NANYANG TECHNOLOGICAL UNIVERSITY

COURSE CONTENT

Academic Year	2021/2022	**Semester**	1
Course Coordinator	Dr. Poernomo Gunawan		
Course Code	CH4801		
Course Title	Final Year Design Project		
Pre-requisites	Core Chemical Engineering Subjects (Materials & Energy Balances, Fluids System, Thermodynamics, Chemical Reaction Engineering, Chemical Engineering Unit Operations, Heat & Mass Transfer)		
No of AUs	8		
Contact Hours	56 hours of lectures, 12 hours of tutorials, 260 hours practical		
Proposal Date	14 January 2020		

Course Aims

On completion of this course, students should be able to apply various chemical engineering principles and economic evaluation methods to design a chemical plant and synthesize process flow diagram with the aid of computer simulation software. In addition to the technical aspect, through working on a capstone project, students will be able to manage projects as a team successfully, and to write good technical reports and effective presentations.

Intended Learning Outcomes (ILO)

1) Apply the principles of chemical engineering (material and energy balances, transport phenomena, thermodynamics, chemical reaction engineering, unit operations, and process safety) in the design and operation of chemical plants.
2) Identify and troubleshoot problems by performing in-depth analysis, root-cause investigation and applying decision making tools.
3) Aptly use process simulation tools as an aid in solving the design problems.
4) Undertake and manage project as a team to its successful completion.
5) Write good technical reports and give effective presentation.

Course Content

1. Introduction to chemical process design
2. Introduction to process simulation software
3. Process flowsheet synthesis
4. Process design heuristics
5. Computer-aided design
6. Thermodynamics model selection
7. Review on chemical reactor design
8. Review on separation process design
9. Heat integration and pinch analysis
10. Cost estimation and economic analysis

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team /Individual	Assessment rubrics
Continuous Assessment – Group project (70%)	1, 2, 3, 4, 5	EAB SLO's a, b, c, d, e, f , g, h, I , j, k	70%	Team	Appendix 1
Peer evaluation	4	EAB SLO's i	Moderating factor in final report		Appendix 1
Continuous Assessment – Quizzes (30%)	1, 2	EAB SLO's a, b, c	30%	Individual	Appendix 1
Total			100%		

Mapping of Course ILOs to EAB Graduate Attributes

Course Intended Learning Outcomes	Cat	EAB's 12 Graduate Attributes*											
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
	Core	●	●	●	●	●	●	●	●	●	●	●	
1) To apply the principles of chemical engineering (material and energy balances, transport phenomena, thermodynamics, chemical reaction engineering, unit operations, and process safety) in the design and operation of chemical plants.	a, b, c												
2) To identify and troubleshoot problems by performing in-depth analysis, root-cause investigation and applying decision making tools.	b, c, d, f, g, h												
3) To aptly use process simulation tools as an aid in solving the design problems.	e												
4) To undertake and manage project as a team to its successful completion.	i, j, k												
5) To write good technical reports and give effective presentation.	j												

Legend: ● Fully consistent (contributes to more than 75% of Intended Learning Outcomes)
◐ Partially consistent (contributes to about 50% of Intended Learning Outcomes)
š Weakly consistent (contributes to about 25% of Intended Learning Outcomes)
Blank Not related to Student Learning Outcomes

Formative feedback

Instructor's feedback on the reports and presentation will be given to the students.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lecture	Lectures would primarily review the fundamentals and principles of chemical engineering and discuss examples of their applications in industrial practices. In-class exercises and discussion would be carried out to enable students' participation in class.
Tutorial	Tutorials would involve hands-on practice on the process simulation software to solve given problem statements.

Reading and References

1) M. S. Peters and K. D. Timmerhaus, Plant Design and Economics for Chemical Engineers, 5th Edition, McGraw-Hill Book Company, New York (2002).
2) W. D. Seider, J. D. Seader, and S. R. Lewin, Process Design Principles, J. Wiley & Sons, Inc., New York (1999).
3) R. Turton, R. C. Bailie, W. B. Whiting, and J. A. Shaeiwitz, Analysis, Synthesis, and
4) Design of Chemical Processes, Prentice Hall, Upper Saddle River, New Jersey (1998).
5) E. L. Cussler and G. D. Moggridge, Chemical Product Design, Cambridge University Press, New York, 2001.

Course Policies and Student Responsibilities

General: Students are expected to complete all online activities and take all scheduled assignments and tests by due dates. Students are expected to take responsibility to follow up with course notes, assignments and course related announcements. Students are expected to participate in all tutorial discussions and activities.

Continuous assessments: Students are required to attend all continuous assessments.
Absenteeism: Continuous assessments make up a significant portion of students' course grade. Absence from continuous assessments without officially approved leave will result in no marks and affect students' overall course grade.

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
Kunn Hadinoto Ong	N1.2-B2-31	65148381	KunnOng@ntu.edu.sg
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Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction to chemical process design	1, 2	
2	Thermodynamics model selection	1, 2	
3	Process flowsheet synthesis	1, 2	
4	Process design heuristics	1, 2	
5	Review on reactor design (part 1)	1, 2	
6	Review on reactor design (part 2)	1, 2	
7	Review on separation process design (part 1)	1, 2	
8	Review on separation process design (part 2)	1, 2	
9	Heat integration (part 1)	1, 2	
10	Heat integration (part 2)	1, 2	
11	Heat integration (part 3)	1, 2	
2-13	Tutorials on process simulation software	3	

Appendix 1: Assessment Criteria

Peer Evaluation Form

Group no:	Member Names	0 - No contribution 5 - Full contribution Contribution to the project (0-5)	Justification for grade
Yourself:			
Member 1:			
Member 2:			
Member 3:			
Member 4:			
Member 5:			
Member 6:			
Member 7:			
Member 8:			

Criteria	Unsatisfactory: <40%	Borderline: 40% to 49%	Satisfactory: 50% to 69%	Very good: 70% to 89%	Exemplary: > 90%
Apply chemical engineering principles in the design and operation of chemical plant	The plant design does not achieve the desired output; technically and economically not viable. The design does not apply the correct chemical engineering principles.	The plant design does not achieve the desired output; technically and economically not viable. The selection of unit operations and the operating parameters are lacking of strong and reasonable justifications.	The plant design achieves the desired output but it may not be technically and economically viable. The selection of unit operations and the operating parameters are lacking of strong and reasonable justifications.	The plant design achieves the desired output, technically and economically viable. The selection of unit operations and the operating parameters are based on plausible heuristics, and supported by reasonable justifications.	The plant design achieves the desired output, technically and economically viable. It proposes creative solutions to the problem. The selection of unit operations and the operating parameters are based on plausible heuristics, and supported by strong and reasonable justifications.

Develop process flowsheet with the aid of simulation tool	The flowsheet is lacking of essential unit operation/process; The process simulation does not reach convergence; Mass and energy balances are not conserved.	The flowsheet is lacking of essential unit operation/process; The process simulation reaches convergence; Mass and energy balances are conserved.	The flowsheet comprises essential unit operation/process; The process simulation reaches convergence; Mass and energy balances are conserved.	The flowsheet comprises essential unit operation/process; The process simulation is not robust enough to accommodate parameters changes in the flowsheet; Mass and energy balances are conserved.	The flowsheet comprises essential unit operation/process; The process simulation is robust to accommodate parameters changes in the flowsheet; Mass and energy balances are conserved.
Technical report writing	The report is poorly written with many errors, poor grammar and sentence structures; The content of the report is incoherent, lacking of data, in-depth analysis and recommendations.	The report is not very well written with some errors; The content of the report is coherent, but missing essential data, lacking of in-depth analysis and recommendations.	The report is written with good grammar and sentence structures; The content of the report is coherent, addresses the problem with essential data, but lacking of in-depth analysis and recommendations.	The report is succinctly written with good grammar and sentence structures; The content of the report is coherent, addresses the problem clearly with essential data, brief analysis and recommendations..	The report is succinctly written with good grammar and sentence structures; The content of the report is coherent, addresses the problem clearly with sufficient data and plausible in-depth analysis and recommendations.

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