface-based wireless power transmission system used for communication between robot swarms. In a resonant system the circular current in the resonant coil is greater that the drive coil by the quality factor, Q. Wireless power transfer system circuit uses the MOSFET power to get a desired transfer frequency. Below shows the block diagram of wireless power transfer transmitter.

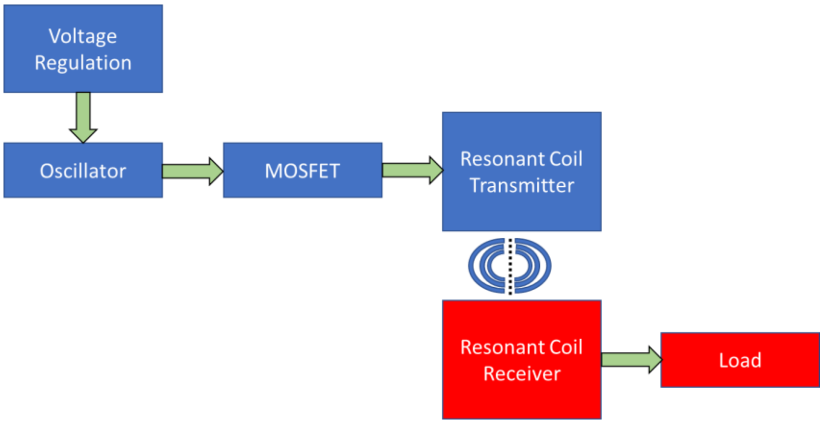


Figure 1.3: Block diagram of wireless power transfer system

During a change in the current flow in a coil transmitter, by the LC receiver coil, a resonance is adjusted. In the transmission frequency, Current is induced within the receiver coil, which is assigned as a resonance frequency. It could be calculated from the LC circuit where he gets the value of inductance and capacitance for calculation.

1.4.3 Magnetic Resonance Coupling

Resonance is associated with energy consumption in two modes and it is defined as an event where a variety of types takes place in the nature. It is feasible solution to accumulate a large amount energy reserved within the system only because of poor weak tension and when it is higher the system's loss rate, then the power getting lost in a resonance system. Figure 1.4 is a example circuit for resonator.

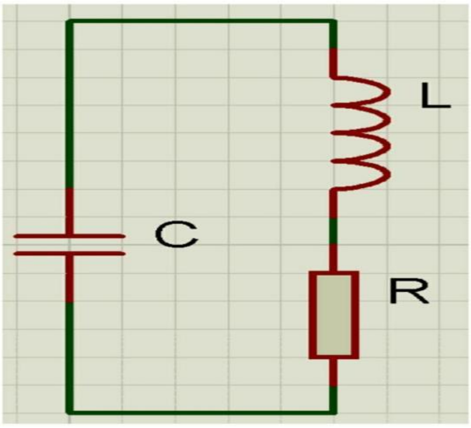


Figure 1.4: Example of a resonator

An isolated resonator's behavior is determined by two primary variables: on of Themis resonance frequency and one is intrinsic loss rate. The ratio of between variables determines the quality factor which is symbolized by Q, of a resonator here which measures how effectively a resonator reserves energy. A magnetic resonance coupling method is applied in this wireless power transfer system which enables not only the efficient but also the robust energy transmission from huge space so far. It depends on antennas, or coils, for location-based energy transfer. In this design we used coils which are follow a solenoid configuration.

1.4.4 System development and validation

In this system, I connected different components together, such as: Transmitter Driver, Matching Network, Receiver Rectifier and Voltage Regulator, etc. Through various tests, we checked how much power could be supplied at a certain distance, by changing the distance between the components. It wasn't just about power supply; we also looked at how stable the output was with different loads. We also tested how much the temperature increased and whether it was higher than expected or if it was suitable for the system

1.4.5 Analyze result

From my all the observations, I found that when the distance increases, the efficiency slowly decreases, which was not expected to me . However, it is true that with the right tuning and matching, we can get very good performance within a certain range.When the load is increased, the output voltage changes a little, but because of the control circuit, mobile charging always remains stable. From the test data, i found two main reasons for loss one of them is resistive loss of the given coil and the other one is misalignment.

1.4.6 Result and Analysis

Our wireless charger prototype worked well to charge a mobile at a short distance. It gave the best result at one fixed distance. Even when the coil was a little bit out of place, it still worked nicely. But when the distance became too long or the angle was too different, it did not work as well. I think in the future, if we use better wires, special shields, or auto frequency systems, it will work even better. This will help science to grow more and more.

1.5 Implementation Schedule

Duration: 15 weak

- 1 weak: Research and Planning
- 2-3 weak: Component Procurement and Setup
- 4-6 weak: Transmitter Circuit Design and Testing
- 7-8 weak: Receiver Circuit Design and Testing
- 9-12 weak: System Integration and Optimization
- 13-15 weak: Final Testing and Documentation

1.6 Structure of the Report

This report includes of seven chapters and each chapter is explained.

Chapter 1: Here we discuss about the introduction related to Wireless Power Transfer Systems and we remarkably briefly and clearly what is the main purpose and which is the main problem to solve.

Chapter 2: We discuss about the literature review of WPT and also the history of WPT.

Chapter 3: We discuss and illustrate about the projects with theory behind the design of it.

Chapter 4: In his chapter, we provide detailed explanation on it that how the device assembled and how operates. Not only that we also explain about the components and each part of the device which we used and what is their role in the design.

Chapter 5: In this chapter, we explained and discussed about what was task, time schedule, milestone and how Cost management modifications are happened and also explained how these were performed.

Chapter 6: This chapter discusses how environmental, social and economic impacts are measured and the application of standard codes.

Chapter 7: This chapter gives the conclusion and recommendations after completion of the final year project. It covers assessment of whether project objectives and scope were achieved, a highlight of areas for future development, and bibliography.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Throughout the last few centuries Wireless power transfer system has been attempted multiple time repeatedly by Henrik Hertz and Nikola Tesla. In the experiment of both in the 1890s and remain ongoing from there the conception ideas started. Although Sir Nikola Tesla believe strongly on his own idea of his transfer. It is shocked that we found there is nobody who as able to confirm this idea. In recent days, interestingly wireless power transfer is shown broadly via induction in all over the world. Despite the fact that WPT via induction has a limits that it can transfer in a very short range. In this chapter we give a literary review on history of wireless power transfer

2.2 Related Research

2.2.1 Development During 19th Century and Dead Ends

During the 19th century, many theories and counter-theories emerged about how to transmit electrical power. In 1826, André-Marie Ampère's circular law demonstrated that electric current produces a magnetic field. Interestingly after long time of period in 1831, Michael Faraday wonders electromagnetic induction and illustration that a changing magnetic field could persuade an electric current in a conductor loop. In the 1860s a significant breakthrough arises with James Clerk Maxwell's equations. These equations unified electricity and magnetism into a single theory electromagnetism and envisioned the existence of electromagnetic waves, which would later form the basis of radio technology while There are many inventors and scientists research state that wireless transmission of electrical energy during this time, but the lack of a unified theory led to confusion and restricted practical progress which was necessary. Then in the positive way, it was introduced the theory of the Pointing vector by John Henry Pointing state that a tool to explain the directional flow of electromagnetic energy, Enabling more reliable study of radio energy systems in around 1884. After that in 1888, This theoretical framework was substantiated by Heinrich Hertz , who finally provided empirical evidence of the existence of radio waves. Two inventors (William Henry Ward (1871) and Mahlon Loomis (1872)) both proposed early wireless signaling concepts at the same time. Both based their ideas on the error and hardly belief that a low-altitude electrical layer in the atmosphere could act as a conductor, with "Earth currents “usually serving as a return path for the current flow. Not only for lighting but also for heating, it was claimed in their patent that telegraph messages and electrical power without batteries both to be used in this system could transmit. After all those things it will regard to say that in 1879 when Amos Dolbear used a magneto-electric telephone to transmit signals over a distance of more than a quarter of a mile through the ground lots of realistic demonstration of wireless transmission came.

2.2.2 Nikola Tesla

Later 1890, inventor sir Nikola Tesla began experimenting with high-frequency resonant transformers powered by electrical sparks—what we now call Tesla coils. These devices generated high-voltage alternating current (AC) and were part of Tesla’s attempts to create wireless lighting systems. He used capacitive coupling and resonance to light Geissler tubes and bulbs on stage without direct wires, demonstrating how an LC (inductor-capacitor) circuit tuned to the same frequency as the transmitter could receive power wirelessly. Although Tesla never commercialized a wireless power product, the principles behind his resonant systems are now used widely in modern electronics and short-range wireless power technologies. Tesla later pursued an ambitious project: wireless power transmission over long distances. Inspired by Mahlon Loomis, he proposed suspending electrodes high in the atmosphere—around 30,000 feet (9,100 meters)—using balloons to transmit electrical energy at extremely high voltages (millions of volts). In 1899, Tesla built a laboratory in Colorado Springs to investigate high-voltage phenomena and the behavior of electricity in the thin air at high altitudes. There, he operated massive Tesla coils producing megavolt-level discharges and studied natural lightning. He incorrectly concluded that the Earth itself could be used to conduct electrical energy worldwide. His theory relied on driving the Earth at its resonant frequency, using the high capacitance of the planet to allow energy transmission anywhere on the globe. Tesla believed that with a properly tuned resonant system, power could be delivered wirelessly to any point on Earth with minimal energy loss.

Figure 2.1: Wardenclyffe unsuccessful of Tesla's power station.

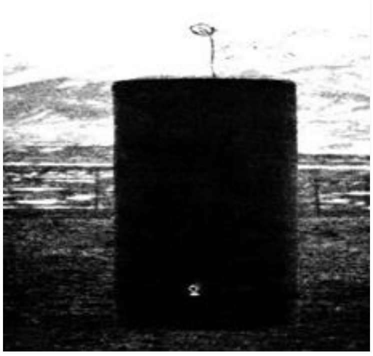


Figure 2.2: Experiment of Tesla’s resonant inductive transfer

Tesla believed strongly using high voltage into a transfer or receiver coil elevated several feet above the ground could "break the layer of air," removed the need to balloons or missiles to establish return circuits named atmospheric. He envisioned a system to transmit information and power wirelessly across the globe, which he called the "World Wireless System." In 1901, he began constructing a large high-voltage radio transmission facility in Shoreham, New York, known as the Wardenclyffe Tower. However, by 1904, funding for the project dried up, and the facility was never completed.

2.2.3 Adjacent Fields and Non-Radiation-based Technologies

The development of wireless power transfer (WPT) has a rich history, beginning with the introduction of wire cables and evolving into wireless systems in the 1800s. The invention of the transformer paved the way for modern power transfer systems, while induction heating had used till the beginning 20th century. As cordless devices became more common, research into induction charging systems was developed to reduce the risk of electric shock in wet environments, leading to applications like electric toothbrushes and razors. One of the early uses of wireless power was for powering electric engines.

In 1880 it started to grow, after two year, Morris Hutton with his partner Maurice patented a system for transferring power to trains using Resonance Coils connected to a cable. In 110 year later, Mario Cardulo and Kouël et al. invented passive RFID (Radio Frequency Identification) technology, which was used in proximity cards and smart cards by the 1990s.

With the rise of portable wireless devices such as mobile phones, tablets, and laptops, the need for wireless power and charging technologies has grown. These advancements aim to eliminate the need to plug devices into wall outlets. The Wireless Power Consortium, proved in 2008, was formed to create standardized solutions for wireless power transfer. Their Qi Inductive Power Standard, introduced in 2008, allows for efficient charging of devices highest 5 watts at a distance of 4 cm (1.6 inches). This technology works by placing a device on a flat charging plate, where power is transferred from a coil in the plate to a corresponding coil in the device.

In 2007, Marin Soljacic's team at MIT demonstrated the use of a dual-resonance transmitter to transfer 10 watts of power over a distance of 6.6 feet using a 25 mm coil. A year later, researchers from Nevada Lightning Lab, led by Greg Leigh and Mike Kane, used a dual-resonance system to transfer power across a 39-foot distance. In 2011, Professor Kevin Warwick from the University of Reading revitalized Tesla's 1900 patent and demonstrated power transfer over a distance of 13 feet with 60.5% efficiency.

2.2.4 Microwave and Laser Technologies

Before World 2nd War, wireless power transmission saw limited progress. While radio technology was making to communicate, it wasn't efficient for power transmission since radio waves spread in all directions, making it hard to focus energy on a receiver. Amplifiers were used to strengthen signals but were not designed for the power transmit. During World War I, the development of microwave technology, including devices like Colston's and magnetron tubes, led to the creation of the first "remote-field" wireless power transmission systems. In the 1960s, William C. Brown achieved the first long-distance wireless power transfer using microwaves. In 1964, Brown developed a rectifier capable of converting microwaves into DC power and demonstrated this by powering a model helicopter using microwaves. In the 1970s and 1980s, microwave research focused on developing solar energy satellites. Peter Glaser, in 1968, proposed using solar cells to collect solar energy and convert it into microwaves to be transmitted to Earth. In the 1970s, NASA's Jet Propulsion Laboratory achieved a 54% DC conversion efficiency for microwave power. By 1983, Japan tested high-power microwave transmission in the Microwave Ionosphere Alien Interaction Experiment (Microx). In the 1990s, microwave technology was explored for drone-powered aircraft. In 1987, CCRC (Canada's Communication Research Center) developed an aircraft as a prototype which is known as the SHARP (Stationary High Altitude Relay Platform). Powered by a rectifier, this aircraft could fly up to 13 miles (21 km) high and stay aloft for months, acting as a communication relay. More recently, in 2003, NASA demonstrated the first laser-powered aircraft. This plane was powered by ground-based infrared lasers, which were absorbed by photocells on the plane, showcasing the potential for laser-based wireless power transmission.

2.2.5 Basic Principles of Wireless Power Transfer

Nikola Tesla, globally known as the "Father of Wireless," was the first to envision the possibility of transmitting power through the air. However his groundbreaking experiments and ideas laid the foundation for what we now know as wireless power transfer, It was a concept that has existed for over a century. Today, many wireless power transfer systems utilize electromagnetic (EM) fields to transmit power without the need for physical connections. Fig 2.1 presents a primary block diagram of a typical wireless power transfer system.

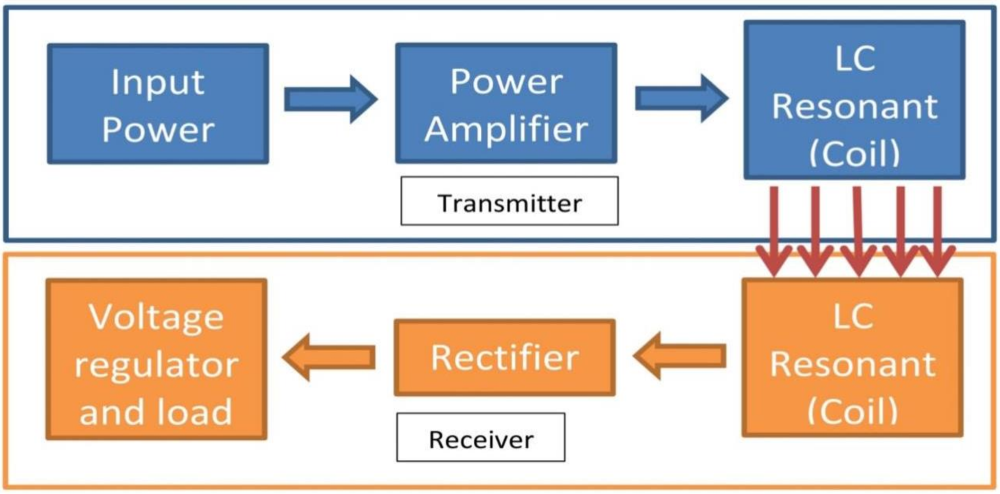
There are three primary methods of wireless power transfer: radiative transfer**,** inductive coupling**,** and resonant coupling**.**

1. Radiative Transfer: Firstly, For a short power transfers this method is primarily used in the milliwatt range in generally. Then a substantial amount of the energy is wasted to free space, making it inefficient for transferring huge amounts of power While it is effective for transmitting information or data wirelessly. In wireless communication systems radiative transfer is often noticed in application.

2. Inductive Coupling: Inductive coupling permits for the transfer of power with high efficiency, but it is limited to short distances. This method includes creating a magnetic field between two coils, as a transmitter and as a receiver

sequentially. For smartphones and electric toothbrushes, moreover it is widely used for devices like wireless charging stations, where for productive power transfer the coils are placed very nearby.

3. Resonant Coupling: On the other hand, for transferring huge amounts of power over mode medium distances which means not too far Resonant coupling is capable. Synchronize the frequencies of two coils, creating a resonance that enhances the power transfer is the main principle behind this method. this approach is generally used in systems where medium-range wireless power is required, like in wireless charging for different kind of electric vehicles and devices .



It can experience here that every method being ideal to various type of applications depending on factors like the required distance and the amount of power to be shifted all kind of these wireless power transfer methods relies on the use of electromagnetic fields. By the way the resonant coupling method, as illustration, is ideal for medium-range power transfer, while for short-range, high-efficiency applications inductive coupling the is most suitable. As a result, in this observation describe that one type can use according its need.

2.2.6 Fundamental principle of Wireless Transmission of Electrical Energy

Comprehensive study in Wireless Power Transfer (WPT) has led to the development of different categories of WPT systems. Based on factors like efficiency, power levels, transmission distance, and system size these systems can be categorized. However, the most relevant and useful between them is classification based on transmission distance.

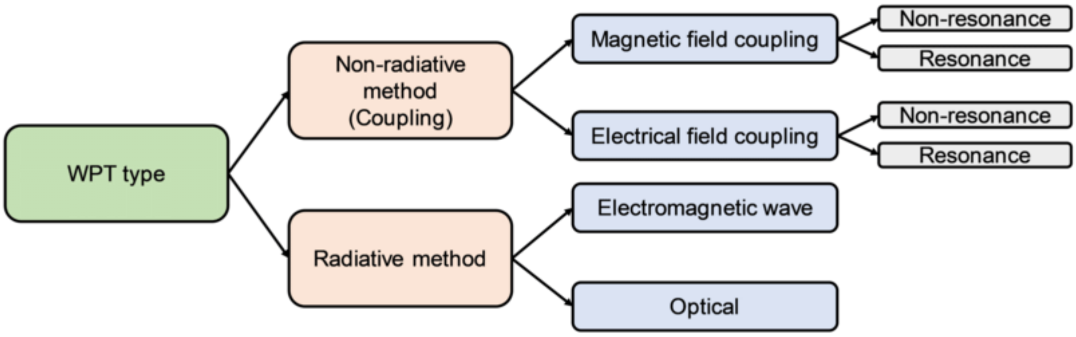


Figure 2.4: Classification of WPT

Electric fields (E-fields) and magnetic fields (H-fields) around them both by Electromagnetic sources generate. Depending on their distance from the source, These fields consist of radiative and non-radiative components. The regions surrounding the source can be classified into three zones: one of them is near-field, other one transfer-zone, and none the less the last one far-field. The transfer-zone is a transition region that shares all the characteristics of both one is the near-field and other one the far-field. Usually the near-field is within the wavelength radius, the source increases with the field strength diminishing as the gap from . For distances greater than twice the wavelength, where the field strength continues to decrease the system come in the far-field zone eventually. Different polarization types like elliptic,vertical, horizontal and circular can occurred by it and each affecting how the power is transferred In the far-field gradually. Between all of them power transfer is the most efficient in the near-field region that studies have shown. This is why the electric and magnetic fields are stronger closer to the source, which allows for the better energy transmission through .The fields weaken and reducing transfer efficiency when the distance from the source increases. Thats why its is the best field region among all. The near-field also supports the splitting of waves into higher frequencies, resulting in more focused power transmission with better directionality. As a result, much research has focused on improving the transfer efficiency in the far-field, where the power levels tend to decrease. Not only Near-field but also far-field transfers both can be classified according on the operational methods used. Below are some of the common methods for far-field power transfer.

2.2.7 The Far-Field Transfer system:

A) The MPT (Microwave Power Transfer)

In the microwave power transfer method, a direct current was supply in a microwave generator, and converts it into microwaves. These microwaves travel through a adapter named coaxial-waveguide, moving by the circular waveguide that helps reduce radiation leakage to the outside. The microwave energy is then passed through a tuner and a directional coupler, which adjusts the signal of a direction for transmission. Afterward, the radiation is transmitted through an antenna into the air. The microwave radiation is captured by an antenna at the receiver side, where it passes through a low-pass filter, removing unwanted high-frequency components. The filtered microwave radiation is then directed to a network which is matching and then transferred back into direct current power using a rectifier. This version organizes the information for better readability and flow while retaining the key technical details. Let me know if you need further adjustments

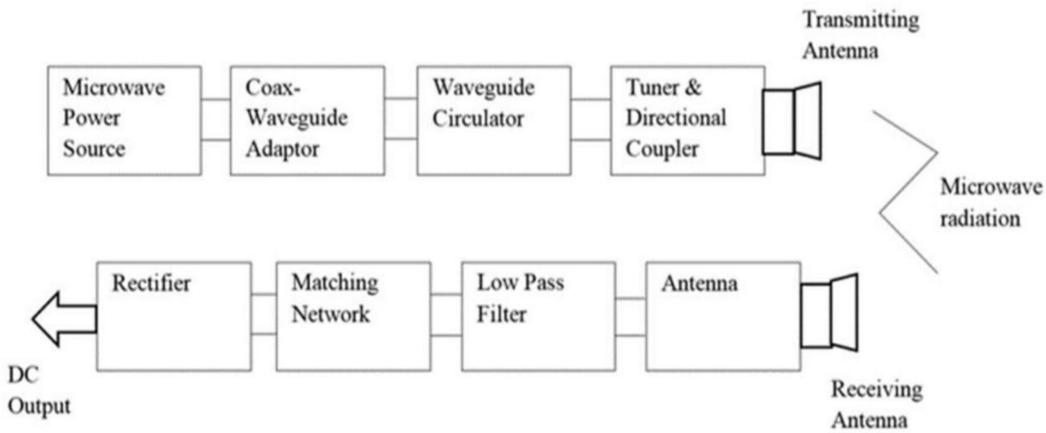


Figure: 2.5: The MPT

b) transmission of electromagnetic waves

firstly, it is the main principle behind a wireless mobile charging system where an AC always deliver in the transmitter coil which produce a time-varying magnetic field by own capability and it then propagates and induces an DC in the receiver coil by using an electromagnetic induction. However, this is easily controlled the wave propagation and its enables efficient with that a contactless energy is transferring from a charger to the using device.

2.2.8 The Near-Field Transfer

a) Inductive Coupling

The main Wireless power transfer's summary interface Standards and Alliances as of January 2015

Table 2.1: Summary of main WPT Interface

Organization	WPC	PMA	A4WP
Established	2008	2012	2012
No. of members	203+	80+	140+
Transfer type	Inductive coupling	Inductive coupling	Magnetic resonance
Max. transfer power	5W (10-15W soon)	5W (10-15W soon)	up to 50W
Range	Short range	Short range	Mid-range
Transfer frequency	100 to 205 kHz	277 to 357 kHz	6.78 MHz
Latest version	1.1.2	PMA1.1	A4WP-S-0001 v1.2
Certified Products	684	24	-
Authorized test labs	10	3	2

2.3 Compare and Contrast

1. Overview of Existing Wireless Charging Technologies: Wireless mobile charging refers to the transfer of energy from a power source to a device without physical connectors. Key technologies include.
2. Inductive Charging (Qi Standard): Uses electromagnetic fields between two coils. Requires close alignment and physical contact. Widely adopted in smartphones (e.g., Apple, Samsung).
3. Resonant Charging:
   - Uses magnetic resonance to transfer power over a larger distance and with more flexibility.
   - Less alignment-sensitive than inductive.
   - Still in development or early-stage commercial use.
   - Radio Frequency (RF) Charging

- Converts RF waves into DC power via rectennas.
- Can power small devices (IoT, wearables) over several meters.
- Lower efficiency, not suited for high-power mobile devices yet.
- Laser/Infrared Charging Uses light-based energy transfer to power devices over longer distances.
- High potential but faces safety, efficiency, and regulatory challenges

Table 2.2: Comparison of Wireless Power Transfer Technologies

Feature/Technology	Inductive (Qi)	Resonant Charging	RF Charging	Laser/Infrared Charging
Charging Distance	Few mm	Few cm to 1 m	Several meters	Several meters
Efficiency	High (70-80%	Moderate (50-70%)	Low (10-30%)	Moderate (30-60%)
Device Alignment	Critical	Flexible	Not needed	Not needed
Power Delivery Capacity	High (up to 15W+)	High	Low	Moderate
Safety concerns	minimum	Minimal	RF exposure concerns	Eye safety & overheating
Current Use	widespread	Emerging	Early – stage	Experimental

2.4 Summary

This chapter provides a thorough assessment of the existing body of work on Wireless Power Transfer (WPT). It critically reviews both technical and academic literature, highlighting key advancements and contributions in the field. The chapter begins with an exploration of the history of wireless power transfer, tracing its development over time. It then examines the fundamental concepts of wireless transmission of electrical energy, delving into the core principles that enable power transfer without the need for physical connections. These principles include electromagnetic induction and other relevant technologies. Additionally, the chapter justifies the need for further research in WPT, emphasizing its potential applications and the importance of overcoming existing challenges in efficiency, range, and cost. The study provides a foundation for understanding the significance of WPT and its future prospects in various fields.

CHAPTER 3
METHODOLOGY

3.1 Introduction

The fundamental topics of this chapter must be discussed not the theoretical framework only but also approaches whom-whom I used to complete the project. In this chapter of the project, I used few equipment and component them are explained by me.

3.2 Using Inductive Coupling for Wireless Power Transfer

The ability to transfer power wirelessly is fundamentally based on the principles of electromagnetic induction and the correct application of electromagnetic fields. According to Biot-Savart's Law, which is analogous to Coulomb's Law, the magnetic field intensity dH at a point r due to a current element Idl at a position r' is related to the distance between them dR. This law describes the relationship between the magnetic field and factors such as the length, direction, proximity, and the current flowing through the conductor that generates the magnetic field.

$$dB = \frac{I\, d\mathbf{l} \times \mathbf{R}}{4\pi R^3}$$

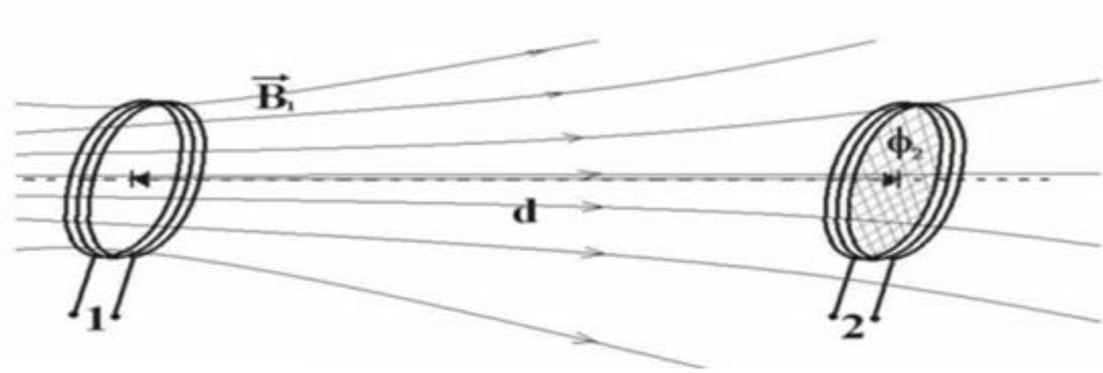


Fig: 3.1: Magnetic flux

In this context, R denotes the displacement vector directed from the current source to the observation point of field, while Idle refers to an infinitesimal current element along the wire. When current flows through a copper coil, it generates a magnetic field denoted as Br. The strength of this magnetic field depends on r, which is the distance from the center of the coil to the observation point in the field. The magnetic field (B) is directly proportional to the current

1. flowing through the coil.

$$B = \frac{\mu_o N I a^2}{2(a^2+d^2)^{3}/_{2}}$$

Here N is symbolized how many number of spin in a coil , I is symbolized how many currents has the transmitter, which was a radius where distance between D and TXX are TX quilts. The magnetic flux would give Rx that will be passed into whole coil.

$$\Phi = \iint_s B dS$$

The density of magnetic flux generated by surface area of two coil.

When current flows through the transmitter (TX) coil, it generates a time-varying magnetic field. This changing magnetic field causes variations in magnetic flux through the nearby receiver (RX) coil. As a result, an electromotive force (emf) is induced in the RX coil. This phenomenon is explained by theory of Induction of Faraday's, and it says: "The induced electromotive force in coil always be proportional with negative rate of change of flux through the coil."

$$\varepsilon = -\frac{d\Phi}{dt}$$

A coil which is contains lots of n loops, then overall MMF would be larger

$$\varepsilon = -N\frac{d\Phi}{dt}$$

Here, Φ represents the magnetic flux. According to Lenz's Law, the electromotive force (EMF) induced in the receiving (RX) coil generates a current that produces a magnetic field opposing the change in the original magnetic flux. This opposition ensures the conservation of energy and facilitates the transfer of power from the transmitter (TX) coil to the RX coil. As a result, a magneto motive force (MMF) is generated, allowing the system to efficiently transmit energy wirelessly.

(i) by varying the magnitude of B with time as in the figure below Input (Manure

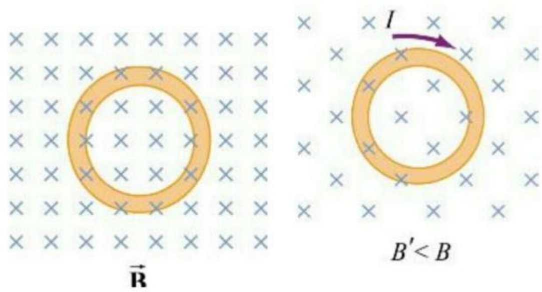


Figure 3.2: Magnitude of B

(ii) by varying the magnitude of A, i.e., the area enclosed by the loop with time

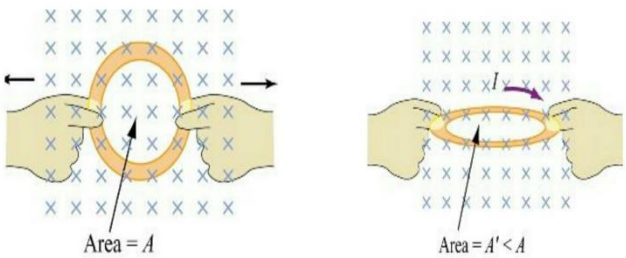


Figure 3.3: Magnitude of A

Characteristics of a own-inductance circuits resistant to the current convert of its self possess magnetic field in the circuit. Here we can defined own-inductance of a coil as:

$$\boxed{L = N\,\Phi/I}$$

Here N is symbolized total number of those magnetic flux and We had main current of coil . thus ,

$$\varepsilon = -L\frac{dI}{dt}$$

Or

$$\varepsilon = -M\frac{dI}{dt}$$

Here

L = own-inductance of the coil

M = mutual inductance of two coils

I = the current of the coil.

Therefore the electromotive force contained in the coil linearly related not only to the coils's mutual inductance but also rate of how much current be fluctuating again and again. therefore the mutual inductance which could be written like

M = K(L1L2) ^½

Here these are symbolized by

K = the coupling factor,

L_1= TX inductance

and

L_2 = RX inductance

Where the Coupling factor is assigned as the grade of a coupling,

A question is to be solved that , What is the amount of total floc is entered inside into a coil which is named receiver? the current finding equation defines bellow:

$$\Phi = \frac{\mu_o N I \sin(\omega t) a^2}{2(a^2+d^2)^3/_2}$$

Therefore,

$$\mathcal{E} = -\frac{d\left(\frac{\mu_o N I \sin(\omega t) a^2}{2(a^2+d^2)^3/_2}\right)}{dt}$$

It can be Explicitly illustrate that the amount of voltage which is introduced in the 2nd coil is depended on how much current and voltage are given in the primary coil, Here not only current but also voltage frequency in the primary coil, the distance between two coils and their consuming area. Therefore, Both the coils are shown below.

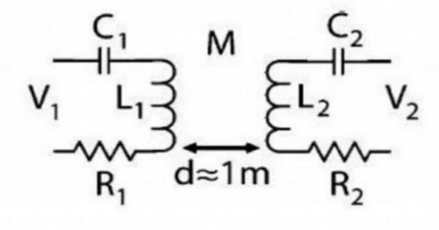


Figure 3.4: The two coil coupling system

Here

C_1 and C_2 = these two are capacitors in the circuit ,

L_1 and L_2 = these two are inductance in the circuit

M = mutual inductance in the circuit,

R_1 and R_2 = these two are resistance in the circuit

d = Receiver coil how much far from transmitter coil

V_1 and V_2 = input and output voltages

Then we can find out the output of Second coil which is defined as energy:

$$P_{out} = \frac{V_1^2 \omega^2 M^2 R_l}{(R_1(R_2+R_l)+\omega^2 M^2)}$$

The ω represents the operating frequency of the system, and R_L is the load resistance. The overall efficiency of the system is influenced by factors such as the transmission frequency, mutual inductance, the parasitic resistances of the coils, and the load resistance.

Firstly, the Q factor, which is a measure of the coil's energy storage efficiency compared to energy loss because of resistance, plays a leading in determining the system's entirely efficiency. Then a high Q factor points to the lower power loss, as a result enhancing transmission efficiency.

However, Q factor values typically range from 0 to 1000, with maximum values signifying better performance in terms of energy transfer efficiency for Wireless Power Transfer coils. Finally, we can write it as:

$$Q = \frac{\omega L}{R}$$

Where L, R and ω all are respectively the total inductance of the given coil, how much resistance in the circuit, and the assumption of frequency in the circuits. By growing up the operating frequency generally leads to a maximum Q factor. However, once the frequency reaches a peak, further increases in the operating frequency cause the Q factor to decrease. A higher Q factor corresponds to a narrower bandwidth, which can lead to reduced coupling efficiency and a need for precise tuning in the circuit. The maximum transfer efficiency is achieved when the system is properly tuned to the optimal frequency, balancing the Q factor and coupling efficiency. As a result Maximum amount of transfer efficiency is defined by:

$$\eta = \frac{k^2 Q_1}{\left(1+\sqrt{1+k^2 Q_1 Q_2}\right)2}$$

Where

k = it is define as coupling factor of receiver and transmitter coils

Q_1 and Q_2 = both define the quality factors of two coils.

So as a outcome , to rise highest efficiency, manufacturers need to optimize not only the system’s quality reasons but also coupling.

3.3 Design Specifications, Standards and Constraints

These are the key performance and technical requirements the wireless charger must meet:

- Output Power: Typically ranges from 5W to 15W or higher
- Input Voltage: Standard input via USB (5V, 9V, or 12V DC).
- Operating Frequency: Usually between 100–205 kHz (for inductive charging per Qi standard).
- Charging Distance: Effective range up to 5–10 mm for inductive systems; resonant systems can extend up to several centimeters.
- Efficiency: Target ≥ 70% energy transfer efficiency.
- Temperature Management: Must include thermal protection (cutoff above ~45–50°C).
- Device Compatibility: Should support Qi-enabled devices and backward compatibility.

- Design Constraints:
- Physical Size: Must be compact and portable for consumer use.
- Alignment Sensitivity: If the coil mismatch then it decrease efficiency or fail to charge.
- Material Limitations: Stay away from metal impediments between TX and RX coils.

- Thermal Constraints: Destroy devices or decease performance if it get too much heat.
- Cost Constraints: Need stability between performance, safety and manufacturing cost.
- Interference: Must not intervene with nearby electronics or communication systems.

3.4 System Analysis or Design Analysis

Firstly, the operation of the system is based on the law of relative coupling, enabling energy transfer between nearby fields. Then efficient transfer and minimizes the risk of damage, making the battery charging circuit both versatile and power-efficient is ensured by the design. Secondly the system is split into two main sections: one transfer and other one is receiver circuit. Where transmitter circuit is contains the power supply, a boost converter, a Royer oscillator, and coils which laminated with copper for effective energy transmission for the receiver. Receiver Circuit: This section contains of a receiver coil, a rectifier, and other components to convert (AC to DC) the received energy into usable power for the devices. This design boost energy transfer while maintaining the safety and the efficiency of power. The figure below illustrate the main block diagram of the design:

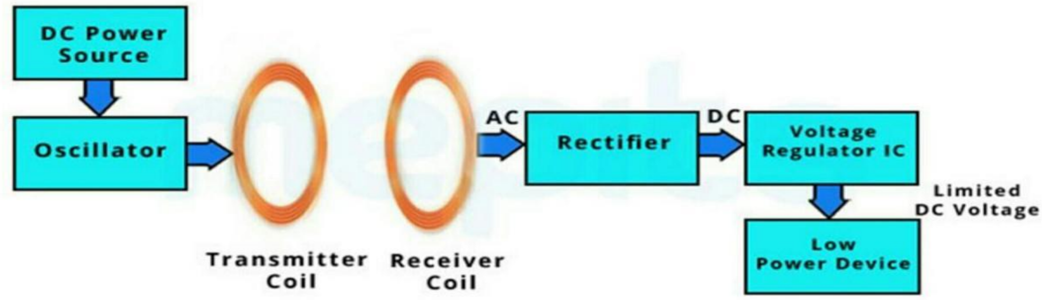


Figure 3.5: block diagram of the design

In the system, firstly the AC power is supplied from the power supply and fed .Then secondly this AC voltage is stepped down and rectified to produce DC power . after that the resulting DC voltage from circuit is passed through a voltage regulator, specifically the LM7805, which assure a stable output of 5V DC. Nevertheless, For induction, the 5V DC signal alone is insufficient to generate a significant EMF (electromotive force). To deal with this, input the 5V DC into a DC boost converter, as a result get 30V which is increased by the converter. Then In the Royer oscillator circuit this 30V is then supplied as the input. Finally the oscillator converts the 30V DC into high-frequency AC power, enabling the induction process necessary for efficient energy transfer. A power source of DC, circuit of an oscillator, also a transmitter module (generally referred to as the electrode), and the transmitter coil all are consists our project. After that a fixed DC voltage input to the oscillator circuit produced by The DC power source while The oscillator then converted DC power into high-frequency AC power. On the other hand the high-frequency AC power which get from oscillator is supplied to the transmitter coil. The transmitter coil generates an alternating magnetic field Once energized by this high-frequency AC current. Likely alternating magnetic field is the main factor to enabling energy and transfer to the receiver coil through inductive coupling. A simple transformer which is step-down and a rectifier circuit consists the DC power source and reduces the high input AC voltage to a desired lower level by the transformer. Then this lower AC voltage is passed through the rectifier circuit, which converts lower AC voltage into a fixed DC voltage and this DC voltage is suitable for powering the rest of the circuit.

1. Oscillator Circuit: Firstly a planned oscillator circuit prototype for this project is a modified Royer oscillator which is known for its simplicity and powerful performance. It is highly capable of handling high-frequency switching and also driving high currents through power semiconductors although its design straightforward. With a positive note the design makes Royer oscillator ideal for generating strong magnetic fields, which are essential for efficient WPT (wireless power transfer). Two inductors labeled L1 and L2, which are parts of a center-tapped transformer, along with two N-channel enhancement-mode power MOSFETs labeled Q1 and Q2 are consist the oscillator circuit. Across the primary coil resonant capacitor (C2) is connected what is forming an LC tank circuit with the transmitter coil. The circuit also includes fast-recovery diodes (D1 and D2) and gate resistors (R1 to R4), which help control the switching of the MOSFETs. DC voltage is applied to the center tap of the transformer for current flows through L1 and L2 into the drain terminals of Q1 and Q2. This creates a voltage across the gates of the MOSFETs, causing them to begin conducting. Due to slight differences in component characteristics, one transistor turns on slightly before the other, initiating the oscillation.

As one MOSFET turns on, current increases through its corresponding half of the transformer, magnetizing the core. When the core reaches saturation, the stored energy is released, switching the conduction to the opposite MOSFET. The LC tank circuit (formed by the coil and capacitor) then oscillates, producing a sinusoidal waveform. During this process, the drain voltage of the active MOSFET drops while the other rises, enabling alternate conduction. The diodes D1 and D2 assist in this switching by feeding back voltage to the gates. This cycle continues repeatedly, generating a high-frequency AC signal. The operating frequency of the oscillator depends on the inductance (L) and capacitance (C) values and is given by the standard resonance formula:

$$\mathbf{F = 1/2 \times \pi \times \sqrt{}\,(LC)}$$

This high-frequency signal is used to drive the transmitter coil**,** which then transfers energy wirelessly to the receiver coil.

2. Transmitter coil: In this project we built the transmitter coil within 9 mm diameter, where we used 17 swg copper wires with its 100 turns . Then we get inductance L = 8.1 uH which is the inductance of a single layer air core coil.
3. Working of receiver circuit: The receiver module in our project consists of a receiver coil, a rectifier circuit, a voltage regulator IC, and an optional buck (step-down) converter. The receiver coil picks up the AC voltage wirelessly transmitted by the transmitter coil. Then this AC voltage is input into the rectifier circuit, which converts AC into DC. The DC output is further steady by the voltage regulator to provide a constant 5V output which is most suitable for powering electronic components. whet higher current is required then a buck(which allowing for increased current output while maintaining power efficiency) converter can be used to step down the voltage from 5V to a lower level.
4. In my project I used design receiver coil as same quality and turn of coil as I used for transmitter coil.
5. The important thing that MOSFET allows a large current to flow through the circuit and it is also connected to a copper coil. The image below shows the transmitter section of the system. Two power MOSFETs that are biased by resistors R1, R2, R3, and R4 are features in this section. A choke formed by inductors L1 and L2, which help manage the current flow includes in the circuit additionally and as a

result the capacitors (C) ensuring finally that the coils operate at their resonant frequencies for efficient energy transfer.

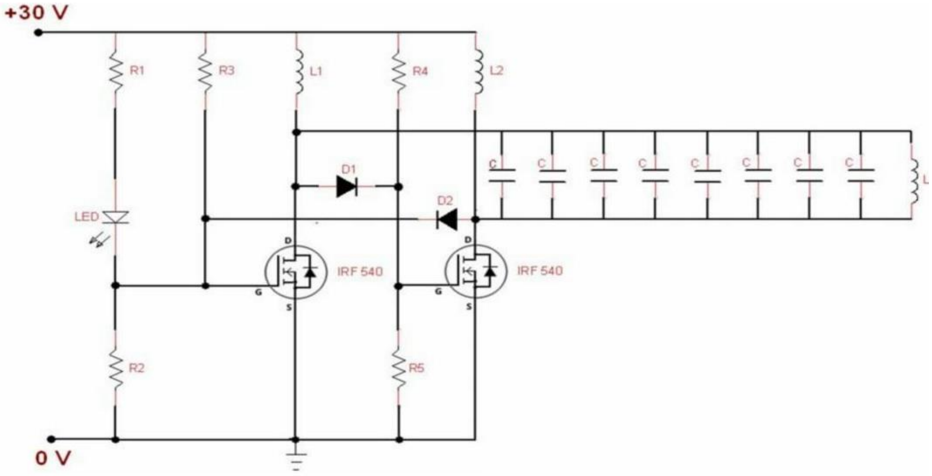


Figure 3.6: Transmitter section circuit

In the circuit diodes (D1 and D2) provide cross-feedback what is helping to control the transistors switching behavior. The transmitter coil (L1) which has 60 turns acts as the core component for electromagnetic induction. When power is supplied to the oscillator circuit, DC current begins to flow through both sides of the coil (L1 and L2) and into the drain terminals of the MOSFETs. At the same time, voltage is applied to the gate terminals of the MOSFETs, causing both transistors to start turning on. One of the transistors will turn on slightly faster than the other, initiating the oscillation. When Q1 turns on, its drain voltage drops to ground, while Q2 remains in the off state. Once Q2 is triggered, its drain voltage starts to rise, and it quickly begins to decrease as energy is transferred through the capacitor (C) and the primary coil, forming an LC tank circuit.

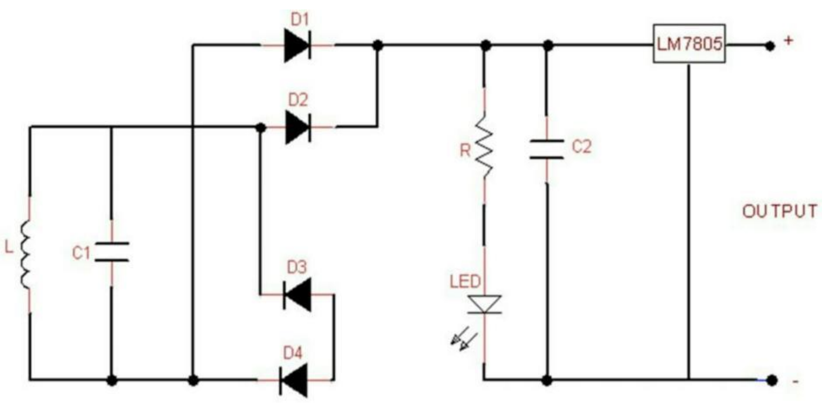


Figure 3.7: Receiver Circuit

When the receiver coil is placed within the magnetic field range of the transmitter coil, the magnetic field from the transmitter induces an AC voltage in the receiver coil. This induced voltage causes current to flow through the receiver coil, powering the wireless charger. The transmitted AC voltage is then directed to a rectifier, which converts it into DC. A capacitive filter is used to smooth out any residual AC ripple, ensuring a cleaner DC output. After that in the voltage regulator, the filtered DC voltage is passing throw, which controls and stabilizes the output voltage. The result is a constant 5V DC output, suitable for powering connected devices.

3.4.1 Components

Name of Items	Quantity
Transistor	1
Heat Sink	1
Some aluminum wire	1
semiconductor Diode	As required
9 cm round shape such things	4 ,for making a bridge connection
Supply DC power	2
Bread board	1
Some Capacitors	1
Charging put	As much needed
hitching	1
plug	1
wrapper	1
LED bulb	2

3.4.2 Hardware

The oscillator circuit requires a 30V DC supply, but the power supply unit provides an output of only 5V DC. To achieve the required voltage, a transformer steps down the 230V AC input to 9V AC. This 9V AC is then fed into a full-wave bridge rectifier, which converts it to DC. Although a half-wave rectifier could be used, a full-wave rectifier is preferred due to its higher efficiency in converting AC to DC. The rectifier output is not a smooth DC signal; it is pulsating, and the voltage is lower than the input due to the inefficiencies of the bridge rectifier, which has an efficiency of about 80%. The rectified output is around 7.2V DC.

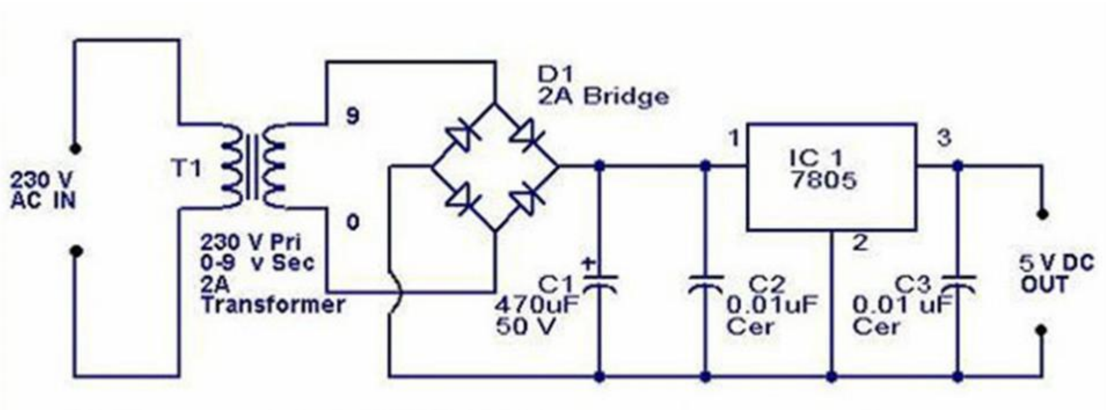


Figure 3.8: Power Supply

This voltage is still unstable and pulsating, so smoothing capacitors are added to reduce the ripple and smooth the DC output. The smoothed DC voltage is then fed to an LM7805 voltage regulator, which ensures a stable 5V DC output.

3.4.3 Full Wave Bridge Rectifier

The receiver side of the wireless charging system receives an alternating current (AC) signal, but for battery charging purposes, direct current (DC) is required. To achieve this, a full-wave bridge rectifier is used instead of a half-wave rectifier. The full-wave rectifier, however, is designed with two bridge rectifiers, which simplifies the circuit and eliminates the need for four diodes. This design is preferred for several reasons. No need for a center tap on the secondary winding of the transformer. This allows the AC voltage to be fed directly into the bridge rectifier circuit. Here we use of Low cost diodes: The crystal diodes used in the circuit are available, affordable, and easy to implement what is making the design more compact.

Higher power handling: Especially in high-power applications this configuration is more efficient for transforming AC to DC. The full-wave bridge rectifier has four diodes arranged in a bridge, forming four diagonal arms. When AC voltage is applied to one side of the bridge, the rectifier produces a DC voltage at the opposite side . For AC positive half cycle when point A becomes positive, and Point B becomes negative then in this time diodes D1 and D2 conduct, and D3 and D4 block the current flow and we get current flow through load. then for AC negative half-cycle, the current path is reversed, D3 and D4 conduct and D3 and D4 block the current and we also get current flow through the load. Both halves of the AC cycle into usable DC..

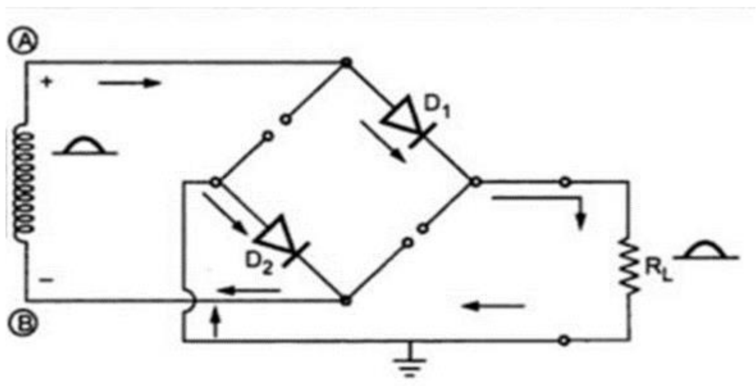


Figure 3.9: Flow of Current 1

Firstly for positive half cycle A become positive and B become negative D1 and D2 conduct than The voltage polarity reverses During the negative half-cycle of the AC input causing Point B to become positive and Point A to become negative.for this reason diodes D3 and D4 become forward-biased and start conducting, This allows current to flow through the load in the opposite direction, completing the rectification process. This ensures that all the time current flows through the load in one direction, Without considering of whether the input AC is in its positive or negative half-cycle and the full-wave bridge rectifier provides a continuous flow of DC current to the load, which we can see from the diagram below.

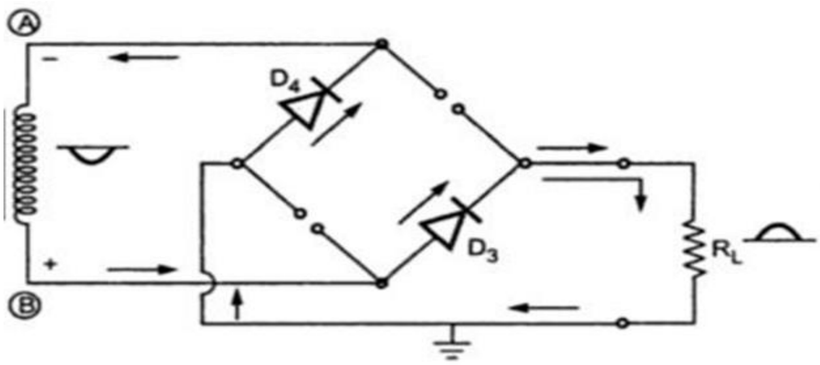


Figure 3.10: Flow of Current 2

For both the positive and negative half-cycles of the AC input the current flowing through the load which is important to note.The current always flows in the same direction is always ensured by the full-wave bridge rectifier,regardless of the AC cycle's polarity. However, while the current is unidirectional some of rectified DC voltage still contains ripples due to the incomplete smoothing of the AC waveform. for this reason a capacitive filter added which ripples and smooth the DC output.. The capacitor charges and discharges, helping to smooth out the fluctuations in the rectified voltage. Since the capacitor's reactive impedance is much smaller than the resistive load in the circuit, it efficiently filters out the ripple, providing a more stable DC voltage.

3.5 Experimental Setup

To implement and test the wireless mobile charging system, both the transmitter and receiver modules were carefully constructed based on the designed circuit diagram. The system functions on the principle of resonant inductive coupling, enabling energy transfer wirelessly through a magnetic field from the transmitter coil to the receiver coil. On the transmitter side, a DC power source capable of delivering up to 30V DC was used. Initially, a transformer stepped down the 230V AC mains supply to 9V AC, which was then converted into DC using a full-wave bridge rectifier and smoothing capacitors. A modified Royer oscillator was built using two N-channel MOSFETs (Q1 and Q2), gate resistors (R1 to R4), inductors (L1 and L2), a resonant capacitor (C), and fast-switching diodes (D1 and D2). The transmitter coil, made from 100 turns of 17 SWG copper wire on a 9 mm diameter air-core former, formed the LC circuit generating high-frequency AC. On the receiver side, a matching coil was placed within range to capture the magnetic field. The induced AC voltage was passed through a full-wave bridge rectifier and smoothed with a capacitive filter to reduce ripple. Constant 5V DC output which was needed as result and it is granted by an LM7805 voltage regulator which is ideal for mobile charging . Some times, a buck converter was included to step down the voltage and increase available current in that case the transmitter oscillated at the resonant frequency and placing the receiver coil within range produced a stable 5V DC output confirming effective wireless power transfer eventually during the test time.

3.6 Summary

At conclusion this section provides a detailed explanation about how the different kinds of components of the wireless mobile charger are assembled not only that but also how they integrated into a functional system. It outlines the key components used in the project and what is the specific roles of each part in the design and operation of the device respectively. Admittedly We gained an understanding of the essential components required for the project and also learned about the basic MOSFET circuit diagram and what is the working principle through this. This chapter covers the design and functionality of the full-wave bridge rectifier and how its works and oscillator circuit and the receiver circuit, Finally we learned how they work together to produce a wireless power transfer.

CHAPTER 4
PROJECT RESULTS AND ITS DISCUSSIONS

4.1 Result of the project and Observation of these

How to develop a device capable of wireless power transfer using an electronic circuit was the main purpose of this project. Firstly to achieve this project goal successfully, planned and the overall objective was broken down into many small tasks that makes the effective design and performance of the system easily. The first past was to design and assemble a power supply unit which could convert 230V AC to 12V AC, and then also rectify it and for mobile charge it was regulated to 5V DC. After doing that, To step up the 5V DC to 30V DC used a boost converter,which is providing the necessary voltage for the oscillator circuit and finally, a suitable oscillator was designed and assembled which is attaced with the Royer oscillator selected as the most effective option for this application. The components were mounted on a Veroboard, and eventually the entire oscillator circuit was fabricated and tested. These three stages collectively make up the transmitter module of the wireless charging system.

When the assembling done with fabricating all equipment's in the board. Then with these two work it had been as depicted in the given figure which illustrate down:

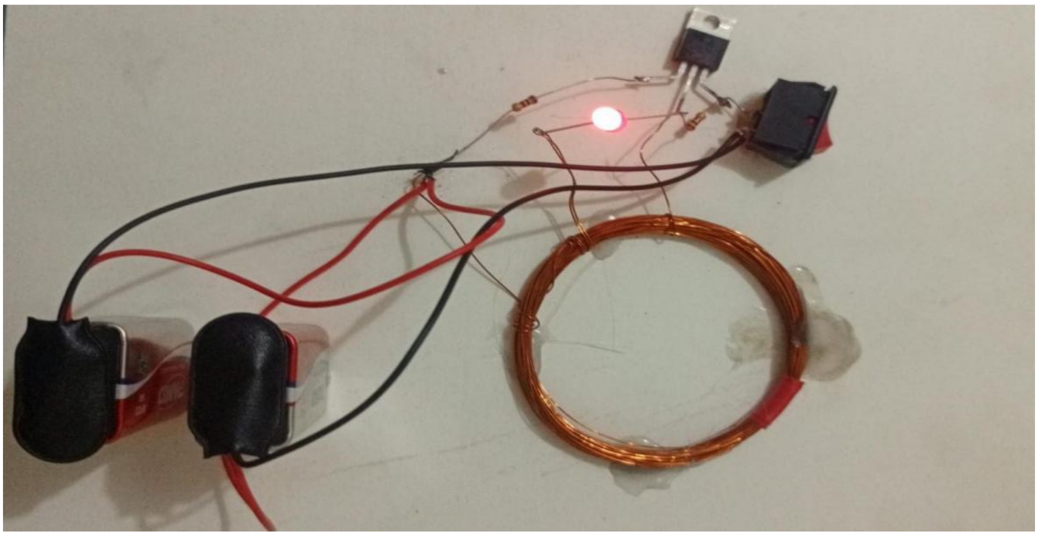


Figure 4.1: Primary coil & main circuit board

The next objective was to develop the transmitter and receiver coils, which are essential for enabling wireless power transfer through electromagnetic induction. When the transmitter coil (TX) is energized, it generates an alternating magnetic field. This magnetic field induces an electromotive force (emf) in the nearby receiver coil (RX), causing a current to flow. Both coils were carefully designed and embedded within the fabricated casing of their respective modules to ensure proper alignment and maximum energy transfer efficiency. The receiver coil, which captures the induced energy from the transmitter, is shown in the fig 4.2 .

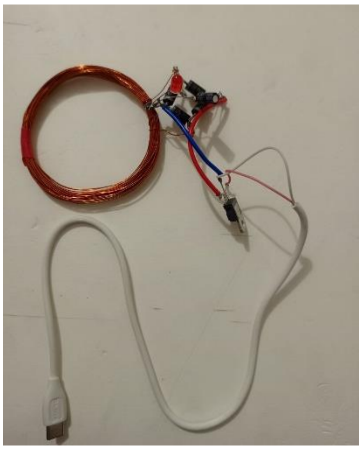


Figure 4.2: Imbedded Coils or receiver coil

- The design module of receiver and it rectify the altermatic current voltage come from transformer coil to receiver. Direct Current power output needed a modification which might be applied for power Element.

4.2 Discussions

To test whether power was being successfully transmitted, an LED was first soldered to the receiver coil. During the initial test, the oscillator circuit operated correctly with a 5V DC supply. Although the voltage was low, it was still sufficient to power a battery charging circuit that included an LCD and a microcontroller. The voltage was then stepped up to 30V DC using a boost converter to meet the power requirements. Two coils were used—each with an LED lamp attached—and both LEDs lit up brightly, confirming successful power transmission. Additional sets of LEDs were added to evaluate performance, and it was observed that increasing the distance between the coils resulted in decreased brightness, proving that the distance directly affects the amount of current induced in the receiver coil. LEDs remained bright up to a separation of about 5 cm, after which their brightness dropped significantly.

It was also noted that wire gauge plays a key role in efficiency. For example, gauge 16 coils allowed brighter illumination at closer distances compared to gauge 26 coils. Various materials were tested between the coils to assess heat dissipation effects.

Although the voltage was successfully stepped up to 30V DC at the primary level, the first MOSFET did not switch fast enough, causing a slow voltage rise as if a short circuit condition existed. To address this, a reset switch was added to the power supply and oscillator circuit, allowing the system and MOSFETs to be reset after heating. It was also observed that increasing voltage to the oscillator improved power output, but the energy captured by the load coil was still insufficient for effective battery charging. This was traced to a slight mismatch in resonance between the transmitter and receiver coils. To correct this, the same number of coil turns and identical capacitors were used in both circuits, ensuring they operated at the same resonant frequency, which significantly improved performance.

Battery charging circuit: The battery charging circuit includes several essential components: an amplifier for converting AC to DC, an ATmega328 microcontroller, a 16x2 LCD display, and a CD4066 electronic switch. This section is primarily controlled by the microcontroller. Initially, the circuit used a relay switch to disconnect the battery once fully charged. However, the relay consumed more current and added bulk to the system. To improve efficiency, the CD4066 was adopted as a suitable alternative due to its lower power consumption and compact size. One of the common challenges in modern chargers is the lack of user notification when charging is complete. To address this, a buzzer was originally used to indicate full charge, but it operated at the same frequency as the oscillator, consuming unnecessary power. As a more energy-efficient and visually informative solution, an RGB LED was implemented. Its behavior is controlled by code in the microcontroller, providing clear feedback during the charging process. It was observed that when the battery began charging, the rectified voltage dropped significantly, which is suspected to be due to the internal resistance of the battery causing a heavier load on the circuit.

Oscillator: The Royer Oscillator was chosen for its simplicity and powerful design, making it ideal for the project. It is capable of producing the high oscillating currents necessary to generate a strong magnetic field. This high current is achieved through the use of semiconductors, specifically the IR540 MOSFETs. However, due to the large current involved, significant heat generation occurred in the MOSFETs, which required attention to manage heat dissipation effectively. The goal of this project was to develop and implement a wireless charger for low-power devices using resonant inductive coupling. After thoroughly analyzing the system and optimizing it step by step, a functional circuit was designed and successfully implemented. Experimental results demonstrated significant improvements in power transfer efficiency. As mentioned earlier, wireless charging has the potential to become a major technological advancement. During testing, it was observed that the transmitter coil played a critical role in effectively sending power. Interestingly, the presence of magnetic elements within the coils had a noticeable impact on the power transmission efficiency, confirming that the arrangement and materials in the coils can influence the performance of wireless power transfer.

Final Result: After designing the product in the initial stage and launching it in a working manner, it is prepared for commercial marketing, with which only the transmission part has been arranged for those mobiles that have a receiving system for charging with a wireless charger, and for those mobiles that do not have this arrangement, a cable has been provided with the receiving part so that they can observe and take advantage of this system. Below is the final look of how it has been prepared for marketing.

Fig: 4.3 Transmitting part

Fig: 4.4 Receiving part

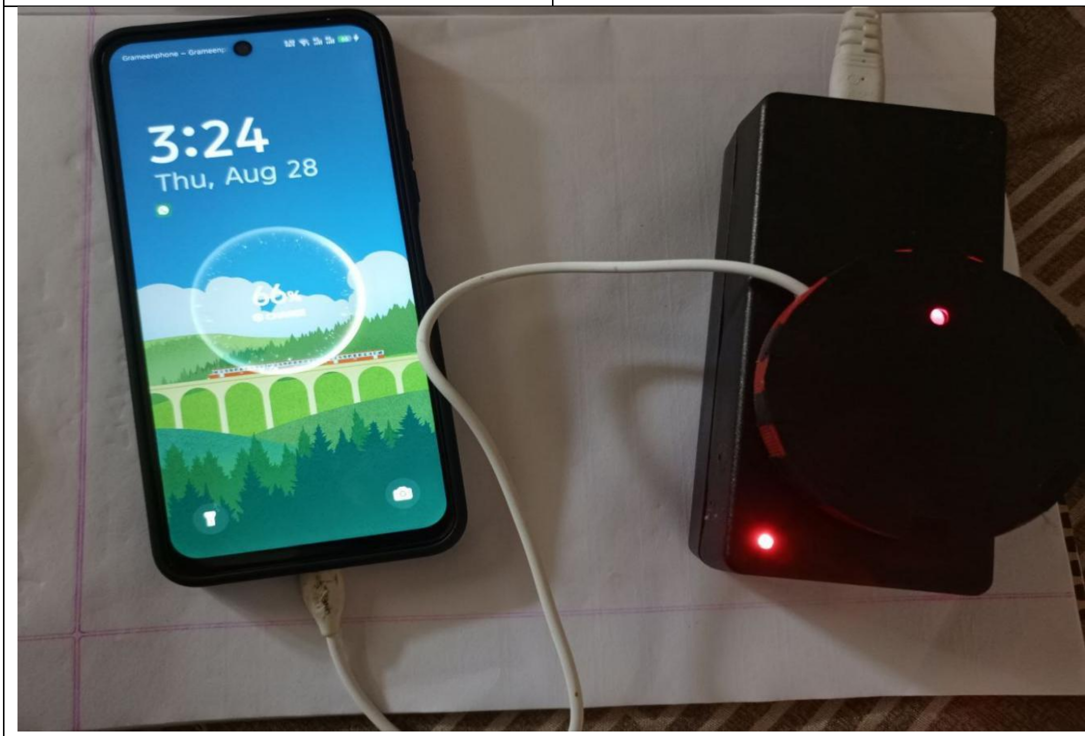


Fig: 4.5 Mobile is charging at the final result.

CHAPTER 5
PROJECT MANAGEMENT

5.1 Discussions

A study for a groundbreaking system in the world is a practical attempt to send and receive electricity demand wirelessly. The technical, economic and environmental effectiveness of the combination will be evaluated, which will reduce suffering. It can be implemented in a short time and in the market.

Table 5.1: Task, Schedule and Milestones

Phase	Description	Weak needed	Time frame
1. Project Planning	Define project scope, Conduct market research and Set objectives and budget	1	Weak 1
2. Requirement Analysis	Identify technical and functional requirements of project and Select wireless charging standard	1	Weak 2
3. Component Selection	Select wireless charging transmitter and receiver modules with Choose coils, power supply components, and other hardware for project	1	Weak 3
4. Circuit Design	Design basic circuits using breadboards, Test individual components like transmitter, receiver, power regulation	2	Weak 4-5
5. Coil & Magnetic Field Design	Design or select appropriate coils for power transfer and Experiment with different coil configurations to optimize charging efficiency	2	Weak 6-7
6. Power Supply Integration	Select and integrate power sources	1	Weak 8
7. Assembly & Integration	Manually wire components together on breadboards or within a custom housing and Integrate transmitter and receiver modules with the charging circuit	2	Weak 9-10
8. Testing & Debugging	Perform functional testing of wireless charging, Ensure safety, thermal management, and efficient power transfer and Fine-tune coil configurations for optimal power output	2	Weak 11-12
9. Enclosure Design	Design and custom casing for the charger and Ensure the casing provides adequate ventilation and protection	1	Weak 13

10. Final Testing & Validation	Complete system testing, Validate with multiple phone models and Ensure charging meets standard power requirements	1	Weak 14
11. Documentation	Prepare project report , and Document circuit diagrams and key design decisions	1	Weak 15

5.2 Resources and Cost Management

There are lots of things are needed when I just going to complete the project. After finishing the project i figure out them and split into two categories. The first one Human resource and other one material resource. With that I also find those places where I spent money.

5.2.1 Resources

The Wireless Mobile Charger project always requires a variety of resources including skilled workers, physical materials and technical equipment which must be readily available to us.

1. **Human Resources**: Firstly, engineers, designers and project managers who will assist in all stages from concept to testing. Secondly, those who will help in making prototypes, modeling and marketing. Always take the experienced person to do the project.
2. **Material Resources**: In Wireless charging modules, PCBs, batteries and casing materials are essential for making prototypes. For current, the model will have to be made in collaboration with the marketing person in the model of other companies. Equipment such as soldering stations and test equipment will be rented as needed to reduce capital expenditure. Resource allocation has been planned keeping in mind the project milestones, we have tried to get the right resources at all times to maintain workflow efficiency and avoid delays.

Table 5.2.: Resources and cost

Resources	Cost (BDT)
Outer casing	130
1 Heat Sink	100
Two 9v battery	90
25 Gauge wire	200
1N4148 Diode	80

8-10 cm round something for coil winding	20
12 volt PS (power supply)	252
A Bread board	130
Some Capacitor	05
A Charger pot	60
1 plug	20
Some wrapper	150
2 LED bulb	05
1 TTC 5200 Transistor	130
3 Resistor	10

5.3 Lesson Learned

In the wireless mobile charger project, several important lessons were learned about project management. The first key lesson was to have a good project scope and specific requirements. To avoid misdirection and scope creep are helped by a clear scope, so that all stakeholders can be united is the first step and then second and importation step was Effective resource planning , as allocating the right resources in the right time prevents the delays. Then a key role is played by the risk management also, in the early on find out the potential challenges likes material shortages or design issues, and preparing interrelated plans how to address them respectively. Then the importance of cross-functional collaboration, to assure that the product meets both of the technical and user needs which emphasized to complete the project gradually. Not only flexibility but also adaptability highlighted when it was faced many delays like certification hurdles or supply chain problems was highlighted. While the main challenge was cost management , as material prices increased,but financial control was maintained by regular budget cheek securely. On the other hand the prototyping phase strongly proved valuable and revealing design flaws that could be corrected before final production. As a result we got finally, A quality product which assurance and user feedback during testing helped refine the final product, ensuring that it met performance standards. These lessons will help my future projects and also improve my overall efficiency on making a project throughout my career too.

CHAPTER 6

IMPACT ASSESSMENT OF THE PROJECT

6.1 Discussions

6.1.1 Economical Impact:

1. **Cost Savings for Consumers:** Firstly wireless charging remove the need for multiple charging cables and connectors for different devices. Secondly it is also reducing the overall cost of purchasing replacement cables or chargers. a single wireless charging pad for many devices which make consumers happy.
2. **Reduced Manufacturing Costs:** luckily For manufacturers, the widespread adoption of wireless charging can reduce lots of cost. Then its reduce the cost of cables, connectors, and adapters, streamlining the production process too. Generally wireless charging become very common, these devices can drive economies of scale interestingly.
3. **Energy Efficiency:** Although wireless charging has low efficient than wired charging. In the future when advancements in technology may lead to more efficient power transfer it can reducing energy wastage. Eventually it is proved that Efficient charging technology can lead to lower electricity consumption, benefiting consumers by its pros.

6.1.2 Societal Impact:

1. **Convenience and Accessibility:** With huge amount of responsibility our devices are modified simpler the way wireless mobile charger charge .It is near future that people need not to search for charging cables or don't need to worry about unplugging them when charge is completed also. Interestingly it is increasing convenience in public spaces like airports, cafes, shopping malls and many other place. In this types of place wireless charging pads can be installed also.
2. **Reduced E-Waste:** By the way wireless charging reduces the need for multiple cables and adapters as a result electrical waste (E-waste)are decrease day by day which is a good for environment. If it got available then that will help our environment by reduce e waste pollution from surface.

3. **Support for Disabilities:** For those people who have physical disabilities or those with limited mobility, wireless charging provides an easier to them. Also happy news and a thoughtful gift for them. It is also reduce accessible way to charge devices their devices, what it is reduce the need for precise plug insertion and decrease the risk of injury finally.

6.1.3 Global Impact:

1. **Sustainability and Environmental Benefits:** By reducing plastic waste from surface wireless mobile charging system helping the environment which is joyful and enjoyable. Furthermore, reduce the carbon footprint of global electronic charging practices by using wireless charging stations powered by renewable energy sources also.
2. **Energy Distribution and Access:** It can be say that in those areas where traditional power infrastructure is not good, enough wireless charging could make great impact on there by its blessing. It is highly effective that it could offer a interesting with lots of convenient and effective means of providing power to essential devices such as mobile phones and medical equipment and many other things also. On the other hand we can say in rural or remote areas, This could be more impact by improving access to education, healthcare and communication and where required.
3. **Global Innovation in Energy Transfer:** We are in the beginning era of the adoption of wireless charging technology. By the way when it will available with new innovation in energy transfer like long-distance wireless power transmission then the whole world will emerged by seeing that how we distribute energy through out the world which reducing dependency not only on wired infrastructure but also efficient power systems. It will happened in near future cause it’s a time demand.

In conclusion, we can say that the economic, societal, and global impact and advantage of WPT (wireless mobile charging) is massive. It has lots of promises and pros such as significant convenience and energy efficiency for consumers etc, with those promises its also provides a great opportunity to reduce electronic waste and foster sustainability gradually. We therefore hope that its potential to revolutionize global energy distribution could get a great acceptability and the innovations will be supported across the world happily.

6.2 Environmental and Ethical Issues

6.2.1 Environmental issues:

1. **Electronic waste (e-waste):** For dispose e-waste of properly we need to use wireless charging system more and more with recycling the waste of cables and connector what we used before into new thing and this step removes pollution.
2. **Energy consumption:** The efficiency of wireless charging is generally low than wired charging and it occur because of energy is lost when transmitting power wirelessly. Its indicate that more energy consumption is required and this could be cause of higher greenhouse gas emissions and environmental degradation..
3. **Material use and resource depletion**: Coils, capacitors, and MOSFETs are the components of the production often relies on materials that may be scarce like certain metals and minerals. It can get negative impact for the mining and processing of the materials. The negative impacts are environmental, habitat destruction and water pollution etc.
4. **Battery disposal:** We need to properly dispose or recycle batteries because it has lots off chemicals property such like lithium, cadmium or lead. Otherwise those enter the environment and its harmful for environment.

6.2.2 Ethical issues:

1. **Access to technology:** In the low-income areas it may not be available or affordable to all individuals because its a new which makes a concerns about the inequality of access to such modern technology . A digital divide will be created by it where some people have access to more efficient charging technology while others are left behind because of economic constraints.
2. **Privacy concerns:** There is a change to collect data from nearby users because some wireless charger has potential to collect data and its can lead to misuse of personal information.
3. **Planned obsolescence:** Some wireless charging products will be designed with a limited lifespan Like other consumer electronics. Dishonest and counterfeit companies may intentionally design products that will need to be replaced after a few years, which will cause waste and force consumers to buy new devices and face financial losses.
4. **Health and Safety:** Although the levels of EMF used in wireless charging are generally considered safe by regulatory agencies, wireless power transmission can still raise concerns about exposure to electromagnetic fields (EMF), and prolonged exposure to electromagnetic radiation is a matter of debate and concern for the

public. Therefore, companies must assure that their products must have the safety standards and do not harm users.

6.3 Use of Established Standards or Codes

Table 6.1: Applicable Standards and codes

Standard	Organization	Description
Qi Standard	Wireless Power Consortium (WPC)	Defines protocols for inductive charging, including power transfer, alignment, and communication between charger and device.
FCC Part 15	Federal Communications Commission	Regulates electromagnetic interference to ensure wireless chargers do not disrupt other devices.
IEC 62311	International Electro technical Commission	Specifies limits for human exposure to electromagnetic fields from wireless power systems.
UL 2738 / UL 2231	Underwriters Laboratories	Establishes safety requirements for electrical energy transfer, including over current and fire protection.
RoHS & CE Compliance	European Union	Ensures devices are free of hazardous materials and meet European safety and environmental standards.

6.4 Other Concerns

Begin with the high power loss over long distances, which significantly impacts efficiency is the primary concerns of wireless power transfer (WPT) while power can be transferred efficiently over small distances commonly, with an increase in the distance between both (Receiver & transformer) then efficiency drops drastically. This issue makes it challenging to implement long-distance wireless charging systems. Additionally, wireless transmission radiation can have some health implications due to electromagnetic fields (EMF) emitted during the power transfer process. Though the radiation levels are generally low, long-term exposure, particularly in dense environments, remains a concern.

CHAPTER 7
CONCLUSION AND RECOMMENDATIONS

7.1 Conclusions

In The purpose of this project has been successfully achieved by developing an electronic device which transmits the electricity without wire and charges batteries. The design of discrete components, such as the Royer oscillator, coils, and a full-bridge rectifier, was essential in system's design and process. The findings from my project study and these are as follows bellow:

1. The system was according to wireless power transfer (WPT) theory, utilizing inductive coupling. It was observed that key factors such as distance, resonance frequency, quality factor, and turns ratio of the coils play a significant role in determining WPT efficiency. Additionally, there is an exponential relationship between power transfer and detachment distance.
2. This analyze showed that when the separation distance was zero (i.e., coils were in close proximity), the power transfer was most efficient, as evidenced by the brightness of the test lighting.
3. As the separation distance increased, the efficiency of power transfer dropped significantly, with noticeable declines in performance as the distance exceeded 5 cm.
4. This was also ended that WPT could be applied to various applications beyond this prototype. For instance, we successfully charged a 9V battery using the wirelessly transmitted power.
5. At the end, I concluded that Wireless mobile charger is not affect with the non-magnetic things which provides shielding to the coils. For that characteristic makes WPT a promising solution for applications such as charging pacemakers and other medical devices, where efficient power transfer without interference is essential.

7.2 Gain valuable Competencies and Practical Insights

1. **Understanding Wireless Power Transfer (WPT):** Learned the principles of energy transmission through inductive coupling and the factors affecting its efficiency (e.g., coil distance, resonance frequency).
2. **Circuit Design and Implementation:** Gained hands-on experience in designing and building circuits such as the Royer oscillator and full-bridge rectifier for efficient signal conversion and power transfer.
3. **MOSFETs and Power Switching:** Improved understanding of MOSFETs for high-power switching applications, including managing thermal dissipation and ensuring reliable performance in power electronics.
4. **Voltage Regulation:** Gained experience in using LM7805 voltage regulators to stabilize and regulate DC voltage for safe and efficient battery charging.
5. **Coil Design and Optimization**: I have earned mot only how to design and optimize transmitter coil but also receiver coils, with that I also learn how ensuring maximum efficiency for wireless power transfer by adjusting various things one bye one like coil turns, material, and geometry.
6. **Troubleshooting and Testing:** Developed skills in testing circuits and troubleshooting performance issues, such as optimizing coil separation and improving power transfer efficiency.
7. **Practical Application of Electromagnetic Theory:** Deepened understanding of electromagnetic fields, resonance frequency, and how these principles apply to real-world devices like wireless chargers.
8. **Hands-on Project Management**: Improved ability to plan, design, and execute a project from concept to prototype, including testing, refining, and finalizing the system.

7.3 Future Recommendations

1. **Applications: Smartphones and Portable Devices**: Without any kind of hesitation wireless charging can be used in lots of devices like smartphones, digital items , headphones, boxes , drone cameras, and also for smart tablets etc.

2. **Public Access Charging Terminals:** With a huge impacts We can install in public places such as airports, cafes, stadiums,beach,shopping mall and parks, can have wireless charging stations for people to charge their devices additionally.
3. **Computer Systems**: Wireless charging could eventually be integrated into laptops, desktops, and other computer systems, making it easier to charge without needing a physical connection which is blessing of sci.
4. **Miscellaneous Devices:** Wireless charging can be used in various battery-powered devices, including game controllers, TV remotes, cordless power tools, vacuum cleaners, hearing aids, and even cardiac pacemakers. It can also be used for super capacitors or devices powered by low-voltage power cables.

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APPENDIX A

TURNITIN REPORT

APPENDIX B

COMPLEX ENGINEERING PROBLEM SOLVING AND ENGINEERING ACTIVITIES

A statement is made about where and how the complex engineering problems of the planned project have been resolved. P1 is required; P2 to P7 can be partially or fully selected.

Problems (P) Solving of Complex Engineering:		
	Attributes	Statement from students
P1	Depth of knowledge required	The project called for knowledge involving different engineering disciplines such as electromagnetic, power electronics, wireless energy transfer and embedded systems. A solid understanding of coil resonance, inductive coupling, and power regulation circuits was key things to achieving reliable and efficient performance.
P2	Range of conflicting requirements	Compactness , efficiency, thermal management, safety, cost, and support for a variety of mobile devices.
P3	Depth of analysis required	Detailed energy transfer efficiency at different coil distances and misalignment conditions using simulation tools
P4	Familiarity of issues	Consider the manufacture cost and reduce use of cable based charger Adapting commercial principles to an academic prototype introduced unique challenges
P5	Extent of applicable codes	Design aligns with relevant renewable energy standards, electrical safety regulations and environmental guidelines in Bangladesh.
P6	Degree of Stakeholder Engagement and Conflicting Requirements	Involves university administration, EEE department, and combined charger making company with varying priorities for cost, sustainability, and ease of operation
P7	Interdependence	transmitter, receiver, voltage regulator, coil design interlinked changes in one affect the performance of the entire system

A description of the complex engineering work performed on the assigned project is provided.

Mention some or all of the following characteristics.

Complex Engineering Activities (A):		
	Attributes	Statement from students
A1	Range of resources	Utilizes simulation software (Proteus, LTspice), PCB design tools (EasyEDA), lab instruments like oscilloscopes,function , generators and custom-fabricated coils
A2	Level of interaction	required between hardware components like coils, regulators and system-level performance goals
A3	Innovation	Its allow multiple phone charge at one time and Energy loss was minimized using a tuned LC circuit
A4	Consequences of society and environment	It minimizes cable e-waste and supports user convenience. Based on environmental impact ratings components were selected where possible
A5	Familiarity	Make a short survey and get answer about awareness, usage, and confidence also. interestingly huge amount respondents that they had basic familiarity, with minimum practical knowledge also.

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