

Contents

1. Formulation of the Time-Optimal Problem and Maximum Principle	1
1.1. Statement of the Optimal Problem	1
1.2. On the Canonical Systems of Equations Containing a Parameter and on the Pontryagin Maximum Condition ...	4
1.3. The Pontryagin Maximum Principle	8
1.4. A Geometrical Interpretation of the Maximum Condition .	11
1.5. The Maximum Condition in the Autonomous Case	12
1.6. The Case of an Open Set U . The Canonical Formalism for the Solution of Optimal Control Problems	16
1.7. Concluding Remarks	19
2. Generalized Controls	21
2.1. Generalized Controls and a Convex Control Problem	21
2.2. Weak Convergence of Generalized Controls	28
3. The Approximation Lemma	37
3.1. Partition of Unity	38
3.2. The Approximation Lemma	45
4. The Existence and Continuous Dependence Theorem for Solutions of Differential Equations	53
4.1. Preparatory Material	53
4.2. A Fixed-Point Theorem for Contraction Mappings	60

4.3.	The Existence and Continuous Dependence Theorem for Solutions of Equation (4.3)	63
4.4.	The Spaces $E_{Lip}(G)$	69
4.5.	The Existence and Continuous Dependence Theorems for Solutions of Differential Equations in the General Case	72
5.	The Variation Formula for Solutions of Differential Equations	79
5.1.	The Spaces E_1 and $E_1(G)$	79
5.2.	The Equation of Variation and the Variation Formula for the Solution	82
5.3.	Proof of Theorem 5.1	87
5.4.	A Counterexample	90
5.5.	On Solutions of Linear Matrix Differential Equations	93
6.	The Varying of Trajectories in Convex Control Problems	99
6.1.	Variations of Generalized Controls and the Corresponding Variations of the Controlled Equation	99
6.2.	Variations of Trajectories	107
7.	Proof of the Maximum Principle	115
7.1.	The Integral Maximum Condition, the Pontryagin Maximum Condition, and Their Equivalence	115
7.2.	The Maximum Principle in the Class of Generalized Controls	118
7.3.	Construction of the Cone of Variations	120
7.4.	Proof of the Maximum Principle	130
8.	The Existence of Optimal Solutions	135
8.1.	The Weak Compactness of the Class of Generalized Controls	136
8.2.	The Existence Theorem for Convex Optimal Problems	146
8.3.	The Existence Theorem in the Class of Ordinary Controls ..	150
8.4.	Sliding Optimal Regimes	156
8.5.	The Existence Theorem for Regular Problems of the Calculus of Variations	162
	Bibliography	171
	Index	173