CONTENTS

PREFACE vii

INTRODUCTION 3
1. The mathematical model of queues 3
2. Input process 6
3. Service mechanism 8
4. A simple waiting time problem 10
Bibliography 11

1. SINGLE SERVER QUEUEING PROCESSES 12
1. The time dependence of a single server finite queue with Poisson input and exponential service times 12
2. The time dependence of a single server queue with Poisson input and exponential service times 22
3. The time dependence of single server queues with Poisson input and general service times 46
4. The time dependence of single server queues with Poisson input and general service times in the case of batch service 81
5. The time dependence of single server queues with Palm input and exponentially distributed service times 112
6. The time dependence of single server queues with Palm input and exponential service times in the case of batch arrival 125
7. General results concerning single server queueing processes with recurrent input and general service times 140
Bibliography 143

2. MANY SERVER QUEUEING PROCESSES 147
1. Many server queueing processes in the case of Palm input and exponentially distributed service times 147
2. General results concerning many server queueing processes with recurrent input and general service times 157
Bibliography 157

3. QUEUES WITH INFINITELY MANY SERVERS 159
1. Formulation of the problem 159

2. Queues with infinitely many servers in the case of a Poisson input 160
3. Queues with infinitely many servers in the case of exponentially distributed service times 163
Bibliography 173

4. TELEPHONE TRAFFIC PROCESSES 174
1. Formulation of the problem 174
2. Exponentially distributed holding times 175
3. Poisson input 186
Bibliography 187

5. A PROCESS OF SERVICING MACHINES 189
1. Formulation of the problem 189
Bibliography 204

6. A PROCESS OF PARTICLE COUNTING 205
1. Formulation of the problem 205
2. Type I counter 206
3. Type II counter 210
4. Type III counter 213
Bibliography 217

APPENDIX 219
1. Markov chains 219
2. Poisson process 221
3. Recurrent processes 222
4. General theorems 230
Bibliography 235

SOLUTIONS OF THE PROBLEMS 237
1. Chapter 1 237
2. Chapter 2 256
3. Chapter 3 258
4. Chapter 4 261
5. Chapter 5 263
6. Chapter 6 264

INDEX 267