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26[49–02, 49J15, 49M37].—K. C. P. MACHIELSEN, *Numerical Solution of Optimal Control Problems with State Constraints by Sequential Quadratic Programming in Function Space*, CWI Tract, Vol. 53, Centre for Mathematics and Computer Science, Amsterdam, 1988, vi+214 pp., 24 cm. Price: Softcover Dfl.59.00.

The aim of this book is to present the application of SQP (the sequential quadratic programming algorithm) to the optimal control of ordinary differential equations with state and control constraints.

The book is structured as follows. Chapter 1 is a brief introduction. Chapter 2 presents a theory of first- and second-order optimality conditions of abstract optimization problems in Banach spaces. The optimality conditions for optimal control problems are presented in Chapter 3, and Chapter 4 presents the principle of SQP for abstract optimization problems and optimal control (without discretization). Chapter 5 discusses the optimality conditions of the quadratic subproblems. The numerical resolution of the quadratic problems is discussed in Chapter 6; Chapter 7 presents some interesting examples in flight mechanics and servo systems. Final remarks are made in Chapter 8. The appendix is devoted to some numerical questions.

Dealing with the subject of this book is a difficult task because one has, on one hand, to present some results of optimization in infinite-dimensional spaces that use the most sophisticated tools of functional analysis, and on the other hand deal with some algorithmic and numerical questions which are rather involved. It is also worth noting that no other book (to the knowledge of the reviewer) covers such a vast domain.

The book seems to have been written very rapidly, and some drawbacks are apparent. For instance, the abstract optimization theory of Chapter 2 is very heavy, probably because of the desire of the author to present several qualification conditions. Also the second-order necessary condition of Theorem 2.14 says that the Hessian of the Lagrangian is nonnegative for a critical direction, a statement that is known to be false in general if an infinite number of inequality constraints appears. Some necessary second-order conditions taking this fact into account can be found in [1]. We note the following strange statement (after (3.2.1), p. 31): "$X = W_{1,\infty}[0, T]^n \times L_\infty[0, T]^n$ is assumed to be a Banach space, but it cannot be expected to be a Banach space unless the spaces $W_{1,\infty}[0, T^n]$ and $L_\infty[0, T]^n$ are both Banach spaces" (perhaps this must be understood as a joke).

On the other hand, Chapter 2 contains a useful review of the discussion of the smoothness of multipliers and of the "alternate optimality conditions" (involving the total derivative of state constraints). It is a merit of this book that it takes into account this "alternative theory" that explicitly handles the switching points (i.e., the times at which the set of active constraints change) and is usually associated with shooting methods. Active set strategies for the resolution of the quadratic subproblems are also discussed.

The examples are interesting. They present the numerical solution of several nontrivial real-world optimal control problems with first- and second-order state constraints.

In conclusion, this book should be considered as an introduction to the subject rather than a definitive treatise. Nevertheless, it should interest anybody willing to have an overview of some modern approaches to numerical optimal control.

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27[90C20, 90C30, 65K10].—CHRISTODOULOS A. FLOUDAS & PANOS M. PARDALOS (Editors), *Recent Advances in Global Optimization*, Princeton Series in Computer Science, Princeton Univ. Press, Princeton, NJ, 1992, x+663 pp., $23\frac{1}{2}$ cm. Price \$69.50 hardcover, \$39.50 paperback.

This volume contains refereed versions of twenty-seven papers presented at the "Recent Advances in Global Optimization" conference held at Princeton University in May, 1991. If you have an interest in global optimization, then you will find this book fascinating. Its pages reveal the breadth of current research in global optimization, from methods tailored to the optimal reloading of a nuclear power plant, to methods designed to minimize portfolio risk.

Global optimization involves finding the minimum (or maximum) value assumed by a continuous real-valued objective function of many variables, over a constraint set which is generally assumed to be compact. Authors differ over the structure assumed of the objective function, and of the constraints. Broadly speaking, the early papers in this volume assume a lot of structure, while the later papers assume little.

The first seven papers consider variants of the situation in which the objective function is quadratic. Complexity questions are addressed, as well as