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CODEN: LUTFD2/(TFRT-6016)/1-21/(1985)

Master Theses in Automatic Control

Björn Wittenmark

**Department of Automatic Control
Lund Institute of Technology
December 1985**

Department of Automatic Control Lund Institute of Technology P.O. Box 118 S-221 00 Lund Sweden		<i>Document name</i> MASTER THESES REPORT	
		<i>Date of issue</i> December 1985	
		<i>Document Number</i> CODEN: LUTFD2/(TFRT-6016)/1-021/(1985)	
<i>Author(s)</i> B. Wittenmark		<i>Supervisor</i>	
		<i>Sponsoring organisation</i>	
<i>Title and subtitle</i> Master theses in Automatic Control 84/85			
<i>Abstract</i> <p>The report contains abstracts of Master Theses (examensarbeten) made at the Department of Automatic Control, Lund, during the academic year 84/85. During this year 16 theses were made by 18 students. Most of the theses are written in Swedish with an English abstract.</p>			
<i>Key words</i>			
<i>Classification system and/or index terms (if any)</i>			
<i>Supplementary bibliographical information</i>			
<i>ISSN and key title</i>			<i>ISBN</i>
<i>Language</i> English	<i>Number of pages</i> 21	<i>Recipient's notes</i>	
<i>Security classification</i>			

MASTER THESES IN AUTOMATIC CONTROL 84-85

B. Wittenmark

1. INTRODUCTION

The education for civilingenjörsexamen (Master Degree in Engineering) is completed with an independent 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 month of full time work. The thesis can be made individually or by two students together.

This report is a collection of the document pages of the theses completed during the academic year 1984/1985. During this time 16 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 in cooperation with the industry or other departments at the university.

Further information concerning the results can be obtained from the Department of Automatic Control by contacting the advisor. The theses may be borrowed through your library service or from the following libraries in Sweden:

Linköpings Universitetsbibliotek
Svensktrycket, S-581 83 Linköping, Sweden

UB 2, Svenska Tryckavdeln.
Box 1010, S-221 03 Lund, Sweden

Stockholms Universitetsbibliotek
Svenska Tryckavdeln., S-106 91 Stockholm, Sweden

Kungliga Biblioteket
Box 5039, S-102 41 Stockholm, Sweden

Umeå Universitetsbibliotek
Box 718, S-901 10 Umeå, Sweden

Uppsala Universitetsbibliotek
Box 510, S-751 20 Uppsala, Sweden

2. LIST OF THESES

- TFRT-5308 Björn Malmström: Dynamisk modellering och simulering av värmecentral med fjärrvärmenät-tillämpning Skurup (Dynamical modelling and simulation of a district heating plant and network in Skurup). July 1984.
- TFRT-5309 Ulf Steen: Simulering och reglering av ett system med en tre-fluids-värmeväxlare (Simulation and regulation of a system including a three-fluid heatexchanger). June 1984.
- TFRT-5310 Jan Eric Larsson: An expert system interface for Idpac. July 1984.
- TFRT-5311 Carl Almquist: Automatisk utvärdering av mätvärden från en hammarkvarnsprocess (Automatic evaluation of measurement values from a hammer mill process). Aug 1984.
- TFRT-5312 Peter Lerup: Ett grafiskt hjälpmedel för programutveckling i Ada (A graphical tool for program development in Ada). Sept 1984.
- TFRT-5313 Anders Jansson: Beräkning av regulatorparametrar med hjälp av i regulatorn inbyggd process modell (Computation of regulator parameters using gain scheduling). Sept 1984.
- TFRT-5314 Kenneth Nilsson: Strukturidentifiering av aktivslamprocessen (Structural identification of the Activated sludge process). Nov 1984.
- TFRT-5315 Ulf Persson: Reglering av system med variabel tidsfördröjning (Control of systems with timevarying timedelay). Nov 1984.

- TFRT-5316 Bernt Nilsson: Enzymatisk hydrolys av cellulosa i tvåfas-system (Enzymatic hydrolysis of cellulose in two-phase system). Dec 1984.
- TFRT-5317 Magnus Taube: Grafisk presentation och editering av matematiska uttryck och reläschema (Graphic Presentation and editing of mathematical expressions and ladder diagrams). Dec 1984.
- TFRT-5318 Ulf Holmberg: Simulering av aktivslamprocessers dynamik (Simulation of the dynamics of activated sludge systems). Febr 1984.
- TFRT-5319 Magnus Lundblad, Richard Svensson: Simulering av frekvenssyntes (Design and simulation of frequency synthesis). Dec 1984.
- TFRT-5320 Mårten Lindberg: Reglering av aktivslamprocessen vid AKO, Karlshamn. En förstudie (Control of an activated sludge process at AKO, Karlshamn. A feasibility studie). Jan 1985.
- TFRT-5321 Jonas Brånhult: Optimal "fed-batch"-odling av jäst (Optimal fed-batch growth of bakers yeast). May 1985.
- TFRT-5322 Ulf Adamsson: Infrysning av livsmedel - simulering av en industriell process (Freezing of foods - simulation of an industrial process). May 1985.
- TFRT-5323 Stefan Nilsson, Tor Sjödin: Autonom reglercentral (Stand alone controller). June 1985.

3. LIST OF SUBJECTS

<u>Subject</u>	<u>Thesis</u>
Adaptive control	5315
Analysis and synthesis	5311, 5323
Biological processes	5316, 5321
Digital control	5317
Expert systems	5310
Modelling and identification	5308, 5309, 5319, 5322
Power systems	5308, 5313
Programming tools	5312
Waste water treatment	5314, 5318, 5320

4. DOCUMENT PAGES

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

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LUND INSTITUTE OF TECHNOLOGY DEPARTMENT OF AUTOMATIC CONTROL Box 725 S 220 07 Lund 7 Sweden		Document name MASTER THESIS	
		Date of issue July 1984	
		Document number CODEN.LUTFD2/(TFRT-5308)/(1-63)/(1984)	
Author(s) Björn Malmström		Supervisor Björn Wittenmark	
		Sponsoring organization	
Title and subtitle Dynamisk modellering och simulering av värmecentral med fjärrvärmenät - tillämpning Skurup. (Dynamical modelling and simulation of a district heating plant and network in Skurup.)			
Abstract The thesis analyzes a heating system comprising a heat pump, auxiliary boilers, piping system, and buildings, including the internal radiator systems. The work concerns a given plant in the town Skurup (in the southern part of Sweden), where the task was to examine the cooperation between the various generating plants to provide a basis for improved control system operation. A general discription is first given of the various part systems, including: sewage water system (the heat source), heat pump, radiator systems, oil boilers, and the control system. From plant measurements the following main conclusions can be drawn: - The radiator supply temperature shows a significant deviation from stipulated value. - A propensity to unstable control system operation is observed For system parts dynamical models were developed and the performance of the system as a whole was simulated by means of the computer program called SIMNON. As an important result the auxiliary boilers were seen to partly replace the heat pump during start-up periods.			
Key words			
Classification system and/or index terms (if any)			
Supplementary bibliographical information			
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Language Swedish	Number of pages 63	Recipient's notes	
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		MASTER THESIS	
		Date of issue	
		JUNE 1984	
		Document number	
		CODEN:LUTFD2/(TFRT-5309)/O-064/(1984)	
Author(s) Ulf Stéen		Supervisor	
		Sponsoring organization	
Title and subtitle			
Simulering och reglering av ett system med en Tre-fluids-värmeväxlare. (Simulation and regulation of a system including a Three fluid heatexchanger.)			
Abstract			
<p>In this report the equations that describes the dynamics of a three-fluid heat-exchanger and also in a counterflow radiator are derived. To be able to simulate the dynamic wring the simulationlanguage SIMNON, the equations has been discretized. The discretized models presented has shown a non-minimum-phase effect. To control and regulate a system consisting of a three-fluid heatexchanger followed by a radiator, the out-temperature of the radiator's airflow was feedback with the mass-velocity of the radiator's waterflow with a PI-regulator. It was shown that disturbances on the system was quickly eliminated with this feedback. In this report examples are given how to further develop and improve the mathematical models and the regulation of the system.</p>			
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Swedish	64		
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DEPARTMENT OF AUTOMATIC CONTROL
 Box 725
 S 220 07 Lund 7 Sweden

Document name	Masters Thesis
Date of issue	July 1984
Document number	CODEN: LUTFD2/(TFRT-5310)/1-84/(1984)
Supervisor	Karl Johan Aström
Sponsoring organization	

Author(s)

 Jan Eric Larsson

Title and subtitle

 An Expert System Interface for Idpac

Abstract

This masters thesis deals with the design of an expert system for performing systems identification. The system is to be used as an expert interface for Idpac, a command driven, interactive program. There is a brief overview of systems identification and possible user types are discussed. The thesis treats the different parts of an expert system: the data base, the production rules handling system and the user interface. Some aspects on implementation and the feasibility of using an existing framework are given. Finally, a small rule base for systems identification is developed.

Key words
 Expert Systems, Expert Interfaces,
 Interaction, Systems Identification.

Classification system and/or index terms (if any)

Supplementary bibliographical information

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Language	English	Number of pages	84	Recipient's notes
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LUND INSTITUTE OF TECHNOLOGY DEPARTMENT OF AUTOMATIC CONTROL Box 118 S 221 00 Lund Sweden		Document name Master Thesis
		Date of issue August 1984
		Document number (TFRT - 5311)/1-058/(1984)
Author(s) Carl Almquist		Supervisor Björn Wittenmark
		Sponsoring organization
Title and subtitle Automatisk utvärdering av mätvärden från en hammarkvarnsprocess (Automatic evaluation of measurment values from a hammer mill process)		
Abstract <p>The process in a mill is frequently monitored with the assistance of list of measurment values and alarms from the process. Much time and concentration is sometimes needed to interpret these lists.</p> <p>If the process is described using a model the interpretation can be made automatically by a computer. This would unload the operator and permit the concentration of the operator to be focused on running the process in an economic and energy saving manner.</p> <p>The possibilities of creating such a model, describing a hammer mill process, are studied. Different parameters and methods of measuring these are discussed. The results of the discussions lead to a series of measurements related to the process. An attempt is made to set up a model to describe how efficently the energy is used and the quality of the product. The results is expresses as the coefficient of process efficiency and is given in percent.</p> <p>The measurement results show very complicated interrelations. They are too few to allow an acceptable model to be set up.</p> <p>In spite of this some conclusions have been made. It seems as if the hammer mill used for the investigations is run unefficently and with great stress. The probable reasons are brought up and suggestions are made to eliminate the causes.</p>		
Key words		
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LUND INSTITUTE OF TECHNOLOGY DEPARTMENT OF AUTOMATIC CONTROL Box 725 S 220 07 Lund 7 Sweden	Document name Master Thesis	
	Date of issue September	
	Document number CODEN:LUTFD2/(TFRT-5312)/1-144/(1984)	
Author(s) Peter Lerup	Supervisor Hilding Elmqvist	
	Sponsoring organization	
Title and subtitle Ett grafiskt hjälpmedel för programutveckling i Ada. (A graphical tool for program development in Ada.)		
Abstract <p>Nowadays abstraction, information hiding and modularization are well known concepts which can be used as tools when creating large, complex software systems. Ada is a programming language which makes good use of these concepts.</p> <p>A system has been developed which, by using computer animation, creates a "programming space" for an Ada program. A user of the system is able to move around within this space consisting of his own Ada program, and place himself at its different modules. Within each module one of the different levels of abstraction can be selected and this level can be studied or changed. Furthermore the user is able, when in a module, to zoom down to submodules on a lower hierarchical level.</p> <p>All this makes it easier to obtain an overview of a complex system and facilitates the use of modularization, information hiding and abstraction.</p> <p>The system can be regarded as a prototype of a software developing system for Ada intended to be used on scientific personal computers.</p>		
Key words		
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LUND INSTITUTE OF TECHNOLOGY DEPARTMENT OF AUTOMATIC CONTROL Box 725 S 220 07 Lund 7 Sweden		Document name Master thesis	
		Date of issue September	
		Document number CODEN:LUTFD2/(TFRT-5313)/1-047/(1984)	
Author(s) Anders Jansson		Supervisor Björn Wittenmark	
		Sponsoring organization	
Title and subtitle Beräkning av regulatorparametrar med hjälp av i regulatorn inbyggd process modell. (Computation of regulator parameters using gain scheduling.)			
Abstract This master thesis describes a way to construct a controller with a built-in model of the controlled process, making it possible to increase the performance over the whole working-area. This resulted in a gain-scheduled controller. The approach has been applied to the control of a hydro-power station, which is a nonlinear and non-minimum phase process. The aim was to improve the performance of frequency control, on disturbances from the connected grid. This resulted in a built-in linear model whose process variables change with the working point of the hydro power process. Controller parameters are computed from this linear model and used for the control of the non-linear process. Simulations for the comparison between the hydro power system with a conventional controller e.g. PID with fixed parameters, and the described controller have been made. This master thesis has been done at the Department of Automatic Control, Lund Institute of Technology. Initiator was ASEA Otkus, Lund.			
Key words			
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LUND INSTITUTE OF TECHNOLOGY DEPARTMENT OF AUTOMATIC CONTROL Box 725 S 220 07 Lund 7 Sweden		Document name Master thesis	
		Date of issue November	
		Document number CODEN:LUTFD2/(TFRT-5314)/14052/(1984)	
Author(s) Kenneth Nilsson		Supervisor Gustaf Olsson	
		Sponsoring organization	
Title and subtitle Strukturidentifiering av aktivslamprocessen. (Structural Identification of the Activated Sludge Process.)			
Abstract <p>In this report, the possibilities to identify unknown model parameters are studied, using real measurements. The actual model describes the biological reactor in a wastewater treatment plant. The model contains many unknown parameters, which makes it awkward to simulate and adapt all of them at the same time. For that reason the model is divided into smaller parts.</p> <p>First the differential equation of dissolved oxygen has been studied. The dissolved oxygen model is simulated using two input signals, the air flow and the influent water flow rates. The output signal (dissolved oxygen) from the model is compared with the real output. This gives an estimation of the oxygen uptake rate OUR of the microorganisms, and of the oxygen transfer rate.</p> <p>Further the suspended solids concentration is studied, using the calculated OUR. From the OUR the specific growth rate for zooglear organisms is calculated.</p> <p>It is difficult to verify the mass balance of the substrate due to insufficient measurements.</p> <p>At last some simulations are made with an expanded model.</p>			
Key words			
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Security classification			

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LUND INSTITUTE OF TECHNOLOGY DEPARTMENT OF AUTOMATIC CONTROL Box 725 S 220 07 Lund 7 Sweden	Document name	
	Master thesis	
	Date of issue November	
Author(s) Ulf Persson	Document number CODEN:LUTFD2/(TFRT-5315)/1-058/(1984)	
	Supervisor Björn Wittenmark	
	Sponsoring organization	
Title and subtitle Reglering av system med variabel tidsfördröjning. (Control of systems with timevarying timedelay.)		
Abstract <p>A method for control of systems with timevarying time delay is investigated. The control algorithm can be viewed as minimizing the expected variance of an auxillary signal which is a function of the system output, input and reference signal.</p> <p>The auxillary signal is defined in such a way that the auxillary-system time delay are less or equal to the system time delay.</p> <p>The parameters in the control law are estimated by the method recursive least-squares from the auxillary signal.</p> <p>The only needed knowledge of the process is the order of the process polynomials and the maximum time delay.</p> <p>The method is investigated using simulation with the interactive simulation program package SIMNON.</p> <p>It is shown that the controller can adapt to changes in the time delay.</p>		
Key words		
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LUND INSTITUTE OF TECHNOLOGY DEPARTMENT OF AUTOMATIC CONTROL Box 118 S 221 00 Lund Sweden		Document name	Master thesis
		Date of issue	December
		Document number	CODEN:LUTFD2/(TFRT-5316)/1-063/(1984)
Author(s) Bernt Nilsson		Supervisor	Per Hagander
		Sponsoring organization	
Title and subtitle (Enzymatic hydrolysis of cellulose in two-phase systems.) Enzymatisk hydrolysis av cellulosa i tvåfas-system.			
Abstract A comparison of experiment and published models of enzymatic hydrolysis of cellulose gives: The three models, that have been studied, predict batchwise experiments with satisfaction. The models do not give satisfactory predicts for a continuous process.. The models were not good enough for wider studies of a continuous process, like for process engineering purpose or automatic control design. A Flow Injection Analysis-system with a dialysis probe is a good alternativ for on-line analysis of enzymatic hydrolysis, also for the purpose of automatic control. In a continuous two-phase process for production of glucose a SISO-regulator can be used for control of glucoseconcentration. Reconstruction should be used in controlling enzym activities in the process. Continuous time control desigh is enough, because the hydrolysis dynamics is slow.			
Key words			
Classification system and/or index terms (if any)			
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Swedish	63		
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LUND INSTITUTE OF TECHNOLOGY DEPARTMENT OF AUTOMATIC CONTROL Box 118 S 221 00 Lund Sweden		Document name Master thesis	
		Date of issue December	
		Document number CODEN:LUTFD2/(TFRT-5317)/1-122/(1984)	
Author(s) Magnus Taube		Supervisor Hilding Elmqvist	
		Sponsoring organization	
Title and subtitle Grafisk presentation och editering av matematiska uttryck och reläschema.			
Abstract Input- and output to computers are generally still line oriented. With personal computers in combination with bitmapped displays it is possible to use a more sophisticated form and leave the line orientation. A system for presentation and editing of mathematical expressions in conventional mathematical notation is implemented. Boolean expressions can also be presented as ladder diagrams. As a separate part a compiler is implemented. The compiler takes a ladder represented by vectors and texts as input and builds up the corresponding boolean expression.			
Key words			
Classification system and/or index terms (if any)			
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LUND INSTITUTE OF TECHNOLOGY DEPARTMENT OF AUTOMATIC CONTROL Box 118 S 221 00 Lund Sweden		Document name	
		Master Thesis	
		Date of issue February 1984	
Author(s) Ulf Holmberg		Document number CODEN:LUTFD2/(TFRT-5318)/1-048/(1984)	
		Supervisor Gustaf Olsson	
		Sponsoring organization	
Title and subtitle Simulering av aktivslamprocessers Dynamik (Simulation of the dynamics of activated sludge systems)			
Abstract This paper is built on results from dynamical simulations of an active sludge process. In the dynamical model the biological reactor (aerator) and the secondary sedimentation basin (settler) are considered as one system, because of the wrong interactions. The strategy, sludge distribution control by the return sludge flow rate, is simulated with different criteria. Also different settler models are simulated.			
Key words			
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LUND INSTITUTE OF TECHNOLOGY DEPARTMENT OF AUTOMATIC CONTROL Box 118 S 221 00 Lund Sweden		Document name Master thesis	
		Date of issue December 1984	
		Document number CODEN:LUTFD2/(TFRT-5319)/1-086/(1985)	
Author(s) Magnus Lundblad Richard Svensson		Supervisor Björn Wittenmark	
		Sponsoring organization Ericsson Radio System AB, Lund	
Title and subtitle Simulering av frekvenssyntes. (Design and simulation of frequency synthesis.)			
Abstract <p>This master thesis describes an aid to construct a Phase Locked Loop, (PLL). The aim was to simulate and dimension a PLL with it's specifications given.</p> <p>The simulation language Simnon is used to simulate the non-linear PLL system. The PLL have both continuous and discrete component's. This make it difficulte to analyze an PLL with other methods than simulation.</p> <p>The main problem to solve was to decrease the adjustment time and keep the dampingfactor on adjacent channel's at a specified level.</p> <p>It's possible with the written programs to see what influence disturbances and component variations have on the system.</p> <p>Two interactive programs have been written. These programs make it possible to dimension and simulate a PLL in an easy way, without knowing any Simnon commands.</p> <p>This master thesis has been done for Ericsson Radio System AB, Lund. Supervision has been given from the Company and from the Department of Automatic Control, Lund Institute of Technology.</p>			
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	Date of issue Januari 1985	
	Document number CODEN:LUTFD2/(TFRT-5320)/1-040/(1985)	
Author(s) Mårten Lindberg	Supervisor Gustaf Olsson	
	Sponsoring organization	
Title and subtitle Reglering av aktivslamprocessen vid AKO, Karlshamn. En förstudie. (Control of an activated sludge process at AKO, Karlshamn. A Feasibility studie.)		
Abstract This master thesis has been performed at the wastewater treatment plant at AB Karlshamns Oljefabriker. In 1981 - 82 the plant was converted from a system with biological filters into an activated sludge treatment plant. The purpose with this study has been to design a control system for the dissolved oxygen level in the activated sludge process. Due to an inflexible design of the plant the main part of the study has been devoted to create the necessary conditions to make control possible. This has been done by installation of an oxygen sensor and air regulators. The study concludes with a presentation of a computer code and a control strategy for the aeration process.		
Key words		
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		Date of issue May 1985	
		Document number CODEN:LUTFD2/(TFRT-5321)/1-044/(1985)	
Author(s) Jonas Brånhult		Supervisor Per Hagander	
		Sponsoring organization	
Title and subtitle Optimal fed-batch growth of bakers yeast (Optimal "fed-batch" -odling av jäst)			
Abstract <p>The report describes a method to optimally regulate a fed-batch culture of baker's yeast. The feeding media are controlled by a computer. The control system is based on a model of the yeast growth and the substrate consumption.</p> <p>A state space model for the yeast growth is derived. The model is used to design a control system. The model is used to design a control system. The model is used to design a control system.</p> <p>Optimal control is designed and simulated resulting in a control system. Two feed-back signals are used: the substrate concentration and the ethanol concentration. Two cases, three regulators, and a PID-regulator, pole placement, and a control system with and without integral action.</p> <p>Finally, some experimental results are given giving some information about the yeast growth.</p>			
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	Date of issue May	
	Document number CODEN:LUTFD2/(TFRT-5322)/1-096/(1985)	
Author(s) Ulf Adamsson	Supervisor Björn Wittenmark	
	Sponsoring organization	
Title and subtitle Infrysning av livsmedel - Simulering av en industriell process. (Freezing of foods - Simulation of an industrial process.)		
Abstract Design and operation of industrial freezers contains the crucial problem of how to make the frozen foods attain a prescribed temperature. Methods for prediction of freezing times under given constant conditions are commonly used in order to calculate the optimum product flow through continuous freezers. However, in reality the processes are time variable, due to disturbances and parameter deviations. Thus, introduction of real time temperature measurements combined with manual or automatic control would be a feasible way to obtain improved reliability, with regard to product quality. Freezing under time-varying conditions is studied, using a numerical solution method for the heat conduction equation with temperature-dependent coefficients. A mathematical model of the freezing process is described, and a Pascal program for simulation of the Frigoscandia Gyrofreeze (spiral freezer) is presented. Finally, the process dynamics are discussed and a regulator structure, based on product temperature feedback combined with feedforward from measurable disturbances (mainly air temperatures), is proposed.		
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LUND INSTITUTE OF TECHNOLOGY DEPARTMENT OF AUTOMATIC CONTROL Box 118 S 221 00 Lund Sweden		Document name Report	
		Date of issue June 1985	
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Author(s) NILSSON Stefan SJÖDIN Tor		Supervisor Björn Wittenmark. Michael Lundh	
		Sponsoring organization	
Title and subtitle AUTONOM REGLERCENTRAL . (Stand alone controller)			
Abstract Constructing a PID-controller by using Intel's 8052-AH Basic makes way for a wide range of realtime applications. Implemented in this construction is a foreground process consists of operator communication while the background process contains the regulator algorithm. This makes it possible for the user to change parameters during program execution in real-time. Control over the system can be actived either by using a button-matris-hand terminal together with an LCD, or by using a usual monitor terminal.			
Key words			
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