The Hong Kong University of Science and Technology

Simplified UG Course Syllabus – Fall 2024-25

Process and Product Design Principles
CENG2110
3 Credits

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Course Description

Scope: Processes and process variables, engineering data, and process representations. The conservation principle. Material and energy balances on non-reactive and reactive unit operations and process systems with recycles. Introduction to chemical product design.

Learning objectives: On successful completion of this course, students are expected to be able to:

1. Explain the essential building blocks of processes, taking into account the categories and attributes of the materials involved, including raw materials, intermediates, products and by-products.
2. Use a variety of methods for organizing information relating to materials for the purpose of product and process design, analysis, and optimization.
3. Identify and analyse mass and energy balances for different kinds of chemical processing units with and without chemical reactions and for complete process systems with recycles.
4. Use computational tools to solve sets of equations that often arise in the various stages of chemical process and product design.
5. Explain the scope of chemical product design.
6. Recognize considerations related to safety, health, and environment for chemical process & product development.

Content

- Chemical process and product definition and classifications
- Design and analysis of input-output diagrams
- Process variables and diagrams.
- Material and energy balances: concept and mathematical analysis applied to (1) processing systems with reactions, separations, recycles and purge streams and (2) chemical products.
- Systematic design procedures for chemical products and processes.
- Comprehensive case studies related to energy, chemicals, the environment, and pharmaceuticals

Assessments:

The final grade will be determined as follows:

- Active participation in tutorials and in-class assignments 5%
- Homework assignments 15%
- Mid-term quiz, closed book / closed notes 20%
- Final Exam, all course material, open book / open notes: 60%

Participation (5%): This course is about developing skills and not about passively absorbing information, therefore, attendance and active participation during the tutorial sessions is important. To reward students for active participation during tutorials, which may also be organized ad-hoc during regular lecture hours. Students need (1) be physically present to work on the problem, (2) submit work showing a sincere effort to solve the problem. Students will be rewarded for their sincere participation in the tutorials, not necessarily the quality of the work.

Homework (15%): The homework assignments initially involve several scenario-based questions to test basic skills and later more open-ended problems that require the use of computational tools. Homework submissions can be submitted late for 50% credit up to one week after the deadline and 0% thereafter. Group study is encouraged, but any submitted work must be your own work.

Mid-term quiz (20%): The mid-term quiz is closed book and closed notes and assesses basic skills of the material covered up to that point. An appendix with formulas will be provided.

Final exam (60%): The final examination is open notes, covers the complete course, and will be held during the Fall Term Examinations period.

Summary Table Assessment

Assessment Task	Contribution to Overall Course grade	Date
Participation	5%	Tutorial every Thursday, occasionally during in-class hours
Homework assignments	15%	Tentatively: HW1 early October, HW2 early November, HW3 November 30
Mid-term quiz	20%	October 22 (in-class)
Final examination	60%	Fall-term examination period

Mapping of Course ILOs to Assessment Tasks

Assessment task	Mapped ILOs	Notes
Participation	1, 2, 3, 4, 5, 6	The tutorial assignments cover all aspects of the course and may require computational tools,
Homework assignments	2, 3, 4, 6	Earlier homework assignments involve simple scenario-based questions, and the last homework will require the use of computational tools (ILO 4)
Mid-term quiz	1, 2, 3, 4	Basic problem solving within the scope of the course up to week 8
Final examination	1, 2, 3, 4, 5, 6	The final exam covers all course material

Final Grade Descriptors

Grade	Short Description	Elaboration on subject grading description.
A	Excellent Performance	Deep understanding of process and product design principles. Can solve complicated problems in unfamiliar scenarios effectively by translating them into a set of consistent equations following a highly systematic and generic solution approach, effectively developing multi-step mathematical / computational solution strategies to solve and analyze them. Can integrate different methods and topics of the course into a single problem. Shows great fundamental understanding by being able to effectively use the skills and tools learned in the course to solve unconventional and/or highly unfamiliar types of problems. Deep understanding and comprehensive practice allow for problems to be solved systematically and quickly. Demonstrate excellent critical thinking skills, both technical as well as related to broader societal impacts of chemical processes and products. Can use the methods discussed in class for problem solving of complicated, integrated, and new types of problems in a systematic and effective way.
B	Good Performance	Solid understanding of process and product design principles. Can solve a wide variety of problems in a systematic way by translating a new engineering scenario into a set of consistent equations, effectively using mathematical and computational tools to solve them. Demonstrates good critical thinking skills. Can use the methods discussed in class for problem

		solving involving scenarios that are somewhat unfamiliar, but mostly on a single main topic of the course only, with good depth in analysis.
C	Satisfactory Performance	Adequate understanding of process and product design principles. Can solve simple problems in familiar settings in a systematic way by translating an engineering scenario into solvable equations. Limited critical reflection on the solution and followed approach. Can use the methods discussed in class for problem solving but may lack depth in analysis and applications restricted to familiar scenarios only.
D	Marginal Pass	Basic understanding of process and product design principles. Can solve simple problems in familiar settings from memory or notes but lacks a systematic approach and sufficient understanding to solve more complicated or unfamiliar problems. Translation of a scenario-based problem into solvable equations shows significant gaps in understanding and/or is replaced by reasoning in words only to get a solution. Can use the methods discussed in class for problem solving, but with minimal effectiveness.
F	Fail	Demonstrates insufficient understanding of process and product design principles. Unable to translate scenario-based problems into a consistent set of equations for analysis and solutions.

Grading policy: The course does not apply norm-referencing for grading, where students are graded with reference to their peers, but instead the course adopts criterion-referencing, where student performance is evaluated against the achievement of learning outcomes.

Required Texts and Materials

- M. Murphy. (2023) Introduction to Chemical Processes, International Edition. McGraw-Hill, New York, NY, USA. 2nd Edition. [This textbook is available from the publisher as eBook or hard copy through the McGraw Hill Connect platform]. We will follow this book closely. Students are strongly recommended to purchase the textbook.

[Optional] Additional Resources

Additional reading / background:

- D.M. Himmelblau, J.B. Riggs. (2022) Basic Principles and Calculations in Chemical Engineering, 9th Edition. Prentice Hall, Upper Saddle River, N.J. [This textbook covers most of the topics that we will discuss and can be accessed online through the library]
- D. Seider, D. R. Lewin, J. D. Seader, S. W., R. Gani, K. M. Ng (2016). Product and Process Design Principles: Synthesis, Analysis and Evaluation, 4th edition, [This textbook is available as e-book through the library]