

Contents

Preface	v
Notation and Conventions	xi
Part A: Simple Markovian Models	1
I Markov Chains	3
1 Preliminaries	3
2 Aspects of Renewal Theory in Discrete Time	7
3 Stationarity	11
4 Limit Theory	16
5 Harmonic Functions, Martingales and Test Functions .	20
6 Nonnegative Matrices	25
7 The Fundamental Matrix, Poisson's Equation and the CLT	29
8 Foundations of the General Theory of Markov Processes	32
II Markov Jump Processes	39
1 Basic Structure	39
2 The Minimal Construction	41
3 The Intensity Matrix	44
4 Stationarity and Limit Results	50
5 Time Reversibility	56

III	Queueing Theory at the Markovian Level	60
1	Generalities	60
2	General Birth–Death Processes	71
3	Birth–Death Processes as Queueing Models	75
4	The Phase Method	80
5	Renewal Theory for Phase–Type Distributions	88
6	Lindley Processes	92
7	A First Look at Reflected Lévy Processes	96
8	Time–Dependent Properties of $M/M/1$	98
9	Waiting Times and Queue Disciplines in $M/M/1$	108
IV	Queueing Networks and Insensitivity	114
1	Poisson Departure Processes and Series of Queues	114
2	Jackson Networks	117
3	Insensitivity in Erlang’s Loss System	123
4	Quasi–Reversibility and Single–Node Symmetric Queues	125
5	Quasi–Reversibility in Networks	131
6	The Arrival Theorem	133
	Part B: Some General Tools and Methods	137
V	Renewal Theory	138
1	Renewal Processes	138
2	Renewal Equations and the Renewal Measure	143
3	Stationary Renewal Processes	150
4	The Renewal Theorem in Its Equivalent Versions	153
5	Proof of the Renewal Theorem	158
6	Second–Moment Results	159
7	Excessive and Defective Renewal Equations	162
VI	Regenerative Processes	168
1	Basic Limit Theory	168
2	First Examples and Applications	172
3	Time–Average Properties	177
4	Rare Events and Extreme Values	179
VII	Further Topics in Renewal Theory and Regenerative Processes	186
1	Spread–Out Distributions	186
2	The Coupling Method	189
3	Markov Processes: Regeneration and Harris Recurrence	198
4	Markov Renewal Theory	206
5	Semi–Regenerative Processes	211
6	Palm Theory, Rate Conservation and PASTA	213

VIII	Random Walks	220
1	Basic Definitions	220
2	Ladder Processes and Classification	223
3	Wiener–Hopf Factorization	227
4	The Spitzer–Baxter Identities	229
5	Explicit Examples. $M/G/1$, $GI/M/1$, $GI/PH/1$	233
IX	Lévy Processes, Reflection and Duality	244
1	Lévy Processes	244
2	Reflection and Loynes’s Lemma	250
3	Martingales and Transforms for Reflected Lévy Processes	255
4	A More General Duality	260
	Part C: Special Models and Methods	265
X	Steady-State Properties of $GI/G/1$	266
1	Notation. The Actual Waiting Time	266
2	The Moments of the Waiting Time	269
3	The Workload	272
4	Queue Length Processes	276
5	$M/G/1$ and $GI/M/1$	279
6	Continuity of the Waiting Time	284
7	Heavy Traffic Limit Theorems	286
8	Light Traffic	290
9	Heavy–Tailed Asymptotics	295
XI	Markov Additive Models	302
1	Some Basic Examples	302
2	Markov Additive Processes	309
3	The Matrix Paradigms $GI/M/1$ and $M/G/1$	316
4	Solution Methods	328
5	The Ross Conjecture and Other Ordering Results . . .	336
XII	Many–Server Queues	340
1	Comparisons with $GI/G/1$	340
2	Regeneration and Existence of Limits	344
3	The $GI/M/s$ Queue	348
XIII	Exponential Change of Measure	352
1	Exponential Families	352
2	Large Deviations, Saddlepoints and the Relaxation Time	355
3	Change of Measure: General Theory	358
4	First Applications	362

5	Cramér–Lundberg Theory	365
6	Siegmund’s Corrected Heavy Traffic Approximations	369
7	Rare Events Simulation	373
8	Markov Additive Processes	376
XIV	Dams, Inventories and Insurance Risk	380
1	Compound Poisson Dams with General Release Rule	380
2	Some Examples	387
3	Finite Buffer Capacity Models	389
4	Some Simple Inventory Models	396
5	Dual Insurance Risk Models	399
6	The Time to Ruin	401
	Appendix	407
A1	Polish Spaces and Weak Convergence	407
A2	Right–Continuity and the Space D	408
A3	Point Processes	410
A4	Stochastical Ordering	411
A5	Heavy Tails	412
A6	Geometric Trials	412
A7	Semigroups of Positive Numbers	413
A8	Total Variation Convergence	413
A9	Transforms	414
A10	Stopping Times and Wald’s Identity	414
A11	Discrete Skeletons	415
	Bibliography	416
	Index	431



<http://www.springer.com/978-0-387-00211-8>

Applied Probability and Queues

Asmussen, S.

2003, XII, 438 p., Hardcover

ISBN: 978-0-387-00211-8