ABSTRACT

This study investigated the free surface flow of a two dimensional, steady, incompressible, irrotational and inviscid fluid under the effects of the force of gravity. Later the effects of both gravity and surface tension are examined. In both cases, the bottom surface is explicitly defined while the free surface is unknown *a priori*. The complexity of the free surface fluids flows compounds with the introduction of an arbitrary body on the bottom surface and a direct numerical solution was not so easy to formulate. Numerous numerical techniques like the Finite Difference Method (FDM), Finite Element Method (FEM) and linearization methods had been used previously to solve fluid flow problems generated by various types of obstacles on the bottom surface. However, these methods generated large matrix equations which are hard to solve. In this thesis, a newer numerical technique is employed to solve these problems which combines the use of Boundary Integral Method(BIM), the Riemann-Hilbert method (RHM) and Muskhelishlivili's singular integral equation theory. These combinations lead to the Boundary Element Method (BEM) which only seeks to solve problems along the given boundaries. Two important dimensionless parameters namely, Froude number, *Fr,* and the Weber number, *We,* are used to examine the effects of gravity and surface tension respectively. Here, the bottom surface is explicitly defined while the free surface is unknown *a priori.*

The shapes of the obstacles considered on the bottom surface are a step, a hump and a single depression and the corresponding positions and shapes of the free surfaces predicted. Later, the case of complex bottom shapes are considered and the respective results given.