

**A NUMERICAL INVESTIGATION ON HEAT AND MASS TRANSFER OF  
CONVECTIVE FLOWS THROUGH POROUS MEDIUM**

*Thesis submitted to Bharathiar University, Coimbatore in partial fulfillment of the  
requirement for the award of the degree of*

**Doctor of Philosophy in Mathematics**

*Submitted by*

**R. KAVITHA**

*Research Guidance*

**Dr. K. SUMATHI**

*Associate Professor of Mathematics*

**DEPARTMENT OF MATHEMATICS**



**PSGR KRISHNAMMAL COLLEGE FOR WOMEN**

***College of Excellence***



**(AN AUTONOMOUS INSTITUTION AFFILIATED TO BHARATHIAR UNIVERSITY)**

**(REACCREDITED WITH "A" GRADE BY NAAC, AN ISO 9001:2008 CERTIFIED INSTITUTION)**

**PEELAMEDU, COIMBATORE – 641 004, TAMIL NADU, INDIA**

**MARCH 2017**

## **DECLARATION**

I, **R. KAVITHA**, hereby declare that the thesis, entitled “**A NUMERICAL INVESTIGATION ON HEAT AND MASS TRANSFER OF CONVECTIVE FLOWS THROUGH POROUS MEDIUM**”, submitted to the Bharathiar University, in partial fulfillment of the requirements for the award of the Degree of *Doctor of Philosophy in Mathematics* is a record of original research work done by me during 2011 - 2017 under the Supervision and Guidance of **Dr. K. SUMATHI**, *M.Sc., M. Phil., Ph.D., PGDCA, Associate Professor*, Department of Mathematics, PSGR Krishnammal College for Women, Coimbatore and it has not formed the basis for the award of any Degree/Diploma/Associateship/Fellowship or other similar title to any candidate of any University.

**SIGNATURE OF THE CANDIDATE**

**Countersigned**

**PRINCIPAL**

## **CERTIFICATE**

This is to certify that the thesis, entitled “**A NUMERICAL INVESTIGATION ON HEAT AND MASS TRANSFER OF CONVECTIVE FLOWS THROUGH POROUS MEDIUM**”, submitted to the Bharathiar University, in partial fulfillment of the requirements for the award of the Degree of *Doctor of Philosophy in Mathematics*, is a record of original research work done by **Mrs. R. KAVITHA** during the period 2011 - 2017 of her research in the Department of Mathematics at PSGR Krishnammal College for Women, Coimbatore, under my supervision and guidance and the thesis has not formed the basis for the award of any Degree/Diploma/Associateship/Fellowship or other similar title to any candidate of any University.

**SIGNATURE OF THE HOD**

**SIGNATURE OF THE GUIDE**

**Countersigned**

**PRINCIPAL**

## ACKNOWLEDGEMENTS

I pay my deepest respects to honorable founders late **Sri. G. R. Govindarajulu**, *Founder Trustee* and **Smt. Chandrakanthi Govindarajulu**, *Founder Correspondent* of PSGR Krishnammal College for Women, who endeavored to offer high quality education for women with strong intellect, constantly empowering them with rich blend of socio-cultural, political and economic values.

I am grateful and much obliged to **Dr. R. Nandini**, *Chairperson*, PSGR Krishnammal College for Women and **Shri. G. Rangaswamy**, *Managing Trustee*, GRG Trust for giving me this wonderful opportunity to pursue my doctoral research programme in this esteemed institution. My stint with PSGR Krishnammal College for Women as a Research Scholar had given me a world of experience in shaping my career in the desired broad field of study which may not have been realized as otherwise.

I also wish to express my sincere thanks to **Dr. N. Yesodha Devi**, M.Com., Ph.D., *Secretary*, PSGR Krishnammal College for Women, Coimbatore and **Dr. S. Nirmala**, MBA, M. Phil., Ph.D., *Principal*, PSGR Krishnammal College for Women, Coimbatore for providing all the necessary facilities needed to carry out my research successfully.

My deepest sense of gratitude and wholehearted thanks to my Supervisor, **Dr. K. Sumathi**, M.Sc., M. Phil., Ph.D., PGDCA, *Associate Professor*, Department of Mathematics, PSGR Krishnammal College for Women, Coimbatore, Tamilnadu, India, who has been the chief source of inspiration and mainstay in pursuing my Doctoral Degree in Mathematics. I was impressed by her guidance during my Master of Philosophy and she has set an example of excellence as a Researcher, Mentor, Instructor and Role model. Her enthusiasm made me extend the study to Ph.D and learnt a lot from her during my research time. This work would not have been possible without her guidance, support and encouragement. Her advice on both research and my career has been invaluable. I am extremely thankful and indebted to her forever.

I place on record, my sincere thanks to our *former Heads of the Department of Mathematics*, **Mrs. V. Vijayalakshmi**, M.Sc., M. Phil., **Dr. S. Chitra**, M.Sc., M.Phil., Ph.D., and **Dr. B. Tamilselvi**, M.Sc., M.Phil., Ph.D., *Associate Professor* and Head,

Department of Mathematics for their constant and continuous support during my stint with the college.

I am also indebted to **Dr. L. Lakshmanan**, M.Sc., M. Phil., Ph.D., *Dean-Mathematical sciences*, PSGR Krishnammal College for Women, Coimbatore for his unconditional support and for providing valuable and insightful suggestions for the entire duration of my research.

I remember with love and regards to my late father **Shri. N. Rangaswamy**, who must be watching me from heaven and blessing me forever,. I would like to pay my high regards to my wonderful mother **Smt. R. Subbulakshmi** for her love, sincere encouragement, suggestions and advices throughout my research work. Words cannot express how grateful I am to her for all the sacrifices that she has made on my behalf, I acknowledge with gratitude to my brother **Mr. R. Kathiravan** and charming sister **Mrs. R. Parimala Devi** for their support.

Last but not least, I would like to thank my beloved husband **Mr. R. Balakrishnan**, for supporting me in everything. Without his boundless support and encouragement I could not have reached this height. I would like to express my thanks to my beloved daughter **B. Yazhini** for being such a good girl and always cheering me up. I owe everything to them. Besides this, several people have knowingly and unknowingly helped me in the successful completion of this thesis.

I would like to thank all those people who made my thesis possible. I express my thanks to all those who contributed in many ways to my success and made this unforgettable experience.

Finally I thank GOD, for letting me through all the difficulties and let me finish this degree.

**R.Kavitha**

## Nomenclature

$k^*$	Permeability of the porous medium	$Re$	Reynolds number
$\mu$	Dynamic Viscosity	$Pr$	Prandtl number
$\rho$	Density of the fluid	$Sc$	Schmidt number
$\gamma$	Kinematic viscosity	$Sr$	Soret number
$m$	Hall parameter	$S$	Suction parameter
$\kappa$	Thermal Conductivity	$Gr$	Grashof number
$g$	Acceleration due to gravity	$Gc$	Modified Grashof number
$\sigma$	Electrical Conductivity	$M$	Magnetic parameter
$\beta$	Coefficient of thermal expansion	$\beta_e$	Hall current
$C_p$	Specific heat at constant pressure	$\beta_i$	Ion-slip
$T$	Temperature	$V$	Velocity vector
$T_w$	Temperature of the plate	$Da_x$	Darcy number
$T_\infty$	Temperature outside the boundary layer	$\Omega$	Angular velocity
$C$	Concentration of the species	$(u, v, w)$	Velocity components
$C_w$	Concentration of the plate	$\zeta$	Mass slip parameter
$C_\infty$	Concentration at infinity	$c$	Stretching ratio
$D_M$	Molecular diffusivity	$N$	Thermal radiation
$D_T$	Thermal diffusivity of the fluid	$n_e$	Density of electron
$\vec{E}$	Intensity vector of the electric field	$\beta$	Reaction rate parameter
$U_\infty$	Free stream velocity		
$\vec{J}$	Electric current density		
$\vec{B}$	Magnetic field vector		
$e$	Charge of electron		
$\beta^*$	Coefficient of expansion with concentration		