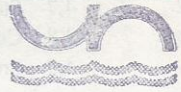


---

# CONTENTS

---



UNIVERSIDAD NACIONAL DE ENTRE RÍOS  
FACULTAD DE INGENIERÍA  
CENTRO DE MEDIOS  
BIBLIOTECA

Preface	xiii
<b>1 Introduction to Automatic Control Systems</b>	<b>1</b>
1.1 Introduction	1
1.2 Closed-Loop vs. Open-Loop Control	2
1.3 Historical and Mathematical Background	6
1.4 Outline of the Book	8
<b>2 Plant Representation</b>	<b>10</b>
2.1 Introduction	10
2.2 Transfer Functions and Block Diagrams	11
2.3 State-Variable Representation	28
2.4 Phase Variables	43
2.5 Physical Variables	51
2.6 Linear Transformation of Variables	58
2.7 Limitations of Mathematical Models	66
2.8 Conclusions	82
2.9 Problems	82
2.A Appendix to Chapter 2—Airplane Dynamics	88
<b>3 Closed-Loop-System Representation</b>	<b>97</b>
3.1 Introduction	97
3.2 The Effects of Feedback in the Output Feedback Problem	98
3.3 Linear State-Variable Feedback—An Example	116
3.4 Linear State-Variable Feedback—General Case	126
3.5 Controllability and Pole Placement	139
3.6 Conclusions	151
3.7 Problems	152
<b>4 Time Response</b>	<b>159</b>
4.1 Introduction	159
4.2 Partial-Fraction Expansion Methods	160
4.3 Step Function Response of Dominantly First-Order Systems	175

4.4	Step Function Response of Dominantly Second-Order Systems	188
4.5	State-Variables Time Response	200
4.6	Time-Domain Methods	209
4.7	Steady-State Errors to Simple Inputs	211
4.8	Conclusions	216
4.9	Problems	217
<b>5</b>	<b>Frequency Response</b>	224
5.1	Introduction	224
5.2	Frequency Response Function	225
5.3	Bode Magnitude Plot—Straight Line Approximation	231
5.4	Bode Phase Plot—Straight Line Approximation	244
5.5	Plant Identification	262
5.6	Accounting for Uncertainty in Modeling	272
5.7	Conclusions	284
5.8	Problems	284
<b>6</b>	<b>Stability</b>	291
6.1	Introduction	291
6.2	Definitions of Stability	292
6.3	The Routh-Hurwitz Criterion	297
6.4	The Nyquist Criterion	307
6.5	Closed-Loop Response and Nyquist Diagrams	322
6.6	Robust Stability	338
6.7	Performance and Robustness	346
6.8	Conclusions	353
6.9	Problems	354
<b>7</b>	<b>The Root Locus Method</b>	359
7.1	Introduction	359
7.2	The Root Locus Method	361
7.3	Additional Root Locus Construction Rules	370
7.4	Additional Examples and Root Locus Rules for Negative $K$	389
7.5	The Closed-Loop Response Plane	400
7.6	The Root Locus Using Parameters Other Than $K$	403
7.7	Conclusions	408
7.8	Problems	408
7.A	Appendix to Chapter 7—Bypassing the Root Locus	413
<b>8</b>	<b>The Design of Control Systems</b>	418
8.1	Introduction	418
8.2	General Principles for Designing Series Compensators Using Frequency Response Techniques	420
8.3	Series Compensator Building Blocks: Proportional Control	431
8.4	Series Compensator Building Blocks: Lag Compensators, PI Compensators	441
8.5	Series Compensator Building Blocks: Lead Compensators, PID Compensators	446
8.6	Series Compensator Building Blocks: High Frequency Roll-Off, Notch Filters, Canceling Plant Dynamics	460

8.7	A Realistic Design Example Using a Lead-Lag Compensator	465
8.8	An Example Using Roll-Off and a Notch Filter to Cancel Plant Dynamics	479
8.9	Controlling Unstable Plants	487
8.10	Controlling Plants with Right Half-Plane Zeros	493
8.11	Pole Placement Control	503
8.12	State-Variable Feedback—The Advantage of Extra Measurements	510
8.13	Conclusions	517
8.14	Problems	518
	<b>Appendixes</b>	525
A	The Laplace Transform—A Summary	525
B	Laplace Transform Table	530
C	Matrix Inversion, Eigenvalues, and Eigenvectors	532
D	Computer Aided Design (CAD) Tools for Control Systems: Introduction to MATLAB®	536
	<b>References</b>	540
	<b>Index Entries for Physically Oriented Phenomena</b>	545
	<b>Index</b>	547