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Physics : Theoretical, Mathematical and Computational Physics

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Variational Inequalities and Flow in Porous Media

These notes are the contents of a one semester graduate course which taught at Brown University during the academic year 1981-1982. They are mainly concerned with regularity theory for obstacle problems, and with the dam problem, which, in the rectangular case, is one of the most interesting applications of Variational Inequalities with an obstacle. Very little background is needed to read these notes. The main results of functional analysis which are used here are recalled in the text. The goal of the two first chapters is to introduce the notion of Variational Inequality and give some applications from physical mathematics. The third chapter is concerned with a regularity theory for the obstacle problems. These problems have now invaded a large domain of applied mathematics including optimal control theory and mechanics, and a collection of regularity results available seems to be timely. Roughly speaking, for elliptic variational inequalities of second order we prove that the solution has as much regularity as the obstacle(s). We combine here the theory for one or two obstacles in a unified way, and one of our hopes is that the reader will enjoy the wide diversity of techniques used in this approach. The fourth chapter is concerned with the dam problem. This problem has been intensively studied during the past decade (see the books of Baiocchi-Capelo and Kinderlehrer-Stampacchia in the references). The relationship with Variational Inequalities has already been quoted above.

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