

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Meta-heuristic Optimization of Constrained Combinatorial Problems . . . . .	3
1.2	Design Space Exploration of Networked Embedded Systems . . . . .	4
1.3	FlexRay Scheduling . . . . .	6
<b>2</b>	<b>Meta-heuristic Optimization of Constrained Combinatorial Problems</b>	<b>7</b>
2.1	Introduction . . . . .	7
2.2	Related Work . . . . .	10
2.2.1	Meta-heuristic Optimization . . . . .	10
2.2.2	Constraint Handling . . . . .	13
2.2.3	Hybrid Optimization Approaches . . . . .	15
2.3	Pseudo-Boolean Problem . . . . .	16
2.3.1	Solver . . . . .	17
2.3.2	Constraint Normalization . . . . .	18
2.3.3	Constraint Linearization . . . . .	20
2.4	Feasibility-preserving Decoding . . . . .	22
2.4.1	Mixed Encoding . . . . .	23
2.4.2	Continuous Encoding . . . . .	23
2.4.3	Discrete Encoding . . . . .	24

## *Contents*

---

2.5	Feasibility-preserving Operators . . . . .	25
2.5.1	Neighborhood Operator . . . . .	26
2.5.2	Mutate Operator . . . . .	26
2.5.3	Crossover Operator . . . . .	27
2.6	Experimental Results . . . . .	28
2.6.1	PB Evaluation . . . . .	29
2.6.2	Multi-objective . . . . .	44
2.7	Summary . . . . .	48
<b>3</b>	<b>Design Space Exploration of Networked Embedded Systems</b>	<b>51</b>
3.1	Introduction . . . . .	51
3.2	Related Work . . . . .	55
3.2.1	Design Space Exploration . . . . .	56
3.2.2	Timing Analysis . . . . .	57
3.2.3	Exploitation of Data Redundancy . . . . .	58
3.2.4	Robust Design . . . . .	59
3.3	Design Space Exploration Model . . . . .	60
3.3.1	Basic Model . . . . .	61
3.3.2	Extended Model . . . . .	65
3.4	Timing Analysis . . . . .	73
3.4.1	Compositional Timing Analysis . . . . .	74
3.4.2	Efficient Fixed Point Iteration . . . . .	76
3.5	Exploitation of Data Redundancy . . . . .	85
3.5.1	Model . . . . .	88
3.5.2	Identifying Data Redundancy . . . . .	90
3.5.3	Reliability as an Optimization Objective . . . . .	96
3.6	Robust Design . . . . .	101
3.6.1	Robustness Evaluation . . . . .	102
3.6.2	Robustness Optimization . . . . .	109
3.7	Experimental Results . . . . .	111
3.7.1	Synthetic Results . . . . .	113
3.7.2	Case Study Results . . . . .	123
3.7.3	Timing Analysis . . . . .	134
3.7.4	Exploitation of Data Redundancy . . . . .	135
3.7.5	Robust Design . . . . .	138
3.8	Summary . . . . .	146

<b>4 FlexRay Scheduling</b>	<b>149</b>
4.1 Introduction . . . . .	149
4.2 Related Work . . . . .	151
4.3 Problem Definition . . . . .	153
4.3.1 Scheduling Requirements . . . . .	153
4.3.2 AUTOSAR Interface Specification . . . . .	154
4.4 Schedule Optimization . . . . .	155
4.4.1 Problem Transformation . . . . .	156
4.4.2 Bin Packing . . . . .	161
4.4.3 Reordering for Extensibility . . . . .	166
4.5 Experimental Results . . . . .	168
4.5.1 Schedule Optimization . . . . .	170
4.5.2 Incremental Scheduling . . . . .	171
4.5.3 Scalability Analysis . . . . .	172
4.5.4 Slot Size Exploration . . . . .	173
4.5.5 Supportive Test Case . . . . .	173
4.5.6 Summary . . . . .	176
<b>5 Conclusion and Future Work</b>	<b>179</b>
5.1 Summary . . . . .	179
5.2 Future Work . . . . .	180
<b>6 German Abstract</b>	<b>183</b>
<b>Bibliography</b>	<b>187</b>
<b>List of Symbols</b>	<b>215</b>
<b>Acronyms</b>	<b>219</b>
<b>Index</b>	<b>221</b>