

# CONTENTS

<b>1. Introduction</b>	7
<b>2. State of the art</b>	9
<b>3. Modelling and estimation of bioprocesses</b>	13
3.1 Typical bioreactors and models of bioprocesses	14
3.1.1 Laboratory bioreactors	14
3.1.2 General dynamical model of bioprocesses	17
3.1.3 Dynamical model of a prototype bioprocess	18
3.1.4 Model of a lipase production process	19
3.2 Modelling and parameter identification for a mammalian cell culture process	21
3.2.1 MAb synthesis by mammalian cell culture: process description and modelling	22
3.2.2 PSO-based technique parameter estimation	26
3.2.3 Results and discussion	30
3.3 Nonlinear estimation of state and kinetic rates for microbial production of enzymes	37
3.3.1 Model of a lipase production by <i>Candida rugosa</i>	38
3.3.2 Design of an asymptotic observer for state estimation	40
3.3.3 On-line estimation of unknown kinetics with high gain observers	43
3.3.4 Simulation results	47
3.4 Multiple estimation of kinetics in a baker's yeast process using partial models	53
3.4.1 Model of baker's yeast bioprocess	53
3.4.2 Nonlinear observers for multiple estimation of kinetic rates	57
3.4.3 Simulation results and discussion	59
<b>4. Bioprocess control</b>	65
4.1 Indirect adaptive control of a fed-batch bioprocess	66
4.1.1 Alcoholic fermentation process model	66
4.1.2 On-line estimation algorithms	67
4.1.3 Design of the indirect adaptive control law	69
4.1.4 Some simulation results	72
4.2 Sliding mode and adaptive sliding mode control of bioprocesses	74
4.2.1 Linearizing sliding mode control law design	75
4.2.2 Adaptive sliding mode control law design	77
4.2.3 Adaptive sliding mode control of a wastewater treatment process inside a SBR	78
4.2.4 Sliding mode and adaptive sliding mode control of a lipase production process	82
4.3 Multivariable robust-adaptive control of a recycled wastewater treatment process	89
4.3.1 Dynamical model of activated sludge process and control problem statement	89
4.3.2 Exact feedback linearizing control and adaptive control	91
4.3.3 Robust-adaptive control design	93
4.3.4 Results and discussion	98
<b>Bibliography</b>	103

