# Contents

1 Introduction 1

1.1 Steady flows around a circular cylinder and a sphere 2
1.2 Effect of magnetic field on the flow 3
1.3 Forced convective heat transfer 4
1.4 Numerical method used in the thesis 7
  1.4.1 Fourth Order Non-Compact Scheme 11
  1.4.2 Higher order compact scheme 11
1.5 Organization of the thesis 15

2 Forced convective heat transfer from sphere under low $R_m$ approximation 17

2.1 Basic equations 17
2.2 Fourth order scheme with MG method 20
2.3 Results and Discussion 24
  2.3.1 Validation 24
  2.3.2 Local and mean Nusselt numbers 28
  2.3.3 Temperature field 30
2.4 Conclusions 31

3 Forced convective heat transfer from a circular cylinder under low $R_m$ approximation 51

3.1 Formulation of the problem 51
3.2 Fourth order Compact Scheme 54
3.3 Results and Discussion 56
4 Forced convective heat transfer from a sphere without using low $R_m$ approximation

4.1 Formulation of the problem
4.2 Fourth order compact scheme
4.3 Results and Discussion
  4.3.1 Discussion on the flow
  4.3.2 Drag coefficients
  4.3.3 Current density and induced magnetic field
  4.3.4 Heat transfer coefficient
  4.3.5 Analysis of Local Nusselt number
  4.3.6 Analysis of Mean Nusselt number
  4.3.7 Temperature field and isotherms
  4.3.8 Conclusions

5 Forced convective heat transfer from a circular cylinder without using low $R_m$ approximation

5.1 Formulation of the problem
5.2 Fourth order Compact Scheme
5.3 Results and Discussion
  5.3.1 Discussion on the flow
  5.3.2 Drag coefficients
  5.3.3 Current density and induced magnetic field
  5.3.4 Heat transfer coefficient
  5.3.5 Analysis of Local Nusselt number
  5.3.6 Analysis of mean Nusselt number
  5.3.7 Temperature field and isotherms
  5.3.8 Conclusions