Contents

Part I. Mohammed Dahleh Legacy

Legacy of Mohammed Dahleh 3
Munther A. Dahleh
1 Childhood (1961-1979) 3
2 College Years (1979-1987) 5
3 Faculty at TAMU 1987-1990 6
4 The Decade at the University of California at Santa Barbara, 1991-2000 7
5 Mohammed's Sickness 10
6 Final Remarks 10
References 12

Part II. Control in Networks and Communications

A Control Theoretical Look at Internet Congestion Control . . 17
Fernando Paganini, John Doyle, Steven H. Low
1 Introduction 17
2 Problem Formulation 18
3 Control design with linear scalable stability 22
4 Nonlinear laws and the equilibrium structure 27
5 Signaling requirements 29
6 Conclusion 30
References 30

Indelible Control 33
Nicola Elia
1 Introduction 33
2 Problem Set-up 35
3 Channels as Model Uncertainty 36
4 Mean Square Closed Loop Stability 37
5 Minimal Channel Quality for Means Square Stability 38
6 Mean Square Stability Robustness to Structured Bounded Variance Uncertainty 39
7 Special Cases with only One Channel 41
8 Minimal Channel Quality for the Stabilization of a Pendubot 42
9 Conclusions 43
10 Appendix 44
References 45

Optimal Control Design under Structural and Communication Constraints 47
Petros G. Voulgaris
1 Introduction 47
2 Specific Structures 48
3 Controller Parametrization 54
4 Optimal Performance 56
5 Conclusions and Discussion 59
References 60

Part III. Quantum Control

Fifteen Years of Quantum Control: from Concept to Experiment 65
Anthony Peirce
1 Preamble 65
2 Molecular control 66
3 Design by intuition 66
4 The optimal control formulation 67
5 Uncertainty and robust design 69
6 Experiments and closed loop design 70
7 Concluding remarks 71
References 72

Directions in the Theory of Quantun Control 73
Domenico D'Alessandro
1 Model of finite-dimensional quantum dynamics 73
2 Lie algebra structure, controllability and analysis of quantum systems 75
3 Methods for control 77
4 Conclusions 78
References 78

Part IV. Micro and Nano-scale Dynamics and Control

System tools applied to micro-cantilever based devices 83
A. Sebastian, S. Salapaka, M. V. Salapaka
1 Introduction 83
2 Atomic Force Microscope: operating principles and features 84
3 Systems approach to the analysis of AFM dynamics 85
4 Broadband nanopositioning 90
5 Conclusions 96
References 97

Micro-scale sensors and filters utilizing non-linear dynamic response of single and coupled oscillators 101
Kimberly Turner, Rajashree Baskaran, Wenhua Zhang
1 Introduction 101
2 MEMS mass sensor 102
3 Electrostatically Coupled Oscillator filter 108
References 112

Part V. Connections with Biology

Feedback Regulation of the Heat Shock Response in *E. coli* ... 115
Hana El-Samad, Mustafa Khammash, Hiroyuki Kurata, John C. Doyle
1 Introduction 115
2 The Heat Shock Response: A Case Study 117
3 Conclusions and Future Work 126
References 127

Stem Cells from the Outside In 129
Marie Csete MD, PhD
1 Introduction: Stem cells 129
2 Oxygen levels 130
3 Conclusions 131
References 132

Optimal Image Interpolation 133
Steven Haker, Allen Tannenbaum
1 Introduction 133
2 Area-Preserving Diffeomorphisms 134
3 Formulation of Optimal Transport 135
4 Gradient Descent for Optimal Transport 136
5 Optimal Image Interpolation 137
6 Optical Flow 138
7 Computer Simulations 140
References 140

Part VI. Control and Identification

Robustness of Finite State Automata 147
Alexandre Megretski
1 System Models 148
2 Analysis and Design of FSA/IC Models 153
References 160

On the role of homogeneous forms in robustness analysis of control systems 161
G. Chesi, A. Garulli, A. Tesi, A. Vicino
1 Introduction 161
2 Problem formulation and preliminaries 163
3 LMI-based conditions for the solution of the POFH problem 165
4 POFH problems in control system analysis 169
5 Conclusions 175
References 175

Control of Electromechanical Actuators: Valves Tapping in Rhythm 179
Katherine Peterson, Anna Stefanopoulou, Yan Wang
1 Introduction 179
2 Variable Valve Timing Technology 180
3 Soft Landing Methodologies 181
4 Nonlinear Model 182
5 Control Analysis 183
6 Observer Design 187
7 Controller Design 189
8 Extremum Seeking Control 190
9 Conclusion 192
References 192

Learning complex systems from data: the Set Membership approach 195
Mario Milanese and Carlo Novara
1 Introduction 195
2 The Nonlinear Set Membership approach 196
3 Nonlinear systems identification 201
4 Prediction of nonlinear systems 203
5 Conclusions 204
References 205

The mixing of state statistics 207
Tryphon T. Georgiou
1 Introduction 207
2 The structure of state covariances 207
3 Mixing of state statistics 209
References 211

Controllability, integrability and ergodicity 213
Igor Mezić
1 Introduction 213
2 Preliminaries 214
3 Hamiltonian systems in action-angle variables 218

4 Controllability by flatness 221
5 Ergodicity and controllability 223
6 Discussion and conclusions 226
7 Epilogue 227
References 228