

## Table of Contents

<b>1. Introduction</b>	<b>1</b>
<b>2. Linear models</b>	<b>7</b>
2.1 One population models	7
2.1.1 SIR model with vital dynamics	8
2.1.2 SIR model with temporary immunity	9
2.1.3 SIR model with carriers	10
2.1.4 The general structure of bilinear systems	10
2.2 Epidemic models with two or more interacting populations	13
2.2.1 Gonorrhea model	13
2.2.2 SIS model in two communities with migration	14
2.2.3 SIS model for two dissimilar groups	15
2.2.4 Host-vector-host model	16
2.3 The general structure	17
2.3.1 Constant total population	18
2.3.1.1 Case A	21
2.3.1.1.1 SIR model with vital dynamics	21
2.3.1.1.2 SIRS model with temporary immunity	22
2.3.1.1.3 SIR model with carriers	22
2.3.1.1.4 SIR model with vertical transmission	23
2.3.1.2 Case B	24
2.3.1.2.1 Gonorrhea model	24
2.3.1.2.2 SIS model in two communities with migration	25
2.3.1.2.3 SIS model for two dissimilar groups	26
2.3.1.2.4 Host-vector-host model	27
2.3.2 Nonconstant total population	30
2.3.2.1 The parasite-host system	35
2.3.2.2 An SIS model with vital dynamics	38
2.3.2.3 An SIRS model with vital dynamics in a population with varying size	39
2.3.2.4 An SIR model with vertical transmission and varying population size. A model for AIDS	44
2.3.4 Multigroup models	47
2.3.4.1 SIS model for $n$ dissimilar groups. A model for gonorrhea in an heterogeneous population	47
2.3.4.2 SIR model for $n$ dissimilar groups	49

<b>3. Strongly nonlinear models</b>	<b>57</b>
3.1 The nonlinear SEIRS model	59
3.1.1 Stability of the nontrivial equilibria	66
3.2 A general nonlinear SEIRS model	69
3.2.1 Stability of equilibria	75
3.3 An epidemic model with nonlinear dependence upon the population size	77
3.4 Mathematical models for HIV/AIDS infections	81
3.4.1 One population models. One stage of infection	81
3.4.2 One population models. Distributed time of infectiousness	90
3.4.3 One population models. Multiple stages of infection, with variable infectiousness	93
3.4.4 Multigroup models with multiple stages of infectiousness	97
 <b>4. Quasimonotone systems. Positive feedback systems. Cooperative systems</b>	 <b>109</b>
4.1 Introduction	109
4.2 The spatially homogeneous case	110
4.3 Epidemic models with positive feedback	112
4.3.1 Gonorrhea	113
4.3.2 Schistosomiasis	114
4.3.3 The Ross malaria model	115
4.3.4 A man-environment-man epidemic system	117
4.4 Qualitative analysis of the space homogeneous autonomous case	118
4.5 The periodic case	129
4.6 Multigroup models	133
4.6.1 A model for gonorrhea in a nonhomogeneous population	133
4.6.2 Macdonald's model for the transmission of schistosomiasis in heterogeneous populations	141
 <b>5. Spatial heterogeneity</b>	 <b>149</b>
5.1 Introduction	149
5.2 Quasimonotone systems	152
5.3 The periodic case	163
5.3.1 Existence and stability of a nontrivial periodic endemic state	166
5.4 Saddle point behavior	169
5.5 Boundary feedback systems	174
5.6 Lyapunov methods for spatially heterogeneous systems	182

<b>6. Age structure</b>	<b>191</b>
6.1 An SIS model with age structure	193
6.1.1 The intracohort case	194
6.1.2 The intercohort case	198
6.2 An SIR model with age structure	201
 <b>7. Optimization problems</b>	 <b>207</b>
7.1 Optimal control	207
7.2 Identification	210
 <b>Appendix A. Ordinary differential equations and dynamical systems in finite dimensional spaces</b>	 <b>211</b>
A.1 The initial value problem for systems of ODE' s	211
A.1.1 Autonomous systems	214
A.1.1.1 Autonomous systems. Limit sets, invariant sets	217
A.1.1.2 Two-dimensional autonomous systems	218
A.2 Linear systems of ODE' s	220
A.2.1 General linear systems	220
A.2.2 Linear systems with constant coefficients	222
A.3 Stability	226
A.3.1 Linear systems with constant coefficients	228
A.3.2 Stability by linearization	228
A.4 Quasimonotone (cooperative) systems	229
A.4.1 Quasimonotone linear systems	230
A.4.2 Nonlinear quasimonotone autonomous systems	232
A.4.2.1 Lower and upper solutions, invariant rectangles, contracting rectangles	235
A.5 Lyapunov methods. LaSalle Invariance Principle	236
 <b>Appendix B. Dynamical systems in infinite dimensional spaces</b>	 <b>239</b>
B.1 Banach spaces	239
B.1.1 Ordered Banach spaces	242
B.1.2 Functions	243
B.1.3 Linear operators on Banach spaces	246
B.1.4 Dynamical systems and $C_0$ -semigroups	249
B.2 The initial value problem for systems of semilinear parabolic equations (reaction-diffusion systems)	252
B.2.1 Semilinear quasimonotone parabolic autonomous systems	255
B.2.1.1 The linear case	257
B.2.1.2 The nonlinear case	259
B.2.1.3 Lower and upper solutions. Existence of nontrivial equilibria	260

xvi	Table of Contents	
-----	-------------------	--

B.2.2 Lyapunov methods for PDE's. LaSalle Invariance Principle in Banach spaces	263
--	-----

<b>References</b>	<b>265</b>
-------------------	------------

<b>Notation</b>	<b>279</b>
-----------------	------------

<b>Subject index</b>	<b>281</b>
----------------------	------------



<http://www.springer.com/978-3-540-56526-0>

Mathematical Structures of Epidemic Systems

Capasso, V.

1993, XVI, 283 p., Softcover

ISBN: 978-3-540-56526-0