The Hong Kong University of Science and Technology

UG Course Syllabus

Integrated Chemical Process and Product Design

CENG3150 [5 Credits]

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Course Description

Conceptual design of chemical processes and products. Integration of prior knowledge in the execution of a structured design project, under the direct guidance of faculty. Project topics encompass both process and product design with different emphases. Design tasks include literature and market survey, ideation, feasibility and viability studies, prototyping and/or simulation, unit operation or component design, planning and project management, and societal and environmental impact assessment. The course is delivered in an experiential and blended-learning format. The Emphasis is on the design process, hands-on experimentation, teamwork, and self-learning.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Perform conceptual design of a chemical process and/or product in a team setting.

2. Assess the societal impact, feasibility, viability, and desirability of a chemical process/product.

3. Communicate and cooperate effectively in a project team.

4. Acquire practical skills and knowledge required of chemical process/product design through self-learning.

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)
Online work	10%
Participation	35%
Mid-term presentation	15%
Project report (including Q&A session in Spring exam period)	40%

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Online work	ILO1, ILO2, ILO3, ILO4	The quizzes assess students' knowledge of the general modules of the course involving: Project management (ILO3), Conceptual product and process design (ILO1), data analytics (ILO4), and safety, health, and environment (ILO2). The logbook assesses students' ability to manage their project with their team (ILO3).
Participation	ILO1, ILO2, ILO3, ILO4	Active participation assesses students' ability to conduct a conceptual process or product design (ILO1) through self-learning (ILO4). In-class tutorials assess students' knowledge of the general modules studied as part of their online work.
Mid-term presentation	ILO3	Students need to communicate their project background, objectives, and planning through an oral presentation.
Final project report (including Q&A session in Spring exam period)	ILO1, ILO2, ILO3, ILO4	The final report documents all project activities detailing how the conceptual process or product design was performed (ILO1), reflect on societal impact of the design (ILO2), and demonstrating the skills and knowledge the students have obtained through self-learning (ILO4). Finally, the effectiveness of the reporting itself will be assessed (ILO3).

Grading Rubrics

Online work (10%)

- Score from online quizzes to be completed before each general session (weeks 1-4)
- Logbook (out of 2)
  - 0: not (seriously) used or no substance,
  - 1: exist but not used effectively or not continuously used throughout the project (but ad-hoc / when asked only).
  - 2: used effectively throughout the entire project.

Participation (35%)

- Attendance during tutorials of the general modules (Weeks 1-5)
- In-class tutorials (Week 1-4)
  - 0: Not submitted or no content.
  - 1: Limited content and/or limited understanding of the module topic.
  - 2: Good effort (possibly not finished or some shortcomings, but the submitted tutorial shows students worked well and applied relevant concepts of the taught module)
- Participation in lab / simulation sessions (Weeks 6-13)
  - 0: mostly absent
  - 1: frequently absent, no tangible contributions
  - 2: some sessions (partially) absent, passive worker

- 3: average participation with some minor absence (or well excused absence with make-up activities) and mostly active. Works effectively but does not develop main initiatives or provides key efforts to push the project forward.
- 4: good participation: practically full attendance, pro-active, new initiatives, and clearly extra efforts (e.g., developing creative ideas).
- 5: Excellent participation: everything from 4 plus obvious leadership role in technical and organizational matters (e.g., organizing the activities, supporting others, leading analysis, excellent communication, developing main ideas to push the project forward). Highly effective in problem solving in an experiential-learning environment.

- Peer evaluation (through Canvas or Feedback Fruits)
- Project specific assignments (online)

Mid-term presentation (15%)

Criteria	Weight	Sophisticated (10-8)	Highly Competent (8-6)	Fairly Competent (6-4)	Not yet Competent (4-0)
Introduction and knowledge collection and utilization 1) Identifies project background and market needs 2) Ability to describe state-of-art in a concise way within the context of the project	15%	• A comprehensive and complete explanation of the project • Ability to argue convincingly for the market needs. • Deep understanding of relevant engineering and project concepts demonstrated by a concise explanation during the presentation. • Concise wrap-up and exciting outlook for the project	• A good explanation of the project. • Clear description of market needs. • Thorough understanding of relevant engineering and project concepts demonstrated by an adequate explanation with some minor gaps and/or redundant elements. • Clear wrap-up and interesting outlook.	• Adequate explanation of the project. Some important points are missing or not presented concisely. • A relevant description of market needs with significant gaps. • Basic understanding of relevant engineering and project concepts demonstrated by a reasonable explanation with substantial gaps / redundant elements. • Adequate wrap-up and outlook.	• Largely unable to explain the project • No relevant description of market needs • No understanding of relevant engineering and project concepts demonstrated by inconsistent or irrelevant explanations. • No wrap-up and/or outlook for the remainder of the presentation
Design process 1) A concise and specific definition of the design objective 2) A systematic approach is presented identifying design variables and performance for optimization 3) Elements of CPD, data analysis, sustainability are identified for the project 4) A functional project management approach is presented	40%	• Concise design objective statement (quantitative, and comprehensive) • The presented approach is argued convincingly to be feasible within project boundaries and would achieve the design objective if successful without any doubts. Excellent design thinking. • Concrete opportunities to use elements from course Modules 2-4 are relevant, feasible, show a deep understanding of course theory. • The presented project management is concisely presented, highly effective and shows evidence of comprehensive	• Functional design objective statement with some shortcomings (e.g., lacks specifics) • The presented approach is likely feasible within project boundaries and achieves design objectives to some extent, but the argumentation is not convincing / incomplete. Adequate design thinking. • Concrete Opportunities to use elements from course Modules 2-4 are identified but do not show evidence of a deep understanding of course theory. • The presented project management is discussed but misses important elements from Module 2.	• Confusing design objective statement or general objective only (e.g., directly adopted from course material) • The presented approach has apparent shortcomings in terms of feasibility and effectiveness. Limited or no design thinking. • Concrete opportunities to use elements from technical course Modules 2-4 are not identified and only mentioned in a general context. • Project management is discussed but no clear evidence for effective use of the tools from Module 2.	• Irrelevant design objective statement • The presented approach is clearly infeasible and/or ineffective to meet the design objective. No design thinking. • Technical course Modules 2-4 are practically ignored. • Project management is practically not addressed in the presentation

		understanding of Module 2.			
Presentation skills 1) Visual appeal of slides: layout and design 2) Correctness of spoken and written English 3) Preparedness, fluency, clarity	20%	• No errors in spelling, grammar and punctuation. Clear and concise information. Excellent spoken English. • Visually appealing slides. • Excellent preparation and rehearsal.	• Few errors in spelling and grammar. Occasional mistakes in spoken English. • Clear and adequate slides. • Very well prepared	• Frequent errors in spelling and grammar. Occasional mistakes in spoken English. No clear implications for understanding. • Clear and adequate slides. • Reasonably well prepared.	• Many errors in spelling and grammar. Poor use of English. Hampering understanding for audience. • Illegible or unclear slides. • Evident lack of preparation/ rehearsal. Overdependence on slides.
Q&A 1) Understanding of the questions and their relevance to the project 2) Accuracy and clarity in answering the questions.	25%	• Ability to answer accurately all questions posed and elaborated in detail with good knowledge of course material. • High level of confidence; ability to handle difficult questions gracefully. • Ability to leverage the Q&A time to further strengthen the audience's understanding and appreciation of the project.	• Ability to answer correctly to most questions related to the presented facts and course material. • Most answers were elaborated in detail.	• Ability to answer correctly to some questions related to the presented facts and course material. • Some answers were elaborated in detail	• Frequent misinterpretation of questions. • Low confidence and comfort level, offering only short answer to even basic questions. • Many mistakes with some answers fundamentally incorrect.

Final report (40%)

Criteria	Weight	Sophisticated (10-8)	Highly Competent (8-6)	Fairly Competent (6-4)	Not yet Competent (4-0)
Background Introduction of project background and literature	20%	• A comprehensive and complete understanding of the project and the relevant technology on the market. • Relevant literature is concisely reviewed. • Only important information is provided, which unambiguously demonstrates clear understanding of the technology. • Excellent explanation of how the technology works through carefully selected and concisely discussed literature papers. • Ability to describe the current business/consumer needs convincingly. • Concise wrap-up and exciting project outlook through concise technology selection	• A good understanding of the project and the relevant technology on the market. • Literature review is useful. • Most important information covered and little irrelevant information. • Clear explanation of the project technology with helpful references to literature. • Clear description of current business/consumer needs. • Clear wrap-up and interesting project outlook with well-motivated technology selection.	• Adequate understanding and summary of the project and the relevant technology. Some important points are missing or not described concisely. • Related papers are discussed but no clear connection with project, i.e., papers are discussed but the information is not helpful to the project. • Most important information covered with some parts containing irrelevant information. • Adequate explanation of the project technology with some important points missing. • A relevant description of business/consumer needs with significant gaps. • Adequate wrap-up and project outlook without a well-motivated technology selection.	• Little understanding of the project or the relevant technology. • Irrelevant and/or incomplete discussion of academic papers • Inclusion of mostly irrelevant information while missing important points. • No meaningful description of technology status • No relevant description of business/consumer needs • No justification for selected technology

Knowledge Ability to apply knowledge of general engineering design concepts (i.e., modules 1-4) and specific project knowledge.	30%	• Deep understanding of relevant engineering and project concepts demonstrated by a concise discussion and the process of motivated decision making during the project. • All reasonable opportunities to use available academic knowledge within the discussion and/or decision making have been exploited.	• Thorough understanding of relevant engineering and project concepts mainly demonstrated by a concise discussion and some well-motivated decisions taken during the project. • Most reasonable opportunities to use available academic knowledge within the discussion and/or decision making have been exploited.	• Adequate understanding of relevant engineering and project concepts mainly demonstrated by a reasonable discussion with some conceptual misunderstandings. The process of decision making during the project does not show evidence of good understanding of engineering design and project knowledge. • Only few reasonable opportunities to use academic knowledge within the discussion / decision making have been exploited.	• No understanding of relevant engineering and project concepts • Either no discussion on knowledge application or irrelevant/incorrect discussions. • No knowledge or highly superficial knowledge used within the discussion and/or decision making during the project.
Design process Application of systematic conceptual process / product design approaches supported by adequate prototyping / simulation / experimentation, as reflected by the reported methodology, results, and discussion	30%	• A systematic process / product design approach has been followed and is concisely presented from start to finish. • Prototyping / simulation / experimentation follows a systematic approach, for example, by using tools from the data analytics module or project-specific material, extensively. • Excellent reflection on results and logical subsequent decision making for optimizing the design.	• The design process contains key elements of a systematic process / product design approach. • Prototyping / simulation / experimentation follows a logical approach to some extent, for example, by using some of the tools from the data analytics module or project-specific material. • There is a relevant discussion on the results and some evidence of any impact of that on decision making (i.e., for optimizing the design).	• The design process contains only ad-hoc elements of a systematic process / product design approach. • Prototyping / simulation / experimentation does not follow any clearly visible systematic approach. Any tools from data analysis module or project-specific materials are not sophisticated and/or not related to the offered material of the course. • There is a discussion on the results but little evidence of any impact of that on decision making (i.e., it is not used to optimize the design) as is commonly done in conceptual design workflows.	• No systematic approach for process / product design has been followed at any point. • Prototyping / simulation / experimentation follows an illogical and/or inconsistent approach. • No reflection on results or follow-up decision making.
Visual aids Use of professional and informative figures and tables.	10%	◆ Well-presented figures and tables that clearly add value to the presentation. Clear formatting so that figures and tables can be understood without extra efforts for readers.	◆ Effective use of figures and tables with mostly professional formatting.	◆ Adequate figures and tables that mostly look professional and are understandable with some efforts from the readers.	◆ Largely unclear figures and tables. Basic formatting mistakes are the norm.
Writing quality and report structure. Demonstrate clarity, proper writing style and good organization of the report, competent use of English.	10%	◆ Superbly organized and lucidly written report. ◆ Complete and consistent citation.	◆ Consistent formatting and logical structure. ◆ Competent use of English. ◆ Proper citation for the most part.	◆ Content is understandable with some efforts. ◆ Fairly logical structure with some unclear parts. ◆ Competent use of English, with some errors.	◆ Unclear content, poor format and writing style, illogical organization. ◆ Frequent grammatical and spelling errors. ◆ Lack of proper citation of sources and references.

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of chemical engineering design, effective problem-solving skills in an experiential-learning setting, and shows significant creativity in design thinking. Easily grasps the multi-faceted nature of engineering design, both in terms of the technical and broader societal aspects and shows clear leadership in team-based exercises. Going beyond core requirements to achieve learning goals and demonstrates a highly systematic work approach to decompose a big design problem into smaller problems to be solved as a team effort. Integrates different theories and practical skills from the chemical engineering discipline effective in the project work. Highly active course participation and an excellent ability to report design achievements concisely in an oral presentation and written documentation.
B	Good Performance	Shows good knowledge and understanding of chemical engineering design, solid competence in problem-solving in an experiential-learning setting, and a good ability to analyze and evaluate issues. Displays high motivation to understand unfamiliar problems and can work effectively with others. Good course participation and effective team participation and communication abilities.
C	Satisfactory Performance	Possesses adequate knowledge of chemical engineering design, shows competence in dealing with familiar and well-defined problems in an experiential-learning setting, and some capacity for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals through adequate course participation and contributions to the team efforts.
D	Marginal Pass	Has threshold knowledge of chemical engineering design, potential to achieve key professional skills, and the ability to make basic judgments in an experiential-learning setting. Benefits from the course and has the potential to develop in the discipline but mostly relies on other team members to take the initiative in the execution of the design project. Makes acceptable contributions to written documentation and oral presentation of the project work.
F	Fail	Demonstrates insufficient understanding of chemical engineering design and lacks the necessary problem-solving skills in an experiential-learning setting. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Shows insufficient course participation and makes limited contribution to the team efforts (e.g., free riding). Ineffective to work in a team.

Course AI Policy

You are allowed to use generative AI only for the purposes of language editing, and it must be properly acknowledged. Content generation through AI is not permitted.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Required Texts and Materials

The course will be offered through an experiential and blended learning format. The course materials will be delivered online. Your weekly activities at home will be to watch short videos and complete an online quiz on Canvas or possibly to conduct small exercises related to your project each week. By doing so, you will be ready to discuss the content when you come to class. These on-campus discussions with the instructors and your fellow classmates will help to deepen your understanding and learn from each other. Your on-campus activities will gradually shift toward project design activities when the course progresses. Design activities include prototyping, laboratory experiments, process simulations, calculations, data analysis, discussion with your project supervisor, etc. Each week will have a 4-hour face-to-face session and one tutorial hour focused on your design project. In the first 4 weeks, we will discuss general topics and skills related to integrated chemical process and product design that are important for all students, irrespective of the project choice. In Week 5, we will have the mid-term presentation in which students will present their project background, objectives, and planning. After Week 5, your activities will be fully related to your chosen design project.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.