SUMMARY REPORT

TEACHING OF UNDERGRADUATE
PROCESS DYNAMICS AND CONTROL

A Mini-session Presented at the

Annual Meeting

American Institute of Chemical Engineers

Chicago, Illinois

November 12, 1985

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INTRODUCTION

In 1971, the Chemical Engineering Education Projects Committee conducted a survey on the teaching of Mass and Energy Balances in the United States and Canada. The purpose was to compile data on texts, laboratories, academic level and course content, and to discover and share innovative teaching techniques. Each year, a different chemical engineering subject area has been surveyed. By 1981, the cycle began its second round with a new survey on Mass and Energy Balances. The 1985 survey deals with the teaching of undergraduate Process Dynamics and Control.

A questionnaire was mailed in March, 1985 to the chairman of the 169 chemical engineering departments in the United States and Canada. A follow-up questionnaire was mailed in September to departments which had not responded by that time. One hundred ten replies were received. This compares to 136 in 1984 (Reactor Design), 123 in 1982 (Chemical Engineering Thermodynamics) and 109 in 1981 (Mass and Energy Balances).

A survey on teaching undergraduate Process Dynamics and Control made in 1975 received 101 replies. Comparisons between the 1975 and 1985 surveys will be made as appropriate.

TEXTBOOKS

Textbooks were named for 132 of the 136 courses at the 110 universities surveyed. In nine of these courses, the text consisted of the instructor's personal notes, a textbook in press, or privately printed texts or manuals. These soruces were used only at one university and are not listed below. One of the three most widely used texts was used in over 75% of the courses. No other text was used in more than four courses. Ten texts were used in only one course. The three most widely used texts are:

Author	Courses	Percent
Stephanopoulis (1984)	64	48
Coughanowr & Koppel (1965)	27	20
Luyben (1972)	14	11
Others (10 texts)	27	20

It is interesting to note the dominance of a single textbook in a given field. Surveys conducted in the past ten years in such uniquely chemical engineering areas as reactor design, ChE thermodynamics, mass and energy balances, plant design, mass transfer and process control show that the most popular text was used in 53% to 75% of the courses.

NUMBER OF COURSES

Chemical engineering curricula generally include a single undergraduate course in process dynamics during the senior year. The present survey showed that 75% of the departments offer a single course, 24% offer two courses and 1% offer three courses.

Forty-two percent of the departments on the quarter system offered 2 or more courses. Only 20% of the departments on the semester basis did likewise (Table 1).

These results are comparable to those of the 1975 survey, when 72% of the departments offered one course, 26% offered 2 courses and 2% offered no course.

COURSE PLACEMENT

In most curricula, Process Control is one of the last chemical engineering courses taken. At schools on the semester basis, half of the courses reported are offered during the final semester of the curriculum. There is an even distribution among the three senior quarters at departments on the quarter system. Regardless of the basis, 94% of the courses are taken in the senior year (Table 2).

CONTACT HOURS

Seventy-eight percent of the courses are offered on the semester schedule while 22% are on the quarter schedule. Courses in departments on the semester basis met for 2.94 hours each week for 14.6 weeks. This gives 43.0 "hours" of instruction in each course. (A 50 minute period is considered to be one "hour".) Courses in departments on the quarter basis met for 3.5 hours each week for 10.2 weeks, resulting in 35.7 hours of instruction. Considering the average number of process

TABLE 1

NUMBER OF COURSES

Number of Courses	SEMESTER BASIS REPLIES	QUARTER BASIS REPLIES	1985 PERCENT	(1975) (PERCENT)
One	68	14	75	(72)
Two	17	9	23	(26)
Three	1	1	2	(2)
	86	24		

Is the course required?	REPLIES
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			
Junior, 3rd Quarter	3	13	(13)
Senior, 1st Quarter	7	29	
Senior, 2nd Quarter	7	29	(87)
Senior, 3rd Quarter	7	29	
	24		

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

EXPERIMENTS
- Using the PDP11/04 Computer
- First-order Process Dynamics
- Impulse testing of a mixing tank
- Real-time Program on the PDP 11/04
- Second-order process dynamics
- Electronic Analog controllers
- Pneumatic Analog controllers
- Derivative control
- Dynamics of a heat exchanger

BRIGHAM YOUNG UNIVERSITY
- Process Control and Dynamics
- Digital Process Control

DIFFICULT CONCEPTS
- Use of LaPlace Transforms to solve differential equations
- Transfer functions
- Root-Locus, Nyquist stability

OBJECTIVES
- Mathematics of control theory
- Feedback control
- Modern control applications

EXPERIMENTS
- Liquid level - Flow-loop

UNIVERSITY OF BRITISH COLUMBIA
- Automatic Control
- Process Dynamics and Control

DIFFICULT CONCEPTS
- Transfer functions
- Interaction
- Phase plane

OBJECTIVES
- Basic understanding of theory
- Testing of theory
- Familiarity with design of systems

EXPERIMENTS
- Liquid level in two tanks
- Measuring dynamics of unknown transfer function set up on analog computer
- Direct digital control - analog computer
- Supervisory control of two reactor batterys - Apple IIe and Isaac 91A interface

UNIVERSITY OF BUCKNELL
- Process Control

DIFFICULT CONCEPTS
- Feedback

OBJECTIVES
- System dynamics
- Closed loop concept
- Effect of controller on dynamics

EXPERIMENTS
- Open and closed loop dynamics
- Frequency response analysis of a pneumatic valve
- Use of microprocessor for time constant measurement of temperature sensing elements
- Control of Fluid-Flow network

UNIVERSITY OF CALGARY
- Process Dynamics and Control

DIFFICULT CONCEPTS
- Feedback

OBJECTIVES
- Understand a loop, feedback, time constant, stability, and reponse

EXPERIMENTS
- One/two/three tank liquid level dynamics
- Two tank liquid level control
- Heat exchanger control
- Heat exchange dynamics /CSSL
- Valve characteristics

OBJECTIVES
- Model or transfer function development
- Feedback control
- Controller tuning methods

EXPERIMENTS
- Transient response/1st and higher order systems
- Analog and digital simulation
- Stability
- Controller tuning
- Digital simulation
- Control of 3-tank pressure process

FLORIDA INSTITUTE OF TECHNOLOGY

Chemical Engineeirng Process Dynamics
Process Control

OBJECTIVES
- Transfer functions
- Dynamics
- Control

UNIVERSITY OF FLORIDA

Process Control Theory and Laboratory

DIFFICULT CONCEPTS
- General Nyquist stability criterion

OBJECTIVES
- Modeling through response curves and first principles
- Methodology for controller design
- Dynamics; stability

EXPERIMENTS
- Linear models obtained via Taylor series expansion from the response curves
- P controller is tuned via root locus and performance is tested
- PID controller is tuned/IMC performance tested

GEORIGA TECH UNIVERSITY

Process Control
Special Topics in Digital Control

DIFFICULT CONCEPTS
- Linearization
- Deviation variable analysis
- Block diagram

OBJECTIVES
- Control concepts
- Linear vs nonlinear systems
- Stability
- On-line tuning

EXPERIMENTS
- Liquid level control
- Two tanks in series
- Thermocouple dynamics
- Water heating by injection of live steam

UNIVERSITY OF IDAHO

1: Automatic Process Control
2: Digital Process Control

DIFFICULT CONCEPTS
- Reducing to a mathematical description
- Simplifying assumptions

OBJECTIVES
- Modeling
- Controller design
- Comparison of models to real systems

EXPERIMENTS
- 1: Valve gain
- Resistance Thermometry
- Level control
- 3-mode control
- Transducor gain
- Phase lag
- 2: Sampling
- Alarm signals
- Proportional control
- Control implementation using deadbeat, control Dahlin salgorithm PID

IOWA STATE UNIVERSITY

Process Control

DIFFICULT CONCEPTS
- Frequency response
- Root-Locus

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

LOUISIANA STATE UNIVERSITY
Process Dynamics

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

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

EXPERIMENTS
- Manual and automatic operation of a process furnace
- Determination of gains and time constants
- Feedback controller modes

UNIVERSITY OF LOUISVILLE
Process Control

OBJECTIVES
- Design, modeling, analysis of SISO systems

UNIVERSITY OF MAINE
Process Control

DIFFICULT CONCEPTS
- Unsteady-state modeling: accumulation terms
- Frequency response

OBJECTIVES
- Dynamic models of processes
- Generalized transient behavior of chemical processes
- Types of controllers and hardware
- Controller design and tuning

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

MANHATTAN COLLEGE
Process Control

DIFFICULT CONCEPTS
- Unsteady-state mass and energy balances
- 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
- Liquid level control
- Computer controlled heat exchangers
- Distillation

UNIVERSITY OF MASSACHUSETTS
Process Control

DIFFICULT CONCEPTS
- Connection between simple models and complex processes

OBJECTIVES
- Basics of system identification and modeling
- Basic limitations of linear system models
- Basics of PID, feed forward, and more advanced controllers
- Controller tuning

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
- Relationships among pulse response, step response, transfer function, and the general unsteady-state behavior of a linear system

OBJECTIVES
- Introduce unsteady state and apply to chemical engineering cases
- Linearization
- Transfer function and block diagrams
- Classical methods for stability analysis

EXPERIMENTS
- 1st order process-analog computer-pressure process-liquid level
- Experimental dynamics-heat exchange-analog computer
- Control/stability-pressure process-analog computer

UNIVERSITY OF NEVADA
Industrial Instrumentation
Control of Process Systems

DIFFICULT CONCEPTS
- Steady-state gain
- Small perturbation analysis

OBJECTIVES
- Instrumentation of process flow diagram
- Achieve physical intuition
- Application of various control strategies

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 reality situations
- Picturing the hardware action and its dynamic role in the loop

OBJECTIVES
- Analyze unsteady-state processes
- Application of previously studied physical principles
- The effect of a valve in a flow system
- Feedback control loop-oscillation and instability

EXPERIMENTS
- Level control (pneumatic devices)
- Level control simulation (analog computer)

UNIVERSITY OF NEW HAMPSHIRE
Process Dynamics and Control

DIFFICULT CONCEPTS
- Digital/analog and A/D conversion

OBJECTIVES
- Solutions to design/control problems
- Basic control loop hardware and software
- Real-time data acquisition and process control using microcomputers

OBJECTIVES
- 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
- Relationship of equations/models to reality

OBJECTIVES
- Talking knowledge of control terms
- Basis for further self-study
- Control of steps in a process

NORTHEASTERN UNIVERSITY
Chemical Process Control

DIFFICULT CONCEPTS
- Writing equivalent system of algebraic and 1st order differential equations from a block diagram

OBJECTIVES
- Apply conservation laws to unsteady-state operation
- Transfer functions
- Computer simulation of control systems
- Frequency response

EXPERIMENTS
- Transmitter characteristics
- Controller tuning
- Steam-heated exchangers

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

OBJECTIVES
- Analytical and empirical modeling
- Feedback control
- Stability
- Controller parameter design

EXPERIMENTS
- Controller calibration
- Liquid level systems
- Process simulators
- Jacketed heat exchangers
- Frequency response
- Control - Ziegler Nichols and Cohen Coon

OKLAHOMA STATE UNIVERSITY
Chemical Process Instrumentation and Control

Process Control Laboratory

DIFFICULT CONCEPTS
- LaPlace transform functions
- Frequency response analysis

OBJECTIVES
- Linearization
- Feedback control
- Stability
- Frequency response and Nyquist stability theorem
- Advanced controllers

EXPERIMENTS
- Feedback control
- Frequency response analysis
- Cascade, F.F. control
- Inverse response compensators

UNIVERSITY OF RHODE ISLAND

Process Dynamics and Control

OBJECTIVES
- Restraint equations for process modeling
- Block diagram; digital-computer program
- Predict parameters of linear responses
- Extract parameters from responses

EXPERIMENTS
- Air-operated valve characteristics
- Liquid-level control
- Dynamic response of a pressure vessel
- Frequency - response of a U-tube manometer

UNIVERSITY OF ROCHESTER

Process Dynamics and Control

OBJECTIVES
- Modeling
- Techniques to study and analyze dynamics of physical systems
- Designing control systems

EXPERIMENTS
- CSTR control
- Temperature control of air-box heated by light bulb
- Computer simulated system of CSTR's control

ROSE-HULMAN INSTITUTE OF TECHNOLOGY

Process Control
Advanced Process Control

DIFFICULT CONCEPTS
- Mathematics of stability determination
- Process Dynamics
- Relevance to real world

OBJECTIVES
- Theory of linear control systems
- Designing control systems
- Hardware

EXPERIMENTS
- Tuning a control system
- Liquid level control
- Comparing differential schemes for control of overhead product from a distillation column

UNIVERSITY OF SASKATCHEWAN

Process Dynamics
Process Control

DIFFICULT CONCEPTS
- Digital control systems
- Design of digital filters
- Dead-time compensation

OBJECTIVES
- Modeling
- Process identification techniques
- Design of control schemes

EXPERIMENTS
- Analog control and DDC control of surge tank level and temperature in a shell and tube heat exchanger
- Data logging

UNIVERSITY OF SHERBROOKE

Control

DIFFICULT CONCEPTS
- Relationship of dependent variable with time
- Relationship between typical forcing functions and the real world

DIFFICULT CONCEPTS
- Behavior of 2nd-order systems
- Blcck diagram algebra
- Frequency response analysis

OBJECTIVES
- Behavior of 1st and 2nd-order systems
- Block diagrams
- System stability
- Frequency response
- Design of feedback control systems
- Modern control systems

EXPERIMENTS
- 2nd order differential equations
- Dynamics of RC circuits
- Feedback systems

UNIVERSITY OF TOLEDO
Process Systems Dynamics and Control

OBJECTIVES
- Review unsteady-state, steady-state, and differential equations
- Process dynamics and modeling
- Feedback control
- Control modes - P, PI, PID, PD
- Lab experience

EXPERIMENTS
- Process dynamics
- pH control
- Level control of tanks (series)
- Control of stirred tanks (series)
- Double pipe heat exchanger control

TRI-STATE UNIVERSITY
Chemical Process Controls

DIFFICULT CONCEPTS
- Frequency response

OBJECTIVES
- Basic theory and application of control systems
- Design of control systems
- Importance of real-world non-linearities of control systems

EXPERIMENTS
- Step response of 1st and 2nd order systems
- Proportional control of a second-order system
- Controller tuning

TUFIS UNIVERSITY
Process Dynamics and Control
Real Time Computing

DIFFICULT CONCEPTS
- Application of theory, stability, tuning to practice

OBJECTIVES
- Terminology
- Feedback
- Getting a feel for dynamics
- Need for control
- Complexity of control

EXPERIMENTS
- Computer control of interacting tanks
- Level control

UNIVERSITY OF UTAH
Process Dynamics I
Process Dynamics II

DIFFICULT CONCEPTS
- Relating theory and analysis to real world

OBJECTIVES
- Physical feeling for dynamic responses
- Feedback control
- Use and application of control systems

EXPERIMENTS
- Liquid level control
- Analog computer simulation
- pH control system
- Digital computer control of continuous process
- Multivariable control
- Frequency response

EXPERIMENTS

- Level control (1st and 2nd order)
- Third order temperature control
- PID controller for temperature control
- Step response transfer function measurement
- Frequency response transfer function measurement
- Speed control system
- Positron control systems
- Third order system simulation and analysis

<u>WIDENER UNIVERSITY</u>

Introduction to Control Systems

DIFFICULT CONCEPTS

- Modeling

OBJECTIVES

- Derive transfer functions
- Determine response to inputs
- Analysis and design of control systems

<u>INDSOR UNIVERSITY</u>

Process Dynamics and Control

DIFFICULT CONCEPTS

- LaPlace Transforms
- Second order systems

OBJECTIVES

- Integrate materials from different courses
- Increase academic maturity
- Build confidence in problem approach and solution
- Modeling

EXPERIMENTS

- Computer simulation of liquid level tanks

<u>UNIVERSITY OF WYOMING</u>

Process Dynamics and Control

DIFFICULT CONCEPTS

- Frequency response

OBJECTIVES

- Math modeling
- Open- and closed-loop transfer functions
- Stability analysis
- Digital simulation and control

EXPERIMENTS

- Liquid level control
  - Manual control
  - Proportional control
  - PI control
  - PID control

<u>UNIVERSITY OF VIRGINIA</u>

Process Modeling; Dynamics and Control

DIFFICULT CONCEPTS

- Transformations from time to LaPlace and frequency domain and back again
- Stability criteria
- Controller tuning
- Root-locus analysis

OBJECTIVES

- Math modeling
- Principles of Process dynamics and control
- Terminology and techniques of feedback control
- Feed forward and computer control

EXPERIMENTS

- Liquid level control in 2-tank cascade
- Computer control of hot water heater

<u>NORTHWESTERN UNIVERSITY</u>

Process Dynamics and Control

Special Topics in Control

DIFFICULT CONCEPTS

- Deviation/variables
- Open- and closed-loop frequency response

EXPERIMENTS
- Air pressure regulation
- Pressure sensor calibration
- Temperature sensor response characteristics
- Flow metering and control valves
- Liquid level system dynamics
- Thermal system dynamics
- Pressure system dynamics
- Off-line tuning and experiment
- On-line tuning
- Controller calibration

<u>RUTGERS UNIVERSITY</u>
Process Simulation and Control

DIFFICULT CONCEPTS
- Closed-loop transient simulation on a computer

OBJECTIVES
- Closed-loop control and computer simulation

EXPERIMENTS
- 3-mode (PID) pH control in a stirred-tank

<u>SAN HOSE STATE UNIVERSITY</u>
Chemical Process Dynamics and Control

DIFFICULT CONCEPTS
- Math modeling
- Block diagram

OBJECTIVES
- Dynamic behavior of process systems
- Analysis and design of control systems

<u>UNIVERSITY OF SOUTH FLORIDA</u>
Automatic Process Control

DIFFICULT CONCEPTS
- Analytical math modeling

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

EXPERIMENTS
- Emperial math modeling
- Tuning feedback controllers
- Scale computing blocks
- Ratio control and setting cascade control systems

<u>TENNESSEE TECHNOLOGICAL UNIVERSITY</u>
Process Dynamics and Control

DIFFICULT CONCEPTS
- Math

OBJECTIVES
- Introduce control ideas and nomenclature
- Introduce control equipment
- Introduce dynamic systems and modeling

EXPERIMENTS
- Developing an IBM PC controlled level experiment

<u>TUSKEGEE UNIVERSITY</u>
Process Control and Instrumentation

DIFFICULT CONCEPTS
- Frequency response
- Control systems simulation

OBJECTIVES
- Process control (application and methods)
- Process dynamics
- Design calculations for control equipment

UNIVERSITY OF TULSA
Process control

DIFFICULT CONCEPTS
Linearization details

OBJECTIVES
Understanding of P, PI, AND PID control
Transfer functions (meaning)
Dynamic behavior system
Basic control elements
Valve sizing

WASHINGTON STATE UNIVERSITY
Process Control

DIFFICULT CONCEPTS
Frequency domain stability

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

ALIFORNIA STATE POLYTECHNIC UNIVERSITY
POMONA
Process Control

DIFFICULT CONCEPTS
Translation of theory to real situations

OBJECTIVES
Introduction to control
Importance of dynamics
Process control equipment and instrumentation

EXPERIMENTS
1st order process - open-loop response; P control
Second order process - PI control; P control
Controller tuning
Control valve characteristics
Digital control

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

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

OBJECTIVES
Understanding of control techniques in industry
Clear idea of control logic and strategy
Process instrumentation (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
Develop qualitative and quantitative skills needed to solve control problems

UNIVERSITY OF OTTAWA
Process Control

DIFFICULT CONCEPTS
Frequency domain concepts

OBJECTIVES
Understand process dynamics and control
Provide tools for analysis and ccntrol
Develop ability to synthesize an effective control system

EXPERIMENTS
PID control of shell and tube heat exchanger (dynamics also)
Computer control of direct contact heater

DIFFICULT CONCEPTS

Frequency response
Complex number

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 of dealing with steady-state processes

OBJECTIVES

Familiarization with controllers, sensors and control elements
Process dynamics and analysis
Develop ability to design control processes

EXPERIMENTS

Level control in one and two tank system
Temperature control (one and two tank system)
Temperature control in exchanger

UNIVERSITY OF HOUSTON

Process Dynamics and Control

DIFFICULT CONCEPTS

Most students are poor programmers - waste of time developing programs

OBJECTIVES

Process modeling
Computer simulation (use of graphics packages)
Fundamentals of linear process dynamics and PID control

EXPERIMENTS

Liquid level control

VANDERBILT UNIVERSITY

Chemical Process Control

DIFFICULT CONCEPTS

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 Block diagram of control system to simulation diagram

UNIVERSITY OF TENNESSEE

Introduction to Process Dynamics and Control
Industrial Process Control
Advanced Process Dynamics and Control

DIFFICULT CONCEPTS

Math and techniques of LT
Stability

OBJECTIVES

Theoretical and empirical modeling
Applied control applications

EXPERIMENTS

Process Identification - 1st-2nd-order and other
Feedback and feed forward
Cascade, RGA, etc.