

Contents

1	Introduction	1
1.1	Fermentation Processes	1
1.2	Fed-Batch Fermentation Processes by Conventional Methods ..	4
1.3	Artificial Intelligence for Optimal Fermentation Control	7
1.4	Why is Artificial Intelligence Attractive for Fermentation Control	12
1.5	Why is Experimental Investigation Important for Fermentation Study	14
1.6	Contributions of the Book	14
1.7	Book Organization	14
2	Optimization of Fed-batch Culture	17
2.1	Introduction	17
2.2	Proposed Model and Problem Formulation	18
2.3	Genetic Algorithm	19
2.4	Optimization using Genetic Algorithms based on the Process Model	20
2.5	Numerical Results	21
2.6	Conclusions	27
3	On-line Identification and Optimization	29
3.1	Introduction	29
3.2	Fed-batch Model and Problem Formulation	30
3.3	Methodology Proposed	31
3.4	Numerical Results	32
3.5	Summary	40
4	On-line Softsensor Development	41
4.1	Introduction	41
4.2	Softsensor Structure Determination and Implementation	42

4.3	Experimental Verification	49
4.4	Conclusions	56
5	Optimization based on Neural Models	57
5.1	Introduction	57
5.2	The Industry Baker's Yeast Fed-batch Bioreactor	58
5.3	Development of Dynamic Neural Network Model	58
5.4	Biomass Predictions using the Neural Model	62
5.5	Optimization of Feed Rate Profiles	66
5.6	Summary	70
6	Experimental Validation of Neural Models	71
6.1	Introduction	71
6.2	Dynamic Models	72
6.3	Experimental Procedure	74
6.4	Model Identification	80
6.5	Conclusions	89
7	Designing and Implementing Optimal Control	91
7.1	Definition of an Optimal Feed Rate Profile	91
7.2	Formulation of the Optimization Problem	94
7.3	Optimization Procedure	95
7.4	Optimization Results and Discussion	97
7.5	Conclusions	108
8	Conclusions	109
8.1	General Conclusions	109
8.2	Suggestions for Future Research	110
A	A Model of Fed-batch Culture of Hybridoma Cells	111
B	An Industrial Baker's Yeast Fermentation Model	113
	References	117