

**UNIVERSITI TEKNOLOGI MARA**

**INVESTIGATION OF POTENTIAL  
POWER GENERATION FROM  
LAPTOP WASTE HEAT**

**DHIYAUDDIN ASYRAF BIN LAILI**

Dissertation submitted in partial fulfilment  
of the requirements for the degree of  
**Master of Science**  
**(Mechanical Engineering)**

**Faculty of Mechanical Engineering**

**August 2019**

## ABSTRACT

Increasing uses of fossil fuels exacerbates its contribution towards waste and pollution, resulting in a response in the demand for cleaner and more renewable energy production. An often neglected energy waste is found in the form of waste heat, primarily those generated by ubiquitous everyday objects, namely electronics. This energy source is abundant, everywhere, but ignored. This project seeks to investigate the potential of the energy harvesting mechanisms of thermoelectric cells (TEG) and heat pipe energy transfer, from a laptop waste heat source. A mathematical model was established, from which the potential generated power from the thermoelectric cells was estimated. The laptop generated heat will be simulated by an external heating unit, while the thermoelectric cell cooling will be handled by a customized heat sink rig. Said thermoelectric cell will be sandwiched between the heat source and the heat sink. The heat sink operates via heat convection, and thus two operating scenarios are explored in this experiment, namely natural convection and forced convection. Current and voltage generated by the thermoelectric cell was observed for multiple iterations of resistance via an electronic load unit. The results of which were recorded and plotted onto graphs for observation of trends and averages. The power generated by the system was calculated from the results, and compared against the estimated values.

## ACKNOWLEDGEMENT

To begin with, I wish to thank the Almighty for allowing me the opportunity to partake in the studies for achieving a Master's degree, and for having blessed me with the successful completion of this long and challenging journey. I would then like to extend my deepest gratitude and thanks to my supervisor Dr. Muhammad Fairuz Remeli. Many, many thanks of appreciation for the support, patience and ideas in assisting me with this significant undertaking. I also would like to express my gratitude to the staffs of both the faculties of Electrical and Mechanical Engineering, especially Mr. Fazly Zaimie Yaacob, Mrs. Hasnaa Abdul Ghani and Mr. Mohd Ezzuan Salleh for providing their facilities, knowledge and assistance.

My appreciation goes to my family members who provided their utmost support and patience during my project. Special thanks to my colleagues and friends for helping me with this project.

Finally, this thesis is dedicated to the loving memory of my very dear late mother for the vision and determination to educate me. This piece of victory is dedicated to you. Alhamdulillah.

# TABLE OF CONTENTS

	<b>Page</b>
<b>CONFIRMATION BY PANEL OF EXAMINERS</b>	<b>ii</b>
<b>AUTHOR'S DECLARATION</b>	<b>iii</b>
<b>ABSTRACT</b>	<b>iv</b>
<b>ACKNOWLEDGEMENT</b>	<b>v</b>
<b>TABLE OF CONTENTS</b>	<b>vi</b>
<b>LIST OF TABLES</b>	<b>vii</b>
<b>LIST OF FIGURES</b>	<b>ix</b>
<b>LIST OF SYMBOLS</b>	<b>xi</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xii</b>
<b>CHAPTER ONE: INTRODUCTION</b>	<b>1</b>
1.1 Research Background	1
1.2 Problem Statement/Problem Identification	4
1.3 Research Objectives	4
1.4 Significance of the Study/ Contribution of Studies	4
1.5 Scope and Limitation of the Study	5
<b>CHAPTER TWO: LITERATURE REVIEW</b>	<b>6</b>
2.1 Waste Heat	6
2.1.1 Laptop Heat Energy	7
2.2 Heat Sink	9
2.3 Heat Pipe	11
2.4 Thermoelectric Power Generator (TEG)	13
<b>CHAPTER THREE: RESEARCH METHODOLOGY</b>	<b>16</b>
3.1 Experiment Scenarios	16
3.2 Mathematical Calculations	17
3.3 Experimental Setup	19
<b>CHAPTER FOUR: RESULTS AND DISCUSSIONS</b>	<b>24</b>
4.1 Results	24
4.2 Discussions	47

<b>CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS</b>	<b>49</b>
5.1 Conclusion	49
5.2 Recommendations	49
<b>REFERENCES</b>	<b>50</b>
<b>APPENDICES</b>	<b>54</b>
<b>AUTHOR'S PROFILE</b>	<b>71</b>