ChE 381 - Process Evaluation and Chemical Systems Design I
Fall Semester - Senior Year

Credits 3 Contact hours: 3 Class; Room106 Time: Monday: 10 – 12.50pm

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Description Required Course - The course uses design projects to explore process flow diagrams and initial equipment design estimates based on process and unit operation material and heat balances. Studies include equipment cost estimation methods that are developed into process economic evaluations and profitability analysis. The course concludes with process and equipment design using Aspen and an examination of optimization techniques.
3 credits each. Prerequisites: ChE 342 and ChE 332

Textbook Peters, M., K. Timmerhaus and R. West, "Plant Design and Economics for Chemical Engineers", 5th Edition., McGraw-Hill, 2003.

References
Turton, R., R. C. Bailie, W. B. Wallace, J. A. Shaeiwitz and D. Bhattacharyya, "Analysis, Synthesis, and Design of Chemical Processes", 4th Edition, Prentice-Hall, 2012.
Towler, G., and R. Sinnott, "Chemical Engineering Design, Principles, Practice and Economics of Plant and Process Design", 2nd Edition, Butterworth-Heinemann (Elsevier), 2013.
Biegler, Grossman, and Westerberg, "Systematic Methods of Chemical Process Design", Prentice-Hall, 1997.
Sinnott, R. K., "Coulson and Richardson's Chemical Engineering, Volume 6 - Chemical Engineering Design", 3rd Ed, Pergamon Press. 1999.
Perry, R. H., and Green, D., "Perry's Chemical Engineering Handbook", 7th Edition, McGraw-Hill. 1999.

Course Objectives
1. Apply conservation of material and energy to process flowsheet development.
2. Introduce the fundamentals of sizing unit operations equipment and design correlations and integrate them with practical considerations.
3. Develop the basics of process design and flowsheets using PRO/II and ProVision process simulation software (or Aspen).
4. Apply cost estimation methods, process economic evaluation and optimization.
5. Introduce the principles of safety analysis and the various governing bodies that regulate safety, health and environmental issues and the fundamentals of "green engineering" and its key considerations.
6. Develop the basic principles of optimization techniques.

Course Topics
Introduction to process design. (*3 hours*)
Review of material and energy balances and their application to process flow diagrams. (*3 hours*)
Project formulation, development and management - introduction to design problem.(*3 hours*)
Flowsheet development from design problem statement.(*2 hours*)
Sizing of process unit operations and equipment (Fluid dynamics, mass and heat transfer, design correlations, thermodynamics).(*3 hours*)
Workshop on design problems using Aspen. (*2 hours*)
Introduction to engineering economics.(*2 hours*)
Cost estimation methods, depreciation and the value of money.(*3 hours*)
Present value and the economic evaluation of projects. (*5 hours*)
Project - Process economic evaluation. (*3 hours*)
Basics of process design optimization. (*3 hours*)
Linear programming. (*3 hours*)
Health, environmental and safety issues and principles of "green engineering". (*4 hours*)

	Project - Process design, costing and evaluation of design problem introduced early in course. (*6 hours*)
Class Schedule	The class meets once a week for a 3-hour session .
Professional Component	The course directly addresses engineering topics consisting of engineering sciences and engineering design. It includes the application of advanced mathematics and sciences to solving engineering problems all in the context of environmental, safety, economic and societal issues. Course includes a workshop on written communication skills.
Program Objectives	The course directly addresses the Chemical Engineering Department's Program Objectives 1, 2, 3 and Criterion 3 issues 1, 2, 3, 4, 5, and 7.
Prepared by:	Ogbonnaya Okorafor.

Course Outline

The course deals primarily with process design and how engineers evaluate projects to design plants which will produce the required products at specified composition economically, efficiently and safely.

The recommended text is Peters, M., K. Timmerhaus and R. West, "Plant Design and Economics for Chemical Engineers", 5th Edition., McGraw-Hill, 2003, however, we will not be basing the course class work on this text. Rather it is a reference text that will be used in both this course and ChE 382. In addition, there are other texts noted above on which class material may be based. Lecture notes will be supplemented by handouts and material from other sources and copies of the earlier editions of the text are available in the departmental secretary's office.

Assignments

Problem assignments will be assigned throughout the course. These will be project assignments and will consist of small projects to be solved and reported individually and larger group projects where group reports will be prepared. The assignments will require you to use computer spreadsheets, graphics, curve-fitting software and PROVISION/PRO/II or Aspen

There will also be problems done in class either individually or in groups. You will be assigned your groups and will remain in those groups for ChE 382. Assignments must be prepared by the due date.

You may consult with each other to arrive at the best way to solve individual projects but the report you hand in must be your own interpretation of the solution. There will be ample opportunity for class discussion on both individual projects and group projects – take advantage of those opportunities!

Finally, you will be given reasonable time to prepare your project reports but that time is only reasonable if you begin working on the projects immediately. For example, if you are given three weeks to complete a project it is for a reason – you will need three weeks!

The will be at least two group projects to hand in and at least three individual projects.

Exams

There will be no exams in the course – grades are based on project reports.

Use of Electronic Devices

No cellphones, computers (e.g., laptops), tablets (e.g. iPads) may be used during the class periods at any time (cellphones must be turned off). You may take hand written notes and will be receiving a number of handouts.

Relationship Between ChE 381 Process Evaluation and Chemical Systems Design I and Chemical Engineering Program Outcomes

Course Objectives	Strategies	Outcomes	Program Objectives	Criterion 3 Requirements	Assessment Methods
Apply conservation of material and energy to process flowsheet development.	Link the fundamentals learned in ChE 221 to the design process. Lectures and in-class problem solving, notes and hand-outs	Students will learn the basic starting point for a design is the mass and energy balance and to present it using a Stream Table and Flowsheets	1, 2, 3.	1, 2, 3, 4, 5, 7.	In-class problems. In-class discussions. Mini-project(s).
Introduce the fundamentals of sizing unit operations equipment, design correlations and integrate them with practical considerations.	Develop to basic sizing principles for several key unit operations. Lectures and in-class problem solving, notes and hand-outs and extensive in-class discussions.	Students will be learn how to develop key sizing parameters for unit operations using short cut methods.	1, 2, 3.	1, 2, 3, 4, 5, 7	In-class problem solving individually and in groups. In class discussions. Mini-projects and Design Project.
Develop the basics of process design and flowsheets using ASPEN process simulation software. (Aspen)	Introduce ASPENI in an intensive computer classroom tutorial and an introduction to the Keyword Input File. (Aspen)	Students will learn the PRO/II simulation program is a valuable tool in process design but not the answer to their dreams.	1, 2, 3.	1, 2, 3, 4, 5, 7	In-class problem solving. In class discussions of problems and Design Project.
Apply cost estimation methods, process economic evaluation and optimization.	Introduce the principles of cost estimation. Lectures and in-class problem solving, notes and hand-outs and extensive in-class discussions.	Students will learn to use the key sizing parameters for unit operations to build a comprehensive cost estimation for a plant design.	1, 2, 3.	1,2, 3, 4, 5, 7	In-class problem solving individually and in groups. In class discussions. Projects.
Introduce the principles of safety analysis and the various governing bodies that regulate safety and health issues and the fundamentals of "green engineering" and its key considerations.	Introduce the fundamental considerations for safety, health and environmental issues. Lectures, notes and hand-outs and extensive in-class discussions.	Students will grasp that beyond the purely technical, there is a complexity of societal, economic, regulatory, ethical pressures that impact engineering.	1, 2, 3	1, 2, 3, 4, 5, 7	Extensive in-class discussion. Project work in ChE 382.
Develop the basic principles of optimization techniques.	Lectures, notes and hand-outs.	Students learn the building blocks of developing optimization approaches to design.	1, 2, 3.	1, 2, 3, 4, 5, 7	Extensive in-class discussion.