CONTENT

PART I: TRAFFIC FLOWS MANAGEMENT

CONTENT……I
GENERAL PRESENTATION OF ADVANCED ROAD TRANSPORT SYSTEMS 3

1. MATHEMATICAL INSTRUMENTS FOR TRAFFIC FLOWS ANALYSIS 6
1.1. Looking at statistics.....6
1.1.1. Collecting statistical data.....6
1.1.1.1. The programme of statistical observation 7
1.1.1.2. Methods of statistical observation.....7
1.1.1.3. Statistical observation errors.....8
1.1.1.4. Control of statistical data.....8
1.1.2. Methods of data primary processing 9
1.1.3. Presenting statistical data.....10
1.1.4. Statistical indicators.....11
1.2. Random variables.....12
1.2.1. Defining the random variables.....12
1.2.2. Basic characteristics of random variables 14
1.2.2.1. Central tendency indicators 14
1.2.2.2. Variation indicators 16
1.2.2.4. Generating function 18
1.2.3. Poisson process.....19
1.3. Distributions or repartition laws.....20
1.3.1. Discrete distributions.....20
1.3.1.1. Binominal distribution.....20
1.3.1.2. Poisson distribution.....21
1.3.1.3. Negative-binominal distribution.....22
1.3.1.4. Geometric distribution.....23
1.3.2. Continuous distribution laws.....24
1.3.2.1. Normal distribution.....24
1.3.2.2. Pearson distribution of third type (Generalized Gamma distribution)...26
1.4. Estimating parameters and criteria of statistical evaluation 27
1.5. Waiting processes in traffic evolution.....32
1.5.1. Bases and classification of waiting systems.....32
1.5.2. Stochastic models and waiting times in stationary traffic.....34
1.5.3. Delays at intersections in case of stationary traffic.....37
1.5.4. Determinist waiting models in case of non-stationary traffic.....41
1.5.5. Waiting models at the crossing limit from free traffic to the partially conditioned one.....45

2. TRAFFIC STUDIES..... 47
2.1. Intoduction 47
2.2. Traffic studies.....47
2.2.1. Study of traffic volumes 48

E1: ANALYSIS OF VEHICLES ARRIVAL TIME AT A POINT 49
1. Collecting traffic data 50
2. Primary data processing 50
2.2.2. Studies of vehicle speeds and delays 58
2.2.3. Studies of road traffic impact 60
2.2.3.1. Stages of traffic impact study 61
2.2.3.2. Describing the content of a study of road traffic impact 62

3. BASIC PARAMETERS OF ROAD TRAFFIC 65
3.1. Introduction 65
3.2. Traffic streams parameters 66
3.2.1. Road traffic flow 68
3.2.2. Road traffic density 69
3.2.3. Speeds 70
3.2.4. Intervals between vehicles 71
3.3. Determining the road traffic parameters through the analysis of stochastic processes 73
3.3.1. Obtaining a unitary stream through local measurements 74
3.3.2. Obtaining the unitary stream through momentary measurements 76
3.4. Correlations between traffic stream parameters 77
3.5. Describing the motion of the individual vehicle 81
3.5.1. Equations of motion of the individual vehicle described with the help of time-dependent values 82
3.5.2. Equations of motion of the individual vehicle described with the help of space-dependent values 84
3.5.3. Statistical approach to individual vehicle motion 86
3.5.4. Correlations between time and space-dependent motion parameters 90

4. HUMAN FACTOR IN THE ROAD TRAFFIC SYSTEM 94
4.1. Introduction 94
4.1.1. What mean „Human factor”? 94
4.1.2. Needs of road users 95
4.1.3. Human factors and traffic safety 97
4.2. Driver characteristics 98
4.2.1. Physical abilities of the driver 98
4.2.2. Perception-reaction time 100
4.3. Senses in vehicles driving 104
4.3.1. Vision 105
4.3.2. Method of transversal motion of the object 111
4.3.3. Designing and installing traffic signs 113
4.3.4. Designing considerations 116

5. INTERSECTIONS DESIGN 118
5.1. Introduction 118
5.2. Principles for intersection design 118
5.2.1. The factors that influence the design of intersections 119
5.2.1.1. The human factor 119
5.2.1.2. Vehicle features 119
5.2.1.3. Environment conditions 120
5.2.2. Types of movements and conflicts of traffic flows 120
5.2.2.1. Movements in intersection 120
5.2.2.2. Conflict points 122
5.2.2.3. Limitation of conflict points in intersections 123
5.2.2.4. Solutions for reducing conflict points 125
5.2.3. Traffic capacity 126
5.2.4. Level of service 129
5.2.5. Selection of intersection' type 131
5.2.6. Features of signal-controlled intersections 132
5.2.7. Features of unsignalised intersections 133
5.2.8. Canalization of traffic flows 134
5.3. Sight distances 135
5.3.1. Intersection sight distance 136
5.3.1.1. Uncontrolled intersections 136
5.3.1.2. Intersections with STOP sign placed on secondary arterial road 138
5.3.1.3. Intersections with the Yield sign placed on the secondary road 139
5.3.1.4. Signalized intersections 141
5.3.1.5. STOP-controlled Intersections at all entrances 141
5.1.3.6. Turn left from the main road 142
5.3.1.7. Sight distances at transversal intersections 142
5.3.2. Stopping sight distance 143
5.3.3. Passing sight distance 145
5.3.4. Programmable Logic Controllers 146
5.3.4.1. Introduction 146
5.3.4.2. Architecture of a PLC 147
5.3.4.3. Components of a PLC 148

6. VEHICLES CHARACTERISTICS 151

PART II: INTELLIGENT TRANSPORT SYSTEMS ARCHITECTURE

7. INTELLIGENT TRANSPORT SYSTEMS AND CURRENT POLICIES 158
7.1. Introduction 158
7.2. Present Context 158
7.3. Systems 159
7.3.1. Onboard equipments. 160
7.3.2. Equipments used for the road infrastructure. 161

7.3.2. Equipments used for the road infrastructure. 161
7.3.3. Communication method 161
7.3.4. Management and informing the traffic participants. 163
7.3.5. Automatically driving systems. 165
7.4. Problems resolved by the telematics applications 166
7.5. Intelligent transportation systems 169
7.6. Conclusions regarding the telematics applications' present context 177

8. THE EVOLUTION OF INTELLIGENT TRANSPORT SYSTEMS 180
8.1. Introduction 180
8.2. Telematic applications at global level 181
8.2.1. European programs 182
8.2.2. Japan 183
8.2.3. The evolution of American ITS applications 184
8.2.4. European research - developing programmes 187

9. SYSTEM ENGINEERING APPLYED TO ADVANCED TRANSPORT SYSTEMS 193
9.1. Introduction to system engineering 193
9.1.1. System and system engineering 193
9.1.1.1. Introductive concepts for system engineering 194
9.1.1.2. System engineering as a complex notion 195
9.1.1.3. Multiple dimensions of system engineering 196
9.1.2. Process models within the system engineering framework 197
9.1.2.1. The V-type model of a system lifecycle 197
9.1.2.2. The WATERFALL type model 199
9.1.2.3. The SPIRAL type model 200
9.1.2.4. The EVOLUTIONAL model seen as a V type developing model 201
9.1.2.5. Process models comparison 202
9.2. The planning process 202
9.2.1. The vision expressing process 205
9.2.2. Defining the system requirements 206
9.2.3. Traceability 207
9.3. The designing process 208
9.3.1. Projecting the requirements into functions 209
9.3.2. ITS Architecture 210
9.3.2.1. The passenger subsystem 212
9.3.2.2. The centre subsystem 212
9.3.2.3. Vehicle subsystem 212
9.3.2.4. The road infrastructure subsystem 213

10. INTELLIGENT TRANSPORT SYSTEMS 214
10.1. Introduction 214
10.2. Intelligent transport systems architecture 214

10.2.1. What is ITS architecture? 214
10.2.2. Public transportation management 218
10.2.3. Electronic payment 219
10.2.4. Commercial vehicle operations 221
10.2.4.2. Automated roadside safety inspection 223
10.2.4.3. On-board safety and security monitoring 223
10.2.4.4. Commercial vehicle administrative processes 224
10.2.4.5. Hazardous materials security and incident response 225
10.2.4.6. Freight mobility 225
10.2.5. Emergency management 226
10.5.3.1. Emergency notification and personal security 227
10.5.3.2. Emergency vehicle management 229
10.5.3.3. Disaster response and evacuation 229
10.2.6. Advanced vehicle safety systems 234
10.2.7. Information management 238
10.2.8. Maintenance and Construction Management. 238

11. COMPUTER VISION-BASED LICENSE PLATE IDENTIFICATION 239
11.1. Introduction 239
11.2. Deblurring and image merging methods 239
11.2.1. Image capture 239
11.2.2. Image frames deblurring 239
11.2.3. Image merging 240
11.2.4. Thresholding method 241
11.3. License plate identification 242
11.4. Extracting the characters of the license plate 244
11.5. Neural network based method of character recognizing 245
11.6. Conclusions 246

PART III: TELEMATICS APPLICATIONS IN ADVANCED ROAD TRANSPORT SYSTEMS

12. “ROAD TELEMATICS” CONCEPT 249
12.1. The concept of intelligent vehicle 252
12.2. The dimensions of "intelligence" 253
12.2.1. The driver 253
12.2.2. Driving conditions 253
12.2.3. The vehicle 253
12.3. The description of the concept 253
12.3.1. Vehicle subsystems control level 255
12.3.2. The integrated control level 255
12.3.3. The level of adaptation to driving conditions 256
12.3.4. The level of adaptation to the driver 256

12.4. Example of adaptation of the vehicle's intelligence 257
12.4.1. The perception process..... 257
12.4.2. The identification process 257
12.4.3. Situation analysis 258
12.4.4. Adaptation..... 258
12.4.5. The vehicle integrated control system..... 258
12.4.6. Support technologies 259

13. ROAD TELEMATICS APPLICATIONS 261
13.1. Road traffic detection systems..... 261
13.1.1. Traffic presence detection systems..... 261
13.1.2. Systems dedicated for pedestrian presence detection..... 266
13.2. Traveler subsystems within the public transport network 268
13.2.1. Traveler information systems 268
13.2.2. Automatic passenger counting systems in public transport vehicles.... 269
13.3. Automatic driving systems 270
13.3.1. AHS Systems..... 270
13.3.2. Adaptive driving systems and CAS - Collision avoidance systems 276
13.4. Systems for road accidents reduction..... 285
13.4.1. Monitoring of driver status..... 285
13.4.1. System of improvement of driver visibility 288
13.5. Navigation and positioning systems 290
13.5.1. Vehicle emergency assistance system 290
13.5.2. Automatic vehicle location systems - AVL..... 293
13.5.3. Vehicle navigation system..... 294
13.5.4. The FCD System 301
13.6. On-board entertainment systems 305
13.6.1. The „car-office” concept 305
13.6.2. The „Audio-Spotlight” System 306
13.6.3. The vehicle infotainment system..... 308
13.7. Driver settings memorizing system 310

Appendix 312
References..... 319