Master's Theses in Automatic Control 1979-1980

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1980

Document Version:
Publisher's PDF, also known as Version of record

CODEN: LUTFD2/(TFRT-6011)/1-16/(1980)

MASTER THESES IN AUTOMATIC CONTROL 1979/80

LARS PERNEBO

DEPARTMENT OF AUTOMATIC CONTROL
LUND INSTITUTE OF TECHNOLOGY
OCTOBER 1980

Organization
LUND INSTITUTE OF TECHNOLOGY
Department of Automatic Control
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Document name
MS theses report

Date of issue
October 1980

CODEN: LUTFD2/(TFRT-6011)/1-16/(1980)

Author(s)
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Sponsoring organization

Title and subtitle

Master theses in Automatic Control 1979/80

A4 A5

Abstract

The report contains abstracts of master theses (examensarbete) made at the Department of Automatic Control, Lund, during the academic year 1979/80. During this year 14 theses were made by 18 students. The theses are written in Swedish with an English abstract.

Key words

A4 A5

Classification system and/or index terms (if any)

Supplementary bibliographical information

Language
English

ISSN and key title

ISBN

Recipient's notes

Number of pages
16

Price

Security classification

Distribution by (name and address)

DOKUMENTDATABLAD enl SIS 61 41 21

1. INTRODUCTION

The education for civilingenjörsexamen (Master Degree in Engineering) is completed with an indpendent work, the master thesis (examensarbete). It should show the student's ability to attack and solve a larger problem. The time devoted to the thesis is about three months of full time work. The thesis can be done individually or by two students together.

This report is a collection of the document pages of the theses completed during the academic year 1979/1980. During this time 14 theses were finished by 18 students. The major part of the theses is made within the framework of the research program at the department. Some of the theses are made as feasibility studies or made in cooperation with the industry or other departments.

Further information concerning the results can be obtained from the Department of Automatic Control by contacting the advisor. The theses are available at the University Library in Lund (Address: University Library 2, Box 1010, S-221 03 LUND, Sweden).

2. LIST OF THESES

TFRT-5222 Kongstad P: Automatisk inställning av PID-regulatorer baserad på optimering och identifiering (Automatic tuning of PID-controllers using optimization and identification), August 1979.

TFRT-5223 Wiberg P: Vibrationer i presspartiet i en pappersmaskin (Press nip vibrations in paper machines), August 1979.

TFRT-5224 Brännström K and Melcher H: Reglering av strängspruta (Control of a rubber extruder), August 1979.

TFRT-5225 Tiljander S: Undersökning av två självinställande regulatorer för servoproblemet (Investigation of two selftuning regulators for the servoproblem), September 1979.

TFRT-5226 von Knorring O and Lindsten L-G: Enkla regulatorer (Single controllers), July 1979.

TFRT-5227 Nilsson H: Insulin-glukos reglering (Insulin-Glucose control), October 1979.

TFRT-5228 Nielsen L: Reglering av ATP-syntesen i mitokondrier (Control of the ATP-synthesis in mitochondria), October 1979.

TFRT-5229 Svensson G and Åhs M: Modellering och simulering av matarvattenförvärmningssystem (Modelling and simulation of feedwater preheating system), November 1979.

TFRT-5230 Ullen K: Styrning av motorprovbädd (Control of a diesel engine test bed), April 1980.

TFRT-5231 Hedin B: Identifiering av dynamiska modeller för temperaturen i ett kontorslandskap (Identification of dynamic models for the temperature in an office landscape), May 1980.

TFRT-5232 Bjartmarsson K: Simulering av en kemisk reaktor (Simulation of a chemical reactor), May 1980.

TFRT-5233 Nilsson M and Olofsson P: Likströmsmotordrivet kraftregler-system (DC-motor driven force control system), June 1980.

TFRT-5234 Olsson R: Modellering och simulering av synkrongenerator-dynamik (Modelling and simulation of synchronous generator dynamics), June 1980.

TFRT-5235 Wennstad P: Adaptiva regulatorer (Adaptive regulators), June 1980.

3. SUBJECT LIST

Subject	Thesis
Adaptive control	5222, 5225, 5235
Modelling and simulation	5223, 5229, 5232, 5233, 5234
Biological systems	5227, 5228
Identification	5231
Analysis and synthesis	5224, 5226, 5230

4. DOCUMENT PAGES

The following pages contain the document pages of the theses. All theses are written in Swedish with an abstract in English.

On the document page the following data are given:

Report number	(Dokumentnamn, Dokumentbeteckning)
Adviser	(Handläggare)
Author	(Författare)
Title in Swedish and English	(Dokumenttitel och undertitel)
Abstract	(Referat)
Keywords	(Förslag till ytterligare nyckelord)

Dokumentutgivare
Lund Institute of Technology
Department of Automatic Control

Handläggare
Björn Wittenmark

Författare
Poul Kongstad

Dokumentnamn
REPORT LUTFD2/(TFRT-5222)/1-084/(1979)

Utgivningsdatum
August 1979

Ärendebeteckning
06T6

10T4

Dokumenttitel och undertitel
Automatisk inställning av PID-regulatorer baserad på optimering och identifiering.

(Automatic tuning of PID-controllers using optimization and identification)

Referat (sammandrag)
This master thesis presents a general structure for the optimization of regulator parameters. It is assumed that control structure and control aim (given as a loss function) are chosen. The process that is controlled need not be known; identification and optimization are performed simultaneously. Processes containing pure time delay can be optimized with only minor program changes.

This search method has been applied to PI- and PID-regulators and processes of moderate order and have been programmed in Simnon, a simulation language. Actual results from the computer simulations using different loss functions and programs are included. The report also contains discussions of the choice of loss function and identification in closed loop systems.

Referat skrivet av
author

Förslag till ytterligare nyckelord
44T0

Klassifikationssystem och -klass(er)
50T0

Indextermer (ange källa)
52T0

Omfång
84 pages

Övriga bibliografiska uppgifter
56T2

Språk
Swedish

Sekretessuppgifter
60T0

ISSN
60T4

ISBN
60T6

Dokumentet kan erhållas från
Department of Automatic Control
Lund Institute of Technology
Box 725, S-220 07 LUND 7, Sweden

Mottagarens uppgifter
62T4

Pris
66T0

SIS-DB 1 DOKUMENTDATABLAD enligt SIS 62 10 12

Blankett LU 11:25 1976—07

Dokumentutgivare
Lund Institute of Technology

Dokumentnamn
REPORT

Dokumentbeteckning
LUTFD2/(TFRT-5223)/1-072)/(1979)

Handläggare
Gustaf Olsson

Utgivningsdatum
August 1979

Ärendebeteckning

Författare
Per Arne Wiberg

10T4

Dokumenttitel och undertitel
Vibrationer i presspartiet i en pappersmaskin
(Press nip vibrations in paper machines)

Referat (sammandrag)
Vibrations in the press section of a paper machine is getting a serious problem. This is caused by the high speeds and the high nip pressure that appear in modern paper machines. In this paper a hypothesis of the causes of vibrations in a press nip has been stated. To validate the hypothesis a mathematical model of the press nip has been derived. The basic model describes the dynamics of a continuous press roll and has been discretized into a model with eight spatial points. A simulation program in SIMNON has been written and the system was simulated on a computer. The results of the simulations seem to verify the hypothesis.

Referat skrivet av
author

Förslag till ytterligare nyckelord
44T0

Klassifikationssystem och -klass(er)
50T0

Indextermer (ange källa)
52T0

Omfång
72 pages

Övriga bibliografiska uppgifter
56T2

Språk
Swedish

Sekretessuppgifter
60T0

ISSN
60T4

ISBN
60T6

Dokumentet kan erhållas från
Department of Automatic Control
Lund Institute of Technology
P O Box 725, S-220 07 LUND 7, Sweden

Mottagarens uppgifter
62T4

Pris
66T0

DOKUMENTDATABLAD enligt SIS 62 10 12

SIS-DB1

Blankett LU 11:25 1976–07

Dokumentutgivare
04T0
Lund Institute of Technology
Handläggare Dept of Automatic Control
26T0
Gustaf Olsson
Författare
08T0
Kjell Brännström

Hans Melcher

Dokumentnamn
04T0
REPORT

Dokumentbeteckning
LUTFD2/(TFRT-5224)/1-033)/(1979)

Utgivningsdatum
August 1979

Ärendebeteckning
06T6

10T4

Dokumenttitel och undertitel
Reglering av Strängspruta

(Control of a rubber extruder)

Referat (sammandrag)

The purpose of this work has been to identify and control a rubber extruder. The product diameter variance has to be minimized. It is controlled by the setpoint value of the screw rotation speed. During the experiments it was not allowed to change or uncouple the temperature controller. A mathematic model has been derived by a process identification of measured data. The results indicate, that the product standard deviation is only one sixth of the stipulated tolerance value, already with no automatic control. Therefore it is not considered worthwhile to implement minimal variance controller, as no significant improvement can be expected.

It is considered interesting to further study the temperature control. It is believed that an improvement of this controller can increase the production rate without loosing in quality.

Referat skrivet av
42T0
authors

Förslag till ytterligare nyckelord
44T0

Klassifikationssystem och -klass(er)
50T0

Indextermer (ange källa)
52T0

Omfång
33 pages

Språk
Swedish

Övriga bibliografiska uppgifter
56T2

Sekretessuppgifter
60T0

ISSN
60T4

ISBN
60T6

Dokumentet kan erhållas från
62T0
Department of Automatic Control
Lund Institute of Technology,
P O Box 725, S-220 07 LUND 7, Sweden

Mottagarens uppgifter
62T4

Pris
66T0

DOKUMENTDATABLAD enligt SIS 62 10 12

SIS-DB 1

Dokumentutgivare
Lund Institute of Technology
Handläggare Dept of Automatic Control
Björn Wittenmark
Författare
Sven Gunnar Tiljander

Dokumentnamn
REPORT
Dokumentbeteckning
LUTFD2/(TFRT-5225)/1-066/(1979)
Utgivningsdatum
September 1979
Ärendebeteckning
06T6

10T4

Dokumenttitel och undertitel

Undersökning av två självinställande regulatorer för servoproblemet

(Investigation of two self-tuning regulators for the servoproblem)

Referat (sammandrag)

Two self-tuning algorithms to take care of the problem with reference signals have been compared in this work. The first algorithm is given by B Wittenmark (1975) and the second by Clarke-Gawthrop (1975). Both regulators are based on a recursive least-squares estimator of the parameter of a feedback control law combined with feedforward signals. The estimated parameters are then used in the control law as if they are the true ones. Some precaution must then be taken to handle steady-state-errors. In this work this has been done by the following two possibilities: i) cascade the regulator with an integrator ii) and increase the order of the polynomials in the model. The properties of the algorithms are investigated by using simulations.

Referat skrivet av
author

Förslag till ytterligare nyckelord
44T0

Klassifikationssystem och -klass(er)
50T0

Indextermer (ange källa)
52T0

Omfång
66 pages

Övriga bibliografiska uppgifter
56T2

Språk
Swedish

Sekretessuppgifter
60T0

ISSN
60T4

ISBN
60T6

Dokumentet kan erhållas från
Department of Automatic Control
Lund Institute of Technology
P O Box 725, S-220 07 LUND 7, Sweden

Mottagarens uppgifter
62T4

Pris
66T0

SIS-DB 1 DOKUMENTDATABLAD enligt SIS 62 10 12

Dokumentutgivare
Lund Institute of Technology
Handläggare Dept of Automatic Control
06T0

Dokumentnamn 04T4 Report
Dokumentbeteckning 04T4 LUTFD2/(TFRT-5226)/1-088/(1979)
Utgivningsdatum 06T4 July 1979
Ärendebeteckning 06T6

Författare 10T4
Olof von Knorring
Lars-Göran Lindsten

Dokumenttitel och undertitel 18T0
Enkla regulatorer
(single controllers)

Referat (sammandrag) 24T0

This report aims to give a general description of single controllers and their inherent characteristics. The worth of some earlier (in the 40- and 50-ies) theoretically derived rules for optimum adjustment of automatic controllers have been particularly examined. The same is applied to the specific effects resulting from the use of an integral part.

Referat skrivet av 42T0 Authors

Förslag till ytterligare nyckelord 44T0
enkla regulatorer, inställningsregler, integratormättning,
single controllers, rules for optimum adjustment, reset windup

Klassifikationssystem och -klass(er) 50T0

Indextermer (ange källa) 52T0

Omfång 56T0 88 pages

Övriga bibliografiska uppgifter 56T2

Språk 58T0 Swedish

Sekretessuppgifter 60T0

ISSN 60T4

ISBN 60T6

Dokumentet kan erhållas från 62T2
Department of Automatic Control
Lund Institute of Technology
P O Box 752, S-220 07, Sweden

Mottagarens uppgifter 62T4

Pris 66T0

DOKUMENTDATABLAD enligt SIS 62 10 12

SIS-DB 1

Blankett LU 11:25 1976–07

Dokumentutgivare
Lund Institute of Technology
Handläggare Dept of Automatic Control
Per Hagander

Dokumentnamn
REPORT

Dokumentbeteckning
LUTFD2/(TFRT-5227)/1-128/(1979)

Utgivningsdatum
October 1979

Ärendebeteckning
06T6

Författare
Christer Nilsson

10T4

Dokumenttitel och undertitel
Insulin-glukos reglering

(Insulin-glucose control)

Referat (sammandrag)

The report is divided into three main parts. In the first part an estimation has been carried out of how different insulin and glucose loads affect the blood glucose concentration in a normal dog. The blood glucose concentration has, in all cases, been measured by the use of Gambro AB's CGM-equipment.

A test of three different pancreatic models is described in the second part. One model has been fitted to data from a glucose toleranse test, and one model to insulin load experiments described in part one. Based on the latter model test simulations have been carried out to test a PD-regulator and one nonlinear regulator.

The simulation and the optimization of parameter fitting have been done in SIMNON, an interactive simulation program for nonlinear systems. In the third part practical regulation experiments have been made on normal and diabetic dogs. Three regulators have been tested. Despite of bad knowledge of models, the test shows that good regulation can be obtained. If the insulin need is unknown there can be considerable stationary errors for regulators without integraleffects. A timedelay leads to that the gain must be kept low to avoid oscillations.

Referat skrivet av
Author

Förslag till ytterligare nyckelord

Klassifikationssystem och -klass(er)

Indextermer (ange källa)

Omfång

Övriga bibliografiska uppgifter
56T2

Språk
Swedeish

Sekretessuppgifter
60T0

ISSN
60T4

ISBN
60T6

Dokumentet kan erhållas från
Department of Automatic Control
Lund Institute of Technology
Box 725, S-220 07 Lund 7, Sweden

Mottagarens uppgifter
62T4

Pris
66T0

Dokumentutgivare
04T0 Lund Institute of Technology
Dept of Automatic Control

Handläggare
06T0 Per Hagander

Författare
08T0 Lars Nielsen

Dokumentnamn
04T6 REPORT

Utgivningsdatum
06T6 October 1979

Dokumentbeteckning
LUTFD2/(TFRT-5228)/1-84/(1979)

Ärendebeteckning
06T6

10T4

Dokumenttitel och undertitel
18T0 Reglering av ATP-syntesen i mitokondrier
(Control of the ATP-synthesis in mitochondria)

Referat (sammandrag)
26T0 The oxidation of NADH, with equilibrium constant $5 \cdot 10^{45}$, is the energy-source for ATP-synthesis in mitochondria. In order to study how control of such an irreversibel process can be managed a mathematical model is built. The model is based on the chemiosmotic theory, where the electro-static potential difference across the inner membrane of mitochondria is explicitly considered in the equations. The results imply that the control mechanism is different from what is usual in biological systems. Also an application of irreversible thermodynamics shows that this mechanism allows a high effectiveness.

Referat skrivet av
42T0 Author

Förslag till ytterligare nyckelord
44T0 Dynamical model

Klassifikationssystem och -klass(er)
50T0

Indextermer (ange källa)
52T0

Omfång
84 pages

Språk
Swedish

Övriga bibliografiska uppgifter
56T2

Sekretessuppgifter
60T0

ISSN
60T4

ISBN
60T6

Dokumentet kan erhållas från
Department of Automatic Control
Lund Institute of Technology
Box 725, S-220 07 Lund 7, Sweden

Mottagarens uppgifter
62T4

Pris
66T0

DOKUMENTDATABLAD enligt SIS 62 10 12

SIS-DB 1

Blankett LU 11:25 1976–07

Dokumentutgivare
Lund Institute of Technology
Dept. of Automatic Control
Handläggare

Dokumentnamn
report LUTFD2/(TFRT-5229)/1-053/(1979)
Dokumentbeteckning

Utgivningsdatum
Nov 1979
Ärendebeteckning

Författare
Göran Svensson
Magnus Åhs

Dokumenttitel och undertitel

Modellering och Simulering av Matarvattenförvärmningssystem (Modelling and Simulation of Feedwater preheating system.)

Referat (sammandrag)

Models of the feedwater preheating system at a BWR are written in the simulation language Simnon.The intention has been to find a simple dynamic model that describes the feedwater preheating system in the nuclear power plant Barsebäck,Sweden.
Two diffrent models have been constructed,one with and one without thermodynamical states.Both models have been investegated through simulations and some conclusions were made.

Referat skrivet av
Authors
Förslag till ytterligare nyckelord

Klassifikationssystem och -klass(er)

Indextermer (ange källa)

Omfång
53 pages
Övriga bibliografiska uppgifter

Språk
Swedish

Sekretessuppgifter

ISSN

ISBN

Dokumentet kan erhållas från
Department of Automatic Control
Lund Institute of Technology
P O Box 752, S-220 07,Sweden
Mottagarens uppgifter

Pris

Organization
LUND INSTITUTE OF TECHNOLOGY
Department of Automatic Control
P O Box 725
S-220 07 LUND 7
Sweden

Document name
Master Thesis

Date of issue
April, 1980

CODEN:
LUTFD2/(TFRT-5230)/1-051/(1980)

Author(s)
Kaj Ullen

Adviser: K J Åström

Title and subtitle

STYRNING AV MOTORPROVBÄDD
(CONTROL OF A DIESEL ENGINE TEST BED)

A4 A5

Abstract

Design of a system for automatic performance testing of diesel engines is described. The system has been in continuous operation at Volvo Skövde factory since 1977 and at Volvo Göteborg factory since 1979.

Key words

A4 A5

Classification system and/or index terms (if any)

Supplementary bibliographical information

Language
Swedish

ISSN and key title

ISBN

Recipient's notes

Number of pages
51

Price

Security classification

Distribution by (name and address)

Organization
LUND INSTITUTE OF TECHNOLOGY
Department of Automatic Control
P O Box 725
S-220 07 LUND 7
Sweden

Document name
Master Thesis

Date of issue
May, 1980

CODEN:
LUTFD2/ (TRFT-5231)/1-084/(1980)

Author(s)
Björn Hedin

Adviser: Lars Jensen

Title and subtitle
Identifiering av dynamiska modeller för temperaturen i ett kontorslandskap.
(Identification of dynamic models for the temperature in an office landscape).

A4 A5

Abstract
This paper describes and analyses some experiments performed to identify dynamic models of the heating system of an office landscape.
The heating system mainly consists of three fan systems, each of them distributes cold or warm air over one part of the landscape. If the inlets' temperatures are regarded as inputs and the space temperatures in the corresponding three parts as outputs, one can (try to) describe the interaction whith tree multiple input - single output ordinary difference - equations.
To excite the process, the setpoint for the temperature in the three parts was independently waried by means of pseudo random binary sequences. Simultaneous values of the inputs and outputs were recorded and used to compute a least square or a maximum likelihood estimate of the model.
It has appered that first order multipel input models often are sufficient to describe the heating process. It should be stressed that these models are designed for control purpose and thus are valid only for short periods (here less than some hours).

Key words
A4 A5

Classification system and/or index terms (if any)

Supplementary bibliographical information

Language
Swedish

ISSN and key title

ISBN

Recipient's notes

Number of pages
84

Price

Security classification

Distribution by (name and address)

Organization
LUND INSTITUTE OF TECHNOLOGY
Department of Automatic Control
P O Box 725
S-220 07 LUND 7
Sweden

Document name
Master Thesis

Date of issue
May, 1980

CODEN:
LUTFD2/(TFRT-5232)/1-106/(1980)

Author(s)
Kristján H. Bjartmarsson

Adviser: Björn Wittenmark

Title and subtitle

Simulering av en kemisk reaktor (Simulation of a chemical reactor)

Abstract

A4 A5

A continuous flow stirred tank reactor is simulated by using SIMNON, an interactive simulation program for nonlinear systems. In the reactor two parallel, irreversible reactions are assumed to take place: A → B and A → C which are, respectively, of 2nd and 1st order with respect to the concentration of A. The reactions are exothermic and hence the reactor is equipped with a cooling coil. A model of this process is derived from first principles and expressed in 5 1st order nonlinear differential equations in normalized form. The objective of the process is specified, and subject to constraints, an optimal unstable operating point is found. A linear model is derived from and compared to the nonlinear one. The eigenvalues are determined and certain transfer functions calculated. A continuous control system for the nonlinear model is developed heuristically by observing the various step responses. Cascade control is used for the temperature and composition loops. The effect of preload in connection with set-point changes is demonstrated. The sensitivity to disturbances in process parameters is investigated. An attempt is made at feedforward control. A conversion to sampled-data control system is made and associated effects on stability accounted for. A simple dead-beat strategy is obtained for the flow and level loops. Bang-bang control is shown to improve performance under certain conditions. The possibility of introducing dead time into the model is discussed briefly.

Key words

A4 A5

Classification system and/or index terms (if any)

Supplementary bibliographical information

Language
Swedish

ISSN and key title

ISBN

Recipient's notes

Number of pages
111

Price

Security classification

Distribution by (name and address)

Organization
LUND INSTITUTE OF TECHNOLOGY
Department of Automatic Control
Box 725
S-220 07 LUND 7, Sweden

Document name
Master Thesis

Date of issue
June, 1980

CODEN:
LUTFD2/(TFRT-5233)/1-078/(1980)

Author(s)
Mats Nilsson
Per Olofsson

Adviser: Björn Wittenmark

Title and subtitle
DC-motor driven force control system
Likströmsmotordrivet kraftreglersystem

A4 A5

Abstract

This report describes a DC-motor driven force control system based on a permanent magnetized DC-motor, a hydraulic transmission mainly comprising pump and cylinder and an electronic motor current controller.

The transfer function from input signal to cylinder output force is derived. Simulations of the dynamic behaviour of the system are carried out utilizing the "SIMNON"-programming package. The theoretical study is verified by constructing and testing a hardware model.

Methods for improving the system response-times are described and verified by simulations.

Key words

A4 A5

Classification system and/or index terms (if any)

Supplementary bibliographical information

Language
Swedish

ISSN and key title

ISBN

Recipient's notes

Number of pages
78

Price

Security classification

Distribution by (name and address)

Organization
LUND INSTITUTE OF TECHNOLOGY
Department of Automatic Control
Box 725
S-220 07 LUND 7
Sweden

Document name
Master Thesis

Date of issue
June 1980

CODEN:
LUTFD2/(TFRT-5234)/0-053/(1980)

Author(s)
Rolf Olsson

Adviser: Björn Wittenmark

Title and subtitle
Modellering och Simulering av Synkrongeneratordynamik
(Modelling and Simulation of Synchronous Generator Dynamics)

Abstract
A4 A5
A number of simple synchronous machine models have been written in the simulation language SIMNON. The intention has been to find a set of models, which reflect physical properties and by conversion routines transfer these to Park form or vice-versa. Three different models are presented. Also the methods for determination of the parameters are presented. Simulation studies on one module show the dynamic behavior of certain step-changes in torque and magnetization.

Key words
A4 A5

Classification system and/or index terms (if any)

Supplementary bibliographical information

Language
Swedish

ISSN and key title

ISBN

Recipient's notes

Number of pages
53

Price

Security classification

Distribution by (name and address)

Organization
LUND INSTITUTE OF TECHNOLOGY
Department of Automatic Control
P.O Box 725
S-220 07 LUND 7
SWEDEN

Document name
Master Thesis

Date of issue
June 1980

CODEN:
LUTFD2/(TFRT-5235)/1-87/(1980)

Author(s)
Pär Wennstad

Adviser: K J Åström

Title and subtitle

Adaptiva regulatorer (Adaptive regulators)

A4 A5

Abstract

The aim of this work is to give an introduction to adaptive regulators and some structures. In dealing with the mathematical description, the investigated systems turn out to show non-analyticity on our way of finding usable criteria. A survey of available methods to overcome this are discussed.

A simple adaptive controller without need of any plant model - proposed by Maršík - is shown to be insufficient in some respects. These are satisfactorily explained. In order to improve the controller some modified models are presented.

Studies are made in the field of model reference adaptive systems. Liapunov´s second method, which is used in the analysis presented, is analyticaly shown to be useless for some testsignals.

Key words

A4 A5

Simple adaptive regulators, Maršík´s regulator, Model reference adaptive systems, Analysis, Analytical calculations.

Classification system and/or index terms (if any)

Supplementary bibliographical information

Language
Swedish

ISSN and key title

ISBN

Recipient's notes

Number of pages
87

Price

Security classification

Distribution by (name and address)