NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

COURSE CONTENT

Academic Year	2024/2025	**Semester**	1
Course Coordinator	Dr. Mukta Bansal		
Course Code	CH3111		
Course Title	Process Control & Dynamics		
Pre-requisites	CH1104, CH2114/CH2104, CH2112/CH3102		
No of AUs	3		
Contact Hours	26 Lecture hours and 13 tutorial hours		
Proposal Date	1 Feb 2022		

Course Aims

The objective of this course is to help you understand process modelling and controller design. The theoretical details for these concepts as well as their application to process systems encountered in chemical and petrochemical industries are covered.

Intended Learning Outcomes (ILO)

At the end of this course, you should be able to:

1. Interpret the need for stable control systems in process industries
2. Conceptually design and tune control systems and different types of controllers
3. Describe the common elements involved in control systems
4. Formulate models for process control
5. Use Matlab and Simulink for controller design and simulation

Course Content

1. Introduction to process control
2. Introduction to modelling
3. Models from fundamental laws
4. Transfer functions
5. Dynamic response
6. Introduction to feedback control
7. PID controller
8. Closed-loop stability
9. Controller tuning
10. Matlab/Simulink

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/ Individual	Assessment rubrics
1. Final Examination *[2hrs; Open Book]*	1, 2, 3, 4	EAB SLO* a, b, c, f	60%	Individual	

2. Continuous Assessment 1 (CA1): Quiz	3, 4	EAB SLO* a, b, f	20%	Individual	
3. CA2: Assignment	1, 2, 3, 4, 5	EAB SLO* a, b, c, e, f	20%	Individual	Appendix 1
Total			100%		

Formative feedback

Describe how you would be giving feedback to students on how they are learning in this course.

The instructor will discuss the quiz scores and answers with you. You will also receive feedback on your performance during the tutorial and the assignment assessment. Finally, you will get the marker's report on the overall examination performance of your cohort.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
LECTURE	Course materials covering all topics
TUTORIAL	12 classroom discussion sessions on tutorial questions and related topics

Reading and References

1. Dale Seborg, Thomas Edgar, Duncan Mellichamp, Francis Doyle, Process Dynamics and Control, 3rd Edition, Wiley, 2011.
2. Jose Romagnoli and Ahmet Palazoglu, Introduction to Process Control, CRC Taylor & Francis, 2005.
3. Thomas Marlin, Process Control: Designing Processes and Control Systems for Dynamic Performance, 2nd Edition, McGraw-Hill, 2000.
4. B.A. Ogunnaike and W.H. Ray, Process Dynamics, Modeling and Control, Oxford University Press, 1994.
5. Wayne Bequette, Process Control: Modeling, Design and Simulation, Prentice Hall, 2002.
6. George Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Prentice Hall, 1984.

Course Policies and Student Responsibilities

- Completed assignments should be submitted through box labeled CH3111. No late assignments will be accepted.
- There will be no make-up quizzes. Zero points for no show up. Exceptions will be made for leave of absence due to medical reasons (with valid proof). In this case,

points will be awarded based on your performance in the final examination.
- Active note taking in the class is encouraged.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Mukta Bansal	N1.2-B2-28	63168775	mbansal@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction to Process Control	1, 3	
2	Theoretical Models of Chemical Processes	3, 4	
3	Transfer Function Models, Laplace Transform	3, 4, 5	
4 & 5	Dynamic Behaviour of First-Order and Second-Order Processes	3, 4	
6	Dynamic Behaviour of Higher Order Processes	3, 4	
7	Quiz		
8	Feedback Controllers	2	
9 & 10	Closed-Loop Dynamics	2, 4, 5	
11 & 12	Stability of Closed-Loop Control Systems	1, 2, 4	
13	PID Controller Design and Tuning	1, 2, 4	

Recommended Appendices

Appendix 1

Criteria	Unsatisfactory : 1	Borderline: 2	Satisfactory: 3	Very good: 4	Exemplary: 5
Interpretation (LO 1)	Interpretation of the problem is not clear	Interpretation of the problem and explanation of the proposed model suggests minimal understanding of the basics	Interpretation of the problem and explanation of the proposed model suggests that there is basic understanding	Interpretation of the problem and explanation of the proposed model suggests that there is clear understanding of the control system.	Interpretation of the problem and explanation of the proposed model suggests a very clear understanding of the control system that is needed for the assignment and provide recommendations
Matlab implementation (LO 2, 3, 4 and 5)	Not able to implement it in MATLAB	Able to do it without having much idea.	Able to understand and implement it in MATLAB	Able to implement it in MATLAB and able to interpret the results.	The Matlab simulation meets all the requirements and presents the results in a very user friendly/useful way.

Appendix 2: The EAB (Engineering Accreditation Board) Accreditation SLOs (Student Learning Outcomes)

a) **Engineering knowledge:** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems
b) **Problem Analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c) **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d) **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e) **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
f) **The engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g) **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
h) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i) **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j) **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k) **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l) **Life-long Learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change