

## **CENG4130 Plant Design and Economics syllabus (tentative)**

Instructor: Marshal LIU, [keysliu@ust.hk](mailto:keysliu@ust.hk)

PG TA: Stuart ROBERSON. [sjrobertson@connect.ust.hk](mailto:sjrobertson@connect.ust.hk)

UG TA: tbc

### **Blended learning**

- More personalized learning (watch lecture video outside of class)
- More interaction (discussion and Homework in class)

### **Intended Learning Outcomes (ILOs)**

By the end of the course, learners will be able to:

- demonstrate mastery of economic analysis in chemical process and/or product development;
- make meaningful estimates on various economic aspects such as the capital investment, product cost, depreciation and profitability of an existing or new chemical process or project;
- be aware of the importance of environment/health issues in chemical industry;
- apply process safety management program, industrial hygiene, fire and explosion, toxic release and dispersion, and pressure relief system, conduct Hazards Identification, Risk Analysis, and HAZOP;

## Weekly schedule

	ILOs	Module title and Topics	Tasks/Submissions/in-class	Remarks
1	<ul style="list-style-type: none"> <li>Describe the purpose of the blended learning approach</li> <li>Recall the course content and learning outcomes</li> <li>Explain the importance of plant design and economics</li> </ul>	<b>Course overview and BL Overview</b> <ul style="list-style-type: none"> <li>Students will be introduced to the blended learning approach</li> <li>Course introduction</li> <li>Introduce the importance of plant design.</li> </ul>	<ul style="list-style-type: none"> <li>Discuss the economics for a typical chemical plant, converting coal to methanol</li> <li>After 1<sup>st</sup> F2F class meeting, start online materials Module 1</li> </ul>	
2	<ul style="list-style-type: none"> <li>Estimate capital investment and equipment cost</li> </ul>	<u><b>Capital and Cost Estimation</b></u> <ul style="list-style-type: none"> <li>Lecture video/notes on process economics, capital investment, equipment cost estimation, etc.</li> </ul>	<ul style="list-style-type: none"> <li>In-class: Scenario-based quiz questions to check understanding of online materials</li> <li>In-class: Tutorials on estimating investment and equipment cost</li> </ul>	
3	<ul style="list-style-type: none"> <li>List the components in TPC</li> <li>Calculate the depreciation</li> <li>Incorporate time value for financial analysis</li> </ul>	<u><b>Total Product Cost (Time Value and Depreciation)</b></u> <ul style="list-style-type: none"> <li>Lecture notes and video on TPC components, time value of money, and depreciation</li> </ul>	<ul style="list-style-type: none"> <li>Online: Scenario-based quiz questions to check understanding of online materials</li> <li>In-class: Activity to calculate product cost, incorporate time value for financial analysis and determine depreciation</li> </ul>	
4	<ul style="list-style-type: none"> <li>Plot cash flow diagram</li> <li>Determine criteria for profitability analysis</li> </ul>	<u><b>Cash position diagram and Profitability criteria</b></u> <ul style="list-style-type: none"> <li>Lecture notes and video on cash flow, cash position, minimum attractive rate</li> </ul>	<ul style="list-style-type: none"> <li>Online: Scenario-based quiz questions to check understanding of online materials</li> <li>In class: Activities to plot cash flow diagram, and determine <math>m_{ar}</math></li> </ul>	
5	<ul style="list-style-type: none"> <li>Use various methods for profitability analysis</li> <li>Incorporate time value of money into profitability analysis</li> </ul>	<u><b>Profitability Analysis</b></u> <ul style="list-style-type: none"> <li>Lecture video/notes on profitability analysis with/without time value</li> </ul>	<ul style="list-style-type: none"> <li>Online: Scenario-based quiz questions to check understanding of online materials</li> <li>In-class: Tutorials on profitability analysis calculation</li> </ul>	
6	<ul style="list-style-type: none"> <li>Compare alternative investment.</li> <li>Evaluate replacement for equipment</li> </ul>	<u><b>Alternative Investments &amp; Replacement</b></u> <ul style="list-style-type: none"> <li>Lecture video/notes on Alternative investment and replacement</li> <li>Debrief Financial Project</li> </ul>	<ul style="list-style-type: none"> <li>Online: Scenario-based quiz questions to check understanding of online materials</li> <li>In-class: Tutorial and debate to weigh out pros and cons for replacement of equipment and alternative investment</li> </ul>	

7	<ul style="list-style-type: none"> <li>Describe the major methods on process safety management</li> <li>Identify the possible reason for accidents</li> <li>Evaluate the chemical exposure</li> </ul>	<u><a href="#">Process Safety Management</a></u> <ul style="list-style-type: none"> <li>Videos investigating past accidents from Chemical Safety Board</li> <li>Video on occupational safety</li> </ul>	<ul style="list-style-type: none"> <li>Online: Scenario-based quiz questions to check understanding of online materials</li> <li>In-class: Activity to analyze case studies on accident prevention and process safety management to real life cases, and tutorial on chemical exposure calculation</li> </ul>	
8	<ul style="list-style-type: none"> <li>Implement fire and explosion prevention measures in process design</li> </ul>	<u><a href="#">Fire and Explosion Prevention</a></u> <ul style="list-style-type: none"> <li>Lecture video/notes on fire and explosion</li> </ul>	<ul style="list-style-type: none"> <li>Online: Scenario-based quiz questions to check understanding of online materials</li> <li>In-class: Activity to design a floated roof tank for flammable liquid with fire and explosion prevention measures in mind</li> </ul>	
9	<ul style="list-style-type: none"> <li>Calculate the release and dispersion of toxics</li> </ul>	<u><a href="#">Toxic Release and Dispersion</a></u> <ul style="list-style-type: none"> <li>Lecture video/notes on the toxic release and dispersion</li> </ul>	<ul style="list-style-type: none"> <li>Online: Scenario-based quiz questions to check understanding of online materials</li> <li>In-class: Activity to calculate toxic release and dispersion of Fukushima or other real life situations and implications on public.</li> </ul>	
10	<ul style="list-style-type: none"> <li>Select the scenario and type of pressure relief</li> </ul>	<u><a href="#">Pressure Relief</a></u> <ul style="list-style-type: none"> <li>Lecture video/notes on pressure relief</li> </ul>	<ul style="list-style-type: none"> <li>Online: Scenario-based quiz questions to check understanding of online materials</li> <li>In-class: Activity to analyze cases on selection of pressure relief device and scenarios to real life case</li> </ul>	
11	<ul style="list-style-type: none"> <li>Conduct HAZOP</li> </ul>	<u><a href="#">HAZOP (Hazard and Operability Study)</a></u> <ul style="list-style-type: none"> <li>Lecture notes and other learning resources on HAZOP</li> <li>Debrief HAZOP Project</li> </ul>	<ul style="list-style-type: none"> <li>Online: Scenario-based quiz questions to check understanding of online materials</li> <li>In-class: Activity to analyze and apply HAZOP to real life case</li> </ul>	
12	<ul style="list-style-type: none"> <li>Calculate the reliability for various safety components</li> <li>Construct Fault Tree and Event Tree</li> </ul>	<u><a href="#">Reliability, Fault tree and Event Tree</a></u> <ul style="list-style-type: none"> <li>Lecture video/notes on reliability, Fault tree and Event tree</li> </ul>	<ul style="list-style-type: none"> <li>Online: Scenario-based quiz questions to check understanding of online materials</li> <li>In-class: Activity to apply Safety and reliability to real life case, construct a Fault Tree, Event Tree and risk calculation</li> </ul>	
13	<ul style="list-style-type: none"> <li>Q&amp;A for HAZOP project</li> <li>Course wrap-up</li> </ul>	<b>Reviewing HAZOP Videos and prepare Q&amp;A</b>	<ul style="list-style-type: none"> <li>In-class: Q&amp;A on HAZOP project</li> <li>Course summary</li> </ul>	

\* Because there are no classes on week 12 & 13 (public holidays), the schedule will be condensed to 11 weeks only.

### Assessments

	Components	Weighting	Details
1	Out-of-class Quizzes (self-assessment)	14%	2 attempts are allowed.
2	Class discussion and participation Online forum participation, 4 questions with 4 points	8%	Either post a valid question in online forum or give an answer to questions posted by others. At least 2 questions for economics and 2 for safety part.
3	Homework *4	10%	Consolidate/practice calculations (help prep for final)
3	Group Project 1: Financial Report (Economics)	10%	Written Report
4	Group Project 2: HAZOP (Safety)	10%	Video presentation + Q&A
5	Peer Evaluation	8%	Contribution to group discussion, homework and project
6	Final Exam	40%	Open book, computer and internet

### Textbook

- Peter, M.S. Timmerhaus, K.D. & West, R.E. Plant Design and Economics for Chemical Engineers, 5<sup>th</sup> ed. McGraw-Hill 2003
- Crowl, D.A. and Louvar, J.F. Chemical Process Safety: Fundamentals with Applications. Prentice Hall International Series, 3<sup>rd</sup>, 2011.  
<http://my.safaribooksonline.com/book/chemistry/9780132762489>

### References

- Towler and Sinnott. Chemical Engineering Design. Elsevier, 2008. E-book
- Turton, Bailie, Whiting & Shaeivitz. Analysis, Synthesis, and Design of Chemical Processes, 3<sup>rd</sup> edition, Prentice Hall PTR 2009