SUMMARY REPORT

TEACHING OF UNDERGRADUATE PROCESS DYNAMICS AND CONTROL

A Mini-session Presented at the

Annual Meeting

Chicago, Illinois

November 12, 1985

INTRODUCTION

In 1971, the Chemical Engineering Education Projects Committee conducted a survey on the teaching of [illegible] in the United States and [illegible]

It is interesting to note the dominance of a single textbook in a given field. Surveys conducted in the

TABLE 1

NUMBER OF COURSES

	SEMESTER BASIS REPLIES	QUARTER BASIS REPLIES	1985 PERCENT	(1975) (PERCENT)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Two	17	9	23	(26)
Three	1	1	2	(2)
	86	24		

	REPLIES
Is the course required?	
Yes	92
No	18

TABLE 2

PLACEMENT IN THE CURRICULUM

	REPLIES	1985 PERCENT	1975 PERCENT
Semester Basis			
Junior, 1st Semester	1	1	(13)
Junior, 2nd Semester	12	14	
Senior, 1st Semester	30	35	(87)
Senior, 2nd Semester	43	50	
	86		
Quarter Basis			
[illegible]			
Junior, 3rd Quarter	3	13	(13)
Senior, 1st Quarter	7	29	

TABLE 4

CLASS DATA

Sections offered (1984-85)	Replies
0	2
1	63
2	16
3	3
4	3
	87

Enrollment per Section	
15-	15
16-20	12
21-25	13
26-30	19
31-35	9
36-40	12
41-45	4
46-50	9
51-55	3
56-60	2
61-65	4
66-70	2
71-75	1
76-80	2
81+	3
	110
Average	34.1

	REPLIES	1985 PERCENT	(1975) (PERCENT)
Course emphasis			
Math modeling-analytical	90	82	(78)
Math modeling-empirical	54	49	(33)
Control	108	98	(88)
Instrumentation	33	30	(27)
Others			
Simulation	4	4	(8)
Stability	4	4	
"Others"	16	15	
Lectures are reinforced with:			
Classroom demonstrations	44	40	(33)
Audio-Visual Aids	45	41	(33)
Lab Experiments	75	68	(75)
None of the Above	13	12	
Others			
Computer simulations	8	7	

OBJECTIVES

Modeling real processes

Realize need for control

Jargon of process control

Using the PDP11/04 Computer

First-order Process Dynamics

Impulse testing of a mixing tank

Real-time Program on the PDP 11/04

Electronic Analog controllers

Pneumatic Analog controllers

Derivative control

Dynamics of a heat exchanger

EXPERIMENTS

Liquid level in two tanks

Measuring dynamics of unknown transfer function set up on analog computer

computer

Supervisory control of two reactor batterys - Apple IIe and Isaac 91A interface

UNIVERSITY OF BUCKNELL

Process Control

Feedback

OBJECTIVES

Model or transfer function development

DIFFICULT CONCEPTS

Linearization

Deviation variable analysis

Block diagram

Controller tuning methods

OBJECTIVES

Control concepts

EXPERIMENTS

- Microprocessor control
- Optimum adjustment of PID controller
- Behavioral system dynamics

LOUISIANA STATE UNIVERSITY

Process Dynamics

DIFFICULT CONCEPTS

- Block diagrams and instrumentation
- Relationship of steady-state to problem variables
- Linear/nonlinear differential equations

OBJECTIVES

- Transfer functions, lags, dead-
- Feedback, feed forward, ratio and cascade control systems design

EXPERIMENTS

- Manual and automatic operation of a process furnace
- Determination of gains and time

EXPERIMENTS

- Dynamic behavior of interacting and non-interacting tank systems
- Level controller tuning

MANHATTAN COLLEGE

Process Control

DIFFICULT CONCEPTS

- Unsteady-state mass and energy
- Importance of temperature, level, and flow controllers to processes

OBJECTIVES

- Control objectives and instrumentation requirements for typical processes
- Jargon of control and control loops
- Analytical and empirical math solution methods
- Controller tuning

EXPERIMENTS

OBJECTIVES

- Simple time constant
- Classic controller functions
- Feedback closed-loop control
- Determination of control constants

EXPERIMENTS

- Double effect evaporation

UNIVERSITY OF NEBRASKA

Automatic Process Control and Laboratory

DIFFICULT CONCEPTS

EXPERIMENTS

- Level control
- Pressure control (single capacity process)
- Use of digital controller in tuning

UNIVERSITY OF NEW BRUNSWICK

Process Dynamics and Control

DIFFICULT CONCEPTS

- Unsteady-state analysis of otherwise well-understood systems
- Relating analytical theory to

Mathematical modeling of processes
Experimental analysis of process dynamics
Stability analysis
Controller selection and tuning

EXPERIMENTS

Impulse response of stirred tank
Sensing means and signal conditioning
Air-operated controllers
Frequency response - one and two stage RC filters
Step response - stirred tank and heat exchanger

UNIVERSITY OF NORTH DAKOTA
Chemical Process Dynamics

DIFFICULT CONCEPTS
[illegible]

UNIVERSITY OF NOTRE DAME

Process Modeling, Analysis, and Control

DIFFICULT CONCEPTS
Qualitative understanding of complex variables and their application

OBJECTIVES
Linear dynamics
Role of feedback
Control design strategies

EXPERIMENTS
Process Simulator

OHIO UNIVERSITY
Process Control and Laboratory

DIFFICULT CONCEPTS
Modeling

Analytical and empirical modeling

DIFFICULT CONCEPTS

Behavior of 2nd-order systems

OBJECTIVES

Behavior of 1st and 2nd-order systems

Block diagrams

EXPERIMENTS

Step response of 1st and 2nd order system

Controller tuning

TUFTS UNIVERSITY

EXPERIMENTS	OBJECTIVES
Level control (1st and 2nd order)	Math modeling
[illegible]	Open- and closed loop transfer
control	Stability analysis
Step response transfer function measurement	Digital simulation and control
[illegible]	EXPERIMENTS
[illegible] measurement	Liquid level control

EXPERIMENTS

Air pressure regulation
Pressure sensor calibration
Temperature sensor response characteristics
Flow metering and control valves
Liquid level system dynamics

OBJECTIVES

Understand need of process control
Meaning and importance of dead-time, gain, time constant
Setting a feedback controller and additional control techniques (ratio, cascade, FFC)

Thermal system dynamics
Pressure system dynamics

EXPERIMENTS

On-line tuning
Controller calibration

Tuning feedback controllers
Scale computing blocks
Ratio control and setting cascade

RUTGERS UNIVERSITY

UNIVERSITY OF TULSA
Process control

DIFFICULT CONCEPTS
Linearization details

[illegible]

control
Transfer functions (meaning)
Dynamic behavior system
Basic control elements

[illegible]

WASHINGTON STATE UNIVERSITY
Process Control

DIFFICULT CONCEPTS
Frequency domain stability

OBJECTIVES
Introduction to dynamics of systems
Controller design techniques
Digital controller testing

CALIFORNIA STATE POLYTECHNIC UNIVERSITY
POMONA

[illegible]

TECHNICAL UNIVERSITY OF NOVA SCOTIA
Process Control I, II and III

DIFFICULT CONCEPTS
Stability concept
Translation of block diagram to actual working system

[illegible]

OBJECTIVES
Understanding of control techniques in industry
Clear idea of control logic and strategy

[illegible]

(introduction)

EXPERIMENTS
Liquid level control
Tanks in series
Introduction to microcomputers

YALE UNIVERSITY
Process Control

DIFFICULT CONCEPTS
Stability, frequency response, z-transformer, Nyquist plots

OBJECTIVES

[illegible]

DIFFICULT CONCEPTS

OBJECTIVES
- System concepts
- Dynamics
- Concept or feedback control

EXPERIMENTS
- Feedback control of tank heater
- Distillation column

UNIVERSITY OF PUERTO RICO
Process Analysis and Control

DIFFICULT CONCEPTS
- Making students think in terms of dynamics of processes instead

VANDERBILT UNIVERSITY

- Frequency response controller design
- Nyquist stability

OBJECTIVES
- Time dependent response of chemical engineering systems
- Math models
- Solving equations and making up model
- Control

EXPERIMENTS
- Liquid level
- Process simulation - analog simulator - Conversion from