

UNIVERSITI TEKNOLOGI MARA

TECHNICAL REPORT

A STUDY OF HEAT DISTRIBUTION  
FOR OPTIMAL DESIGN SHAPE OF BROWNIE'S  
PAN

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IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

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## TABLE OF CONTENTS

<b>ACKNOWLEDGEMENTS</b>	<b>ii</b>
<b>TABLE OF CONTENTS</b>	<b>iii</b>
<b>LIST OF FIGURES</b>	<b>v</b>
<b>LIST OF TABLES</b>	<b>vi</b>
<b>ABSTRACT</b>	<b>vii</b>
<b>1 INTRODUCTION</b>	<b>1</b>
1.1 Research Backgroud	1
1.2 Problem Statement	3
1.3 Research Objective	3
1.4 Significant Of Project	4
1.5 Scope Of Project	4
<b>2 LITERATURE REVIEW</b>	<b>5</b>
<b>3 METHODOLOGY</b>	<b>7</b>
3.1 Step I : Derivation of the Heat Conduction Equations	7
3.2 Step II : Study the behavior of parameter in two-dimensional graph	7
3.3 Step III : Approximate temperature distribution by Gauss-Seidel Iteration Method	8
<b>4 IMPLEMENTATION</b>	<b>9</b>
4.1 Derivation of the two-dimensional heat equation for optimal shape	9
4.2 To study the behavior of parameter from the mathematical model of optimal shape using PDETOOL in MATLAB	14

## ABSTRACT

In this research, the heat distribution on optimal pan at the outer edges are examined. The model of heat distribution is derived from heat flux equation and energy flow balance equation by using Fourier's Law. Laplace Transform method is used to develop the model. The mathematical model of heat distribution for the optimal shape is solved in two-dimension and computerized by using MATLAB. Gauss-Seidel Iteration method is applied to approximate the temperature distribution of each nodes on the pan. It's shown from the graph and the calculation that the boundary temperature for the optimal shape is distributed evenly. Thus, the brownie does not overcooked at four corners.

# 1 INTRODUCTION

## 1.1 Research Background

Brownie pan has many different kind of shapes used for baking Brownie mostly. According to survey, especially women and people who do business of Brownie have a problem with Brownie pan. The shape of Brownie cake is mostly circular and rectangular due the basic shape of pan. As is known to all, cake in round pan is heated more evenly than rectangular pan. It is not a good idea to produce uniformly baked Brownie in a rectangular pan which makes it impossible to make the heat distributed evenly. Therefore, food get overcooked at each corner of rectangular pan. In contradiction, the round pan cannot make full use of oven which is rectangular in shape. In other words, it is not productive to use round pan in an oven compared to rectangular pan.

Because of this problems, many researchers examine the baking oven to enhance the power of the technique and the quality of product. (Savoye et al., 1992),(Sablani et al., 1998), (Lostie et al., 2002) and (Yilmazer et al., 2007). Heat utilization and heat transfer are necessary elements in the baking process. Heat transfer is the exchange of thermal energy between physical systems. The rate of heat transfer is dependent on the temperatures of the systems and the properties of the intervening medium through which the heat is transferred. Heat is transferred from a region with high temperature to another region with lower temperature. Heat transfer occur when thermal equilibrium is reached at all point of area and the surroundings reach the same temperature.

The inner heat are transferred by convection, radiation as well as conduction. Heat convection occurs when warmer areas of liquid or gas rise to cooler areas. Cooler liquid or gas then takes the place of the warmer areas which have risen higher. This results in a continuous circulation pattern. The best example of heat convection in these situation is water boiling in a pan. Next, heat radiation is heat transfer mechanism that does not depends on any medium between the heat source and heated object. Thermal radiation occurs when heat is being trans-