ABSTRACT

The analysis of real flow past bodies of arbitrary shape is a difficult task. Advanced computers applying modern numerical techniques are capable of handling satisfactorily only a small number of practical problems. The investigation of such limited number of flow problems becomes even more difficult when computing fascilities are limited.

In this thesis, an attempt has been made to develop numerical methods suitable for commonly avialable mini-computers for a selected number of two-dimensional incompressible viscous flow problems. These methods can be extended to more general class of problems, if appropriate computing facilities are avialable.

The primary objective of the present investigation is to develop an understanding of the viscous flow characteristics of practical flow problems. The full Navier-Stokes equations give a complete description of the flow-field but their solutions are still restricted to a relatively small number of cases, particularly at high Reynolds numbers. Many problems of practical importance are often solved by using other techniques which give results of acceptable accuracy.

In the present investigation, the analysis has been broadly divided into two categories. In the first category,

problems associated with low Reynolds number (laminar) flows have been considered. For such flow problmes solutions of the full Navier-Stokes equations have been obtained. Both explicit and implicit finite-difference schemes have been developed for this purpose. The second category of problems is associated with high Reynolds number (turbulent) flows. Solutions of the Navier-Stokes equations at high Reynolds numbers require an enormous amount of computer resources even when moderately sophisticated models of turbulence are used. An alternative approach which is less demanding on computer resources and yet gives sufficiently accurate solutions for high Reynolds number flows uses Viscous Inviscid Interaction techniques.

The laminar flow problems studied in this thesis are:

i) Flow in a Driven Square Cavity,

ii) Flow past a Rear-ward facing Step,

iii) Flow past a Circualr Cylinder,

iv) Flow past Aerofoils.

The turbulent flow problems studied in this thesis are:

i) Turbulent Attached Flow past Aerofoils,

ii) Turbulent Separated Flow past Aerofoils.

To assess the accuracy of the developed calculation methods the results have been compared with existing numerical and experimental data whereever these are avialable. The results seem to agree quite satisfactorily.