Contents

1 Introduction ......................................................... 1
  1.1 Aim and Scope of the Book .................................. 1
  1.2 Brief Overview ............................................... 2
  1.3 Acronyms and Nomenclatures ............................... 4

2 Concepts and Applications of Stochastic Ageing .............. 7
  2.1 Introduction ................................................. 7
  2.2 Characterizations of Lifetime Distributions ............... 9
    2.2.1 Shape of a Failure Rate Function .................... 11
  2.3 Ageing Distributions ....................................... 15
    2.3.1 Exponential ............................................. 16
    2.3.2 Gamma ................................................... 16
    2.3.3 Truncated Normal ..................................... 17
    2.3.4 Weibull ............................................... 18
    2.3.5 Lognormal .............................................. 19
    2.3.6 Birnbaum-Saunders ................................... 20
    2.3.7 Inverse Gaussian ...................................... 21
    2.3.8 Gompertz ............................................... 22
    2.3.9 Makeham ............................................... 22
    2.3.10 Linear Failure Rate .................................. 23
    2.3.11 Lomax Distribution ................................... 23
    2.3.12 Log-logistic .......................................... 24
    2.3.13 Burr XII ............................................... 25
    2.3.14 Exponential-geometric (EG) and Generalization ....... 26
  2.4 Basic Concepts for Univariate Reliability Classes ........ 27
    2.4.1 Some Acronyms and Notions of Aging ................ 27
    2.4.2 Definitions of Reliability Classes ................... 28
    2.4.3 Interrelationships .................................... 29
  2.5 Properties of the Basic Ageing Classes .................... 31
    2.5.1 Properties of IFR and DFR .......................... 32
    2.5.2 Properties of IFRA ................................... 33
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5.3</td>
<td>NBU and NBUE</td>
<td>34</td>
</tr>
<tr>
<td>2.5.4</td>
<td>DMRL and IMRL</td>
<td>38</td>
</tr>
<tr>
<td>2.5.5</td>
<td>Summary of Preservation Properties of Classes of Distributions</td>
<td>38</td>
</tr>
<tr>
<td>2.5.6</td>
<td>Moments Inequalities</td>
<td>39</td>
</tr>
<tr>
<td>2.5.7</td>
<td>Scaled TTT Transform and Characterizations of Ageing Classes</td>
<td>42</td>
</tr>
<tr>
<td>2.6</td>
<td>Non-monotonic Failure Rates and Non-monotonic Mean Residual Lives</td>
<td>44</td>
</tr>
<tr>
<td>2.6.1</td>
<td>Non-monotonic Failure Rates</td>
<td>44</td>
</tr>
<tr>
<td>2.6.2</td>
<td>Non-monotonic Mean Residual Lives</td>
<td>45</td>
</tr>
<tr>
<td>2.7</td>
<td>Some Further Classes of Ageing</td>
<td>45</td>
</tr>
<tr>
<td>2.8</td>
<td>Failure Rates of Mixtures of Distributions</td>
<td>47</td>
</tr>
<tr>
<td>2.8.1</td>
<td>Mixture of Two DFR Distributions</td>
<td>48</td>
</tr>
<tr>
<td>2.8.2</td>
<td>Possible Shapes of $r(t)$ When Two Subpopulations Are IFR</td>
<td>48</td>
</tr>
<tr>
<td>2.8.3</td>
<td>Mixture of Two Gamma Densities with a Common Scale Parameter</td>
<td>49</td>
</tr>
<tr>
<td>2.8.4</td>
<td>Mixture of Two Weibull Distributions</td>
<td>50</td>
</tr>
<tr>
<td>2.8.5</td>
<td>Mixtures of Two Positively Truncated Normal Distributions</td>
<td>52</td>
</tr>
<tr>
<td>2.8.6</td>
<td>Mixtures of Two Increasing Linear Failure Rate Distributions</td>
<td>53</td>
</tr>
<tr>
<td>2.8.7</td>
<td>Mixtures of an IFR Distribution with an Exponential Distribution</td>
<td>55</td>
</tr>
<tr>
<td>2.8.8</td>
<td>Failure Rate of Finite Mixture of Several Components Belonging to the Same Family</td>
<td>56</td>
</tr>
<tr>
<td>2.8.9</td>
<td>Initial and Final Behavior of Failure Rates of Mixtures</td>
<td>57</td>
</tr>
<tr>
<td>2.8.10</td>
<td>Continuous Mixtures of Distributions</td>
<td>59</td>
</tr>
<tr>
<td>2.9</td>
<td>Partial Orderings and Generalized Partial Orderings</td>
<td>60</td>
</tr>
<tr>
<td>2.9.1</td>
<td>Generalized Partial Orderings</td>
<td>61</td>
</tr>
<tr>
<td>2.9.2</td>
<td>Connections Among the Partial Orderings</td>
<td>64</td>
</tr>
<tr>
<td>2.9.3</td>
<td>Generalized Ageing Properties Classification</td>
<td>64</td>
</tr>
<tr>
<td>2.9.4</td>
<td>Applications of Partial Orderings</td>
<td>66</td>
</tr>
<tr>
<td>2.10</td>
<td>Relative Ageing</td>
<td>67</td>
</tr>
<tr>
<td>2.11</td>
<td>Shapes of $\eta$ Function for $s$-order Equilibrium Distributions</td>
<td>68</td>
</tr>
<tr>
<td>2.12</td>
<td>Concluding Remarks on Ageing</td>
<td>70</td>
</tr>
<tr>
<td>3</td>
<td>Bathtub Shaped Failure Rate Life Distributions</td>
<td>71</td>
</tr>
<tr>
<td>3.1</td>
<td>Introduction</td>
<td>71</td>
</tr>
<tr>
<td>3.2</td>
<td>Bathtub Shaped Failure Rate Is Not a Myth</td>
<td>72</td>
</tr>
<tr>
<td>3.3</td>
<td>Definitions and Basic Properties</td>
<td>72</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Acronyms for Bathtub Shaped Failure Rate Life Distributions</td>
<td>73</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Definitions</td>
<td>74</td>
</tr>
</tbody>
</table>
3.3.3 Some Further Properties ........................................ 76

3.4 Families of Bathtub Shapes Failure Rate Distributions .... 77
3.4.1 Bathtub Distributions with Explicit Failure Rate Functions ........................................ 77
3.4.2 Finite Range Distribution Families ..................... 82
3.4.3 Bathtub Distributions with More Complicated Failure Rates ............................................ 84
3.4.4 A Mistaken Identity: the Mixed Weibull Family ...... 86
3.4.5 Some Comments on the Bathtub Shapes ............... 87
3.5 Construction Techniques for BT Distributions .......... 87
3.5.1 Glaser’s Technique .................................. 88
3.5.2 Convex Function ................................ 88
3.5.3 Function of Random Variables .................... 88
3.5.4 Reliability and Stochastic Mechanisms .............. 88
3.5.5 Mixtures ........................................ 89
3.5.6 Sectional Models ................................. 89
3.5.7 Polynomial of Finite Order ...................... 90
3.5.8 TTT Transform ................................ 90
3.5.9 Truncation of DFR Distribution .................... 90
3.6 Change Point Estimation for BT Distributions .......... 91
3.7 Mean Residual Life and Bathtub Shaped Life Distributions ... 92
3.7.1 Mean Residual Life ................................ 92
3.7.2 Bathtub Shaped Failure Rate and Decreasing Percentile Residual Life Function ..................... 93
3.7.3 Relationships Among NWBUE, BT and IDMRL Classes 93
3.8 Optimal Burn-in Time for Bathtub Distributions .......... 94
3.8.1 Concepts of Burn-in ............................... 94
3.8.2 Burn-in and Bathtub Distributions .................. 95
3.8.3 Burn-in Time for BT Lifetime under Warranty Policies 98
3.8.4 Optimal Replacement Time and Bathtub Shaped Failure Rate Distributions ....................... 99
3.9 Upside-down Bathtub Shaped Failure Rate Distributions ... 99
3.9.1 UBT Models ......................................... 100
3.9.2 Optimal Burn-in Decision for UBT Models ..... 102
3.10 Modified and Generalized Distributions .................. 102
3.10.1 Modified Bathtub Distributions .................. 102
3.10.2 Generalized Bathtub Curves ....................... 104
3.10.3 Roller-Coaster Curves ............................ 105
3.11 Applications ............................................ 106

4 Mean Residual Life – Concepts and Applications in Reliability Analysis ............................. 109
4.1 Introduction ........................................ 109
4.2 Mean Residual Life and Other Ageing Properties .......... 110
4.2.1 Mean Residual Life and its Reciprocity with Failure Rate ............................................ 111
4.3 Mean Residual Lives of Some Well-known Lifetime Distributions 112
4.4 Mean Residual Life Classes ........................................ 114
  4.4.1 Monotonic MRL Classes ........................................ 114
  4.4.2 Non-monotonic MRL Classes .................................... 115
4.5 Non-monotonic MRL and Non-monotonic Failure Rate ......... 116
  4.5.1 Non-monotonic Failure Rates Life Distribution ........ 117
  4.5.2 Relations Between MRL and Failure Rate in Terms of Shapes and Locations of Their Change Points ........ 117
  4.5.3 A General Approach Determining Shapes of Failure Rates and MRL Functions ................ 124
  4.5.4 Roller-Coaster Failure Rates and Mean Residual Lives . 126
4.6 Effect of Burn-In on Mean Residual Life .................... 128
  4.6.1 Optimal Burn-in Criteria .................................... 130
  4.6.2 Optimal Burn-in for Upside-down Bathtub Distributions 130
4.7 Tests and Estimation of Mean Residual Life ............... 130
  4.7.1 Tests for Monotonic Mean Residual Life ................. 131
  4.7.2 Tests of Trend Change in Mean Residual Life .......... 131
  4.7.3 Estimation of Monotonic Mean Residual Life ........... 131
  4.7.4 Estimation of Change Points .............................. 132
4.8 Mean Residual life with Special Characteristics ............ 132
  4.8.1 Linear Mean Residual Life Function ...................... 132
  4.8.2 Proportional MRL and its Generalization .............. 133
4.9 Other Residual Life Functions ................................. 133
  4.9.1 Residual Life Distribution Function ..................... 133
  4.9.2 Variance Residual Life Function ......................... 134
  4.9.3 Percentile Residual Life Function ....................... 134
4.10 Mean Residual Life Orderings ................................. 134
4.11 Multivariate Mean Residual Life .............................. 135
  4.11.1 Characterizations of Multivariate Survival Distributions Based on Mean Residual Lives ........ 136
  4.11.2 Bivariate Decreasing MRL .............................. 137
4.12 Applications and Conclusions ................................. 137

5 Weibull Related Distributions ........................................ 139
5.1 Introduction .................................................... 139
5.2 Basic Weibull Distribution .................................. 140
  5.2.1 Two-parameter Weibull Distribution and Basic Properties ........................................ 140
  5.2.2 Parameter Estimation Methods ......................... 142
  5.2.3 Relative Ageing of Two 2-Parameter Weibull Distributions ........................................ 144
5.3 Three-parameter Weibull distribution ....................... 144
5.4 Models Derived from Transformations of Weibull Variable . 148
5.4.1 Reflected Weibull Distribution .......... 148
5.4.2 Log Weibull Distribution ................. 149
5.4.3 Inverse (or Reverse) Weibull Model ...... 149
5.5 Modifications or Generalizations of Weibull Distribution .... 150
5.5.1 Extended Weibull Distribution .......... 151
5.5.2 Exponentiated Weibull Distribution ...... 152
5.5.3 Modified Weibull Distribution ........... 154
5.5.4 Modified Weibull Extension .............. 155
5.5.5 Generalized Weibull Family .............. 156
5.5.6 Generalized Weibull Distribution of Gurvich et al. ... 158
5.6 Models Involving Two or More Weibull Distributions ...... 158
5.6.1 \(n\)-fold Mixture Model ............... 158
5.6.2 \(n\)-fold Competing Risk Model ......... 159
5.6.3 \(n\)-fold Multiplicative Model .......... 160
5.6.4 \(n\)-fold Sectional Model .............. 161
5.6.5 Model Involving Two Inverse Weibull Distributions ... 161
5.7 Weibull Models with Varying Parameters .... 162
5.8 Discrete Weibull Models ..................... 163
5.9 Bivariate models ............................ 163
5.9.1 Marshall and Olkin (1967) .............. 164
5.9.2 Lee (1979) ............................... 164
5.9.3 Lu and Bhattacharyya (1990)-I .......... 164
5.9.4 Morgenstern-Gumbel-Farlie System ....... 165
5.9.5 Lu and Bhattacharyya (1990)-II .......... 165
5.9.6 Lee (1979)-II ......................... 165
5.10 Applications of Weibull and Related Models ...... 165
6 An Introduction to Discrete Failure Time Models ........ 167
6.1 Introduction .................................. 167
6.2 Survival Function, Failure Rate and Other Reliability
Characteristics .................................. 168
6.3 Elementary Ageing Classes ................... 171
6.3.1 IFR and DFR .............................. 171
6.3.2 IFRA and DFRA ............................ 174
6.3.3 NBU (NWU) .............................. 175
6.3.4 NBUE .................................... 175
6.3.5 DMRL and IMRL ......................... 176
6.3.6 Relationships Among Discrete Ageing Concepts ...... 178
6.4 More Advanced Ageing Classes .............. 178
6.5 Non-monotonic Models ...................... 179
6.5.1 BT Failure Rate and DIMRL .............. 180
6.5.2 UBT Failure Rate and DIMRL .......... 183
6.5.3 Discrete IDMRL (DIMRL) and BT (UBT) Failure Rate 184
6.5.4 Discrete Bathtub-shaped Failure Rate Average ........ 186
6.6 Preservation under Poisson Shocks ............ 187
6.7 Examples of Discrete Time Failure Models .................................. 187
   6.7.1 Common Discrete Lifetime Distributions Derived from Continuous Ones .................. 188
   6.7.2 Distributions Derived from Simple Failure Rate Functions ..................................... 191
   6.7.3 Determination of Ageing from Ratio of Two Consecutive Probabilities ..................... 192
   6.7.4 Polya Urn Distributions ..................................... 194

6.8 Discussion on Discrete Failure Time Models ...................................... 195

6.9 Applications of Discrete Failure Time Models ...................................... 196

6.10 Some Problems of Usual Definition of Discrete Failure Rate ........................ 198

6.11 Alternative Definition of Failure Rate and Its Ramification ....................... 199
   6.11.1 The Relationships between $r(k)$ and $r^*(k)$ ........................................... 200
   6.11.2 Effect of Alternative Failure Rate on Ageing Concepts .......................... 200
   6.11.3 Additive Property for Series System .................................................. 201
   6.11.4 Examples .............................................. 202

7 Tests of Stochastic Ageing .......................................................... 203
   7.1 Introduction ................................................... 203
   7.2 Exponential Distribution ............................................. 204
   7.3 A General Sketch of Tests ............................................... 204
      7.3.1 Estimation of Survival, Failure Rate and Mean Residual Life Functions ............. 206
   7.4 Statistical Tests for Univariate Ageing Classes ........................................ 206
      7.4.1 Some Common Bases for Test Statistics ............................................... 207
      7.4.2 IFR Tests ............................................... 207
      7.4.3 IFRA Tests ............................................. 209
      7.4.4 NBU Tests ............................................... 211
      7.4.5 NBUE Tests ............................................... 214
      7.4.6 HNBUE .................................................. 215
      7.4.7 NBU-$t_0$ .................................................. 216
      7.4.8 NBUC Tests ............................................... 218
      7.4.9 NBUFR (NWUFR) Test ....................................... 218
      7.4.10 DPRL-$\alpha$ and NBUP-$\alpha$ Tests .................................................. 218
      7.4.11 Summary of Tests of Basic Ageing Classes ........................................... 219
   7.5 Tests of Aging Properties When Data Are Censored ...................................... 222
   7.6 Tests of Monotonic Mean Residual Life Classes ...................................... 223
      7.6.1 DMRL .................................................... 223
      7.6.2 DMRLHA Test ............................................. 226
   7.7 Tests of Non-monotonic Mean Residual Life ............................................... 226
      7.7.1 IDMRL (DIMRL) Test When Turning Point $\tau$ Is Known .......................... 228
      7.7.2 IDMRL Test When the Proportion $p$ Is Known ...................................... 228
      7.7.3 Tests of IDMRL When Both $p$ and $\tau$ Are Unknown .......................... 229
      7.7.4 Tests for NWBUE Class .............................................. 231
   7.8 Tests of Exponentiality Versus Bathtub Distributions ...................................... 231
7.8.1 Test Based on Total Time on Test (TTT) Transform . . . 231
7.8.2 Park’s Test for BT ................................ 234
7.8.3 Graphical Tests for BT Failure Rate Distributions . . . 234
7.9 Other Miscellaneous Tests ................................ 235
  7.9.1 Test of Change Point of Failure Rate ................... 235
  7.9.2 Aly’s Tests for Change Point ........................ 235
  7.9.3 Testing Whether Lifetime Distribution Is Decreasing
       Uncertainty ....................................... 235
7.10 Final Remarks ........................................ 236

8 Bivariate and Multivariate Ageing .................................. 237
  8.1 Introduction ........................................ 237
  8.2 Bivariate Reliability Classes .......................... 238
     8.2.1 Different Alternative Requirements ............... 238
  8.3 Bivariate IFR ......................................... 239
  8.4 Bivariate IFRA ........................................ 241
  8.5 Bivariate NBU .......................................... 243
  8.6 Bivariate NBUE and HNBUE ............................. 244
  8.7 Bivariate Decreasing Mean Residual Life ................... 245
  8.8 Tests of Bivariate Ageing ................................ 246
     8.8.1 Summary on Tests of Bivariate Ageing ............... 249
  8.9 Discrete Bivariate Failure Rates ........................ 250
  8.10 Applications ........................................ 251
     8.10.1 Maintenance and Repairs ........................ 251
     8.10.2 Warranty Polices ................................ 252
     8.10.3 Failure Times of Pumps ........................... 252
  8.11 Bayesian Notions of Multivariate Ageing ................... 252
     8.11.1 Motivations and Historical Development of Bayesian
           Approach ........................................ 253
     8.11.2 Concepts of Ageing and Schur Concavity ............. 253
     8.11.3 Bayesian Notions of Bivariate IFR ................... 254
     8.11.4 Bayesian Bivariate DMRL .......................... 256
     8.11.5 Other Bayesian Bivariate Ageing Concepts ........... 257
  8.12 Conclusions ........................................ 258

9 Concepts and Measures of Dependence in Reliability ........... 259
  9.1 Introduction ......................................... 259
  9.2 Important Conditions Describing Positive Dependence ...... 260
     9.2.1 Six Basic Conditions .............................. 261
     9.2.2 The Relative Stringency of the Conditions .......... 263
     9.2.3 Associated Random Variables ....................... 264
     9.2.4 RCSI and LCSD ................................... 265
     9.2.5 WPQD ........................................ 266
     9.2.6 Positively Correlated Distributions ................. 266
     9.2.7 Summary of Interrelationships ...................... 266
9.3 Positive Quadrant Dependent (PQD) Concept .............. 267
  9.3.1 Constructions of PQD Bivariate Distributions ............ 269
  9.3.2 Applications of Positive Quadrant Dependence
     Concept to Reliability .................................. 269
9.4 Families of Bivariate Distributions That Are PQD ............ 270
  9.4.1 PQD Bivariate Distributions with Simple Structures ... 271
  9.4.2 PQD Bivariate Distributions with More Complicated
     Structures ............................................ 273
  9.4.3 PQD Bivariate Uniform Distributions .................... 275
9.5 Some Related Issues on Bivariate Dependence ............... 277
  9.5.1 Examples of Bivariate Positive Dependence Stronger
     than PQD Condition ...................................... 277
  9.5.2 Examples of NQD and Other Negative Ageing ............. 280
  9.5.3 Concluding Remarks on Concepts of Dependence ......... 281
9.6 Links Between Dependence Concepts and Bivariate Ageing
     Notions ................................................ 282
9.7 Dependence Concepts and Bayesian Multivariate Ageing ...... 283
9.8 Positive Dependence Orderings ............................ 285
  9.8.1 More PQD ........................................ 285
  9.8.2 More SI .......................................... 286
  9.8.3 More Associated ................................... 287
  9.8.4 More TP2 ......................................... 288
  9.8.5 Relations Among Different Partial Orderings ........... 288
  9.8.6 Other Positive Dependence Orderings .................... 289
  9.8.7 Multivariate Dependence Ordering ...................... 289
9.9 Measures of Dependence .................................. 290
9.10 Pearson’s Product-Moment Correlation Coefficient ......... 291
  9.10.1 Robustness of Sample Correlation .................... 292
  9.10.2 Interpretation of Correlation ........................ 293
9.11 Rank Correlations ....................................... 294
  9.11.1 Kendall’s tau .................................... 295
  9.11.2 Spearman’s rho ................................... 296
  9.11.3 The Relationship between Kendall’s tau and
     Spearman’s rho ....................................... 298
  9.11.4 Other Concordance Measures ......................... 300
9.12 Local Measures of Dependence ............................ 301
  9.12.1 Definition of Local Dependence ........................ 302
  9.12.2 Local Dependence Function of Holland and Wang ...... 302
  9.12.3 Properties of $\gamma(x, y)$ ........................ 303
  9.12.4 Clayton-Oakes Association Measure .................... 304
  9.12.5 Local $\rho_S$ and $\tau$ .......................... 304
  9.12.6 Local Correlation Coefficient ....................... 305
  9.12.7 Local Linear Dependence Function .................... 305
  9.12.8 Applications of Several Local Indices in Survival
     Analysis .............................................. 306
10 Reliability of Systems with Dependent Components

10.1 Introduction ............................................ 307
10.2 Bivariate Distributions for Modelling Lifetimes of Two Components ............................................ 307
  10.2.1 Examples of Bivariate Distributions Useful for Reliability Modelling ............................................ 309
  10.2.2 Other Bivariate Distributions ............................................ 314
10.3 Effectiveness of Redundancy for Reliability System ............................................ 314
  10.3.1 Redundancy ...................................... 314
  10.3.2 Effectiveness of Parallel Redundancy of Two Independent and Identical Components ............................................ 315
  10.3.3 Parallel Redundancy of Two Independent but Nonidentical Components ............................................ 316
  10.3.4 Dependence Concepts and Redundancy ............................................ 316
10.4 Parallel Systems ......................................... 317
  10.4.1 Mean Time to Failure of a Parallel System of Two Independent Components ............................................ 317
  10.4.2 Mean Lifetime of a Parallel System with Two PQD Components ............................................ 317
  10.4.3 Mean Lifetime of a Parallel System with Two NQD Components ............................................ 319
  10.4.4 Relative Efficiency from Different Joint Distributions ............................................ 320
  10.4.5 MTTF Comparisons of Three PQD Bivariate Exponential Distributions ............................................ 323
  10.4.6 Efficiency of Redundancy by NQD Components ............................................ 324
10.5 Series Structures ........................................ 325
  10.5.1 Series and Parallel System of n Positive Dependent Components ............................................ 326
10.6 Ageing Classes for Series and Parallel Systems with Two Dependent Components ............................................ 327
  10.6.1 Ageing Class ...................................... 327
10.7 k-out-of-n Systems ........................................ 329
  10.7.1 Reliability of a k-out-of-n System ............................................ 329
  10.7.2 Ageing properties of a k-out-of-n system ............................................ 330
  10.7.3 Comparative Studies of Two k-out-of-n Systems ............................................ 331
  10.7.4 Ageing Properties Based on the Residual Life of a k-out-of-n System ............................................ 335
  10.7.5 Dependent Component Lifetimes ............................................ 335
10.8 Consecutive k-out-of-n:F Systems ............................................ 336
  10.8.1 Reliability and Lifetime Distribution ............................................ 337
  10.8.2 Structure Importance of Consecutive k-out-of-n Systems ............................................ 339
XX  Contents

10.8.4 Ageing Property ......................................... 339
10.8.5 Consecutive-$k$-out-of-$n$:F System with Markov Dependence .................................................. 340
10.9 On Allocation of Spares to $k$-out-of-$n$ Systems .......... 340
10.10 Standby Redundant System .................................. 342
10.10.1 Standby Redundancy in $k$-out-of-$n$ Systems .......... 342
10.10.2 Standby Redundancy at Component Versus System Level ...................................................... 343
10.10.3 Dependent Components ................................... 343
10.11 Future Directions ........................................... 344

11  Failure Time Data ............................................. 345
11.1 Introduction ..................................................... 345
11.2 Empirical Modelling of Data ................................ 345
11.3 Data Presentation and General Comments on Reliability Estimation ..................................................... 346
11.4 IFR Data ........................................................ 347
11.5 DFR Data ........................................................ 349
11.6 NBU Data ........................................................ 352
11.7 Bathtub Shaped Failure Rates Data ......................... 353
11.8 Upside-down Bathtub Shaped Failure Rates Data ........... 358
11.9 Other Sources of Survival and Reliability Data ............ 362

References .......................................................... 363

Index ............................................................... 409
Stochastic Ageing and Dependence for Reliability
Lai, C.-D.; Xie, M.
2006, XX, 418 p. 7 illus., Hardcover