Outcome 1. Graduates will understand and be able to analyze entire chemical processes, including those with life science applications.

This outcome maps to ABET Criterion 3 a, c, e, k

Course	Performance indicators
ChE 201, 202, 230, 310, 311, 312, 315, 320, 325, 326, 435, 455, 465	Graduates will be able to design and will understand the individual functions of (major) equipment used in chemical processes.
	Graduates will understand and be able to apply the underlying engineering science, chemistry, and physics associated with chemical processes.
	Graduates will be able to solve complex problems by resolving them into solvable component engineering and science problems.
	Graduates will be able to apply economic and physical constraints and optimization methods to arrive at a best possible solution to a complex design problem.

Tools used:	Design Rubric
Data Collection:	The data are collected every semester based on the course offerings.
Frequency of data collection:	The data are collected every time courses are taught.
Data Analysis:	The data obtained are analyzed every year.
Closing the loop:	This outcome is subject to review every year based on performance criteria and metrics and specific action items are developed, if necessary, to revise the content of the courses. The analyzed data are presented separately to the following groups in meetings. a) Feedback to students on all assignments

b) Feedback to faculty, particularly from major design project.

Performance criteria and metrics:

a) Students should reach a level of proficiency defined as a goal metric value of 2.8 based on the Design Rubric scale of 0-4.

Assessment Tool:

Design Rubric

Design Rubric

Attribute	0 (F) – Not proficient	1 (D) – Less than desired proficiency	2 (C) – Marginal proficiency	3 (B) – Good proficiency	4 (A) – Superior proficiency	Score
Design of equipment, analysis of performance of existing equipment, understand interrelationship between equipment in process						
Design of individual equipment	unable to design equipment	significant errors in equipment design	some errors in equipment design but generally correct	equipment designed correctly	equipment designed correctly and with creativity	
Understand interrelationship between equipment on flowsheet	no understanding of equipment interrelationship	understands interrelationship between a few pieces of equipment	understands interrelationship between some equipment, but not all equipment	understands interrelationship between equipment, but may require questioning	understanding of equipment interrelationship clearly demonstrated and presented without questioning	
Constraints/limitations of individual equipment and flowsheet understood	constraints/ limitations not understood	very few constraints/ limitations understood	some constraints/ limitations understood	constraints/ limitations understood, but may require questioning	understanding of constraints/ limitations clearly demonstrated, without questioning	
Significance of conclusions understood	lack of understanding, no explanations	major gaps in understanding, few explanations	some gaps in understanding, some weak explanations	understood, but may require questioning	understanding clearly demonstrated, without questioning	

Attribute	0 (F) – Not proficient	1 (D) – Less than desired proficiency	2 (C) – Marginal proficiency	3 (B) – Good proficiency	4 (A) – Superior proficiency	Score
Apply chemistry, math, physics, life science, engineering science						
Apply engineering science	inability to apply principles	few basic principles applied	many principles applied, but some noticeable gaps	most principles applied, demonstration of effect on design	all principles applied and interwoven with engineering to enhance design	
Apply chemistry	inability to apply principles	few basic principles applied	many principles applied, but some noticeable gaps	most principles applied, demonstration of effect on design	all principles applied and interwoven with engineering to enhance design	
Apply physics	inability to apply principles	few basic principles applied	many principles applied, but some noticeable gaps	most principles applied, demonstration of effect on design	all principles applied and interwoven with engineering to enhance design	
Apply life science	inability to apply principles	few basic principles applied	many principles applied, but some noticeable gaps	most principles applied, demonstration of effect on design	all principles applied and interwoven with engineering to enhance design	
Apply mathematics	inability to apply principles	few basic principles applied	many principles applied, but some noticeable gaps	most principles applied, demonstration of effect on design	all principles applied and interwoven with engineering to enhance design	
Response to questions indicates ability to apply these principles	inability to apply principles demonstrated	few principles applied	many principles applied, but some noticeable	ability to apply most principles demonstrated and to	superior ability to apply all principles demonstrated and	

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			gaps in understanding	explain impact on design of	clear explanations of impact on design	
Resolve complex problem into components and synthesize new result	inability to recognize component problems	recognizes a few component problems, little synthesis	recognizes many component problems and some synthesis done	breaks problem into most components and synthesizes new result	superior ability to break problem into all expected components and to synthesize new result	
Apply economic constraints, physical constraints, and optimization methods to obtain solution						
Show ability to use economics to drive solution to problem and focus on important parameters	economics not used to drive solution and/or to define key parameters	economics used sparingly to drive solution and/or to define key parameters	economics used to drive solution and/or to define some parameters	economics used to drive solution or to define key parameters	economics used to drive solution and to define key parameters	
Define objective function	no objective function used	objective function used, but inappropriate	objective function used, but inappropriate (but possibly more appropriate than D)	valid objective function used, but a more appropriate one could have been used	correct objective function used	
Define decision variables	no decision variables defined or used	inappropriate decision variables used	some valid decision variables used, but some omissions or some inappropriate	valid decision variables used, but some may be inappropriate	valid and appropriate decision variables used	

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Correct use of optimization techniques	no optimization	some topological or parametric optimization used, but not both	topological and parametric optimization attempted, but errors	topological and parametric optimization done	use of topological and parametric optimization interwoven to obtain solution	
Computer usage						
Demonstrates use to solve problem	computer not used	computer used but major errors	computer used with some errors	computer used correctly	superior use of computer to obtain unique solution	
Demonstrated use to find information	information not found	computer used but major errors	computer used with some errors	computer used correctly	superior use of computer to obtain unique solution	
Critical analysis of computer results	no analysis, no results	no analysis, just presents results	little critical analysis	critical analysis of results, but missing features	good critical analysis of results	
Response to questions - technical						
Knowledge of ChE principles	does not demonstrate knowledge of ChE principles	siginficant gaps in knowledge of ChE principles demonstrated	basic knowledge of ChE principles, but some notable gaps	demonstrates good knowledge of ChE principles	demonstrates clear knowledge of ChE principles with a big-picture perspective	
Prompting required	cannot provide correct answers, even with prompting	can provide some correct answers with prompting	some correct answers provided without prompting,	correct answers provided with little or no prompting required	answers questions correctly without prompting, anticipates and	

Attribute	0 (F) – Not proficient	1 (D) – Less than desired proficiency	2 (C) – Marginal proficiency	3 (B) – Good proficiency	4 (A) – Superior proficiency	Score
			others require prompting		answers follow-up questions	
Application of safety principles (if applicable)	not done	poorly done, superficial analysis, few aspects considered	some aspects considered, not all considered in design	done well, typical aspects considered and applied to design	all usual and some unusual aspects considered, considerations clearly interwoven into design	
Other economic, global, societal, and legal considerations (if applicable)	not done	poorly done, superficial analysis, few aspects considered	some aspects considered, not all considered in design	done well, typical aspects considered and applied to design	all usual and some unusual aspects considered, considerations clearly interwoven into design	