Appendix A: Syllabi

Engineering Physics

Bachelor of Science in Engineering Physics

Self-Study Report

New Mexico State University

Chemical Engineering Courses

Course Number and Name: Ch E 111: Introduction to Computer Calculations in Chemical Engineering

Credits and Contact Hours:	3
Instructor:	Jessica Houston
Textbook:	MATLAB for Engineers 2/E; Holly Moore; Pearson Prentice Hall, 2008 Introduction to MathCAD 15 2/E; Ronald W. Larsen; Pearson Prentice Hall, 2011

Specific course information

catalog description	Introduction to the use of computer software to solve engineering problems. Chemical engineering majors must earn a C or better.
Pre- and co-requisites:	MATH 121 or MPL greater than or equal to 4.
Required/elective/selected	Required for EP students with Chemical concentration

Specific goals for the course: The central goal of this course is for students to develop competency in the use of the primary computational tools used in the Chemical Engineering Curriculum including structured programming, spreadsheeting, and mathematical software.

outcomes of instruction	• Program effectively with the Matlab7 software using built-in functions; operations; arrays; functions; plotting; logical statements; and structured programming with looping operations. • Perform spreadsheet-based calculations and operations with Excel by formatting cells, rows, columns, and sheets; graphing functions and regressing data; solving formulas; utilizing functions; implementing logical statements; and performing filters and sorts. • Program effectively with MathCad software by defining variables, functions, ranges, vectors matrices; building expressions; creating graphs; formatting areas; using/converting units; data analysis by linear regression; solving an equation in a single unknown; solving a system of linear/non-linear equations; finding the roots of a polynomial; symbolic solutions of equations; simple programming operations.
Student outcomes addressed:	a, k
Brief list of topics to be covered	1. MATLAB programming 2. MathCAD programming 3. Microsoft Excel

Course Number and Name: Ch E 201: Material and Energy Balances

Credits and Contact Hours:	4 (2+2P)
Instructor:	David Rockstraw
Textbook:	Elementary Principles of Chemical Processes, 3rd Update Edition, Richard M. Felder and Ronald W. Rousseau, 2005

Specific course information

catalog description	Chemical Engineering basic problem-solving skills; unit conversions; elementary stoichiometry; material balances; energy balances; combined energy and material balances including those with chemical reaction, purge and recycle; thermochemistry; application to unit operations. Sources of data. Introduction to the first law of thermodynamics and its applications. Chemical engineering majors must earn C or better in this course. Restricted to CH E majors.
Pre- and co-requisites:	CHEM 115 or CHEM 111G, Ch E 111 and MATH 192G
Required/elective/selected	Required for EP students with Chemical concentration

Specific goals for the course

outcomes of instruction	Student will be able to apply concepts in topics covered
student outcomes addressed	a, c, d, e, g, k
Brief list of topics to be covered	units and conversions; data analysis; process classification; balances and flowcharts; degree of freedom analysis; general material balance; material balances; recycle and by-pass; limiting/excess reactant; fractional conversion; chemical equilibrium; molecular/atomic balances; extent of reaction; combustion reactions; non-ideal gas equations of state; compressibility; chemical equilibria; Gibbs phase rule; condensable components; liquid solutions and solubility; forms of energy; first law of thermodynamics; closed system energy balance; open system energy balance; the steam tables; energy balance calculations; phase changes and latent heat; psychometric charts; adiabatic cooling; mixing and solution; heat of reaction; heat of formation; heat of combustion; reactive processes energy balance; adiabatic reactors; solution thermochemistry; fuels and combustion; adiabatic flame temperature; flammability and ignition; and flames and detonations.

Course Number and Name: Ch E 301: Chemical Engineering Thermodynamics I

Credits and Contact Hours:	3
Instructor:	Hongmei Luo
Textbook:	Sandler, Stanley I., *Chemical, Biochemical, and Engineering Thermodynamics*, 4th edition, John Wiley and Sons, 1999, ISBN# 0-471-66174-0.

Specific course information

catalog description	Applications of the first and second law to chemical process systems, especially phase and chemical equilibrium and the behavior of real fluids. Development of fundamental thermodynamic property relations and complete energy and entropy balances. Chemical engineering majors must earn C or better in this course.
Pre- and co-requisites:	CH E 201 and MATH 291
Required/elective/selected	Required for EP students with Chemical concentrations

Specific goals for the course: This course is one of the core courses in the Chemical Engineering curriculum that satisfies the professional component to enable graduates to design, analyze and control physical, chemical and biological processes consistent with program objectives to provide all graduating B.S. students with a solid foundation in the fundamentals of chemical engineering science, design, and practice.

outcomes of instruction	At the end of this course the student will be able to: • Define a system, outcome (a) an ability to apply knowledge of mathematics, science, and engineering; • Solve problems using the energy balance appropriate for a system (the First Law of Thermodynamics), outcome (e) an ability to identify, formulate and solve engineering problems; • Solve problems using the entropy balance appropriate for a system (the Second Law of Thermodynamics), outcome (e) an ability to identify, formulate and solve engineering problems; • Evaluate, manipulate and use thermodynamic partial derivatives, outcome (a) an ability to apply knowledge of mathematics, science, and engineering; • Correctly use a thermodynamic property chart and the steam tables, outcome (a) an ability to apply knowledge of mathematics, science, and engineering and outcome (k) an ability to use the

	techniques, skills, and modern engineering tools necessary for engineering practice • As a team, choose a process related to energy production or refrigeration, and present a description of the process, including mass, energy and entropy balances, via written and oral presentations, outcome (d) an ability to function on multidisciplinary teams, (e) an ability to identify, formulate and solve engineering problems and outcome (g) an ability to communicate effectively.
student outcomes addressed	a, d, e, g, k
Brief list of topics to be covered	1. Conservation of Mass 2. Application of Mass Balance 3. The First Law of Thermodynamics, Conservation of Energy 4. Application of Energy Balance 5. Entropy, the Second Law of Thermodynamics 6. Application of Entropy Balances 7. Steam Table 8. Heat, Work, Engines 9. Power and Refrigeration Cycles 10. Thermodynamics Fundamental Equations 11. Evaluation of Thermodynamic Partial Derivatives 12. Ideal Gas 13. Equation of State 14. Criteria for Equilibrium 15. Stability of Thermodynamic systems 16. The Third Law of Thermodynamics

Course Number and Name: Ch E 302: Chemical Engineering Thermodynamics II

Credits and Contact Hours:	2
Instructor:	Martha Mitchell
Textbook:	Sandler, Stanley I., *Chemical, Biochemical, and Engineering Thermodynamics*, 4th edition, John Wiley and Sons, 1999, ISBN# 0-471-66174-0.

Specific course information

catalog description	Continuation of CH E 301. Chemical engineering majors must earn C or better in this course.
Pre- and co-requisites:	CH E 301 and MATH 392
Required/elective/selected	Required for EP students with Chemical concentration

Specific goals for the course: This course is one of the core courses in the Chemical Engineering curriculum that satisfies the professional component to enable graduates to design, analyze and control physical, chemical and biological processes consistent with program objectives to provide all graduating B.S. students with a solid foundation in the fundamentals of chemical engineering science, design, and practice.

outcomes of instruction	At the end of this course the student will be able to: • State and apply the First and Second Laws of thermodynamics to open and closed systems (student outcome (e) an ability to identify, formulate, and solve engineering problems) • Use departure functions to solve First and Second Law problems for non-ideal systems (student outcome (e) an ability to identify, formulate, and solve engineering problems) • State the conditions of equilibrium for multiphase systems (student outcome (a) an ability to apply knowledge of mathematics, science, and engineering) • Understand and apply fugacity to phase equilibria problems (student outcome (a) an ability to apply knowledge of mathematics, science, and engineering) • Compute the vapor pressure for single-component multiphase systems (student outcome (a) an ability to apply knowledge of mathematics, science, and engineering) • Apply partial molar quantities to compute mixture properties (student outcome (a) an ability to apply knowledge of mathematics, science, and engineering) • Know and apply models for excess Gibbs free

	energy in nonideal mixtures (student outcome (a) an ability to apply knowledge of mathematics, science, and engineering) • Construct binary phase diagrams for multiple phase systems correcting for nonideal behavior using fugacity coefficients and activity coefficients (student outcome (a) an ability to apply knowledge of mathematics, science, and engineering) • Perform bubble and dewpoint calculations for vapor-liquid equilibria (student outcome (a) an ability to apply knowledge of mathematics, science, and engineering) • Determine the equilibrium composition for a reacting system given the reaction stoichiometry, temperature and pressure (student outcome (a) an ability to apply knowledge of mathematics, science, and engineering)
student outcome addressed	a, e
Brief list of topics to be covered	1. Review of the First and Second Laws of Thermodynamics 2. Review of nonideal fluids and estimation of thermodynamic properties using equations of state and departure functions 3. Equilibrium and stability in one-component systems 4. Thermodynamics of multicomponent mixtures 5. Estimation of Gibbs energy and fugacity of components in mixtures (including activity coefficient models) 6. Multiphase equilibrium in mixtures (vapor-liquid, liquid-liquid, vapor-liquid-liquid) 7. Phase equilibria in systems including solids 8. Chemical equilibrium

Course Number and Name: Ch E 302L: Thermodynamic Models of Physical Properties

Credits and Contact Hours:	1 (3P)
Instructor:	Martha Mitchell
Textbook:	none

Specific course information

catalog description	Computational analysis of thermodynamic models in a chemical process simulator, and comparison to experimental data. Specification of pseudo-components. Generation of physical properties by group contribution methods.
Pre- and co-requisites:	CH E 302 (corequisite)
Required/elective/selected	Required for EP students with Chemical concentration

Specific goals for the course

outcomes of instruction	At the end of this course the student will be able to: • Use MathCAD to calculate one-component properties using cubic equations of state (student outcome (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering) • Use MathCAD to ompute the vapor pressure for single-component systems • Use MathCAD to calculate fugacity coefficients for mixture equations of state (student outcome (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering) • Use MathCAD to calculate activity coefficients (student outcome (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering) • Use MathCAD to calculate bubble and dewpoints coefficients (student outcome (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering) • Use Visual Basic program UNIFAC to determine mixture properties from group contribution methods (student outcome (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering) • Use AspenPlus (flowsheeeting software) to analyze thermodynamic models and compare to experimental data, to specify pseudo-components

	and generate physical properties by group contribution methods methods (student outcome (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering)
student outcomes addressed:	k
Brief list of topics to be covered	1. Use of MathCAD to predict single-component properties for cubic equations of state (enthalpy, entropy, specific volume, fugacity) 2. Use of MathCAD to predict multi-component properties (fugacity coefficients, activity coefficients) 3. Use of UNIFAC (through a Virtual Basic interface) to predict multi-component mixture properties 4. Use of ASPEN to predict single component properties, such as vapor pressure 5. Use of ASPEN to predict multi-component mixture properties 6. Use of ASPEN to predict vapor-liquid equilibrium

Course Number and Name: Ch E 305: Transport Operations I: Fluid Flow

Credits and Contact Hours:	3
Instructor:	Paul Andersen
Textbook:	Andersen (2012) *Fluid Mechanics: Theory and Applications*, 2012 Edition (available on line).

Specific course information

catalog description	Theory of momentum transport. Unified treatment via equations of change. Shell balance solution to 1-D problems in viscous flow. Analysis of chemical engineering unit operations involving fluid flow. General design and operation of fluid flow equipment and piping networks. Chemical engineering majors must earn C or better in this course.
Pre- and co-requisites:	CH E 201, MATH 291G, MATH 392 (corequisite)
Required/elective/selected	Required for EP students with the Chemical concentration

Specific goals for the course

outcomes of instruction	Students successfully completing this course will demonstrate the ability to do the following: **1. Basic Concepts.** Write and explain the meanings of the basic balances and equations of fluid mechanics. [Outcome 3(a)] **2. Model Building.** Given a verbal or pictorial description, create useful mathematical models of engineering flow systems. [3(e)] **3. Problem Solving.** Solve problems involving mass, energy, momentum balances, fluid forces, etc. [3(a)(e)] This course addresses the following student outcomes from ABET Criterion 3: (a) Ability to apply knowledge of mathematics, science, and engineering (e) Ability to identify, formulate, and solve engineering problems
student outcomes addressed	a, e

List of topics to be covered	• Balances • Supplemental relations • Mass • Energy • Entropy and free energy • Momentum • Static fluid forces • Dynamic fluid forces • Dimensionless parameters and scale-up • Lift and drag • Flow in conduits • Friction • Fluid machinery

Course Number and Name: Ch E 306: Transport Operations II: Heat and Mass Transfer

Credits and Contact Hours:	3
Instructor:	Shuguang Deng
Textbook:	Frank P. Incropera and David P. DeWitt "Fundamentals of Heat and Mass Transfer" 6th Edition, John Wiley & Sons, 2007 (ISBN: 0-471-45728-0)

Specific course information

catalog description	Theory of heat and mass transport. Unified treatment via equations of change. Analogies between heat and mass transfer. Shell balance solution to 1-D problems in heat and mass transfer. Analysis of chemical engineering unit operations involving heat transfer. Design principles for mass transfer equipment. Chemical engineering majors must earn C or better in this course.
Pre- and co-requisites:	CH E 305, MATH 392
Required/elective/selected	Required for EP students with Chemical concentration

Specific goals for the course: for students to learn to apply the fundamentals of transport phenomena to solve problems relevant to chemical engineering practice: energy and mass transfer. In each case, we will work through examples that help to explore both the intuitive concepts and the formal mathematical framework necessary to make predictions. Transport phenomena, along with thermodynamics and reactor design, define the fundamental skill set necessary for solving the challenging problems that arise in the chemical engineering profession.

outcomes of instruction	At the completion of this course, the students will be able to (the mapping of these objectives to ABET outcomes a-k): • Set up microscopic and macroscopic energy and mass balances (conservation principles) (a, e); • Know the flux laws for heat and mass transport (a, c, e); • Apply the conservation principles and flux laws to model transport processes central to chemical engineering (a, c, e); • Use the physical and mathematical similarities between the processes of heat and mass transfer to solve new problems "by analogy" (a, c, e); • Perform basic unit operation design calculations for heat and mass transfer equipment (a, c, e)
student outcomes addressed	a, c, e

Brief list of topics to be covered	• Heat Transfer • Conservation of Energy • 1-D and 2-D Steady-State Conduction • Transient Conduction • Convection Heat Transfer • Heat and Mass Transfer Analogies • Internal and External Flow • Free Convection • Boiling and Condensation • Heat Exchangers • Mass Transport in Non-stationary Media • Conservation Equations and Concentrations at Interfaces • Diffusion with Homogeneous Chemical Reactions • Transient Diffusion

Course Number and Name: Ch E 361: Engineering Materials

Credits and Contact Hours:	3
Instructor:	M. Ginger Scarbrough
Textbook:	*Materials Science and Engineering, An Introduction* 8/e; Callister and Rethwisch; John Wiley and Sons, 2009

Specific course information

Catalog description	Bonding and crystal structure of simple materials. Electrical and mechanical properties of materials. Phase diagrams and heat treatment. Corrosion and environmental effects. Application of concepts to metal alloys, ceramics, polymers, and composites. Selection of materials for engineering design.
Pre- and co-requisites:	CHEM 111 or 114 or 115
Required/elective/selected	Required for EP students with Chemical concentration

Specific goals for the course

Outcomes of instruction	At the completion of this course, students will be able to: analyze the interrelationship between chemical bonding and composition, structures, and processes (including heat treatments and mechanical strengthening mechanisms) and their effect on material properties (mechanical, thermal, and electrical); select materials, given specific design parameters; and evaluate and discuss economic, environmental, and societal issues in Materials Science and Engineering.
Student outcomes addressed	a, h
Brief list of topics covered	1) Introduction to Materials Engineering 2) Atomic Structure & Bonding 3) Crystal Structure & Geometry 4) Crystalline Imperfections 5) Diffusion 6) Mechanical Properties 7) Dislocation Strengthening 8) Failure 11) Thermal Processing 12) Ceramics & Applications 13) Polymers & Applications 14) Nanotechnology 15) Composites 16) Electrical Properties 17) Corrosion

Course Number and Name: Ch E 441: Chemical Kinetics and Reactor Engineering

Credits and Contact Hours:	3
Instructor:	David Rockstraw
Textbook:	Elements of Chemical Reaction Engineering, 4th ed., H. Scott Fogler, 2007

Specific course information

catalog description	Chemical Kinetics and Reactor Engineering, 3 cr.; Analysis and interpretation of kinetic data and catalytic phenomena. Applied reaction kinetics; ideal reactor modeling; non-ideal flow models. Mass transfer accompanied by chemical reaction. Application of basic engineering principles to design, operation, and analysis of industrial reactors.
Pre- and co-requisites:	CHEM 314; CH E 306; CH E 307 (co-requisite)
Required/elective/selected	Required for EP students with Chemical concentration

Specific goals for the course

outcomes of instruction	At the completion of this course, students will be able to: perform mole balances in systems involving chemical reaction; calculate conversion in batch and flow systems; size single and staged continuous-stirred tank, and plug flow reactors; develop rate laws from mechanisms and experimental data; calculate pressure drops and the effect on kinetics in packed-bed PFRs; apply the differential and integral methods of kinetic data analysis; maximize product selectivity for systems involving multiple reactions; understand effects of non-isothermal operation and unsteady-state behavior; apply rate limiting step and quantify performance in catalytic systems, quantify mass transfer limitations on heterogeneous systems, and understand the idea of a residence time distribution, and the effect on reactor ideality.
student outcomes addressed	a, e
Brief list of topics to be covered	Design/Performance Equations; Reaction Conversion; Isothermal Reactor Design; Rate Laws/Stoichiometry; Kinetic Data Analysis; Multiple Reactions; Unsteady State, Nonisothermal, and Nonadiabatic Reactor Operation; Effect of Mass Transfer Resistance on Heterogeneous Reactions; Catalysis and Catalyst Deactivation, Design and Analysis of Catalytic Reactors; Residence Time Distributions; Nonideal Reactor Models