SYNOPSIS

We are, in this thesis, concerned with the unsteady behaviour of certain fluid flows in rotating environments. The subject is of particular interest because of its application to certain physical phenomena encountered in oceanography, geophysics, meteorology and fluid engineering. The organisation of the thesis, which contains six chapters, is as follows :

As a prelude to the main part of the thesis, a brief review of some of the previous studies relevant to the present work, is given in Chapter I.

In Chapter II, the effects of a time-dependent normal velocity, at the bounding porous plane, on the unsteady boundary layer flow in an incompressible homogeneous viscous rotating fluid, are studied. The unsteady flow arises either due to the oscillations of the porous plane, or due to the fluctuations in the free stream. The boundary value problem is solved by making a Fourier expansion of the velocity function. Expressions for velocity and skin-friction are obtained in closed form. For the case of suction, the oscillations are confined to boundary layers of finite thickness, whereas a resonant behaviour is possible in the case of injection. It is found that the resonance can be avoided under certain conditions.

Chapter III is devoted to the study of an unsteady flow due to the superposition of small amplitude torsional vibrations on a rotating disk in a semi-infinite fluid. Analytical -

numerical solutions are obtained for the second-order time mean flow. Two separate solutions are constructed for the limiting cases of large and small frequencies of oscillation. It is found that the mean axial inflow at large distances from the disk increases due to small frequency oscillations and the Stokes shear layer plays a vital role in the high frequency range. Specific formulae for the shear stress at the surface of the disk are also obtained.

In Chapter IV, an exact solution of the Navier-Stokes equations for the flow due to the harmonic oscillations of a free stream past a rotating disk is presented. The governing equations for this flow, valid for all frequencies and amplitudes of oscillations, are obtained. Analytical - numerical solutions are developed for low and high frequencies of oscillation and enough number of terms are used in the calculation to give the solution a satisfactory accuracy over the entire flow regime.

The fluid motion induced by an impulsive rotation imparted to the stationary disk in the Bödewadt flow is analysed in Chapter V. A highly accurate analytical - numerical solution for the basic steady state is developed. Separate solutions are derived for the early development and for the approach to the ultimate state. The spin-up is marked by the propagation of a complicated wave system generated by the interplay of diffusion, inertial oscillations and the basic spatial oscillations. Results are extended to rotationally symmetric flows in general.

In Chapter VI, an analysis showing how a rotating fluid layer, bounded by two horizontal thermally conducting planes, subjected to a moving thermal wave, could acquire and maintain a horizontal flux of momentum is presented. The basic equations are linearised under the assumption that the induced motion is slower than the speed of the heat source. The net flux of horizontal momentum is calculated for different values of the Reynolds number and for different frequency ratios. The gyroscopic torque due to rotation tends to inhibit the meridional overturning. When the rotation rate exceeds a critical value, the Coriolis force inhibits the overturning motion and promotes a different type of flow. It is found that the rotation can cause a reversal of the mean flow.