Abstract

Within the framework of the linearized theory of water waves, the present thesis is concerned with the study of some problems related to scattering and generation of water waves in single layer fluid as well as in two-layer fluid. The entire work presented in this thesis is divided into five parts, viz., **Part I**, **II**, **III**, **IV** and **V**. **Part I** is comprised of a general introduction, a brief literature review related to the work presented in the thesis, basic equations of the linearized theory of water waves, and some mathematical techniques employed in the later part of the thesis. **Part II** involves the study of the generation of water waves due to a ring source submerged in single and two-layer fluid mediums. **Part III** deals with water wave scattering problems in a two-layer fluid involving obstacles in the forms of an inclined plate or a circular plate or two interface piercing inclined permeable plates. **Part IV** is concerned with the investigation of water wave scattering and radiation problems in three-dimensions by a submerged horizontal rigid disc in a two-layer fluid. **Part V** highlights the conclusion as well as the future scope of the research carried out in this thesis.

Part II consists of two problems. In the first problem of **Part II**, the velocity potentials due to a horizontal circular ring of wave sources of time-harmonic strength submerged in a single layer fluid with a floating elastic plate or a floating membrane are constructed in the presence of a porous bottom. The second problem of **Part II** deals with the construction of the velocity potentials due to a submerged horizontal ring of wave sources of time-harmonic strength present in either of the fluids of a two-fluid medium when the upper layer is of finite height above the mean interface and bounded by a thin elastic plate, while the lower layer extends infinitely downwards. Both the problems are formulated as initial value problems for the velocity potentials and Laplace transform in time is employed to solve these. After invoking the inverse transform, the potential functions are obtained and then their asymptotic representations for large time and large distance are derived. For time-harmonic source strength, the existence of progressive waves of arbitrary frequency is established. In the first problem of **Part II**, solution of dispersion equation arising in the single-layer fluid with a membrane-cover in the presence of a porous bottom is also considered. For this equation, the nature of all the roots is established using the argument principle of complex variable theory.

Part III consists of three problems. In the first problem of **Part III**, free surface wave and interface wave interaction with an inclined thin plate submerged in the lower layer of a two-layer fluid of finite depth are investigated. The second problem of **Part III** deals with flexural gravity wave and interface wave scattering by a circular-arc-shaped plate placed in the lower layer of two-layer finite depth water with an ice-cover. Both the problems are reduced to one-dimensional hypersingular integral equations of the first kind by employing Green's integral theorem and using the boundary condition on the plate. These hypersingular integral equations involve the discontinuity in the potential function across the plate, which is approximated by finite series involving Chebyshev polynomials. The coefficients of these finite series are obtained numerically by collocation method. The reflection and the transmission coefficients and the hydrodynamic force acting on the plate are then computed numerically using the computed values of the coefficients. The third problem of **Part III** is related to water wave scattering by two interface piercing permeable plates which are inclined and symmetric about a vertical line and are present in two-layer finite depth water. The problem is formulated in terms of a set of coupled one-dimensional hypersingular integral equations of the second kind for the difference of potentials across the plates. These integral equations are solved numerically by employing expansion-collocation methods. The solutions are utilized in

computing the reflection and the transmission coefficients acting on the plates and the amount of dissipated wave energy. Also, relevant energy identities for this scattering problem are derived from which it has been possible to get a mathematical expression for the energy dissipation by porous plates.
In **Part IV**, we consider a fixed disc to study the scattering problem and a heaving disc to examine the radiation problem in three-dimensions. Both the problems are solved by transforming them into two-dimensional hypersingular integral equations. With the help of Fourier series expansions of various functions, these integral equations are further reduced to one-dimensional Fredholm integral equations of the second kind in terms of a newly defined function. Using these solutions the total scattering cross-section and the hydrodynamic force associated with the scattering problem and the added mass and the damping coefficient for the radiation problem are derived. Haskind relations connecting the solutions of the radiation and the scattering problems are also derived in a two-layer fluid.

Keywords: Water wave scattering and radiation; Linear theory; Single-layer fluid; Two-layer fluid; Floating elastic plate; Floating membrane; Ring source potential; Inclined plate; Circular-arc-shaped plate; Two inclined permeable plates; Horizontal rigid disc; Reflection coefficient; Transmission coefficient; Energy identity; Hydrodynamic force; Energy dissipation; Total scattering cross-section; Added mass and the damping coefficient; One-dimensional hypersingular integral equation; Two-dimensional hypersingular integral equation; One-dimensional Fredholm integral equation; Green's integral theorem; Haskind relation;