**MATHEMATICS**

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Author : **ADILAXMI MADIREDDY**

Title of the thesis : **Quantitative approaches for solving differential- difference equations having boundary layers**

Guide : **Dr. D. BHARGAVI**

Degree : **Ph. D.**

Student ID No. : **716186**

**ABSTRACT**

Ordinary differential equation (ODE) which contains a delay parameter is called delay differential equation. ODE which contains an advance parameter is called advanced differential equation. ODE which contains both delay and advance parameters is called differential-difference equation. In the literature, the expressions “positive shift” and “negative shift” are also used for “advance” and “delay” terms respectively. If highest order derivative of the differential-difference equation is multiplied by small parameter then the solution will exhibit the boundary layer phenomenon. By definition, the boundary layer is an interval in which the solution changes very rapidly. Perturbation methods such as matched asymptotic expansions and WKB method are extensively used to solve these problems. These asymptotic expansions require skill, insight and experimentation. Hence, researchers started using the numerical methods. If we use the existing numerical methods with the step-size more than the perturbation parameter for solving these problems we get oscillatory/ unsatisfactory solutions due to the presence of the boundary layer. But if the step-size is equal or less than the perturbation parameter then only the existing numerical methods will give better results. This is very costly and time consuming process as well. So, there is a great demand and urgent need for developing new methods which can work with a reasonable step-size to solve these problems. Hence, in this thesis, we have proposed some quantitative approaches for solving the differential-difference equations having boundary layers. The thesis comprises of ten chapters. In fact the proposed methods are non-asymptotic and do not depend upon any lengthy series expansions. All the quantitative approaches presented in here are implemented on several model problems for different values of delay, advance and perturbation parameter. Our solutions are tabulated and compared with exact solutions and/ also with the solutions available in literature. To understand the impact of the delay and advanced parameters, the solution is also plotted in figures. It is noticed from the tables and figures that our quantitative approaches produce very good approximation to the exact solution. Above all, these quantitative approaches are conceptually simpler, easier to use and also readily adaptable for computer implementation with modest amount of computational effort.

**MATHEMATICS**

Author : **GOVINDARAO TANGUDU**

Title of the thesis : **RESONANCE TYPE FLOWS DUE TO OSCILLATIONS OF SYMMETRIC BODIES IN FLUIDS WITH COUPLE- STRESSES**

Guide : **Dr. J. V. RAMANA MURTHY**

Degree : **Ph. D.**

Student ID No. : **701153**

**ABSTRACT**

In the classical flow problems, for the case of non-Newtonian fluids, the oscillation problems are very important to study, since many of the elastic properties of the dilute polymer solutions can be determined by the oscillation processes. In non-Newtonian fluids, fluids with Couple stresses are having special status, since the oscillations generated in these fluids exhibit effect of Couple stresses on the Drag or Couple. The problems of the different oscillations of symmetric bodies (like circular cylinder or sphere) along/about its axis of symmetry in an incompressible Micro-polar fluid/Couple-stress fluid and the flow generated due to these oscillations in the fluid is considered. The Stokes flow is considered by neglecting nonlinear convective terms in the equations of motion on the assumption that the flow is so slow that oscillations Reynolds number is less than unity. The solution of this case cannot be obtained as limiting case of non-resonance problem. The velocity and micro-rotation components of the flow for the case of *resonance* and *non-resonance* are obtained. The Drag / Couple / Skin friction are derived analytically and the effect of physical parameters like Micro-polarity and Couple stress parameter on the Drag / Couple / Skin friction due to oscillations is shown through graphs. The thesis consists of twelve chapters and Four parts. Part - I and Chapter one is introductory in nature. Part – II is devoted to flows generated in Micro-polar fluids and contains Five chapters ( Chapters two to six ). Part – III is devoted to flows in the Couple stress fluids and contains Five chapters ( Chapters seven to eleven ). Part - IV and Chapter twelve gives concluding remarks of the thesis and possible directions in which further work can be carried out. In all these chapters, the expressions for the velocity, micro-rotation for Micro-polar fluids and velocity field for Couple-stress fluids are obtained. The Drag/Couple/Skin friction is derived analytically and the effect of physical parameters like Reynolds number and Couple stress parameter on the Drag/Couple /Skin friction are studied graphically.

**MATHEMATICS**

Author : **JAGADEESHWAR PASHIKANTI**

Title of the thesis : **VISCOUS FLUID FLOW OVER AN EXPONENTIALLY STRETCHING PERMEABLE SHEET WITH HALL EFFECT AND CONVECTIVE THERMAL CONDITION**

Guide : **Dr. D. SRINIVASACHARYA**

Degree : **Ph. D.**

Student ID No. : **714048**

**ABSTRACT**

The thesis consists of NINE chapters. In each chapter, we consider two different physical conditions on the sheet i.e. when the sheet is (i) subjected to thermal convective boundary condition and (ii) maintained at uniform wall temperature with Hall effect. Chapter 1 provides an introduction to the concepts in Newtonian fluid, heat and mass transfer and a review of the pertinent literature. Chapter 2 presents the effect of thermal radiation and chemical reaction in a viscous fluid flow over an exponentially stretching sheet. Chapter 3 investigates the effect of Joule heating on the viscous follow over an exponentially stretching sheet. Chapter 4 deals the numerical solution of influence of cross-diffusion effects on the ow of viscous incompressible uid due to the exponentially stretching sheet. Chapter 5 studies the select of variable uid properties and heat source/sink on the laminar viscous own on an exponentially stretching sheet. Chapter 6 presents the inuence of thermophoresis and viscous dissipation select of incompressible viscous uid own due to a sheet stretching exponentially. Chapter 7 studies the double dispersion selects in a laminar slip own of conducting viscous uid over an exponentially stretching permeable sheet. Chapter 8 explores the inuence of homogeneous-heterogeneous reactions in presence of thermal radiation on the laminar slip own of viscous incompressible uid on an exponentially stretching sheet. Except for case (a) of chapters 3 and 6 and both cases of chapters 7 and 8, in all the chapters, the governing non-linear ordinary differential equations and their associated boundary conditions are linearized by using successive linearization method and then solved numerically by using Chebyshev spectral collocation method. For the case of non-similar equations, in the above-mentioned chapters, a local similarity and non-similarity method is used to transform the governing partial differential equations into ordinary differential equations and then solved by using Successive linearization method together with Chebyshev spectral collocation method.

The selects of convective heat transfer coefficient (Biot number), Hall parameter, magnetic parameter, thermal radiation, chemical reaction, Joule heating, cross-diffusion selects, variable viscosity, variable thermal conductivity, heat source or sink, thermophoresis, viscous dissipation, double dispersion effects, homogeneous and heterogeneous reactions are considered on the own characteristics such as the velocity, temperature and concentration distributions along with the local heat and mass transfer coefficients and are presented through graphs. The last chapter (Chapter and scope of the work for further study.

**MATHEMATICS**

Author : **V. NARAYANA**

Title of the thesis : **NUMERICAL VISUALIZATION OF NATURAL AND MIXED CONVECTIVE FLOWS IN CAVITY ENCLOSURES**

Guide : **Dr. H. P. Rani**

Degree : **Ph. D.**

Student ID No. : **715077**

**ABSTRACT**

The complexity of own regimes requires an accurate and physically reasonable simulation and leads to very expensive mathematical models based on time and computational resources. Generally the fluid own problems require solving the coupled systems of non-linear partial differential equations. To simulate and capture the own features in detail, accurate solutions are needed. This is the main concern in the Computational Fluid Dynamics (CFD) studies. Thus, it is aimed to study the own in enclosures using the Finite Volume Method (FVM). In FVM the convection term is discritized based Central Differencing (CD), which is of second order accurate. However, combination of the explicit time- integration and CD creates an unconditionally unstable solutions. In order to attain stability, differencing schemes of order accurate have been introduced. The unsatisfactory behavior of order schemes with respect to the boundedness, the combined spatial and temporal discretization introduces an unnecessary dependence of the solution on the time-step used to create it. Hence it is important to obtain bounded numerical solutions while solving the transport equations. Thus, a good differencing scheme must balance between boundedness and accuracy. Apart from the issues of accuracy and boundedness, which are essential for ac- curate calculations, modern differencing schemes are also required to be convergent and computationally inexpensive. The issue of computational cost includes both the additional face-by-face operations required to determine the weighting factors in Total Variation Diminishing (TVD) and Normalised Variable Diagram (NVD) schemes and the additional effort required to obtain solutions for steady-state problems. With the development of NVD, the accuracy and boundendness of differencing schemes has been improved at the expense of convergence. For this reason, still there is a need to analyse the convection discretisation schemes. In this thesis, numerical examples are given using the high order convection differencing schemes, namely, Upwind Difference, QUICK, SUPERBEE from a family of TVD schemes and SFCD from a family of NVD schemes. They are compared with respect to their accuracy and computational time. The SIMPLE algorithm (Patankar [52]) is used to deal with the pressure-velocity coupling. The system of algebraic equations is solved using the Gauss-Seidel method of iterative procedure. The grid independent non- uniform mesh is used such that the near wall eddies is captured accurately. The results are validated with those available in the literature. The results also show that distributed memory parallel processors greater potential CPU speedup. The above discretization procedure is employed along with the open source CFD software, namely, Open FOAM and the plotting software, Tecplot, to simulate and visualize the convective heat transfer in rectangular and cubical cavities. Over the past several decades, free and mixed convection in enclosures has received a remarkable attention because of its wide and practical applications in real world engineering concerns. From the literature survey it can be observed that plotting of velocity, streamlines and temperature contours are the general visualization tools for the convection heat transfer problems. But these tools, however, cannot able to describe relationship among energy flow mechanisms of fluid own and thermal diffusion. Recently Hooman [26] introduced energy ux vectors to relate the heatlines and energy streamlines and these vectors are tangent to the heatlines thus represent the flow of energy. Another visualisation method, called, field synergy principle presents the similarity between conduction and convection. The field synergy principle of convective heat transfer shows that the convective heat transfer intensity is related to temperature gradient, fluid velocity and their properties, and also on the included angle of the velocity and the temperature gradient vectors. The above discussion is detailed in the present thesis in six chapters. The need of the CFD based numerical simulation tools to deal with the complexity of flow regimes are discussed with respect to an accuracy and boundedness of the discretization methods. An overview of the subject is presented, covering the relevant studies concerning the accuracy of \_nite volume discretization, with reference to the convection term. The visualisation tools used in this dissertation such as, energy streamlines and field synergy is outlined and derived different case studies with respect to natural and mixed convection in 2D and 3D enclosures are analysed. The organization of other chapters is briey presented at the end of this chapter.

**MATHEMATICS**

Author : **GOPAGANI NITHISH KUMAR**

Title of the thesis : **SOME STUDIES ON FUZZY SOLID TRANSPORTATION PROBLEMS WITH ROUGH INTERVALS, STOCHASTIC AND BUDGET CONSTRAINTS**

Guide : **Dr. DEBASHIS DUTTA**

Degree : **Ph. D.**

Student ID No. : **701319**

**ABSTRACT**

The transportation problem (TP) is a well-known optimization problem in operational research, in which two kinds of constraints are taken into consideration, i.e., source constraint and destination constraint. But in the real system, we always deal with other constraints besides the source constraint and destination constraint, such as product type constraint or transportation mode constraint. If more than one objective is to be considered and optimized at the same time in a STP, then the problem is called multi-objective solid transportation problem (MOSTP). Besides the source, destination and conveyance capacity in an STP, there may exist some other constraints. For example, budget constraints may arise due to limited budget, space constraints may arise due to limited space in warehouses, stores, etc. Due to insuffcient information, lack of evidence, punctuating financial market, the available data of a transportation system such as transportation costs, resources, demands and conveyance capacities are not always crisp or precise. For example the transportation cost depends upon fuel price, tax charges, labour charges, etc., each of which are punctuated from time to time. It will be more realistic to express those parameters by fuzzy numbers. Fuzzy set theory is a generalization of the conventional set theory to represent vagueness or imprecision in everyday life. Thus, fuzzy sets have found applications.

**DEPARTMENT OF MATHEMATICS**

Author : **PAVAN KUMAR REDDY M**

Title of the thesis : **FLUID FLOW AND HEAT TRANSFER IN A RECTANGULAR GEOMETRY WITH/WITHOUT SUCTION/INJECTION**

Guide : **Dr. J.V. RAMANA MURTHY**

Degree : **Ph. D.**

Student ID No. : **716185**

**ABSTRACT**

The study of fluid flow and heat transfer is very important in micro reactor channels, filtration units and in membrane reactor ducts. It is important in Nuclear waste management and to determine residence time distributions in the process of drying of solids in fluidized beds and in cooling devices. In chemical engineering, there are major applications on laminar flow in channels. The effect of suction/injection over the walls in the flow field is encountered in filtration units, micro reactor channels, membrane reactor ducts and in fuel cell manifolds.

The objective of the present studies is to investigate the two dimensional flow and the heat transfer due to laminar flow convection in a rectangular channel with suction on neighboring and opposite walls when (i) the fluid is a viscous fluid, (ii) the fluid is Couple stress fluid and (iii) a circular cylinder is inserted in the channel. Geometry considered in this thesis is a rectangular geometry.

Analytical or numerical solutions have been obtained for flow field in the above geometry under the cases: (i) Fluid is Newtonian and viscous, (ii) Fluid is couple stress fluid, (iii) Flow is along the axial direction of the channel, (iv) Flow is due to suction/injection in the plane perpendicular to the channel and (v) A cylinder is inserted in the flow.

The values of the parameters characterizing the different problems are taken as follows. Reynolds number *Re*=0.5, 1, 5, 10, 20 and 30. Suction parameter: *V*0= 0.2, 0.5, 0.8, 2, 5, 10, 50, 100 and 200. eclet number: *Pe* = 0.001, 0.005, 0.01 and 0.02. Prandtl number *Pr*=0.71, 1 and 10. Brinkman number: *Br* = 0.4 and 0.8. Hartmann number *M*=1, 3, 5 and 7. Couple stress parameter *S*=1, 10, 20, 30 and 50.

The thesis consists of Five parts and nine chapters. Part - I and Chapter one is introductory in nature. Part – II is devoted to viscous fluid flows in a rectangular channel with adjacent wall suction and contains Three chapters ( Chapters two to four ). Part – III is devoted to Couple stress fluid flows in a rectangular channel with/without suction and contains Two chapters ( Chapters five and six ). Part – IV is devoted to Stokes flows past a circular cylinder in a square cavity with adjacent and opposite wall suction and contains Two chapters ( Chapters seven and eight ). Part–V and Chapter nine gives concluding remarks of the thesis and possible directions in which further work can be carried out.

In all these chapters, the expressions for the stream function, temperature, entropy generation number, Bejan number, heat function and pressure for viscous fluids and velocity field and temperature for Stokes flow past cylinder and for Couple-stress fluids are obtained. The Volumetric flow rate and Skin friction is derived analytically and the effect of physical parameters like Reynolds number, Magnetic parameter and Couple stress parameter on the Volumetric flow rate and Skin friction are studied graphically. The effect of Reynolds number and suction parameter on stream lines, isothermal lines, entropy generation number, Bejan number, heat lines and pressure are studied.

**MATHEMATICS**

Author : **S V KIRANMAYI. CH**

Title of the thesis : **SOLUTION OF HIGHER ORDER BOUNDARY VALUE PROBLEMS BY PETROV-GALERKIN METHOD WITH B- SPLINES**

Guide : **Dr. K .N.S. KASI VISWANADHAM**

Degree : **Ph. D.**

Student ID No. : **715081**

**ABSTRACT**

In this thesis, various orders of higher order boundary value problems have been solved with the B-splines as basis functions as well as weight functions by Petrov Galerkin Method. In Petrov-Galerkin Method, the basis functions, which form a basis for the considered approximation space, have been redefined into a new set of basis functions which becomes zero on the boundary where the given set of boundary conditions or most of the boundary conditions are mentioned and also the weight functions have been redefined into a new set of weight functions which contain the number of weight functions that are equal in number with the redefined basis functions. The various orders of higher order boundary value problems have been solved by Petrov-Galerkin Method with redefined set of basis functions and the redefined set of weight functions. The solution to a nonlinear boundary value problem has been obtained as the limit of solutions of sequence of linear boundary value problem generated by quazilinearization technique. Several numerical examples of linear boundary value problems and nonlinear boundary value problems have been considered to test the efficiency of the present Petrov-Galerkin Method.

**MATHEMATICS**

Author : **J SHARATH KUMAR REDDY**

Title of the thesis : **FORCED CONVECTION HEAT TRANSFER IN PARALLEL PLATE CHANNELS**

Guide : **Dr. D. BHARGAVI**

Degree : **Ph. D.**

Student ID No. : **715079**

**ABSTRACT**

The objective of the present study has been to make available hydrodynamic and thermal characteristics of a Newtonian fluid for laminar incompressible flow in channels partially filled with porous material. The given amount of porous material porous layer was distributed equally at the two walls. Porous fraction, , is defined as the ratio of the porous layer thickness to the distance between the walls of the channel. *p*γ Analytical or numerical solutions have been obtained for the following values of the parameters characterizing the different problems studied. Porous fraction : , Darcy number, *Da*: 0.001 to 1.0. When magnetic field is considered, the Hartman number, *M* is between 1 to 10. When axial conduction is considered, the select number, *Pe* ranges from 5 to 100. When viscous dissipation is included, the Brinkman number *Br* assumes a value between and 1.0, i.e.,. Numerical solutions have been obtained employing Successive Accelerated Replacement scheme after validating the scheme. *p*γ01.0*p*γ≤≤1.0− 1.01.0*Br*−≤≤ As Hartmann number (Magnetic field parameter) *M* increases, the porous channel behaves like a clear fluid channel for all Darcy numbers. The magnetic field parameter is negligible in the fully filled porous region with such high Hartmann number. Axial conduction effects are significant for *Pe* < 100 and become negligible even near the entry for *Pe* > 100 in channels partially filled with porous material. When viscous dissipation is included, the limiting bulk mean temperature is higher than the wall temperature. The local Nusselt number displays an unbounded swing since the bulk mean temperature reaches the wall temperature and exceeds it because of viscous dissipation. Limiting temperature and limiting Nusselt number depend on the Brinkman number when the channel walls are subjected to constant wall heat flux. In the case of constant wall temperate, limiting Nusselt number is independent of Brinkman number for *Br* ≠ 0. Developed flow depends on *Da*, *γp* and developing temperature field depends on *Da*, , *Pe*, and *Br*. Local Nusselt number, *Nupx* is significantly large when *Pe* is low. *Nupx* decreases with increasing *X\**. Influence of axial conduction, viscous dissipation and developing thermal field on temperature profiles and local Nusselt number, have been evaluated when different models have been employed. The local Nusselt number attains a minimum for some, (subjected to constant wall heat flux). It has been found that minimum value of is practically independent of the axial location and Peclet number.*p*γ01.0*p*γ<< *p*γ Effects of viscous dissipation employing Darcy model and the clear fluid compatible model have been studied. The results include the effects of viscous dissipation on temperature profiles and Nusselt numbers. In general the effects of axial conduction are subdued when viscous dissipation is strong and vice versa.

**MATHEMATICS**

Author : **SREENATH ITIKELA**

Title of the thesis : **BIOCONVECTION FLOW OF POLAR FLUIDS IN CHANNELS**

Guide : **Dr. D. SRINIVASACHARYA**

Degree : **Ph. D.**

Student ID No. : **716049**

**ABSTRACT**

Bioconvection is due to microscopic convection generated by the density gradient produced by the collective motion of self-propelled motile microorganisms within the fluid. Several researchers have enticed in the study of the bio convection in Newtonian and non- Newtonian fluids due to multifaceted range of applications in biological systems and biotechnology. Although the interaction of polar selects such as microstructure and micro motion of the fluid elements and the bio convection is important, a very little work has been reported in literature. The purpose of this thesis is to study the bio convection flow of polar fluids (micropolar and of a couple-stress fluid)in the presence of microorganisms through channels. This thesis consists of Four parts and Twelve chapters. Part - I consists of a single chapter (Chapter-1), which provides an introduction to the concepts and a review of the pertinent literature. Part-II contains Five chapters (Chapters 2, 3, 4, 5 and 6). Chapter-2 deals with the bio convection squeezing flow of an incompressible micro polar uid containing microorganisms between two infinite parallel plates. In Chapter - 3, the bio convection of a micro polar fluid containing microorganisms in an annulus is considered. Chapter - 4 presents the bio convection flow of an incompressible micro polar fluid containing microorganisms through a horizontal porous channel with expanding or contracting walls. Chapter - 5 considers the bio convection squeezing flow of an incompressible micro polar fluid containing microorganisms in a horizontal rotating channel with the lower stretching wall. In Chapter - 6, the bio convection in a squeezing flow of an incompressible micro polar fluid containing with the gyrotactic microorganisms between two parallel discs is studied. Part-III ( Chapters 7, 8, 9, 10 and 11) deals with the bio convection in a couple stress fluid under various geometries as in Part-II. In these chapters, the bio convection flow of an incompressible couple-stress uid containing microorganisms in geometries viz., between two parallel plates, an annulus horizontal porous channel with expanding or contracting walls, squeezing ow in a horizontal rotating channel and between two parallel discs is considered. In all the above chapters, the governing system of nonlinear partial differential equations describing the total mass, thermal energy, mass diffusion and microorganisms are reduced to a set of non linear ordinary differential equations with the help of suitable transformations. The resulting non-linear ordinary differential equations are linearized using successive linearization and the resulting system of equations are solved numerically using Chebyshev collocation method. Part - IV consists of a single chapter (Chapter - 12), which gives summary and overall conclusions and scope for future work.