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# From Automation and Control Training to the Overall Roll-Out of Industry 4.0 Across South-East Asian Nations

# (ASEAN FACTORI 4.0)

**PROJECT No. 609854-EPP-1-2019-1-FR-EPPKA2-CBHE-JP**

**PROCESS DYNAMICS AND CONTROL** **COURSE SYLLABUS**

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CHULALONGKORN UNIVERSITY

**COURSE SYLLABUS**

1. Course Number 2105472
2. Course Credit 3 Credit
3. Course Title Process Dynamics and Control
4. Faculty Faculty of Engineering
5. Semester Second
6. Academic Year 2565

7) Instructor/Academic Staff

7.1 Assoc. Prof. Amornchai Arpornwichanop, D.Eng. (AAN) (Course Coordinator)

7.2 Instructor Sirikanya Singcuna (SSN)

Meeting time: Wednesday 9.30-12.30 Room 305 Building 3

8) Condition

8.1) Prerequisite –

8.2) Corequisite –

8.3) Concurrent –

9) Status Required

10) Curriculum Bachelor of Engineering (Chemical Engineering)

11) Degree Bachelor of Engineering

12) Hours / Week 3 Hours/Week

13) Course Description

The objective of this course is to foster an understanding of mathematical modeling in chemical engineering systems, including solution techniques and system dynamics. It introduces the principles of automatic control, emphasizing the concept of feedback control and stability analysis. The course also covers frequency response and control system designs, as well as an introduction to measurement and the characteristics of control instruments.

14) Course Outline

14.1) Learning Objectives Behavioral Objectives

At the end of this course, students are able to articulate the significance of fundamental control system components, analyze the response of processes utilizing a controlled system, elucidate the concept of stability in controlled processes, and apply cascade and feedforward controls to processes effectively.

14.2) Learning Contents

|  |  |  |
| --- | --- | --- |
| Weeks | Contents | Activities |
| 1 | - Essential - Control system analysis: Mathematical tools (1) | Lecture (AAN) |
| 2 | - Control system analysis: Mathematical tools (2) | Lecture (AAN) |
| 3 | - Dynamic systems: Simple process | Lecture (AAN) |
| 4 | - Dynamic systems: Simple process (2)  - Dynamic systems: Higher-order-processes | Lecture (AAN) |
| 5 | - Dynamic systems: Higher-order-processes with recycle streams (2) | Lecture (AAN) |
| 6 | - Control systems and their basic component (1) | Lecture (SSN) |
| 7 | - Control systems and their basic component (2) | Lecture (SSN) |
| 8 | - Analysis of feedback control loops (Level/Temperature/Pressure/Composition) (1) | Lecture (SSN) |
| 9 | Midterm |  |
| 10 | - Analysis of feedback control loops (Level/Temperature/Pressure/Composition) (2) |  |
| 11 | - Adjusting controller parameters  - Frequency response technique | Lecture (SSN) |
| 12 | -Fundamental and benefits of cascade control  -Some control strategies for productivity and safety | Lecture (SSN) |
| 13 | -Feedforward control: principles and application | Lecture (SSN) |
| 14 | - Industrial cases (Control structure and Advanced control strategy) | Lecture (SSN) |
| 15\* | Introduction to Programmable Logic Controllers (PLC) | Lecture (Prof.Paisan K.) |
| 16\* | Applications of Programmable Logic Controllers (PLC) | Lecture (Prof. David B.) |
| 17\* | PLC Programming Languages | Lecture (SSN) |
| 18\* | Lab 1 | Lecture (SSN) |
| 19\* | Lab 2 | Lecture (SSN) |
| 20 | FINAL EXAM |  |

Remark: \* means additional topics. Basics of modern communication networks. Communication networks. History of Programmable Logic Controllers (PLC) and programming languages. Modern Industrial Networks and Industrial Applications of Programmable Logic Controllers. Industrial Control Systems.The modified curriculum has been meticulously crafted in collaboration with the Factori 4.0 Erasmus+ project 609854-EPP-1-2019-1-FR-EPPKA2-CBHE-JP.

Add the following PLC trainings as part of the teaching.

* Applications of Programmable Logic Controllers: Prof. David Banjerdpongchai
* Introduction to Programmable Logic Controllers (PLC): Prof. Paisan Kittisupakorn
* Ladder Diagram, Function Block Diagram, Sequential Function Chart Using CODESYS, Visualization: Sirikanya Singcuna and team
* PLC Benchmark, HMI GALILEO: Sirikanya Singcuna and team

14.3) Method

Lecture 45 hour (VDO Clip / On-line class)

Lecture and Discussion

Brainstorming and discussion of case study so that students learn to analyze and solve problems

Making a summary of the main points or presentation of the results of researching or the assigned tasks

14.4) Media

Transparencies and opaque sheets

PowerPoint media

Electronics and website media

VDO Clip

14.5) Assignment

14.5.1 Assigning and Submitting Method –

14.5.2 Learning Management System –

14.6) Evaluation

14.6.1 Assessment of academic knowledge

- Mid-Term Exam percent 50

- Final Exam percent 50

14.6.2 Assessment of work or classroom activities

14.6.3 Assessment of the assigned tasks

\*\*\*Note: Plagiarism in any form, including homework, reports, or projects, will result in a complete loss of points.

14.7) Summary of the course syllabus

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Content | Objectives | Learning Result | Teaching Method | Assessment | Lecturer |
| 1. Explain the importance of basis control system components | 5 | c3 | Lecture | Midterm | AAN, SSN |
| 2. Analyze the response of processes with a controlled system | 1,2,3 | c3 | Lecture | Midterm, Final | SSN |
| 3. Explain the stability of controlled processes | 3 | c3 | Lecture | Final | SSN |
| 4. Apply cascade and feedforward controls to processes | 4 | c3 | Lecture | Final | SSN |

|  |  |  |  |
| --- | --- | --- | --- |
| Behavioral Objectives | Learning Outcomes | Teaching Method  (14.3-14.4) | Assessment  (14.6) |
| 1. Create dynamic models for traditional chemical processes. | 4 Develop mass balance for unstable systems without chemical reactions, systems involving chemical reactions and even systems incorporating chemical reactions with recycle. | Lecture | Midterm, Final |
| 2. Calculate the dynamic behavior of processes to assess their stability. | 4 | Lecture | Midterm, Final |
| 3. Design or tuning feedback controls to ensure optimal performance and stability of systems. | 4 Select the appropriate control valve type and control strategy. | Lecture | Final |
| 4.Design complex control systems such as front-feeding and ratio-based control to achieve stable and optimal for closed-loop operation. | 4 | Lecture | Final |
| 5. Understand the basic operation of measuring instruments and control equipment. | 4 | Lecture | Midterm |

14.8) Scoring criteria

The allocation of points will be determined based on the accuracy of students’ answers and ideas.

14.9) Grading

A > 80% and F < 40% (Group points may also be taken into account.)

15) Reading List

15.1) Required Text

Smith and Corripio, Principles and Practice of Automatic Process Control, 3rd edition, John Wiley, 2006.

15.2) Supplementary Texts

1. Marlin, T. E., Process Control: Designing Processes and Control Systems for Dynamics Performance, McGraw Hill, 2000.

2. Ogunnaike, B. A. and Ray, W. H., Process Dynamics, Modeling, and Control, Oxford University Press, 1994.

3. Seborg, D. E., Edgar, T. F. and Mellichamp, D. A., Process Dynamics and Control, 2nd edition, Wiley, 2004.

4. Hanssen, D.H., Programmable Logic Controllers: A Practical Approach to IEC 61131-3 using CoDeSys, Wiley, 2015.

5. Other relevant teaching materials from lecturers.

15.3) Research Articles / Academic Articles (If any) -

15.4) Electronic Media or Websites -

16) Teacher Evaluation

16.1) Teacher Evaluation Teaching assessment

16.2) Changes made in accordance with the previous evaluation

Sample problems will be included so that students have the opportunity to apply problem-solving skills, and develop a deeper comprehension of the subject matter

16.3) Discussion or analysis which creates desirable qualifications of Chulalongkorn University graduates (specifying what aspect(s) required by the University which has been achieved. The four required aspects include intellect and academic knowledge, skills and professional knowledge, ethics, and social responsibility. Intellect and academic knowledge