

**CH E 328 Chemical Reaction Kinetics**

**Instructor:** Daniel L Shaffer

**Total Credits:** 4

Lecture Cr: 3

Fall

Update Date: 2/20/2003

**Text:** Fogler, Elements of Chemical Reaction Engineering, 3rd ed

Lab Cr: 1

Spring

Inst. Rev. Date:

**ISBN:**

Recitation Cr:

Summer

Dept. Rep.:

**Pre Req(s):** CH E 216, CH E 220, and MATH 225

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):** CH E 323, CH E 307 or CHEM 324

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Application of the chemical kinetics of homogeneous and heterogeneous reactions to the design of chemical reactors and associated processing equipment.(2002-2004)

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Ability to design isothermal reactors for homogeneous and heterogeneous systems.	3		2		3						1			Exams, Homework, Student Evaluations, Written Report, Oral Report
2 Ability to determine a rate law and reaction mechanism from laboratory rate data.	3				2						1			Exams, Homework, Student Evaluations, Written Report, Oral Report
3 Ability to analyze a catalytic mechanism and establish rate limiting step(s).	3				2						1			Exams, Homework, Student Evaluations, Written Report, Oral Report
4 Ability to work as a team to achieve laboratory and research project goals.				2			2							Exams, Homework, Student Evaluations, Written Report, Oral Report
5 A basis for incorporating safety into any reactor design.						2		1	1					Exams, Homework, Student Evaluations, Written Report, Oral Report

- a. Ability to apply knowledge of math, engineering, and science.
- b. Ability to design and construct experiments.
- c. Ability to design a system, component, or process.
- d. Ability to function on multi-disciplinary teams.
- e. Ability to identify, formulate, and solve engineering problems.
- f. Understanding of professional and ethical responsibility.
- g. Ability to communicate effectively.

- h. ...broad education ... to understand the impact of eng. solutions in a global and societal context.
- i. Recognition of the need for and ability to engage in life-long learning.
- j. Knowledge of contemporary issues.
- k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.
- L. Quickly contribute in their focus area.
- M. Team contributors.

**CH E 215 Elementary Principles I**

**Instructor:** Jim Duffy

**Total Credits:** 3

Lecture Cr: 3

Fall

Update Date: 3/28/2003

**Text:** R.M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd edition, Wiley, 2000.

Lab Cr:

Spring

Inst. Rev. Date: 2/13/2003

**ISBN:** 0-471-53478

Recitation Cr:

Summer

Dept. Rep.:

**Pre Req(s):** Chem 131

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):**

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Material balance calculations applied to industrial processes. Analysis of gas behavior and gas-liquid systems. (2002-2004)

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Able to convert quantities from one set of units to another quickly and accurately.	3				1									Homework, Exams, , ,
2 Able to define and determine properties of process streams including fluid density, flow rate, chemical composition (mass and mole fractions, concentrations), fluid pressure, and temperature.	3				1		2							Homework, Exams, , ,
3 Material balance calculations: Draw and label process flowcharts from verbal process descriptions. Carry out degree of freedom analyses (process bookkeeping). Write and solve material balance equations for single-unit and multiple-unit processes, processes with recycle and bypass, and reactive processes.	3				3									Homework, Exams, , ,
4 Applied physical chemistry: Perform pressure-volume-temperature calculations for ideal and non-ideal gases. Incorporate the results of these calculations into process material balance calculations.	3				3									Homework, , , ,
5 Applied physical chemistry: Perform vapor-liquid equilibrium calculations for systems containing one condensable component and for ideal multicomponent solutions. Incorporate the results of these calculations into process material balance calculations.	3				3									Homework, Exams, , ,
6 Teamwork: Work effectively in problem-solving teams both in and out of class.							2						3	Homework, Student Evaluations, , ,

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- d. Ability to function on multi-disciplinary teams.
- e. Ability to identify, formulate, and solve engineering problems.
- f. Understanding of professional and ethical responsibility.
- g. Ability to communicate effectively.

- h. ...broad education ... to understand the impact of eng. solutions in a global and societal context.
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- j. Knowledge of contemporary issues.
- k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.
- L. Quickly contribute in their focus area.
- M. Team contributors.

**CH E 424 Transport Analysis**

**Instructor:** Joseph Seymour

**Total Credits:** 3

Lecture Cr: 3

Fall

Update Date: 2/18/2003

**Text:** Intro. to Transport Phenomena, W. J. Thomson, Prentice Hall PTR, 2000

Lab Cr:

Spring

Inst. Rev. Date: 2/18/2003

**ISBN:** 0-13-454828-0

Recitation Cr:

Summer

Dept. Rep.:

**Pre Req(s):** CH E 323, MATH 224

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):**

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Deterministic modeling techniques are applied to processes for the transport of momentum, energy and mass. Analytical and numerical solution techniques for the differential equations commonly encountered in the transport processes. (2002-2004)

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Students should understand the origins of transport phenomena in conservation laws and be able to formulate transport equations from the general conservation equation.  This includes the ability to write down in mathematical terms the diffusive, convective and generation terms for a given problem and grasp the meaning of each.	3				3						2			Exams, Homework, , ,
2 The capacity to generate differential equations governing transport in physical systems will be developed.  This will include the use of order of magnitude analysis and non-dimensionalization methods to simplify equations in a systematic fashion. An understanding of dimensionless groups in a physical context will be promoted. Generation of differential equations will include understanding of boundary conditions in physical and mathematical terms.	3	1	2		3						3			Exams, Homework, Project, ,
3 Students will develop knowledge of the molecular scale origin of transport coefficients and an awareness of the derivation of macroscopic scale transport coefficients, such as the Taylor-Aris dispersion coefficient.  Students will have the ability to identify the appropriate empirical transfer coefficients for heat and mass for given physical situations and understand their relations to dimensionless groups where appropriate. The skills necessary to calculate transport and transfer coefficients will be established.	3	1	2								3			Homework, , , ,
4 Students will gain competence in solving differential equations using numerical and analytical methods.  Numerical solution skills in MATHCAD will be developed in solving unsteady and steady state transport equations. Students should develop an understanding of the graphical forms of the solutions in the context of the physical process it describes, allowing for discussion of the solution shape and slope in terms of the process.	3	1	1								3			Homework, Project, , ,

5 Problem solving skills, which integrate the above objectives and prior student knowledge to set up and solve macroscopic heat and mass transport problems will be developed.

3	1	2	3							3		
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Exams, Homework, Project, ,

Students should be able to use both fundamental transport phenomena balances and transfer coefficient approaches to solve transport problems relevant to Chemical Engineering design and practice.

- a. Ability to apply knowledge of math, engineering, and science.
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- f. Understanding of professional and ethical responsibility.
- g. Ability to communicate effectively.

- h. ...broad education ... to understand the impact of eng. solutions in a global and societal context.
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- L. Quickly contribute in their focus area.
- M. Team contributors.



**CH E 322 Fluid Mechanics and Heat Transfer**

**Instructor:** Ron Larsen

**Total Credits:** 4

Lecture Cr: 4

Fall

Update Date: 2/25/2003

**Text:** Unit Operations of Chemical Engineering, 6th ed., McCabe, Smith, Harriott

Lab Cr:

Spring

Inst. Rev. Date: 2/25/2003

**ISBN:**

Recitation Cr:

Summer

Dept. Rep.:

**Pre Req(s):** CH E 216, CH E 220

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):** MATH 225

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Theory and equipment for fundamental chemical engineering operations involving fluid mechanics and heat transfer. Equipment design and computations of operational rates. (2002-2004)

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Fluid Statics: Determine the pressure at the bottom of a column of fluid	3		2		3									Homework, Student Evaluations, , ,
2 Fluid Statics: Calculate the pressure difference across a manometer.	3		2		3									Exams, Homework, Student Evaluations, , ,
3 Mechanical Energy Balance: Apply simplifications to the mechanical energy balance that are appropriate to a particular situation.	3		3		3									Exams, Homework, Student Evaluations, , ,
4 Mechanical Energy Balance: Explain the difference between the energy "to the pump" and "to the fluid".			2		3									Exams, Student Evaluations, , ,
5 Mechanical Energy Balance: Solve the mechanical energy balance to determine the required pump size for a particular problem.	3		3		3						3			Exams, Homework, Student Evaluations, , ,
6 Mechanical Energy Balance: Determine the required pump power using the results of the mechanical energy balance and the mass flow rate through the system.	3		3		3									Exams, Homework, Student Evaluations, , ,
7 Fluid Friction: Determine friction factors and hfs values for laminar and turbulent flow problems in both smooth and rough pipes.	3		3		3									Homework, Exams, Student Evaluations, , ,
8 Fluid Friction: Determine friction losses in valves and fittings.	3		2		3						2			Homework, Student Evaluations, , ,
9 Compressible Flow: Relate reservoir and receiver pressure, temperature, and density for isentropic expansions.	3		2		3						2			Homework, Student Evaluations, , ,
10 Compressible Flow: Calculate the acoustic velocity of an ideal gas at specified temperature and pressure.	3		2		3						2			Homework, Student Evaluations, , ,
11 Compressible Flow: Calculate the maximum permissible length of an adiabatic or isothermal pipeline.	3		2		3						2			Exams, Homework, Student Evaluations, , ,
12 Packed and Fluidized Beds: Calculate the sphericity of a non-spherical particle.	2		1		3									Homework, Student Evaluations, , ,

13	Packed and Fluidized Beds: Understand the meaning of porosity, or void fraction.	2			2													Student Evaluations, , ,
14	Packed and Fluidized Beds: Calculate the pressure drop across a packed bed using the Ergun equation.	3	3	3								3						Homework, Exams, Student Evaluations, ,
15	Packed and Fluidized Beds: Calculate the pressure drop across a fluidized bed at minimum fluidization.	3	3	3								3						Homework, Student Evaluations, , ,
16	Pumps: Explain the difference between a positive displacement pump and a centrifugal pump.	1	1															Student Evaluations, , ,
17	Pumps: Read a centrifugal pump curve to identify the operating point, best efficiency point, end of curve horsepower, and required trim.	2	2	1								2						Homework, Exams, Student Evaluations, ,
18	Pumps: Explain why the net positive suction head (NPSH) must be checked to avoid cavitation.	1	1															Student Evaluations, , ,
19	Heat Transfer: Explain the differences between conduction, convection, and radiation heat transfer.	2	1	1														Student Evaluations, , ,
20	Heat Transfer: Solve for the temperature profile in a conductive medium (e.g., metal rod) with constant temperature boundary conditions.	3	1	2								3						Homework, Student Evaluations, , ,
21	Heat Transfer: Calculate an overall heat transfer coefficient from individual heat transfer coefficients.	3	2	2														Homework, Exams, Student Evaluations, ,
22	Heat Transfer: Estimate wall temperatures based on an analysis of major resistance to heat transfer in a system.	2	1	1														Homework, Exams, Student Evaluations, ,
23	Heat Transfer: Select the appropriate equation to determine individual heat transfer coefficients for laminar or turbulent flows in various geometries.	2	3	1														Exams, Homework, Student Evaluations, ,
24	Heat Transfer: Calculate the rate at which energy can move across the tube wall(s) in a heat exchanger using the overall heat transfer coefficient, area available for heat exchange, and temperature driving force.	3	3	3								2						Homework, Exams, Student Evaluations, ,
25	Heat Transfer: Calculate a corrected log mean temperature difference for a multi-pass heat exchanger using FG charts.	2	3	1														Homework, Student Evaluations, , ,

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- e. Ability to identify, formulate, and solve engineering problems.
- f. Understanding of professional and ethical responsibility.
- g. Ability to communicate effectively.

- h. ...broad education ... to understand the impact of eng. solutions in a global and societal context.
- i. Recognition of the need for and ability to engage in life-long learning.
- j. Knowledge of contemporary issues.
- k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.
- L. Quickly contribute in their focus area.
- M. Team contributors.

**CH E 251 V Societal Impacts of Chemical Engineering**

**Instructor:** Phil Stewart

**Text:** Grice and Skinner, Mastering Public Speaking, 4th ed., Allyn and Bacon (2001)

**ISBN:** 0-205-31808-8

**Pre Req(s):** ENGL 121, CH E 215

**Co Req(s):**

**Total Credits:** 3

Lecture Cr: 1

Lab Cr:

Recitation Cr: 2

Seminar Cr:

Ind. Study Cr:

Other Cr:

Fall

Spring

Summer

On Demand

Alt. Years

Update Date: 2/17/2003

Inst. Rev. Date: 2/17/2003

Dept. Rep.:

Dept. Rev. Date:

**Catalog Data**

Study of ethical guidelines and professional practices and impacts of engineering on society and technology through discussion format, readings and formal oral presentations.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Ability to prepare and deliver effective informative presentations.							3			2				Oral Report, Written Report, Student Evaluations, ,
2 Ability to prepare effective visual aids for oral presentations.							3				3			Oral Report, Exams, Student Evaluations, ,
3 Ability to prepare and deliver effective persuasive presentations.							3			3				Oral Report, Exams, Student Evaluations, ,
4 Ability to identify principles from the AIChE Code of Ethics.						3		3						Oral Report, Exams, Student Evaluations, ,
5 Ability to apply ethical principles to the analysis of specific professional situations.			1		2	3		3						Exams, Recitation, , ,
6 Ability to explain how chemical engineering technologies affect people and the environment.						3	3	3		2	3			Exams, Recitation, , ,

- a. Ability to apply knowledge of math, engineering, and science.
- b. Ability to design and construct experiments.
- c. Ability to design a system, component, or process.
- d. Ability to function on multi-disciplinary teams.
- e. Ability to identify, formulate, and solve engineering problems.
- f. Understanding of professional and ethical responsibility.
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- h. ...broad education ... to understand the impact of eng. solutions in a global and societal context.
- i. Recognition of the need for and ability to engage in life-long learning.
- j. Knowledge of contemporary issues.
- k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

- L. Quickly contribute in their focus area.
- M. Team contributors.

**CH E 323 Mass Transfer Operations**

**Instructor:** Duffy

**Total Credits:** 3

Lecture Cr: 3

Fall

Update Date: 3/28/2003

**Text:** Unit Operations of Chemical Engineering, 6th ed., McCabe, Smith, Harriott

Lab Cr:

Spring

Inst. Rev. Date:

**ISBN:**

Recitation Cr:

Summer

Dept. Rep.:

**Pre Req(s):** CH E 322

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):**

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Theory and equipment for fundamental chemical engineering operations involving mass transfer. Equipment design and computations of operational rates.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Describe the various separation processes available to chemical engineers and formulate an appropriate separation strategy for a process stream based on composition, physical properties, and design heuristics.	3		1											Project, Student Evaluations, , ,
2 Analyze a steady state mass transfer situation, determine or derive the appropriate mass transfer equation, and solve the resulting expression.	3				2									Exams, Student Evaluations, , ,
3 Evaluate and solve design problems involving the following unit operations: Membranes.	3		3		2									Exams, Project, Student Evaluations, , ,
4 Evaluate and solve design problems involving the following unit operations: Gas absorption and stripping.	3		3		2									Exams, Project, Student Evaluations, , ,
5 Evaluate and solve design problems involving the following unit operations: Multicomponent distillation.	3		3		2									Exams, Project, Student Evaluations, , ,
6 Evaluate and solve design problems involving the following unit operations: Binary distillation.	3		3		2									Exams, Project, Student Evaluations, , ,
7 Evaluate and solve design problems involving the following unit operations: Liquid extraction.	3		3		2									Exams, Project, Student Evaluations, , ,
8 Evaluate and solve design problems involving the following unit operations: Partial vaporization/condensation.	3		3		2									Exams, Project, Student Evaluations, , ,
9 Evaluate and solve design problems involving the following unit operations: Flash vaporization.	3		3		2									Exams, Project, Student Evaluations, , ,
10 Utilize ChemCAD to design simple distillation systems and analyze the program output for the effects of design parameter variability.	3		3		2						3			Project, Student Evaluations, , ,
11 Work effectively on problem solving teams.													2	Student Evaluations, , , ,

- a. Ability to apply knowledge of math, engineering, and science.
- b. Ability to design and construct experiments.
- c. Ability to design a system, component, or process.
- d. Ability to function on multi-disciplinary teams.
- e. Ability to identify, formulate, and solve engineering problems.
- f. Understanding of professional and ethical responsibility.
- g. Ability to communicate effectively.

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- i. Recognition of the need for and ability to engage in life-long learning.
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- k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

- L. Quickly contribute in their focus area.
- M. Team contributors.

**CHE 100 Freshman Seminar**

**Instructor:** Seymour

**Text:**

**ISBN:**

**Pre Req(s):**

**Co Req(s):**

**Total Credits:** 1

Lecture Cr: 1

Lab Cr:

Recitation Cr:

Seminar Cr:

Ind. Study Cr:

Other Cr:

- Fall
- Spring
- Summer
- On Demand
- Alt. Years

Update Date: 3/28/2003

Inst. Rev. Date:

Dept. Rep.:

Dept. Rev. Date:

**Catalog Data**

An introduction to engineering methods, problem solving, and computers. Description of chemical engineering and discussion of special interests to students.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Students experience the variety of topics and disciplines within chemical engineering through classroom discussion, demonstrations and group excercises, and guest lectures by Chemical Engineering Faculty				1		1			3		3			Student Evaluations, , ,
2 Students are introduced to problem solving strategies, engineering design considerations, and library research skills.	2		2											In Class Assignments, Student Evaluations, , ,
3 Students' required attendance and participation in group exercises and discussions foster teamwork and collegiality among incoming students.													3	In Class Assignments, Attendance, , ,

- a. Ability to apply knowledge of math, engineering, and science.
- b. Ability to design and construct experiments.
- c. Ability to design a system, component, or process.
- d. Ability to function on multi-disciplinary teams.
- e. Ability to identify, formulate, and solve engineering problems.
- f. Understanding of professional and ethical responsibility.
- g. Ability to communicate effectively.

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- i. Recognition of the need for and ability to engage in life-long learning.
- j. Knowledge of contemporary issues.
- k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

- L. Quickly contribute in their focus area.
- M. Team contributors.

**CHE 215 Elementary Principles I**

**Instructor:** Deibert

**Total Credits:** 3

Lecture Cr: 3

Fall

Update Date: 2/20/2003

**Text:** R.M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd edition, Wiley, 2000.

Lab Cr:

Spring

Inst. Rev. Date:

**ISBN:** 0-471-53478

Recitation Cr:

Summer

Dept. Rep.:

**Pre Req(s):** CHEM 131

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):**

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Material balance calculations applied to industrial processes. Analysis of gas behavior and gas-liquid systems.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Convert variable values between the major systems of units and between different dimensional units within each system.	2													Homework, Exams, , ,
2 Identify and label the units of each variable and value used in a problem solution.	3													Homework, Exams, , ,
3 Express answers in appropriate units and with a reasonable number of significant figures based on the information provided in problem statements.				2										Homework, Exams, , ,
4 Determine orderly approaches to solving simple, single unit, material balance problems (using in = out).					3						3		2	Homework, Exams, Group study involvement and contribution, ,
5 Calculate accurate answers to problems by implementing these orderly approaches.	1													Homework, Exams, , ,
6 Calculate accurate answers to material balance problems for processes that include several interconnected operations, some with recycle or bypass streams.					3									Homework, Exams, , ,
7 Solve material balance problems on processes which include chemical reactions using either the extent(s) of reaction(s) or the elemental balance approach (using in + generated = out + consumed).	1				3						3		2	Homework, Exams, Group study involvement and contribution, ,
8 Be able to identify the problems for which the extent of reaction approach is preferable to the elemental balance approach, and vice versa.					2									Homework, Exams, , ,
9 Calculate accurate answers to problems involving chemical reaction using the definitions of limiting reactant, excess reactant, fractional excess, fractional conversion, yield and selectivity in the problem definitions and/or solution requirements.	1				2									Homework, Exams, , ,
10 Solve material balance problems on processes which include fuel combustion reactions using the definitions of theoretical air (oxygen) and excess air (oxygen).					2									Homework, Exams, , ,
11 Calculate answers to combustion material balance problems for which product gas compositions are presented on a dry basis.	1				2									Homework, Exams, , ,



**CHE 216 Elementary Principles II**

**Instructor:** Deibert

**Total Credits:** 3

Lecture Cr: 3

Fall

Update Date: 3/26/2003

**Text:** R.M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd edition, Wiley, 2000.

Lab Cr:

Spring

Inst. Rev. Date:

**ISBN:** 0-471-53478

Recitation Cr:

Summer

Dept. Rep.:

**Pre Req(s):** CHE 215, MATH 181

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):**

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Energy balances and combined energy-material balances. Introduction to processes.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 List and define in your own words the three components of the total energy of a process system and the two modes of energy transfer between a system and its surroundings. State the conditions under which energy transfer by heat and by work are positive.	1				2									Homework, Exams, , ,
2 Convert an energy or power (energy/time) expressed in any unit (e.g., J, dyne.cm, Btu, ft.lbf/h, kW, hp) to its equivalent in any other dimensionally consistent units.	1				2									Homework, Exams, , ,
3 Calculate the kinetic energy of a body of mass m moving with velocity u or the rate of transport of kinetic energy by a stream moving with mass flow rate m and velocity u.	1				2									Homework, Exams, , ,
4 Calculate the potential energy of a body of mass m at elevation z or the rate of transport of potential energy by a stream moving with mass flow rate m at elevation z, where z is a reference plane at which potential energy is defined to equal zero.	1				2									Homework, Exams, , ,
5 Define the terms closed process system, open process system, isothermal process, and adiabatic process					2									Homework, Exams, , ,
6 Write the first law of thermodynamics (the energy balance equation) for a closed process system and state the conditions under which each of the five terms in the balance can be neglected.	1				2									Homework, Exams, , ,
7 Given a description of a closed process system, simplify the energy balance and solve it for whichever term is not specified in the process description.					2									Homework, Exams, , ,
8 Define the terms flow work, shaft work, specific internal energy, specific volume, and specific enthalpy.					2									Homework, Exams, , ,

9	Write the energy balance for an open process system in terms of enthalpy and shaft work and state the conditions under which each of the five terms can be neglected.					2												Homework, Exams, , ,
10	Given a description of an open process system, simplify the energy balance and solve it for whichever term is not specified in the process description.	1				3												Homework, Exams, , ,
11	State why the actual values of U and H can never be known for a given species in a specified state (temperature, pressure, and phase) and define the concept of a reference state.					2												Homework, Exams, , ,
12	Explain why the reference state used to generate a table of specific internal energies or enthalpies is irrelevant if one is only interested in calculating $\Delta U$ or $\Delta H$ for a process.					2												Homework, Exams, , ,
13	Given a process in which a specified mass m of a species goes from one state to another and tabulated values of U or H for the species at the initial and final states are available, calculate $\Delta U$ or $\Delta H$ .					2												Homework, Exams, , ,
14	Given values of V at each state, calculate $\Delta H$ from the previously calculated $\Delta U$ or vice versa. Carry out the corresponding calculations to determine $\Delta U$ or $\Delta H$ for a stream with mass flow rate m going from one state to another.					2												Homework, Exams, , ,
15	Use the saturated and superheated steam tables to determine describe properties of the liquid and vapor phases. (a) Whether water at a specified temperature and pressure is subcooled liquid, saturated liquid, saturated vapor, or superheated vapor;					2												Homework, Exams, , ,
16	Explain the significance of the specific internal energy values and enthalpy values tabulated in the steam tables,use the steam tables to calculate $\Delta U$ (or $\Delta U$ ) and/or $\Delta H$ (or $\Delta H$ ) for a given process where water changes .					2												Homework, Exams, , ,
17	Given a description of a nonreactive process,draw and completely label a flowchart, including Q and W if their values are either specified or called for in a problem statement;perform a degree-of-freedom analysis and write equations to find all variables.					2												Homework, Exams, , ,
18	Define both formally (in terms of internal energies and enthalpies) and in words a high school senior could understand the variables $C_v(T)$ , $C_p(T)$ , $\Delta H_v$ , and $\Delta H_s$	1			1				1									Homework, Exams, , ,
19	Calculate $\Delta U$ and $\Delta H$ for the following changes in state of a species:Isenthalpic changes in pressure,Isenthalpic changes in pressure, isothermal isobaric phase changes and Isothermal isobaric mixing of two or more species.					2												Homework, Exams, , ,
20	Know when the formulas you use for $\Delta U$ and $\Delta H$ calculations are exact, good approximations, and poor approximations.					2												Homework, Exams, , ,

21	Given a reference state and a process state for a species, choose a path from the reference state to the process state consisting of a series of isothermal pressure changes, isobaric temperature changes, and isothermal isobaric phase changes.					2													Homework, Exams, , ,
22	Derive $\Delta U = mC_p\Delta T$ (listing assumptions) from the closed system energy balance ( $Q + W = \Delta U + \Delta E_k + \Delta E_p$ ).					2													Homework, Exams, , ,
23	Estimate the heat capacity of a liquid or solid species using Kopp's rule. Estimate the energy of fusion and energy of vaporization of a species using correlations in Section 8.4b.					2													Homework, Exams, , ,
24	Given any nonreactive process: Draw and label the flowchart, including Q in labeling; carry out a degree-of-freedom analysis; write material & energy balances and other equations, perform the calculations, listing the assumptions and approximations.					2													Homework, Exams, , ,
25	Given an adiabatic process or any other nonreactive process for which the value of Q (closed system) or Q (open system) is specified, write material and energy balance equations and solve them simultaneously for requested quantities.					3													Homework, Exams, , ,
26	Explain the meaning of the apparently contradictory term adiabatic cooling. Explain how spray cooling and humidification, spray dehumidification, and spray drying work. Explain how it is possible to dehumidify air by spraying water into it.				1	2													Homework, Exams, , ,
27	Explain to a first-year engineering student why a beaker containing acid gets hot if you add water to it.	1			1	1		1											Homework, Exams, , ,
28	Use energy of solution data and solution heat capacity data to: calculate the enthalpy of a hydrochloric acid, sulfuric acid, or sodium hydroxide solution of a known composition (solute mole fraction) relative to the pure solute and water at 25°C					3													Homework, Exams, , ,
29	Use energy of solution data and solution heat capacity data to: Calculate the required rate of energy transfer by heat to or from a process in which an aqueous solution is formed, diluted, or combined with another solution of the same species.					3													Homework, Exams, , ,
30	Use energy of solution data and solution heat capacity data to: Calculate the final temperature if an aqueous solution of HCl, H <sub>2</sub> SO <sub>4</sub> , or NaOH is formed, diluted, or combined with another solution of the same species adiabatically.					3													Homework, Exams, , ,
31	Perform material and energy balance calculations for a process that involves solutions for which enthalpy-concentration charts are available.					3													Homework, Exams, , ,
32	Explain in your own words the concepts of heat of reaction, exothermic and endothermic reactions, heat of formation, combustion, heat of combustion; standard heats of formation, combustion, and reaction; heating value and adiabatic flame temperature.	1			1														Homework, Exams, , ,



**CHE 216 Elementary Principles II**

**Instructor:** Duffy

**Text:** R.M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd edition, Wiley, 2000.

**ISBN:** 0-471-53478

**Pre Req(s):** CHE 215, MATH 181

**Co Req(s):**

**Total Credits:**

Lecture Cr:

Fall

Update Date: 3/28/2003

Lab Cr:

Spring

Inst. Rev. Date:

Recitation Cr:

Summer

Dept. Rep.:

Seminar Cr:

On Demand

Dept. Rev. Date:

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Energy balances and combined energy-material balances. Introduction to processes.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Basic engineering calculations. Convert quantities from one set of units to another quickly and accurately.	3													Exams, Student Evaluations, , ,
2 Basic engineering calculations. Define and determine or estimate properties of process streams including fluid density, flow rate, chemical composition, pressure, temperature, enthalpy, internal energy, kinetic energy, potential energy, and flow work.	3													Exams, Student Evaluations, , ,
3 Draw and label process flowcharts from verbal process descriptions. Write and solve material and energy balance equations for single-unit and multiple-unit processes, processes with recycle and bypass, and reactive processes.	3				3									Exams, Student Evaluations, , ,
4 Perform pressure-volume-temperature calculations for ideal and non-ideal gases. Incorporate the results of these calculations into process material and energy balance calculations.	3				3									Exams, Student Evaluations, , ,
5 Perform vapor-liquid equilibrium calculations for systems containing one condensable component and for ideal multicomponent solutions. Incorporate the results of these calculations into process material and energy balance calculations.	3				3									Exams, Student Evaluations, , ,
6 Calculate internal energy and enthalpy changes for process fluids undergoing specified changes in temperature, pressure, phase, and chemical composition. Incorporate the results of these calculations into process material and energy balance calculations.	3				3									Exams, Student Evaluations, , ,
7 Work effectively in problem-solving teams.							2						3	Student Evaluations, , ,

- a. Ability to apply knowledge of math, engineering, and science.
- b. Ability to design and construct experiments.
- c. Ability to design a system, component, or process.
- d. Ability to function on multi-disciplinary teams.
- e. Ability to identify, formulate, and solve engineering problems.
- f. Understanding of professional and ethical responsibility.
- g. Ability to communicate effectively.

- h. ...broad education ... to understand the impact of eng. solutions in a global and societal context.
- i. Recognition of the need for and ability to engage in life-long learning.
- j. Knowledge of contemporary issues.
- k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

- L. Quickly contribute in their focus area.
- M. Team contributors.

**CHE 220 Computations in Chemical Engineering**

**Instructor:** Larsen

**Total Credits:** 3

Lecture Cr: 2

Fall

Update Date: 2/20/2003

**Text:** (1) Larsen, Engineering with Excel Larsen (2) Larsen, Introduction to Mathcad (3) Larsen, More Mathcad

Lab Cr:

Spring

Inst. Rev. Date: 2/20/2003

**ISBN:** 0-13-017696-6, 0-13-020007-7, local

Recitation Cr: 1

Summer

Dept. Rep.:

**Pre Req(s):** CHE 215, MATH 182

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):**

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Effective methods for applying the computer to common numerical problems encountered in chemical engineering. Chemical engineering examples will provide a basis for more comprehensive problems encountered in the other professional level courses.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Basics: Students will gain a high degree of proficiency using Excel for standard mathematical operations (cell arithmetic), built-in functions, and graphing XY-scatter plots.	3		1								3			Homework, , ,
2 Regression: Students will be able to add various types of trend lines (linear, polynomial, etc.) to a graph they have created, and have Excel display the equation of the line and, when appropriate, the R2 value of the fit curve. Students will know that Excel provides a Regression Analysis Package that is available if there is no suitable trend-line for a particular application.	3				2						3			Homework, Exams, , ,
3 Statistics: Students will understand the meaning of terms such as normal distribution, population, sample, error, and deviation. Students will be familiar with and able to use Excel's built-in functions for basic statistical operations such as calculating an average, standard deviation, or variance for either a sample or a population. Students will be able to compute the confidence interval about a mean value (normal distribution), and understand the meaning of the result.	3	2	1		2						3			Homework, Exams, , ,
4 Time Value of Money: Students will understand how interest rates create a time value of money, and why interest rates must be considered as amounts of money are moved through time. Students will be able to use Excel's time value of money functions to move amounts through time (FV, PV, PMT). Students will be able to use Excel's time value of money functions to compare alternatives. Students will be able to use Excel functions to compute an internal rate of return for a series of incomes and expenses, and understand the meaning of the result.	2				2		1			2	3			Homework, Project, , ,
5 Matrix Math: Students will know the standard matrix math operations, and how to accomplish them in Excel. Students will understand how to use Excel's "array" functions, why there are special procedures for entering array functions, and the benefit array functions provide the user. Students will be able to solve systems of linear equations using Excel's matrix mat functions.	3				2						3			Homework, Exams, , ,

6	Solving One Ordinary Differential Equation: Students will learn to use Euler's method to create an arithmetic approximation of an ODE. Students will learn about stability and accuracy (or lack thereof) associated with using Euler's method to find approximate solutions to ODEs.	3	2	2						3		Homework, , ,
7	Basics: Students will learn how to enter equations in Mathcad, how to control the order in which equations are solved, and how to control the presentation of results. Students will understand how Mathcad handles units, and the types of unit conversions that are not possible in Mathcad.			1						3		Homework, , ,
8	Functions: Students will learn how to use Mathcad's built-in functions. Students will learn how to write their own functions in Mathcad.	2	1	1						3		Homework, Exams, , ,
9	Matrix Math: Students will know the standard matrix math operations, and how to accomplish them in Mathcad. Students will be able to solve systems of linear equations using Mathcad.	3		1						3		Homework, , , ,
10	Graphing, Curve-Fitting, Interpolation: Students will learn how to create a multi-curve plot in Mathcad. Students will learn to use Mathcad's spline fit and interpolation functions. Students will be able to look at a graphed data set and recognize when regression is more appropriate than spline fitting.	3	1	1						3		Homework, Exams, , ,
11	Iterative Solutions: Students will be able to set up a solve block to solve iterative problems using Mathcad.	3	1	1	1					3		Homework, Project, , ,
12	Numerical Differentiation: Students will understand how finite difference approximations are derived for common first and second order derivatives. Students will recognize the difference between forward, backward, and central first-order finite differences. Students will be able to use finite differences to compute estimates of derivatives from data sets.	3		1						3		Homework, Exams, , ,
13	Numerical Integration: Students will understand the relationship between the area beneath a curve and the integral of the function represented by the curve. Students will write a trapezoidal integration function and be able to use that function to compute the area beneath a curve.	3		1						3		Homework, , , ,
14	Solving One Ordinary Differential Equation: Students will learn to use Mathcad's rkfixed function to solve a single ordinary differential equation using fourth order Runge-Kutta methods.	3	1	2						3		Homework, , , ,
15	Solving Simultaneous Ordinary Differential Equations: Students will learn to rewrite higher order differential equations as systems of first-order differential equations. Students will learn to use Mathcad's rkfixed function to solve a system of single ordinary differential equations using fourth order Runge-Kutta methods.	3	1	2						3		Homework, , , ,

<p>16 Solving One Partial Differential Equation: Students will learn to use the Method of Lines to transform one partial differential equation into a series of first-order ordinary differential equations.</p> <p>Students will recognize that a partial differential equation cannot be solved unless sufficient boundary and/or initial conditions are known. Students will be able to solve a series of ordinary differential equations using Mathcad's rkfixed function.</p>	<table border="1"> <tr> <td>3</td><td></td><td>1</td><td></td><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>	3		1		2								3								<p>Homework, , , ,</p>
3		1		2								3										

<p>17 Programming: Students will learn the fundamental operations of all programming languages: Data, Input, Operations, Output, Conditional Execution, Loops, Functions</p> <p>Students will learn typical flowchart symbols, and be able to read and understand simple programming flowcharts.</p>	<table border="1"> <tr> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>														1							<p>Homework, Exams, , ,</p>
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|---|--|
| <ul style="list-style-type: none"> <li>a. Ability to apply knowledge of math, engineering, and science.</li> <li>b. Ability to design and construct experiments.</li> <li>c. Ability to design a system, component, or process.</li> <li>d. Ability to function on multi-disciplinary teams.</li> <li>e. Ability to identify, formulate, and solve engineering problems.</li> <li>f. Understanding of professional and ethical responsibility.</li> <li>g. Ability to communicate effectively.</li> </ul> | <ul style="list-style-type: none"> <li>h. ...broad education ... to understand the impact of eng. solutions in a global and societal context.</li> <li>i. Recognition of the need for and ability to engage in life-long learning.</li> <li>j. Knowledge of contemporary issues.</li> <li>k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.</li> <li>L. Quickly contribute in their focus area.</li> <li>M. Team contributors.</li> </ul> |
|---|--|

**CHE 307 Chemical Equilibrium**

**Instructor:** Sears

**Total Credits:** 4

Lecture Cr: 4

Fall

Update Date: 3/28/2003

**Text:** Text: Introductory Chemical Engineering Thermodynamics, by Elliott and Lira, Prentice Hall (1999)

Lab Cr:

Spring

Inst. Rev. Date:

**ISBN:**

Recitation Cr:

Summer

Dept. Rep.:

**Pre Req(s):** CHE 216, MATH 225

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):**

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Application of first and second laws of thermodynamics to phase and chemical equilibrium, thermodynamic cycles, statistical mechanics, and process analysis.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 State the first and second laws of thermodynamics in words or equation form. Recite the microscopic and macroscopic views of entropy in words or equation form.					2									Homework, Exams, , ,
2 Use thermodynamic tables to determine thermodynamic values such as enthalpy or entropy, given sufficient values of thermodynamic state variables.					3									Homework, Exams, , ,
3 Use heat capacity relations to calculate the change in enthalpy or entropy of a fluid or solid, given the change in temperature, pressure or relative change to the standard state of the component.					3									Homework, Exams, , ,
4 Use the first law of thermodynamics and the enthalpy or internal energy of a fluid(s) to calculate the energy balance; i.e. work, or enthalpy state of a stream in a process system.			3		3									Homework, Exams, , ,
5 Use the laws of thermodynamics and entropy in a process analysis to calculate the efficiency of a process or the work given the efficiency.			3		1									Homework, Exams, , ,
6 Know how to find the derivative relations of thermodynamics.					2									Homework, Exams, , ,
7 Use an equation of state to calculate the true T-P-density conditions for a fluid and use a departure function to calculate the true enthalpy of a fluid, given the specified equation or function.					2									Homework, Exams, , ,
8 State the definition of fugacity and be able to calculate the fugacity of a fluid or solid using a specified method of thermodynamics.					3									Homework, Exams, , ,
9 State the criteria for phase equilibrium in terms of fugacity, temperature and pressure in word or equation form.					3									Homework, Exams, , ,
10 Specify the degrees of freedom in a system, given the components and some thermodynamic state properties.			1		3									Homework, Exams, , ,

11	State the definition of a distribution coefficient in word or equation form.  Use it in conjunction with fugacity coefficients, Raoult's Law and Henry's Law to find the distribution coefficient for a component between two phases for a system.					3								2	Homework, Exams, , ,
12	Use fugacity relations and the determination of equilibrium from equations of state (theory and associated numerical software) to calculate equilibrium in pure component and multi-component systems.					3									Homework, Exams, , ,
13	State the definition of an activity coefficient and the Gibbs-Duhem equation and solution models; use a chemical engineering software package to calculate the composition in equilibrium.					3							3	Homework, Exams, , ,	
14	Interpret a phase equilibrium diagram and use it to obtain compositions and intensive variable thermodynamic functions.					3								Homework, Exams, , ,	
15	State the criteria for chemical equilibrium; calculate the reaction equilibrium composition for a single reaction, in a single phase and in multiple phases.					3								Homework, Exams, , ,	
16	Calculate the reaction equilibrium composition for more than one reaction in a single phase. Calculate multiple equilibrium compositions, using available software packages or algebraic relations from material balances and chemical equilibrium			3		3							3	Homework, Exams, , ,	
17	Calculate the change in the chemical equilibrium constant from standard state, using van't Hoff's Law; and, at a given temperature if given a chemical composition, or from the chemical engineering software.					3							3	Homework, Exams, , ,	
18	Be able to solve an engineering problem by combining at least two of these objectives.					3								Homework, Exams, , ,	
19	Perform an energy balance on a reacting, equilibrium system to find an outlet condition of a process system.  a. Ability to apply knowledge of math, engineering, and science. b. Ability to design and construct experiments. c. Ability to design a system, component, or process. d. Ability to function on multi-disciplinary teams. e. Ability to identify, formulate, and solve engineering problems. f. Understanding of professional and ethical responsibility. g. Ability to communicate effectively.			3		3								Homework, Exams, , ,	
														h. ...broad education ... to understand the impact of eng. solutions in a global and societal context. i. Recognition of the need for and ability to engage in life-long learning. j. Knowledge of contemporary issues. k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.  L. Quickly contribute in their focus area. M. Team contributors.	

**CH E 338 Bioprocesses in Engineering**

**Instructor:** Pasmore

**Total Credits:** 2

Lecture Cr: 2

Fall

Update Date: 4/14/2003

**Text:**

Lab Cr:

Spring

Inst. Rev. Date:

**ISBN:**

Recitation Cr:

Summer

Dept. Rep.:

**Pre Req(s):** BCHM 340, CH E 322

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):**

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Biotechnology fundamentals on physiology and metabolism of microbes in natural and engineered systems for both planktonic and biofilm phenotypes and transition between types.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Students will demonstrate a knowledge of basic cellular biology.														» » »
2 Students will discuss of the current areas where biology is used in engineering.														» » »
3 Students will design the control biological processes.														» » »
4 Students will predict and calculate the energetics of biological reactions.														» » »
5 Students develop an understanding of the current literature on a biologic process that they are interested in.														» » »
6 Students will critique literature and develop an understanding not all literature is “good” and aid in distinguishing “good” from “bad”.														» » »
7 Students will develop/improve technical writing skills, in the format of a review article.														» » »
8 Students will know the basic processes involved in wound healing and immune response														» » »
9 Students will understand the basic aspects and concerns in tissue engineering.														» » »

- a. Ability to apply knowledge of math, engineering, and science.
- b. Ability to design and construct experiments.
- c. Ability to design a system, component, or process.
- d. Ability to function on multi-disciplinary teams.
- e. Ability to identify, formulate, and solve engineering problems.
- f. Understanding of professional and ethical responsibility.
- g. Ability to communicate effectively.

- h. ...broad education ... to understand the impact of eng. solutions in a global and societal context.
- i. Recognition of the need for and ability to engage in life-long learning.
- j. Knowledge of contemporary issues.
- k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.
- L. Quickly contribute in their focus area.
- M. Team contributors.

**CH E 400 Professionalism in Chemical and Biological Engineering**

**Instructor:** Larsen  
**Text:**  
**ISBN:**  
**Pre Req(s):** Senior standing.  
**Co Req(s):**

**Total Credits:**

Lecture Cr:  Fall  
 Lab Cr:  Spring  
 Recitation Cr:  Summer  
 Seminar Cr: 1  On Demand  
 Ind. Study Cr:  Alt. Years  
 Other Cr: 4 maximum 4 credits

Update Date:  
 Inst. Rev. Date:  
 Dept. Rep.:  
 Dept. Rev. Date:

**Catalog Data**  
 Seminar

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Students explore post-graduation career paths (including graduate school and/or professional engineer registration) in light of their own career goals and interests.														,,, ,
2 Students recognize the ethical and professional responsibilities of an engineer in the workplace and in the larger community, including an understanding of the impacts of engineering decisions on globally significant issues.						3		3		2				,,, ,
3 Students understand the Professional Registration Process and its undertaking as part of ongoing educational process of career enhancement and advancement.						2								,,, ,

- a. Ability to apply knowledge of math, engineering, and science.
- b. Ability to design and construct experiments.
- c. Ability to design a system, component, or process.
- d. Ability to function on multi-disciplinary teams.
- e. Ability to identify, formulate, and solve engineering problems.
- f. Understanding of professional and ethical responsibility.
- g. Ability to communicate effectively.

- h. ...broad education ... to understand the impact of eng. solutions in a global and societal context.
- i. Recognition of the need for and ability to engage in life-long learning.
- j. Knowledge of contemporary issues.
- k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.
- L. Quickly contribute in their focus area.
- M. Team contributors.

**CHE 402 Chemical and Petroleum Industries**

**Instructor:** Sears

**Total Credits:** 3

Lecture Cr: 2

Fall

Update Date: 3/31/2003

**Text:** Analysis, Synthesis, and Design of Chemical Processes by Richard Turton, et al.; Prentice Hall, 2002

Lab Cr:

Spring

Inst. Rev. Date:

**ISBN:**

Recitation Cr:

Summer

Dept. Rep.:

**Pre Req(s):** CHE 322, CHEM 215

Seminar Cr: 1

On Demand

Dept. Rev. Date:

**Co Req(s):**

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Present day chemical and biochemical processes in industry and processes which may assume industrial importance. Problems in economic and thermo analysis of processes.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Identify and discuss which type of diagram (BFD, PFD, P&ID, or 3-D layout) is appropriate to use for a given application.			3											Homework, Exams, , ,
2 Given a flow diagram, identify heuristics/factors which might have been used in developing the process scheme.			3											Homework, Exams, , ,
3 Given a flow sheet and flowrates, be able to calculate Single-Pass Conversion, Overall Conversion, and/or Yield.					3									Homework, Exams, , ,
4 Calculate the Bare Module equipment cost of an item.					3									Homework, Exams, , ,
5 Given a flow sheet or unit operation, estimate the operating cost and operating labor required.					3									Homework, Exams, , ,
6 Estimate the operating costs of a process given flows, total F.C.I. And %R & D, And Administrative, Distribution and Patent costs.					3									Homework, Exams, , ,
7 Calculate Annual Net Profit of a process given flows, total F.C.I. And %R & D, And Administrative, Distribution and Patent, and material and product costs.					3									Homework, Exams, , ,
8 Calculate the NVP given a cash flow diagram.					3									Homework, Exams, , ,
9 Choose the best of two investment alternatives based on the NPV.					3									Homework, Exams, , ,
10 Determine the ROROI (average) or DCFROR for a simple process with straight line depreciation.					3									Homework, Exams, , ,
11 Perform a calculation of a total grass-roots capital investment, given Bare Module equipment costs.					3									Homework, Exams, , ,
12 Specify why the ammonia synthesis uses a particular operation.					3									Homework, Exams, , ,

13	Given a process flowsheet, identify 1) purpose of a given operation, 2) why a material of construction for unit and given T & P are used.			3															Homework, Exams, , ,
14	For a given hydrocracking process and product mix, identify 1) why short or long exposure times were chosen, and 2) why direct-fired or indirect heaters were chosen in design.			3															Homework, Exams, , ,
15	Determine potential sites for a chemical facility using the relationships between raw materials, intermediates and final products.				3														Homework, Exams, , ,
16	Describe in detail the design rationale for the unit operations examined on the field inspection trip.			3															Homework, Exams, , ,
17	Discuss design and operation of of materials, petroleum, environmental, chemical and/or biochemical processes; and, perform an economic analysis of portion of one particular process.			3	3														Homework, Exams, Project, ,
18	Discuss current management and economic issues and trends in chemical industry, as well as, current structural interaction of companies.												3						Homework, Exams, , ,

- a. Ability to apply knowledge of math, engineering, and science.
- b. Ability to design and construct experiments.
- c. Ability to design a system, component, or process.
- d. Ability to function on multi-disciplinary teams.
- e. Ability to identify, formulate, and solve engineering problems.
- f. Understanding of professional and ethical responsibility.
- g. Ability to communicate effectively.

- h. ...broad education ... to understand the impact of eng. solutions in a global and societal context.
- i. Recognition of the need for and ability to engage in life-long learning.
- j. Knowledge of contemporary issues.
- k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.
- L. Quickly contribute in their focus area.
- M. Team contributors.

**CHE 411 C Design of Chemical and Petroleum Processes I**

**Instructor:** Shaffer

**Total Credits:** 2

Lecture Cr: 1

Fall

Update Date: 2/20/2003

**Text:**

Lab Cr:

Spring

Inst. Rev. Date:

**ISBN:**

Recitation Cr: 1

Summer

Dept. Rep.:

**Pre Req(s):** CH E 323, CH E 328, CH E 402

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):**

Ind. Study Cr:

Alt. Years

**Catalog Data**

Senior capstone course. Design and simulation of chemical engineering equipment, processes and plants.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Ability to undertake and succeed in the open-ended design of a chemical process plant.	3		3		2				2		1	2		Weekly design team meetings/updates., Interim group teamleader presentations, Final written/oral reports, Internal group member evaluations, Student Evaluations
2 Ability to assemble a logical and practical sequence of integrated unit operations for a safe and workable chemical process operation.	3		3	1	2							2		y design team meetings/updates., Interim group teamleader presentations, Final written/oral reports, Internal group member evaluations, Student Evaluations
3 Ability to design process plant hardware.	2		3											y design team meetings/updates., Interim group teamleader presentations, Final written/oral reports, Internal group member evaluations, Student Evaluations
4 Ability to work as an effective team member.				2				2						y design team meetings/updates., Interim group teamleader presentations, Final written/oral reports, Internal group member evaluations, Student Evaluations
5 Ability to prepare and present written and oral technical reports.								1	3					y design team meetings/updates., Interim group teamleader presentations, Final written/oral reports, Internal group member evaluations, Student Evaluations

- a. Ability to apply knowledge of math, engineering, and science.
- b. Ability to design and construct experiments.
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- h. ...broad education ... to understand the impact of eng. solutions in a global and societal context.
- i. Recognition of the need for and ability to engage in life-long learning.
- j. Knowledge of contemporary issues.
- k. Ability to use techniques, skills, and modern engineering tools necessary for engineering practice.
- L. Quickly contribute in their focus area.
- M. Team contributors.

**CHE 412 C Design of Chemical and Petroleum Processes II**

**Instructor:** Shaffer  
**Text:**  
**ISBN:**  
**Pre Req(s):** CHE 411  
**Co Req(s):**

**Total Credits:** 3

Lecture Cr: 2  
 Lab Cr:  
 Recitation Cr: 1  
 Seminar Cr:  
 Ind. Study Cr:  
 Other Cr:

Fall  
 Spring  
 Summer  
 On Demand  
 Alt. Years

Update Date: 2/20/2003  
 Inst. Rev. Date:  
 Dept. Rep.:  
 Dept. Rev. Date:

**Catalog Data**

Senior capstone course. Design and economic analysis of chemical engineering equipment, processes and plants

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Ability to complete the open-ended design of a chemical process plant.	3		3		2			2		1	2			y design team meetings/updates., Interim group teamleader presentations, Internal group member evaluations, Written Report, Oral Report
2 Ability to use cash flow and time value of money concepts to determine the profitability of a process plant.	1								1	1	1			y design team meetings/updates., Interim group teamleader presentations, Internal group member ev, Written Report, Oral Report
3 Ability to work as an effective team member.				2			2						3	y design team meetings/updates., Interim group teamleader presentations, Internal group member ev, Written Report, Oral Report
4 Ability to prepare and present written and oral reports.						1	3							y design team meetings/updates., Interim group teamleader presentations, Internal group member ev, Written Report, Oral Report

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**CHE 415 Design Case Studies**

**Instructor:** Deibert

**Text:**

**ISBN:**

**Pre Req(s):** CH E 323

**Co Req(s):**

**Total Credits:** 2

Lecture Cr: 2

Lab Cr:

Recitation Cr:

Seminar Cr:

Ind. Study Cr:

Other Cr:

Fall

Spring

Summer

On Demand

Alt. Years

Update Date: 3/31/2003

Inst. Rev. Date:

Dept. Rep.:

Dept. Rev. Date:

**Catalog Data**

Design of chemical processes, equipment and plants utilizing open-ended case problems. Process troubleshooting and optimization.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Create process simulations using ChemCad and use these simulations to model the design and operating characteristic of a broad spectrum of physical and chemical processes.			3		2						3			Homework, Exams, , ,
2 Explain the advantages of using process simulation programs to model and design chemical process, and the ways that these programs can readily be misused.					1						3			Homework, Exams, , ,
3 Design integrated sequences of unit operations into processes that substantially comply with reasonable process constraints and efficiently achieve design objectives.			3		1									Homework, Exams, , ,
4 Efficiently design and simulate integrated processes involving interconnected unit operations.			3		1									Homework, Exams, , ,
5 Classify independent and dependent process design variables and explain why an engineer must understand the differences and relationships between these two design variable classes in order to develop viable unit operation and process designs.			2		2		1							Homework, Exams, , ,
6 Identify the impact of thermodynamics on the design and operating characteristics of simulated and real physical and chemical processes and the means of incorporating appropriate thermodynamic models and correlations in ChemCad process simulations.			3											Homework, Exams, , ,
7 Solve phase equilibrium (especially for multi-component vapor-liquid systems) problems for ideal and non-ideal systems using ChemCad unit operations and appropriate thermodynamic models.			3											Homework, Exams, , ,
8 Directly incorporate phase equilibrium data into a simulation without using a thermodynamic model to estimate phase behavior.			2											Homework, Exams, , ,
9 Design unit operations using reasonable values for design parameters (such as heat transfer coefficients in heat exchangers).			3											Homework, Exams, , ,

10	Create process simulations in which the unit operations are fixed in size (e.g., heat exchange area and heat transfer coefficient) rather than fixed in task (e.g., specification of output conditions for the fluids passing through a heat exchanger).			3															Homework, Exams, , ,
11	Design staged contacting unit operations (distillation and extraction towers) using ChemCad. Incorporate concepts of energy and economic efficiency in the design specifications of these units.			3															Homework, Exams, , ,
12	Design a pressure-swing distillation system			1															Homework, Exams, , ,
13	Design an emission control system for VOC's dissolved in water.			1								1							Homework, Exams, , ,
14	Design a pipe insulation system.			1															Homework, Exams, , ,
15	Simulate chemical reactors with equilibrium, kinetic and fractional conversion constraints.			1															Homework, Exams, , ,
16	Simulate the time-dependent behavior of transient processes.			1															Homework, Exams, , ,
17	Develop simulations to model process upset (pre-accident) conditions with the objective of discovering possible causes for the upset.			2								1							Homework, Exams, , ,
18	Design a re-circulating cooling water supply system.			1															Homework, Exams, , ,
19	Design processes that involve ionic solutions and reactions (e.g., acid-gas absorption in a caustic solution).			2															Homework, Exams, , ,
20	Analyze the adequacy of a pre-simulated process to: 1) represent a reasonable response to the process design objectives; and, 2) Incorporate diligent design practice.			3		2		1	1										Homework, Exams, , ,

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- M. Team contributors.

**CH E 438 Bioprocess Engineering**

**Instructor:** Stewart  
**Text:**  
**ISBN:**  
**Pre Req(s):** CH E 328, CH E 338  
**Co Req(s):**

**Total Credits:** 2

Lecture Cr: 2  Fall  
 Lab Cr:  Spring  
 Recitation Cr:  Summer  
 Seminar Cr:  On Demand  
 Ind. Study Cr:  Alt. Years  
 Other Cr:

Update Date: 3/31/2003  
 Inst. Rev. Date:  
 Dept. Rep.:  
 Dept. Rev. Date:

**Catalog Data**

Biotechnology process engineering - microbial process fundamentals, enzyme catalysis, bioreactor design and analysis, separation of biomaterials

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 List several examples of biochemical products and outline their manufacture and uses.			1			1	1	1	1	2		3		Homework, Exams, Oral Report, ,
2 Analyze enzyme and microbial growth kinetics using models describing the rate dependence on substrate, inhibitor, and product concentrations.	3		1		2							3		Homework, Exams, , ,
3 Calculate reaction-diffusion phenomena as they apply to immobilized enzyme and immobilized cell systems and discuss the tradeoffs in immobilized catalyst designs.	3		1		2							2		Homework, Exams, , ,
4 Describe the features of reactor designs commonly used for bioprocesses and apply material balances and mass transfer models to analyze the operation of such bioreactors.	2		3		2							3		Homework, Exams, , ,
5 Develop (or critique proposed) unit operation trains for the production and purification of biochemical products.			2									3		Homework, Exams, , ,
6 Explain the advantages and differences of plant and animal cell culture compared to microbial systems.			1							2		3		Homework, Exams, , ,
7 Describe different types of controlled release devices and apply quantitative models of their behavior.	3		1		2							2		Homework, Exams, , ,

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**CH E 441 CH E Laboratory**

**Instructor:** Sears, Seymour, Yurt

**Text:** Instructors' notes

**ISBN:**

**Pre Req(s):** CH E 251

**Co Req(s):** CH E 323

**Total Credits:** 4

Lecture Cr: 1

Lab Cr: 3

Recitation Cr:

Seminar Cr:

Ind. Study Cr:

Other Cr:

Fall

Spring

Summer

On Demand

Alt. Years

Update Date: 3/31/2003

Inst. Rev. Date:

Dept. Rep.:

Dept. Rev. Date:

**Catalog Data**

Experimental studies of unit operations and transport phenomena. Pilot plant studies. Design of chemical processes and equipment from experimental studies.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Identify an experimental objective.		3			2		2						3	Student Evaluations, Written Experimental Proposal, , ,
2 Develop and implement an experimental plan.		3			2		2						3	Written Experimental Proposal, , , ,
3 Independently investigate the relevant theory and background information for your proposed experiment.							2		2					Written Experimental Proposal, Oral Report, , ,
4 Operate laboratory equipment to meet an experimental objective.		3												Observation, Written Report, , ,
5 Analyze data for statistical significance.	3				3		2						3	Written Report, , , ,
6 Draw conclusions from experimental data.	3	2			3		2						1	Oral Report, Written Report, , ,
7 Communicate technical information verbally and in written documents (i.e. an abstract, written report)					2		3							Written Report, Oral Report, Homework, , ,

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**CHE 444 Hazardous Waste Management**

**Instructor:** Shaffer

**Total Credits:** 3

Lecture Cr: 3

Fall

Update Date: 2/20/2003

**Text:**

Lab Cr:

Spring

Inst. Rev. Date:

**ISBN:**

Recitation Cr:

Summer

Dept. Rep.:

**Pre Req(s):** Junior standing and one of the following: CHEM 215 or EM 335

Seminar Cr:

On Demand

Dept. Rev. Date:

**Co Req(s):**

Ind. Study Cr:

Alt. Years

Other Cr:

**Catalog Data**

Introduction to the technologies, regulations, political and social issues, and environmental impacts of hazardous wastes. Management approaches are developed through fundamental studies and review of case histories.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Ability to recognize and assess the risks of a hazardous waste site.	2	1		1		3	1	2		1				Exams, Written Report, Oral Report, Student Evaluations,
2 Ability to determine which environmental laws and regulations apply at a particular hazardous waste site.				1		2	1	2	3	2				, , , ,
3 Ability to appreciate the interaction of politics, economics, technology, and social factors in dealing with a hazardous waste issue.							1	3	3	3				, , , ,
4 An enhanced sense of the ethics and environmental justice elements of a hazardous waste management issue.							1	2	2	2				, , , ,

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- b. Ability to design and construct experiments.
- c. Ability to design a system, component, or process.
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**CE 445 Hazardous Waste Treatment**

**Instructor:** King **Total Credits:** 3  
**Text:** Hazardous Waste Management, 2nd Ed.; LaGrega, Buckingham, and Evans  
**ISBN:** 0-07-039365-6  
**Pre Req(s):** CE 340 or equivalent.  
**Co Req(s):**

Lecture Cr: 3  Fall  
 Lab Cr:  Spring  
 Recitation Cr:  Summer  
 Seminar Cr:  On Demand  
 Ind. Study Cr:  Alt. Years  
 Other Cr:

Update Date: 3/31/2003  
 Inst. Rev. Date:  
 Dept. Rep.:  
 Dept. Rev. Date:

**Catalog Data**

Principles, theory, and practice of treating hazardous materials.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Understand the health and environmental risks associated with exposure to uncontrolled hazardous wastes through a social/historical review of HW regulations and case histories.						3		3	1	3		3		Homework, Exams, Project Reports, ,
2 From the perspectives of various stakeholders, discuss the trade-offs between exposure risk and economics associated with containment vs. remediation strategies as part of the process of remedial alternative development and analysis.			3			2		3	1	1			1	Exams, Project Reports, , ,
3 Understand how the chemical structure of a hazardous waste compound influences its physical and chemical properties (i.e. solubility, volatility, hydrophobicity, bioaccumulation).	3				3								3	Homework, Exams, , ,
4 Use empirical measures and/or experimental data of a hazardous waste compound solubility, Henry's constant, bioconcentration factor, partitioning constants (Kow, Kf, Kd, Kom) to predict and quantify partitioning in the environment.	3		3		3						2		3	Homework, Exams, Project Reports, ,
5 Use empirical measures and/or experimental data of a hazardous waste compound solubility, Henry's constant, bioconcentration factor, partitioning constants (Kow, Kf, Kd, Kom) to select appropriate remediation technologies.			3		2						2		3	Exams, Project Reports, , ,
6 Understand and apply the basic principles of groundwater and contaminant transport to quantitatively predict exposure levels and pathways; and, to design containment and treatment methods for contaminated groundwater, LNAPL and DNAPL in the subsurface.	3		3		2								2	Homework, Exams, , ,
7 Combine underlying scientific principles with engineering design criteria, mathematics and/or environmental engineering software to design effective removal of HW from of industrial waste streams or contaminated media.	1		3		3						3		2	Homework, Exams, , ,
8 Use classical chemico-physical unit operations and biological reactors as components in a remedial design strategy.	3		3		3								2	Homework, Exams, Project Reports, ,
9 Use technologies for "permanent" disposal of hazardous wastes; as well as, methods of waste recovery, reduction and prevention.	3		3		3			3		2			2	Homework, Exams, Project Reports, ,

10 Propose, design and present a Hazardous Waste Treatment/Remediation plan (and all design considerations) for a waste stream or a remediation site; developing a list of alternatives and defending the final selected technologies. | 3 | | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 |  | 2 | 3 | | Written Report, Oral Report, Student Evaluations, ,

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- M. Team contributors.

**CH E 451 Process Dynamics and Control**

**Instructor:** Larsen

**Text:** Chemical Process Control, Riggs

**ISBN:**

**Pre Req(s):** CH E 328, CH E 323, MATH 225

**Co Req(s):**

**Total Credits:** 3

Lecture Cr: 2

Lab Cr: 1

Recitation Cr:

Seminar Cr:

Ind. Study Cr:

Other Cr:

Fall

Spring

Summer

On Demand

Alt. Years

Update Date: 3/31/2003

Inst. Rev. Date:

Dept. Rep.:

Dept. Rev. Date:

**Catalog Data**

Transient response analysis of controllers and instruments. Design of chemical process control systems.

Objective	a	b	c	d	e	f	g	h	i	j	k	L	M	Assessment Tool(s)
1 Understand the function of P, I, and D actions in PID control, know when to use I and D and when not to.	3	2	3		2						2			Exams, Homework, , ,
2 For PID control, be able to tune a process "tight" using on-the-fly tuning rules, know when not to tune a process "tight".					3						3			Exams, Homework, , ,
3 For PID control, be able to calculate initial tuning constants from process step response data.	3	3	3		3						3			Exams, Homework, , ,
4 Understand advanced PID controls such as ratio, cascade, and logic control.	2				3						3			Exams, Homework, , ,
5 Be able to develop a simple dynamic process model and solve it.	3	2	2		3						3			Exams, Homework, , ,
6 Know the process control standard forms for 1st and 2nd order differential equations; and, understand that combining 1st order processes results in 2nd or higher order responses.	3		2		3									Exams, Homework, , ,
7 Be able to write a order differential equation describing a first order process, including coefficient values, from step response data.	3	3	2		3						3			Exams, Homework, , ,
8 Know what a transfer function is, and for what they are used.	3		2		3						3			Exams, Homework, , ,
9 Be able to take the laplace transform of a process model (differential equation).	3				3						3			Exams, Homework, , ,
10 Write a transfer function for each common element of a controlled process, and, be able to write down the combined transfer function for a controlled process responding to a change in set point or load.	3		2		3						3			Exams, Homework, , ,
11 Be able to determine the characteristic equation from a process transfer function.	3		2		3						3			Exams, Homework, , ,
12 Understand the meaning and usage of the terms poles and zeroes.	3		2		3						3			Exams, Homework, , ,
13 Be able to solve for the roots of a characteristic equation with appropriate math software.	3		2		3						3			Exams, Homework, , ,

14	Recognize that there are other types of control than just PID, such as, Dynamic Matrix Control.					2						2	Exams, Homework, , ,
15	Understand that DMC is model-based.					3							Exams, Homework, , ,
16	Know that DMC can be used to control the setpoints on PID controllers to achieve plant-wide optimization.					2						2	Exams, Homework, , ,

- a. Ability to apply knowledge of math, engineering, and science.
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