UNIVERSITI TEKNOLOGI MARA

TECHNICAL REPORT

ANALYSIS OF TEMPERATURE RESPONSE SUBJECT TO ELECTROMAGNETIC (EM) FIELD ON BIOLOGICAL TISSUE USING BIO-HEAT EQUATION.

P31S19

MUHAMMAD AIZZUL MOHD LAZIM- 2017908019
NURUL AIN BINTI ZAINUDIN - 2017134681
AIN NORHANIS BINTI NORDIN - 2017785893

Report submitted in partial fulfillment of the requirement for the degree of
Bachelor of Science (Hons.) Computational Mathematics
Faculty of Computer and Mathematical Sciences

DECEMBER 2019

ACKNOWLEDGEMENTS

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

Firstly, we are grateful to ALLAH S.W.T for giving us the strength to complete this project successfully. We are finally coming to the end of up and down journey.

A special gratitude we give to our final year project supervisor, Dr. Nor Azni Binti Shahari, who's with her encouragement got us to the finish line despite numerous obstacles along the way. Thank you for always believing in us and for your dedicated contribution.

We also indebted to our fellow friends for encourage us to complete this report. The information they provide help us a lot in completing this study. For all our friends, thanks a million. You are a part of this research journey.

Thank you also to the team members, who help to assemble the parts and gave suggestion about the task "*An Analysis of Thermal Response on Biological Tissues subject to Electromagnetic (EM) field of Bio-Heat Equation*".

Last but not least, many thanks go to the head of the project, Dr. Nor Azni Binti Shahari whose have invested her full effort in guiding the team in achieving the goal. Our appreciation also goes to other supervisor for their guidance as well as the panels and examiner for our project presentation that has improved our presentation skills thanks to their comment and advices.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ii
TABLE OF CONTENTS iii
LIST OF TABLES v
LIST OF FIGURES v
ABSTRACT vi

CHAPTER 1: INTRODUCTION 1

1.1 Background of Study 1
1.2 Problem Statement 3
1.3 Objectives of the Study 4
1.4 Scope and Limitation of the Study 4
1.5 Significant of the Study 5
1.6 Organization of Chapters 6

CHAPTER 2: BACKGROUND THEORY AND LITERATURE REVIEW 7

2.1 Background Theory 7
2.1.1 Overview of Existing Bio-Heat Models 7
2.1.2 Development of Pennes' Bio-heat Equation 9
2.1.3 Numerical Method 11
2.2 Literature Review/ Related Research 14
2.2.1 The Influence of Thermal Properties in Biological Tissues 14
2.2.2 The Influence of Blood Perfusion term, Q_b 15
2.2.3 The Influence of External Heat Source, Q_r 16
2.2.4 The Influence of Metabolic Heat, Q_m 17

CHAPTER 3: METHODOLOGY AND IMPLEMENTATION.....19

3.1 Mathematics Formulation.....19
3.2 Computational Formulation.....22
3.3 Flow Chart.....24

CHAPTER 4: RESULTS AND DISCUSSION.....26

4.1 The Effect of Thermal Conductivity on Temperature Response.....26
4.2 The Effect of Blood Perfusion term, Q_b on Temperature Response.....26
4.3 The Effect of External Heat Source Term, Q_r on Temperature Response.....30
4.4 The Effect of Metabolic Heat Generation Term, Q_m on Temperature Response.....32

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS.....34

REFERENCES.....35
APPENDIX A.....38

ABSTRACT

The success of hyperthermia treatment can be affected by thermal properties of biological tissues. Thus, the aim of this research is to investigate the influence of thermal properties on tissue during hyperthermia treatment. It was absolutely essential to know the suitable temperature within biological tissue as the success of hyperthermia treatment depends on it. In this study, the influence of thermal conductivity on temperature distribution in biological tissues has been examined. At the same time, the influence of blood perfusion term and external heat source on temperature distribution is also investigated. The effect of metabolic heat generation on temperature is also evaluated in this study. A finite difference method has been used to discretize the bio-heat equation and achieved the numerical solution of the problem. The reduced equation of second order ordinary differential equation is then solved by using toolbox ode45 in MATLAB. The results indicate that the increase of blood perfusion rate will decrease the tissues temperature while the temperature increases when the external heat increased. The study also found that the metabolic heat generation can be neglected. All the results for this study are simulated graphically and then discussed in detail. This study helps in understanding the temperature within tissue that can cause failure during hyperthermia treatment. Thus, the investigation on the influence of variable thermal properties is extremely beneficial for the clinical therapeutic application in the treatment of cancerous cells.