Equations governing natural convection have been solved using a fast and stable finite difference approximation, which has been developed and validated. The technique relies on using different false transient factors in different flow regions. The efficiency was illustrated by solving a three-dimensional heated cavity and the flow and thermal fields in a rectangular enclosure in which one wall is heated and cooled with all the remaining walls adiabatic.

A second order central difference approximations in space and first order in time is used to discretized the governing equations together with the boundary conditions. The vorticity transport equations and the energy equation were solved to the steady state using the Sarmaski-Andreyev (1963) Alternative-Direct Implicit (ADI).

Solutions are presented for the colliding boundary layer problem for air in the Rayleigh number range $5 \times 10^{10} \leq Ra \geq 5 \times 10^{11}$. The turbulent boundary layers form on the hot and cold end wall. A parametric study of the window problem with a variable area and a fixed center is performed for $Ra = 5 \times 10^{11}$ the velocity and temperature distribution was considered when the heater is placed between the window and the floor of the cavity.

In conclusion the vorticity vector potential formulation has been successfully used in solving natural convection problems due to non-uniformities in temperature boundary condition.