

---

# Contents

---

<b>Introduction</b> . . . . .	ix
<b>Chapter 1. Diagnostic Methods for the Health Monitoring of Gearboxes</b> . . . . .	1
Abdenour SOUALHI and Hubert RAZIK	
1.1. Introduction . . . . .	1
1.2. Identification of critical components in gearboxes . . . . .	2
1.2.1. Types of gears . . . . .	4
1.2.2. Types of gear defects . . . . .	5
1.3. Diagnostic methodology . . . . .	8
1.4. Methods of analysis . . . . .	9
1.4.1. Temperature analysis . . . . .	9
1.4.2. Oil analysis . . . . .	9
1.4.3. Acoustic analysis . . . . .	10
1.4.4. Vibration analysis . . . . .	10
1.4.5. Electromagnetic torque analysis . . . . .	11
1.4.6. Flux analysis . . . . .	11
1.4.7. Analysis of electric currents . . . . .	11
1.5. Monitoring methods . . . . .	12
1.5.1. Temporal analysis . . . . .	14
1.5.2. Frequency analysis . . . . .	24
1.5.3. Time–frequency analysis . . . . .	26
1.6. Diagnostic methods . . . . .	27
1.6.1. Model approach . . . . .	29
1.6.2. Data-driven approach . . . . .	33
1.7. Conclusion . . . . .	37
1.8. References . . . . .	38

<b>Chapter 2. Techniques for Predicting Defects in Bearings and Gears</b> . . . . .	45
Abdenour SOUALHI and Hubert RAZIK	
2.1. Introduction . . . . .	45
2.1.1. Bearing degradation . . . . .	47
2.1.2. Degradation of gears . . . . .	51
2.2. Prediction . . . . .	54
2.2.1. Hidden Markov models . . . . .	54
2.2.2. Fault prediction by identifying the degradation process of the system . . . . .	56
2.3. Conclusion . . . . .	80
2.4. References. . . . .	81
<b>Chapter 3. Electrical Signatures Analysis for Condition Monitoring of Gears</b> . . . . .	83
Shahin HEDAYATI KIA and Mohammad HOSEINTABAR MARZEBALI	
3.1. Introduction . . . . .	83
3.1.1. Different kinds of gear defects . . . . .	84
3.1.2. Torsional vibration study . . . . .	86
3.2. Gear torsional vibration effects on EMSs . . . . .	87
3.3. Modeling gears in complex electromechanical systems . . . . .	89
3.3.1. Parallel shaft gears . . . . .	91
3.3.2. Planetary gears . . . . .	92
3.3.3. Mechanical shafts and couplings . . . . .	94
3.3.4. Electrical machine model. . . . .	95
3.4. Modeling gear tooth surface damage faults . . . . .	97
3.4.1. Parallel shaft gears . . . . .	97
3.4.2. Planetary gear faults . . . . .	100
3.5. Online condition monitoring of gears in complex electromechanical systems . . . . .	102
3.5.1. Mechanical torque and stator current analysis . . . . .	103
3.5.2. Stator current space vector analysis . . . . .	109
3.6. Conclusion . . . . .	114
3.7. References. . . . .	114
<b>Chapter 4. Modal Decomposition for Bearing Fault Detection</b> . . . . .	121
Yassine AMIRAT, Elhoussin ELBOUCHIKHI, Claude DELPHA, Mohamed BENBOUZID and Demba DIALLO	
4.1. Introduction . . . . .	121
4.2. Condition monitoring of electrical machines . . . . .	123

4.2.1. Detection of faults using MCSA . . . . .	123
4.2.2. Bearing failures . . . . .	124
4.3. Signal processing tools . . . . .	126
4.3.1. Empirical mode decomposition method . . . . .	128
4.3.2. EEMD principle . . . . .	131
4.3.3. Variational mode decomposition principle . . . . .	134
4.4. Mode decomposition-based notch filters . . . . .	139
4.4.1. Statistical distance measurement . . . . .	139
4.4.2. Dominant Mode cancellation . . . . .	140
4.5. Fault detectors . . . . .	141
4.6. Simulation and experimental validation . . . . .	142
4.6.1. Synthetic signals . . . . .	142
4.6.2. Experimental validation . . . . .	149
4.7. Conclusion . . . . .	161
4.8. References . . . . .	162
<b>Chapter 5. Methods for Lifespan Modeling in Electrical Engineering . . . . .</b>	<b>169</b>
Antoine PICOT, Marie CHABERT and Pascal MAUSSION	
5.1. Introduction . . . . .	169
5.2. Parametric methods . . . . .	170
5.2.1. Design of experiments . . . . .	170
5.2.2. Response surfaces . . . . .	173
5.2.3. Application of DoE and RSM to aging and lifespan modeling . . . . .	174
5.2.4. Factor effect significance . . . . .	186
5.2.5. Multilinear regression . . . . .	187
5.2.6. Conclusion regarding parametric methods . . . . .	198
5.3. Nonparametric models . . . . .	199
5.3.1. Regression trees . . . . .	199
5.3.2. Hybrid models . . . . .	205
5.4. Conclusion . . . . .	209
5.5. References . . . . .	210
<b>List of Authors . . . . .</b>	<b>215</b>
<b>Index . . . . .</b>	<b>217</b>
<b>Summary of Volume 2 . . . . .</b>	<b>219</b>