The present thesis entitled “Mathematical Modeling of Malignant skin tumor in Human Body” submitted for the award of Ph.D. degree, is my small attempt to give a mathematical modeling approach for the understanding of complicated phenomena such as Cancer and to provide some useful Mathematical techniques for the future therapeutic applications regarding the treatment of cancer.

Mathematical Biology, an academic research field, with a range of applications of Mathematics in Biology, aims at the mathematical representation, treatment and modeling of biological process with the variety of mathematical techniques and tools. For the understanding of complex phenomena of cancer, the mathematical approach has become widely acceptable now a days and these has inspired me to complete my work through these approach.

In present thesis, the study is mainly concerned with the thermoregulation analysis of malignant skin tumours in human body, where a group of cells display uncontrolled growth beyond the normal limits, and one does not consider the single tumor cell and their mutual and external interaction, but attempts to describe the body as continuum and tries to find the solutions to such bio-heat transfer problem, either in one dimensional geometry for a steady state, heat conduction equations in
an infinite domain, or for a constant heating at skin surface or inside the tissue volume, which may not be practical for some real bio-thermal situations. Therefore it is required to obtain as flexible way to analytically solve the most widely accepted Pennes Bio-Heat equation in the bio-heat field.

Up to now quite a few authors have applied the Green’s function Method to solve the Bio-heat Problems. Their solutions are very useful in the study of transient temperature behaviour in an arbitrary number of physiologically distinct regions, although the calculations appear rather complex. The present model is to be represented in the form of a parabolic partial differential equation along with supporting equations, atmospheric conditions and by considering significant physiological and biochemical parameters such as perfusion, metabolism, diffusion and heat transfer in living tissue.

The present thesis consists of Six chapters, which mathematically demonstrate the temperature distribution in a tissue during malignant skin tumors in humans. The solution, based on the Green function method is capable of dealing with the transient or space–dependent boundary conditions and hence provide the desired transient solution to the governing equation. The obtained solutions will incorporate relatively
complete situations such as finite tissue domain, the transient or space dependent boundary conditions and volumetric heatings.

**Chapter one** gives the brief idea about the involvement and impact of mathematics in biological phenomena and it also throw a light to the role of a mathematics in cancer biology. A quantitative and qualitative understanding of cancer can be facilitated using a mathematical framework that describes the principles that governs tumor initiation and progression. The fundamental study regarding the biological aspects involved in this complex process of cancer evolution, is also discussed in this chapter.

**Chapter two** refers to the theoretical analysis of heat transfer in biological tissue with the brief description of three responsible processes perfusion, diffusion and metabolism. With the parameters involved in this complex processes a mathematical model is derived, which ultimately gives the Governing Equation - Pennes Bio-Heat equation

\[
\rho_t T + \frac{\partial}{\partial t} E = \omega_b \rho_b E_b (T_b - T) + k \left( \frac{\partial^2 T}{\partial x^2} \right) + Q_m
\]

to model heat transfer in biological tissue.

**Chapter three** deals with the analytical steady state solution of Pennes bioheat equation in a cylindrical tissue, without considering spatial heating on the skin surface. The analytical solution, cannot only
accurately reflect the actual physical feature of equations but also be used as standards to verify the corresponding results of numerical calculations. With the help of Bessel’s equation, we reach to our desired steady state solution by analyzing the effects of the thermal conductivity, the blood perfusion, the metabolic heat generation and the coefficient of heat transfer on the temperature distribution in living tissues.

Chapter four gives full description of the concerned solution method- The Green’s Function method, by the means of simple ordinary and partial differential equations which will serve us to illustrate how the Green’s Function of the problem arises quite naturally in the course of the analysis. The Green function obtained for the differential equation is independent of the source term and hence can be flexibly used to calculate the temperature distribution for various spatial or temporal source profiles.

Considering spatial heating on the skin surface, in chapter five the desired transient solution of the Pennes bio-heat equation by the means of Green’s function method is derived. Green function method has long been applied to boundary value problems for a variety of physical phenomena. Given an inhomogeneous partial differential equation with boundary conditions, its unique solution is represented by the convolution integral of the Green function that has the same singularity of the
corresponding fundamental solution and satisfies the associated boundary conditions.

**Chapter six** is related to the result analysis of the solution obtained. From the data taken from the different clinical case studies, a comprehensive result analysis of the solution is presented in this chapter.

I hope my small effort to relate Mathematics to the complicated biological phenomena of cancer may provide some useful information for future understanding.