4103 (3 hours) Process Component Design
Required Course for ChE Degree

Current Catalog Description: Open-ended problems in economic design of chemical process components. Economic aspects of engineering, including evaluating alternative courses of action, depreciation, replacement analysis, and process optimization. Lecture 2 hours per week, laboratory 3 hours per week. Prerequisites: Senior Standing, ChE 3084.

Recent Textbook: P. Buthod, R.E. Thompson, A.J. Wilson, "Process Component Design", The University of Tulsa, 1993

Recent References: Perry's ChE Handbook, 8th ed., McGraw-Hill; Walas, "Chemical Process Equipment - Selection and Design", Butterworths, 1988.

Set of Course Goals/Objectives: At the end of the course, students will be able to:
1. Apply engineering judgment, including safety and ethics, in the selection and design of process equipment, including piping systems, tanks and vessels, heat exchangers, trayed and packed columns.
2. Apply engineering economics to the design and sizing of process equipment, including estimation, escalation, and optimization of equipment cost.
3. Use modern computing tools to design process equipment.
4. Evaluate options for corrosion mitigation and selection of materials of construction.
5. Develop process flowsheets.

Prerequisites by Topic: (1) Stoichiometry; (2) Basic and advanced thermodynamics; (3) Fluid mechanics; (4) Heat transfer; (5) Mass transfer

Major Topics Covered in the Course: (1) Cost estimation; (2) Estimation of physical properties; (3) Materials selection; (4) Piping and instrumentation drawings (5) Pipe, fittings, and piping systems, pipe sizing (6) Tanks and vessels, separator and accumulator sizing (7) Pump design and selection; (8) Compressor design and selection; (9) Heat exchangers; (10) Shell-and-tube heat exchangers; (11) Fired heaters (12) Tray columns; (13) Packed columns: **and (14) Process flow sheets.**

Class/Laboratory Schedule: two 50-minute lectures and one three-hour lab session per week for 14 weeks.

Laboratory Projects: (1) Pipe, fittings, and piping systems; (2) Materials selection; (3) Tanks and vessels; (4) Pump design and selection; (5) Reviews for FE exam; (6) Safety review; (7) Compressor design and selection; (8) Tray and packed columns; (9) Heat exchangers (10) Tests.

Oral and Written Communications: Design projects must include an appropriate written report. At least three such projects. Each design group also presents its findings orally.

Social, Ethical and Professional Issues: Social and ethical issues are discussed throughout the course whenever they impact process design. Usually they appear when safety, emissions, noise, regulations and codes are involved in design. Professional registration is discussed in detail. Students are urged to take the FE exam.

Theoretical Content: Each topic starts with a brief review of the underlying theory.

Analysis/Design: The course emphasizes design and analysis of process equipment.

Teamwork: Three design projects require that students work in teams of 2 or 3.

Laboratory/Data Interpretation: While students do not take any experimental data, they are frequently asked to analyze and interpret data on heat exchangers, compressors, and distillation columns. Sometimes the data are either missing or faulty.

Contemporary Issues Presented/Discussed: Current Federal regulations on industrial safety, health, emissions, and pollution control are discussed whenever relevant.

Computer Usage: (1) Computation of gas properties using HYSYS process simulation software; (2) Design of shell-and-tube exchangers using HYSYS, optimizing results of hand calculation assignment; (3) Design of fractionators by HYSYS, based on hand shortcut calculations, confirm hand-calculated tower sizing.

Field Experiences: Field trips to manufacturers of shell-and-tube heat exchangers.

Relationship to Student Outcomes	
outcome:	**Description of related course content:**
(a) an ability to apply knowledge of mathematics, science and engineering	Students learn the theory and basic equations behind the design of piping systems, tanks and vessels, pumps and compressors, shell-and-tube heat exchangers, and trayed and packed columns.
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	Students spend approximately two-thirds of the course designing and sizing process equipment.
(d) an ability to function on multi-disciplinary teams	
(e) an ability to identify, formulate, and solve engineering problems	Class discussions, homework, and the design projects focused on finding the information required to design process equipment.
(f) an understanding of professional and ethical responsibility	Ethical behavior is required in the course. Safety, environmental, federal codes, and API and ASME RPs, specs, and codes are emphasized in the course.
(g) an ability to communicate effectively	Students are required to write team reports for the design project. When required, the reports must be revised to meet acceptable technical writing standards.
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	Lectures and the design project included issues relating to environmental and societal needs.
(i) a recognition of the need for, and an ability to engage in life-long learning	Professional registration and the continuous improvement of engineering design are emphasized.
(j) a knowledge of contemporary issues	Recent case histories are used when appropriate.
(k) an ability to use the techniques, skills and modern engineering tools necessary for engineering practice	Students are required to use computers to solve problems throughout the course. Excel and HYSYS are required.

	A. Apply Math and Science	B. Design/Conduct/Analyze Experiments	C. Design Process with constraints	D. Multi-disciplinary teams	E. Identify/Formulate/Solve engineering problems	F. Professional and ethical responsibility	G. Communicate effectively	H. Understand impact of engineering solutions	I. Life-long learning	J. Contemporary issues	K. Modern engineering skills/ tools
ChE 4103 Process Component Design											
Objectives											
1. Apply engineering judgment, including safety and ethics, in the selection and design of process equipment, including piping systems, tanks and vessels, heat exchangers, trayed and packed columns	X		X		X	X		X	X		
2. Apply engineering economics to the design and sizing of process equipment, including estimation, escalation, and optimization of equipment cost.			X		X					X	
3. Use modern computing tools to design process equipment			X								X
4. Evaluate options for corrosion mitigation and selection of materials of construction.			X					X		X	
5. Develop process flowsheets.			X				X				

Modified as per faculty meeting 11/3/11 to convert form ChE 4104 to 4103
Modified 5/3/07 by GLP for FSM as per faculty meeting changes made 4/26/07
Modified 1/11/08 by Francis S. Manning, P.E.
Modified 5 / 8 / 08 by Francis S. Manning, P.E.
Course objectives from Spring 2009 added by G. L. Price
Modified 11/1/11 by Francis S. Manning, P.E.