

Contents

FOREWORD BY PIERRE GRIVET
PREFACE

v
ix

<i>Chapter I. Linearity and Nonlinearity</i>	1
1. An Example of a Nonlinear System: The Simple Pendulum	1
2. Conservative Oscillators	2
3. Approximate Solutions of the Pendulum Equation	7
4. Exact Solution by Elliptic Integral	18
5. Representation in a Phase Plane	19
6. Nonlinear Oscillator with Damping	21
7. Simple Pendulum with Forcing Function. Resonance	30
References	44
<i>Chapter II. Self-Oscillatory Systems</i>	45
Introduction	45
1. Electronic Oscillators	48
2. Phase-Plane Representation	62
3. Cauchy-Lipschitz Theorem	71
4. Geometric Study of Periodic Solutions	73
5. Analytic Approaches to Periodic Phenomena	84
6. Synchronization of Self-Oscillators	96
7. Subharmonic Response	105
References	106
<i>Chapter III. Classification of Singularities</i>	108
1. Singular Points	108
2. Distribution of Singular Points in Phase-Plane R^2	112

3. Static and Dynamic Systems	118
4. Extension of the Theory: Sources, Sinks, and Transformation Points	121
5. Transformations of the Vector Field	124
6. Three-Dimensional Singularities	126
References	130
Chapter IV. Systems with Several Degrees of Freedom	132
1. Introduction	132
2. Example of a Conservative Oscillator	132
3. Nonlinear Oscillations in a Particle Accelerator	138
4. Self-Sustained Oscillators with Two Degrees of Freedom	151
5. Normal Vibrations on Nonlinear Systems	165
References	175
Chapter V. Equivalent Linearization	177
1. Stating the Problem	177
2. A Model in Classical Optics	181
3. Introduction to the Optimal Linearization Method	185
4. Similarity with Fourier's Method	187
5. Optimal Linear Operator	188
6. Iteration of the Procedure	192
7. The Describing Function	194
8. Additive Property of the Describing Function	198
9. Matrix Calculus in the Analysis of Nonlinear Systems	198
References	205
Chapter VI. The Describing Function Method	207
1. Equation of Feedback Loops	207
2. Linear and Nonlinear Feedback Loops	211
3. Nyquist's Diagram	212
4. Mikailov's Hodograph	214
5. Generalization of Mikailov's Hodograph for Nonlinear Systems	217
6. Applications to Autonomous Systems	227
7. Applications to Nonautonomous Systems	239
8. Sensitivity with Respect to Small Changes in Parameters	256
9. Retarded Actions	260
10. Multiple-Input Describing Function	262
References	269
Chapter VII. Nonlinear Equations with Periodic Coefficients	271
Introduction	271
1. Perturbation Method	274
2. Stepwise Method: Application to the Orbital Stability Problem in a Synchrotron	284

3. Hamiltonian Representation	299
4. The Smooth Approximation	307
References	312
Chapter VIII. System Response to Random Inputs	314
1. Campbell's Theorem	315
2. Fokker-Planck-Kolmogorov Method	319
3. Solution of the Fokker-Planck-Kolmogorov Equation Based on Campbell's Theorem	333
References	337
Chapter IX. Random Fluctuations of Self-Oscillators	339
Introduction	339
1. Berstein's Method	340
2. Blaqui��re's Method	347
3. Lerner's Quasi-Linear Method	357
4. Flicker Noise	360
5. Error in Frequency Measurement Using a Finite Time t'	364
6. Application to Masers	366
References	373
Appendix. Sinusoidal Modes of Electromagnetic Resonators	375
by F. BERSTEIN	
1. Equation for Linear Oscillations	375
2. Nonlinear Oscillations: Single Mode	377
3. Synchronization of Two Modes, Spatially Separated, in the Nonlinear Region	379
4. Synchronization of Two Modes, Nonspatially Separated, in the Nonlinear Region; Coupling by the Nonlinearity Only	382
References	383
AUTHOR INDEX	385
SUBJECT INDEX	388