
Contents

Preface	VII
Symbols and Notations	IX
1 An introduction to MATLAB[®]. Elementary models with applications	1
1.1 Why MATLAB [®] ?	1
1.1.1 Arrays and matrix algebra	1
1.1.2 Simple 2D graphics	9
1.1.3 Script files and function files	10
1.2 Roots and minimum points of 1D functions	16
1.3 Array-smart functions	19
1.4 Models with ODEs; MATLAB functions ode23 and ode45	22
1.5 The spruce budworm model	28
1.6 Programming Runge–Kutta methods	32
1.7 Systems of ODEs. Models from Life Sciences	34
1.8 3D Graphics	52
Bibliographical Notes and Remarks	55
Exercises	56
2 Optimal control of ordinary differential systems. Optimality conditions	59
2.1 Basic problem. Pontryagin’s principle	59
2.2 Maximizing total consumption	65
2.3 Maximizing the total population in a predator–prey system ...	72
2.4 Insulin treatment model	83
2.5 Working examples	93
2.5.1 HIV treatment	93
2.5.2 The control of a SIR model	95
Bibliographical Notes and Remarks	96
Exercises	97

3 Optimal control of ordinary differential systems.
Gradient methods 99
 3.1 A gradient method 99
 3.2 A tutorial example for the gradient method 105
 3.3 Stock management 121
 3.4 An optimal harvesting problem 128
 Bibliographical Notes and Remarks 141
 Exercises 141

4 Optimal harvesting for age-structured population 145
 4.1 The linear age-structured population dynamics 145
 4.2 The optimal harvesting problem 160
 4.3 A logistic model with periodic vital rates 172
 Bibliographical Notes and Remarks 181
 Exercises 182

5 Optimal control of diffusive models 185
 5.1 Diffusion in mathematical models 185
 5.2 Optimal harvesting for Fisher’s model 189
 5.3 A working example: Control of a reaction–diffusion system 199
 Bibliographical Notes and Remarks 204
 Exercises 204

Appendices 207
 A.1 Elements of functional analysis 207
 A.1.1 The Lebesgue integral 207
 A.1.2 L^p spaces 209
 A.1.3 The weak convergence 212
 A.1.4 The normal cone 213
 A.1.5 The Gâteaux derivative 214
 A.2 Bellman’s lemma 215
 A.3 Existence and uniqueness of Carathéodory solution 217
 A.4 Runge–Kutta methods 218

References 227

Index 233



<http://www.springer.com/978-0-8176-8097-8>

An Introduction to Optimal Control Problems in Life
Sciences and Economics
From Mathematical Models to Numerical Simulation with
MATLAB®

Anița, S.; Arnăutu, V.; Capasso, V.

2011, XII, 232 p., Hardcover

ISBN: 978-0-8176-8097-8

A product of Birkhäuser Basel