UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND DEVELOPMENT WIRELESS POWER TRANSMISSION BY USING TESLA TOWER

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

Signature : ……

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ABSTRAK

Kebelakangan ini, elektrik menjadi isu yang serius menyebabkan kos yang tinggi dalam pengeluaran dan permintaan tinggi daripada pengguna. Selain itu, penggunaan sumber kuasa seperti bateri mempunyai jangka hayat yang singkat dan pengisian semula meningkatkan kos operasi. Kawat atau wayar yang berselirat dan tidak teratur mengundang bahaya kepada persekitaran terutama pengguna. Jadi, pemindahan kuasa tanpa wayar menjadi cara alternatif untuk menjana elektrik kepada peranti elektronik, kereta elektrik dan banyak lagi. Projek ini membincangkan dan menerokai tentang merekabentuk dan membangunkan pemindahan kuasa tanpa wayar yang dihasil menggunakan menara tesla dengan menggunakan kaedah gabungan induktif. Kaedah gabungan induktif ini telah dilaksanakan dan telah terbukti berjaya dengan kecekapan pemindahan kira-kira 95%. Saiz gegelung dan bilangan lilitan telah memberikan impak yang tinggi untuk mendapat keluaran yang tinggi di gegelung kedua. Apabila arus elektrik bergerak melintasi gegelung, medan magnet akan terbentuk di dalamnya. Selepas itu, voltan melaluinya akan terhasil dan mempunyai kecenderungan untuk bertentangan dengan arus memandu. Justeru itu, medan magnet akan menjana voltan yang menentang pertukaran pindaan ke lapangan. Apabila gegelung utama dipasang menghampiri gegelung kedua, beberapa bahagian medan magnet akan menghasilkan aliran gegelung kedua. Arus yang dihasilkan di gegelung kedua boleh digunakan untuk menghasilkan kuasa kepada beban seperti mentol lampu atau lampu.

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ABSTRACT

Lately, electric become a serious issue cause high cost in production and consumer demand. Besides the using of source power like battery highly strained lifetime and their recharging increase the operational cost. Interconnecting wire which inconvenient and unorganized harmful to environment especially consumer. So, wireless power transfer become an alternative way in generate electric to electronic device, electric car and many else. This paper discusses and explore on design and develop wireless power transfer by using tesla tower. This inductive coupling method has been perform and its prove work successfully with transfer efficiency about 95%. Size of coil and number of turn have given high impact in getting desire output at secondary coil. Since the current moving across the coil, the magnetic field will form inside it. So that, the voltage through it will produce and has a tendency to contradict the driving current. Accordingly, the magnetic field will generate a voltage that opposes any amendment exchange to the field. Since secondary coil brought near to primary coil, some part of magnetic field will generates current in secondary coil. The current that generated in the secondary coil can be utilized to power the load such as fluorescent bulb or lamp.

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DEDICATION

To my beloved parents Mr Omar Bin Ali and Mrs Salma Binti Abdullah for their support and pray. A full appreciation to my supervisor Kamilah Binti Jaffar for advising and helping through this project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

SSTC	-	Steady state tesla coil
WPT	-	Wireless power transfer
EMF	-	Electromotive force
AC	-	Alternating Current
DC	-	Direct current
dt	-	Rate of change in time in second
N	-	Number of turn
ΦB	-	Magnetic flux
I	-	Current(Amp)
MMF	-	Magnetomotive Force
RIC	-	Resonant inductive coupling
η	-	Efficiency
Pout	-	Output power
V	-	Voltage (Volt)
Pin	-	Input power
AWG	-	American Wire Gauge
GSM	-	Global System for Mobile Communication
LED	-	Light-Emitting Diodes
D1	-	Diode

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CHAPTER 1
INTRODUCTION

1.0 Introduction

For this segment, it usually explains the project background. It also explain the objective, scope, problem statement and project framework.

1.1 Background

Electric become an issue in looking forward of technologies lack of high cost of production and consumer demand. Electricity can occur naturally in two ways which are wire and wireless. Lately, electrical costing and consumption become a serious issues among consumer lack ineffectiveness with right way. Beside, interconnecting wires are inconvenient, hazardous or impossible when in high population country. Several countries all over the globe are finding alternative ways by proposing new approaches of energy transmission without wire. The history had been introduced us to wireless energy transfer by Nikola Tesla over century ago. His vision is to create something that can distribute power over large power using earth's ionosphere by using Tesla Tower. He thought that by making a sufficiently major tesla coil, with enough high voltage, he could ionized the entire earth environment, enabling it to lead electricity power .There are two type of technique that can be used which are near-field and far-field .For the near field techniques, there are a few method used such as inductive coupling, evanescent wave coupling, air ionization, electro-dynamic. While for far-field technique, the method used are microwave and electromagnetic transmission.

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So, for this paper had been finalized to design and develop wireless power transmission by using Tesla tower using inductive coupling method. After had a research from previous, it prove that this method achieves an energy transfer efficiency around 70%-90% depend on it coil and number of turn at secondary coils. But at the same time another methods such as magnetic resonant coupling and capacitive coupling also can be used, but because lack of efficiency and low power output, it shouldn't to develop. Based on inductive coupling, the basic should be considered must be a concept of electromagnetism. By applying Faraday's law induction, the magnetic field will increase since the voltage through wire is directly proportional with magnetic flux that is formed. This phenomenon is used in creating tesla coil design.

The project will show process how the wireless energy can be occur by using this concept. Since the current moving across the coil, the magnetic field will form inside it. So that, the voltage through it will produce and has a tendency to contradict the driving current. Accordingly, the magnetic field will generate a voltage that opposes any amendment exchange to the field. A conductive material like copper is very suitable in moving current through it. When the AC power supplies around coil, magnetic field will form around the loop. When a secondary coil brought near to primary coil, some part of magnetic field will generates current in secondary coil. The current that generated in the secondary coil can be utilized to power the load such as fluorescent bulb or lamp

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1.2 Problem Statement

(Bhardwaj and Ahlawat, 2018) said a consistent power supply become a real issues and problems .It is because the battery highly strained lifetime and not sub-planted by another sources power. Besides, (Makaa B.M, 2015)also highlight the needed of this wireless power transmission due continuous energy contribution day by day cause of the addition of household point. It also cause the interconnecting wires are badly designed , perilous or outlandish.

Next, (Anthony and Navghare, 2016) also described that the real issue in power distribution are cause the losses in transmission and distribution of electrical power from the generating system. It is because power losses always occur due to resistance of wire and conductors used in the power transmission.

Finally, (Jawad *et al.*, 2017) have explain the battery that we used in daily life had short lifetime and their recharging or replacement of it will increase the operational cost. So, that why a wireless energy transfer had be introduced in this this paper to design and develop a tesla coil.

1.3 Objective

The purposes of doing this projected are stated below:

i. To design and develop a tesla tower circuit by using inductive coupling method.
ii. To analyse the system performance on fluorescent lamp and fluorescent bulb.
iii. To build a real tesla coil based on system performance which has high transfer energy efficiency.

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1.4 Scope

The project scope refer how to develop and design a system that can generate higher wireless energy transfer using inductive coupling method. In developing this steady state Tesla coil (SSTC), the design based on this criterion:

- Used on 0.2 mm copper coil at secondary coil.
- 30cm high of tower.
- 20cm width X 20 cm length X 7cm of box to replace main and secondary circuit.
- 10cm diameter of toroid.
- AC to DC converter as secondary circuit.(12V DC)
- Tesla circuit as main circuit.
- The performance of project only test on Philips bulb (18Watt) and Philips fluorescent lamp (18Watt).

1.5 Project Framework

This project is done basically to report the activities, result and thought of this project that lead in the project progress. The project involves parts that is for PSM 1 and PSM 2. There are:

- Chapter 1

  Briefly describe about the background, problem statement, objective and scopes of project.

- Chapter 2

  This chapter will lead to previous research regarding of the project and describes the detail about technique and method uses in developing a project. There is also working principle of activities or research that have already been done in past. So that individual research on

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dissimilar, benefits and disadvantages of previous project and the differences of this project compare to others.

- Chapter 3

  Describes s about the journey of the project where the project implementation will be divide into three stages which are circuit simulation, design a hardware and electrical part. This section more perform in give information about the principal of component that will be used in the project. The flows of the project are illustrated in this chapter.

- Chapter 4

  This chapter will examine about analysis of the project outcome. All the results will be recorded from actual observation and data analysis.

- Chapter 5

  This part more prefer in making conclusion and recommendations on future in the development of the system. It also stresses about the yield of the project.

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CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter provides us information on how to develop and to set up the prototype of this project by explorations on related previous research. Necessary related knowledge can be found by doing this literature review. There are few main topics that should be focuses on to investigate which are basic solid state tesla coil, size and number turn of coil, technique used and the rate efficiency for different type of method.

The main objective of developing tesla coil which can generate wireless energy transfer that working without wire. The technique and type of method used are the most important part that must to be finalized before developing a hardware. Moreover, the size and number turn of coil also should be considered to know how much energy transfer and rate of efficiency to the load.

2.1 Near field technique

Refers (Jawad *et al.*, 2017), near field technique can be divided into 4 type which are magnetic resonant coupling, inductive coupling, capacitive coupling and electromagnetic wave. This paper said magnetic resonant coupling and inductive coupling is the most reasonable. It is because the amount of power transfer in capacitive coupling increased with the capacitance. Figure 2.1 show the comparison for near and far field technique.

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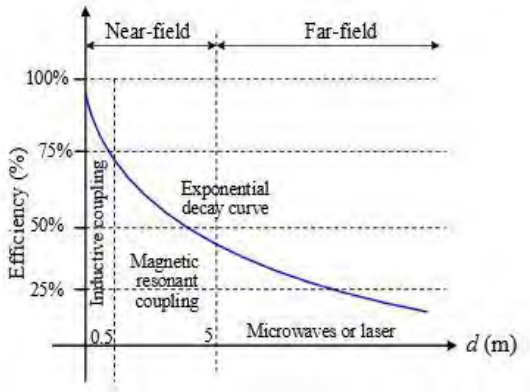

Figure 2.1: Comparison of efficiency for different WPT technique (Jawad *et al.*, 2017)

2.1.1 Inductive coupling

(Makaa B.M, 2015)said that inductive coupling between two coils can transfer wireless energy. It works when no physical contact between primary and secondary coils to produce electromagnetic coupling. Figure 2.2 shows system design for both coil and spark gap

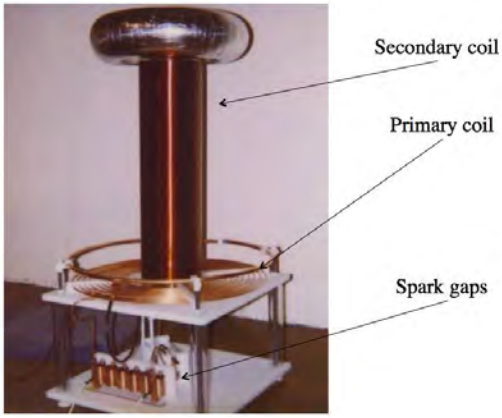

Figure 2.2: Primary coil, secondary coil and spark gaps (Makaa B.M, 2015)

(Saswade *et al.*, 2017) reminded that inductive coupling works on standards of electromagnetism. The source and transmitter in this method are near each other yet stand confined. The separation amongst transmitter and recipient is short and thus this

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strategy is otherwise called the short range transmission technique. The amount of power transmit depends on number of turns and material of the coil.

(Dewi *et al.*, 2016) have Faraday's laws states rate of change of magnetic flux can calculate from the equation (**Ɛ= -dΦB/dt)** where **Ɛ** is the electromotive force (emf), **ΦB** is the magnetic flux and **dt** is rate of change in time in second. The Lenz's law states that the negative sign monitors the flow of the electromotive force. Lenz's law also highlight that induced electromotive force (emf) will gain current that rises magnetic field that used to limit the change in magnetic flux. But in Lenz's law states for tightly wound of coil, it has addition element in formula which is (**Ɛ= -N (dΦB/dt)** refer **N** to number of coil. It said the higher number of turn of coil increase the magnetic field.

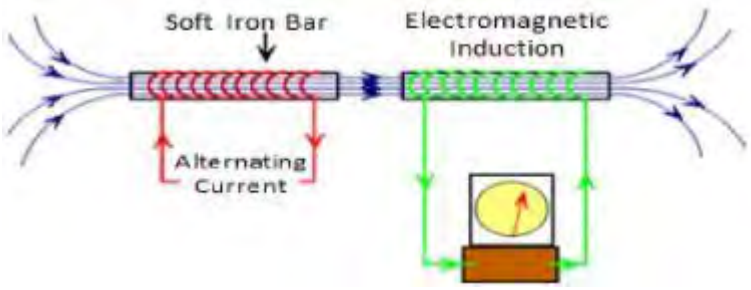

Figure 2.3: Electric current induces in secondary coil (Dewi *et al.*, 2016)

Refers to Figure 2.3, it shows a coil such as copper, moving an alternating current is an exceptionally effective structure in producing magnetic field. The Magnetomotive Force (MMF) highlight when current flow through coil, the energy of flux is created. The relationship of MMF refer to the number of turn and current flow. It prove that the MMF increase directly proportional the increase of number of turn and amount of current. The formula shown below

Mmf, Fm=N*I
N=Number of turn
I=Current in coil

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