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Introduction to Control Theory

S. A. MARSHALL

*Chairman and Professor of Mechanical Engineering,
University of Wollongong,
New South Wales*

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To my wife, Margaret Rose

Contents

<i>Preface</i>	xi
1 Introduction	1
1.1 Open- and Closed-loop Concepts	1
1.2 Historical Development	2
1.3 Outline of Text	2
2 Mathematical Modelling	4
2.1 The Need for Mathematical Modelling	4
2.2 Description of Simple Mechanical Systems	5
2.3 More about Mathematical Modelling	9
2.4 Model of a Trailer Suspension System	9
2.5 Modelling of Simple Electrical Systems	12
2.6 Modelling of Chemical Systems	16
2.7 Linearisation of Non-linear Equations	18
2.8 Concluding Remarks	20
3 The Need for Some Mathematics	23
3.1 Classical Method of Solution of Linear Differential Equations	24
3.2 Introduction to the Laplace Transformation	27
3.3 Some Properties of the Laplace Transformation	28
3.4 Laplace Transformations of Some Time Functions	30
3.5 Roots of Polynomials	32
3.6 Partial-fraction Expansions	35
3.7 Solution of Linear Differential Equations Using the Laplace Transformation	39
3.8 Second-order Differential Equations	41

4	Control-system Representation	49
4.1	Open-loop and Closed-loop Control	49
4.2	Transfer Functions	53
4.3	Block-diagram Representation	57
4.4	Signal-flow Graphs	64
4.5	Concluding Remarks	69
5	Steady-state and Transient Behaviour of Control Systems	73
5.1	Performance Criteria	73
5.2	Absolute Stability: the Method of Routh	75
5.3	Steady-state Analysis and Classification of Systems	79
5.4	Transient Behaviour of Control Systems	87
5.5	Sensitivity of Control Systems	96
5.6	Behaviour of a Governor System	98
5.7	Use of Computer Graphics	101
6	The Root-locus Method	105
6.1	Pole-Zero Configuration	106
6.2	Root-locus Method	109
6.3	Rules for Drawing the Root-locus Diagram	111
6.4	Determining the Transient Response	120
6.5	Use of Digital Computer and Graphics Terminal	124
7	Frequency-response Methods	129
7.1	Derivation of the Frequency Response of a System	130
7.2	Graphical Representation of the Frequency-response Function	136
7.3	Stability from the Nyquist Diagram	154
7.4	Relative Stability: Gain and Phase Margins	161
7.5	Closed-loop Performance from Open-loop Frequency Characteristics	163
7.6	Performance Requirements	171
7.7	System Sensitivity	172
7.8	Inverse Nyquist Diagram	172
8	Control-system Synthesis	175
8.1	Series Compensation	177
8.2	Parallel Compensation	184
8.3	System Synthesis in the s -plane Using the Root-locus Method	186
8.4	System Synthesis in the $G(j\omega)H(j\omega)$ Plane Using the Frequency-response Method	192
8.5	System Synthesis in the $G(j\omega)H(j\omega)$ Plane Using the Nyquist Diagram	198
8.6	System Synthesis in the $G(j\omega)H(j\omega)$ Plane Using the Inverse Nyquist Diagram	203
8.7	Feedforward Control	205
8.8	Concluding Remarks	207

Contents

ix

9	Bridging the Gap	210
9.1	Representation of Multivariable Systems	212
9.2	The Inverse-Nyquist-array Technique	216
9.3	Conclusion	224
	<i>Appendix</i>	226
	<i>Index</i>	229

Preface

This book has arisen, after many years' association with automatic control both in the university and in industry, from the growing conviction that there is a need for a new and modern text dealing with classical linear control theory, especially since many universities and polytechnics now have access to digital computers that have graphics terminals for interactive design work. Most of the classical control work is concerned with the analysis of the behaviour of closed-loop systems using knowledge of the open-loop system together with well-tried graphical techniques. It is this dependence that creates new possibilities for the use of control theory—there is now no need for laborious hand calculation and graph plotting since it is possible to automate all the techniques and carry out the analysis and synthesis of control systems via a graphics terminal with accuracy and speed. Further, it is possible to interact with the computing system and hence to build up progressive design techniques.

It has been recognised for some years that classical control theory has not been sufficiently developed to include techniques for designing industrial control systems in which there are many inputs and outputs and interaction between the control loops; hence alternative methods have been developed. Recent developments (at U.M.I.S.T.) have shown that the design of such control systems may be tackled in two parts: firstly, the interaction is systematically reduced until it can be safely ignored; and secondly, the many control loops may subsequently be designed using classical control theory. These developments in control theory stress the need for a thorough understanding of the classical approach. Indeed, in his book *Computer-Aided Control System Design*, Professor H. H. Rosenbrock states that 'The second development which will have a profound and increasing influence on all engineering design, is the availability of computers with graphical display. This allows a complete re-evaluation of the existing frequency-response methods, so that the graphical features are used only for communication with the designer, and not to replace standard numerical procedures for root solving etc. . . .'

This book was written mainly during my leisure hours and consequently was made possible only by the continued encouragement and understanding of my wife.

Wollongong, N.S.W.

S. A. MARSHALL