ABSTRACT

Classical von Kármán swirling flow and Bödewadt swirling flow furnish two examples of exact solutions of the Navier-Stokes equations. Spin-down from the classical von Kármán flow following the abrupt cessation of the disk motion is studied. Asymptotic expressions for the initial development and the final decay of the fluid flow are supplemented by numerical solutions. Exact solutions are obtained for certain flows in which an infinite plane is in relative translation adjacent to the Bodewadt swirling flow. An initial-value problem is posed and analysed in order to resolve the resonance which occurs when the frequency of the longitudinal oscillations of the plane equals the angular velocity of the rotating fluid. Asymptotic expressions for the skin friction components and the flow at infinity are derived for low- and high- frequency oscillations when a disk is vibrating torsionally against a swirling fluid. Rotationally symmetric flow about a rotating disk is investigated by a new method which is further extended to include uniform suction or injection at the rotating disk. For an oscillatory suction, it is proved that the resonance occurs only when the angular velocity of the fluid is greater then the angular velocity of the rotating disk.

Key words: von Kármán flow, Spin-down, Exponential-decay, Newton cotes formulae, Centrifugal force, Skin friction coefficients, Rotational Rayleigh layer, Torque, Characteristic length, Swirling flow, Frequency, Axisymmetry, Bödewadt flow, Longitudinal oscillations, Acceleraiton, Symmetric flow, Resonance, Secondary cross flow, Wave-trains, Spatial oscillations, Elliptic harmonic oscillations, Torsional oscillations, Rosenblat flow, Fluctuating flow, Mean flow, Rotationally symmetric flow, Perturbation, Impulsive boundary layer type flows, deceleration, solid body rotation, Stokes boundary layer, Skin waves, Quasi-steady state, Suction, Injection, Oscillatory suction.