
Contents

Foreword	ix
Acknowledgments	xiii
Lecture 1. The Brachistochrone	1
Lecture 2. The Fundamental Problem. Extremals	7
Appendix 2: The Fundamental Lemma	15
Lecture 3. The Insufficiency of Extremality	19
Appendix 3: The Principle of Least Action	26
Lecture 4. Important First Integrals	29
Lecture 5. The du Bois-Reymond Equation	35
Appendix 5: Another Fundamental Lemma	40
Lecture 6. The Corner Conditions	41
Lecture 7. Legendre's Necessary Condition	51
Appendix 7: Yet Another Lemma	55
Lecture 8. Jacobi's Necessary Condition	57
Appendix 8: On Solving Jacobi's Equation	65

Lecture 9. Weak Versus Strong Variations	67
Lecture 10. Weierstrass's Necessary Condition	73
Lecture 11. The Transversality Conditions	81
Lecture 12. Hilbert's Invariant Integral	91
Lecture 13. The Fundamental Sufficient Condition	101
Appendix 13: The Equations of an Envelope	108
Lecture 14. Jacobi's Condition Revisited	111
Lecture 15. Isoperimetrical Problems	119
Appendix 15: Constrained Optimization	124
Lecture 16. Optimal Control Problems	127
Lecture 17. Necessary Conditions for Optimality	135
Appendix 17: The Calculus of Variations Revisited	146
Lecture 18. Time-Optimal Control	149
Lecture 19. A Singular Control Problem	159
Lecture 20. A Biological Control Problem	163
Lecture 21. Optimal Control to a General Target	167
Appendix 21: The Invariance of the Hamiltonian	180
Lecture 22. Navigational Control Problems	183
Lecture 23. State Variable Restrictions	195
Lecture 24. Optimal Harvesting	203
Afterword	219
Solutions or Hints for Selected Exercises	221
Bibliography	245
Index	249