APPENDIX I

B. Course Syllabi

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CHE 111 INTRODUCTION ENGINEERING MODELING
(Required Course)

CATALOG DATA:
CHE 111 INTRODUCTION ENGINEERING MODELING
(0-1) 1 credit.
Prerequisite or corequisites: CHEM 112.
The primary objectives of this course are: introduction to mathematical modeling of physical and chemical systems; verification of mathematical models by experiment; development and interpretation of engineering drawings, process flow diagrams (PFD's), and piping and instrumentation diagrams (P&ID's); use of a drawing program, such as Visiotec; and an introduction to the process simulator AspenPlus.]

TEXTBOOK:
R. Turton et al., Analysis, Synthesis and Design of Chemical Processes, Prentice Hall, Chapter 1 19XX.

INSTRUCTOR:
R.M. Winter, C-220, 394-1237 (w) 394-2421 (secretary), robb.winter@sdsmt.edu
Teaching Assistant, TBA, C-213A, 394-1234 (w)
Office hours: C-220; M, 4:00 p.m., W, 4:00 p.m. or by appointment

EXPECTATIONS:
Students entering this course are expected to know:
- Algebra and calculus I
- English composition
- The fundamentals of chemistry (elements, compounds, reactions, and properties
- The fundamentals of physics (Newton’s law)

COURSE OBJECTIVES:
(Knowledge the average student should have after taking this course)
To introduce you to chemical engineering through laboratory experiences. To extend your skills in the use of spreadsheets. To use mathematics in developing models to describe experiments. To use elementary numerical methods to analyze laboratory data/results. To develop skills in the use of chemical engineering specific software.

CLASS SCHEDULE:
C-304 (lecture), C-108 (laboratory) Thursdays, 2:00 – 4:50 p.m.

PROFESSIONAL COMPONENT:
Engineering Science: 1 credit or 100%
Engineering Design: 0 credit

TOPICS:
- Introduction to Modeling and review of EXCEL (spreadsheet).
- Development of Mathematical Model for “Drainage of a Tank through a Capillary Tube,” Experiment #1.
- Career Opportunities in ChE; Development of Mathematical Model for “Cooling of Glycerin,” Experiment #2.
- Ms Visio, CAD Software.
- Development of Mathematical Model for “Dissolution of Benzoic Acid in Water,” Experiment #3.
- Aspen Plus Software
**Computer Usage:**
- Word
- Excel
- Aspen Plus
- Ms Visio
- PowerPoint

**Course Outcomes:**
After completion of this course the average student is expected to be able to:
1. Develop simple mathematical models to explain physical phenomena found in engineering problems
2. Take laboratory data and compare to mathematical models
3. Clearly present laboratory results in both written and oral formats
4. Set up and perform engineering experiments
5. Create and interpret PFD’s and PID’s
6. Use Aspen Plus for rudimentary chemical engineering analysis

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strengths of each course outcome in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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<tr>
<th>ChE 111 Program Outcomes</th>
<th>Objective 1</th>
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*For a list of Program Objectives and Program Outcomes, please go to [http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396](http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396)*

**Laboratory:**
- Set up and conduct drainage of a cylindrical tank through a capillary tube
- Set up and conduct convective cooling of a beaker of glycerin inserted a Styrofoam block
- Set up and conduct the dissolution of a benzoic acid pellet in a stirred beaker of water

**Assessment and Evaluation:**
- Exams
- Reports
- Homework

**Prepared By:**
R. M. Winter, Spring 2004
ChE 117 Professional Practices in Chemical Engineering
(Required Course)

CATALOG DATA:
CHE 117/117L PROFESSIONAL PRACTICES IN CHEMICAL ENGINEERING
(2-0) 2 credits.
Prerequisite or corequisite: MATH 123.
An introduction to chemical engineering through the development of computational and laboratory skills. The extended use of spreadsheets, programming, and computational software packages will be covered. Elementary numerical methods will be utilized in process modeling and laboratory experiments.

TEXTBOOK:
Introduction to Visual Basic 6.0, David I. Schneider, Prentice Hall, 2001

INSTRUCTOR:
Dr. David Dixon (primary)  Dr. Stanley Smith
394-1235(w); 716-2932(b)  394-2491
C-218  C-215
David.Dixon@sdsm.edu  StanleySmith@bhsu.edu

Office Hours:
Optional recitation: C-208 computer lab or other TBA; Friday (3 pm – 4:30 pm) Dixon: TBA; I’m available most anytime except as noted on the schedule posted outside my office door. You may wish to call ahead, use email, or make an appointment to see me at a specific time. Smith: MWF 2 – 3 pm (C-215)

EXPECTATIONS:
Students entering this course are expected to know how to:
• login to the campus computer systems
• save and retrieve files from their fileserver space (on H: drive)
• use the GUI interface on typical Microsoft software applications
• use MS Excel or equivalent spreadsheet program.

COURSE OBJECTIVES:
Knowledge the average student should have after taking this course:
• To apply knowledge of visual basic to create a program capable of solving a complex problem.

CLASS SCHEDULE:
C 304 / Computer lab TBD; Tu 2 pm – 3:50 pm
Because of the nature of this class, at times students will need to have access to a computer lab. At other times, class will begin in a lecture room. Consequently, different topics will be held in different locations. Please ensure you receive weekly room updates from your instructor.

PROFESSIONAL COMPONENT:
Engineering Science: 2 credits or 100%
Engineering Design: 0 credits

TOPICS:
• Flow charting / Objects
• Objects, Evens, Numbers, Strings
• Input & Output
• Intrinsic Functions
• Programming Projects
• General Procedures
• Decision Statements
• Loops
• Numerical Solutions: (1) Newton's Method (2) Bisection
• Arrays
• Programming Projects
• Numerical Solutions (Integration)
• Excel & Visual Basic

**Computer Usage:**
• MS Excel
• MS Visual Basic 6.0

**Course Outcomes:**
After completion of this course the average student passing the course should be able to:
1. demonstrate how to apply the 5 step algorithm for writing a computer program
2. write a visual basic program to solve a simple problem
3. write a visual basic program to solve an engineering problem
4. create a VB program that uses arrays, logic, and loops to solve a problem
5. demonstrate how to find the root(s) of a single non-linear equation using a numerical algorithm, such as
   Newton's method, incremental search, or the bisection method
6. demonstrate how to program a numerical integration algorithm, such as the trapezoidal or Simpson's method
7. create a macro in MS Excel using visual basic.

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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<th>ChE 117 Course Outcomes</th>
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**Laboratory:**
None

**Assessment and Evaluation:**
• Homework
• Quizzes

**Prepared By:**
David J. Dixon, Spring 2004
ChE 217 CHEMICAL ENGINEERING I  
(Required Course)

CATALOG DATA:
CHE 217 CHEMICAL ENGINEERING I  
(3-0) 3 credits
Prerequisites: concurrent registration in CHEM 114 and PHYS 211.
The first course on the theory and practice of Chemical Engineering. A study of engineering measurements, 
real and ideal gas calculations, material balances, and energy balances. This course is cross-listed with 
ENVE 217.

TEXTBOOK:
Wiley & Sons, Inc. (2000)

INSTRUCTOR:
Dr. James M. Munro
394-2422
E-mail: james.munro@sdsmt.edu
Office: C-227

EXPECTATIONS:
Students are expected to have a fundamental understanding of:
• Algebra
• The concept of the derivative and the integral

COURSE OBJECTIVES:
The objective of ChE 217 is for students to learn to apply basic principles of chemical engineering, 
especially the material balance.

CLASS SCHEDULE:
C-303 Monday-Wednesday-Friday; 9:00 – 9:50 a.m.

PROFESSIONAL COMPONENT:
Engineering Science: 3 credits or 100%
Engineering Design: 0 credits

TOPICS:
• Engineering units
• Material balances
• Energy balances
• Graphical representation of engineering data

COMPUTER USAGE:
• Spreadsheets
• Aspen Plus (is taught in this course).

COURSE OUTCOMES:
Each student successfully completing ChE 217 is expected to have the following abilities:
1. Perform unit conversions in both SI and English systems.
2. Determine whether process data can be modeled mathematically by a linear, exponential or power law 
   relationship.
3. Express chemical compositions and flow rates in either component flow rates or as mole or mass 
   fractions.
4. Perform mass balances on single-unit and on multiple-unit systems, for processes with and without chemical reactions.
5. Perform ideal and real gas calculations involving P, V, T and Z.
7. Perform mass balances on gas/liquid systems with one condensable component.
9. Apply the steady-state energy balance on open systems.

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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<th>ChE 217 Program Outcomes</th>
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**Laboratory:**
None

**Assessment and Evaluation:**
- Homework
- Exams

**Prepared By:**
James M. Munro, Fall 2003
CHE 218 CHEMICAL ENGINEERING II
(Required Course)

CATALOG DATA:
CHE 218 CHEMICAL ENGINEERING II
(3-0) 3 credits.
Prerequisites: CHE 217, MATH 125.
The second course on the theory and practice of Chemical Engineering with emphasis on momentum transfer.

TEXTBOOK:

INSTRUCTOR:
Dr. James M. Munro
394-2422 (w), 721-6815 (h) james.munro@sdsmt.edu
Official Office hours: Mon., Wed., Fri. 3:00-4:00 p.m.
Unofficial: I have an open door policy and will often be able to see you at other times. Feel free to knock on my office door if closed, as I may be available. For appointments outside of office hours please email me or contact me in my office.

EXPECTATIONS:
Students entering this course are expected to already have the following abilities:
• The ability to perform unit conversions as needed, especially within and between the SI and English systems of units.
• The ability to create and interpret graphs of two variables.
• The ability to use the ideal gas law to describe the behavior of ideal gases.
• The ability to use the fluid static equation to determine pressures within a static fluid.
• The ability to use the principle of conservation of mass to write mass balance equations and to use them to solve chemical engineering problems.

COURSE OBJECTIVES:
• To gain fundamental and practical knowledge in the field of fluid mechanics.
• To further develop critical thinking skills.
• To gain experience in the use of Pipe-Flo® simulation software for solving pump and piping system problems.

CLASS SCHEDULE:
C303, Monday-Wednesday-Friday; 9:00-9:50am

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credits or 83.3%
Engineering Design: 0.5 credit or 16.6%

TOPICS:
• Viscosity
• Mass balances
• Energy balance
• Bernoulli’s equation
• Centrifugal pumps
• Design of piping systems
• Terminal settling velocities
• Fluidized bed performance
**Computer Usage:**
- Spreadsheets
- Flo-series software

**Course Outcomes:**
Each student successfully completing ChE 218 is expected to have the following abilities:
1. Demonstrate knowledge of the primary types of fluid rheologies and explain how their viscosities relate to the flow curve for each type.
2. Apply Bernoulli’s equation to a variety of flow systems including orifice meters, pressure drop through piping.
3. Understand the difference between laminar and turbulent flow and knows how to determine the difference in a variety of flow systems.
4. Design piping systems, using economic factors and including the determination of pressure drop due to fittings and valves.
5. Use PIPE-FLO® software to model flow systems in piping.
6. Understand the performance of a centrifugal pump, including the concept of net positive suction head (NPSH), and is able to apply that knowledge to design and predict the performance of a pump in a piping system.
7. Compute terminal settling velocities of an object in a fluid.
8. Use agitator power numbers to analyze mixing efficiency and power requirements for agitated vessels.
9. Predict the pressure drop or friction loss of a flow through a packed column or other porous media and can describe the processes of fluidization and pneumatic transport.

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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**Laboratory:**
None

**Assessment and Evaluation:**
- Exams
- Homework
- In class exercises
- Pop-quizzes

**Prepared By:**
James M. Munro, Spring 2004
CHE 222 CHEMICAL ENGINEERING THERMODYNAMICS I
(Required Course)

CATALOG DATA:
CHE 222 CHEMICAL ENGINEERING THERMODYNAMICS I
(3-0) 3 credits.
Prerequisites: CHE 217, concurrent registration in MATH 225.
A study of the principles and applications of thermodynamics with emphasis on the first law, the energy
balance.

TEXTBOOK:

INSTRUCTOR:
James M. Munro
C-227
Official Office hours: Mon., Wed., Fri. 3:00-4:00 p.m.
Unofficial: I have an open door policy and will often be able to see you at other times. Feel free to knock
on my office door if closed, as I may be available. For appointments outside of office hours please email
me or contact me in my off office.

EXPECTATIONS:
Students entering this course are expected to already have the following abilities:
• The ability to perform unit conversions as needed, especially within and between the SI and English
  systems of units.
• The ability to create and interpret graphs of two variables.
• The ability to use the ideal gas law to describe the P-V-T behavior of ideal gases.
• The ability to use the principle of conservation of mass to write mass balance equations and to use
  them to solve chemical engineering problems

COURSE OBJECTIVES:
To gain fundamental and practical knowledge of the first and second laws of thermodynamics as utilized in
the field of chemical engineering.

CLASS SCHEDULE:
Monday-Wednesday-Friday; 8:00 – 8:50 a.m.

PROFESSIONAL COMPONENT:
Engineering Science: 3 credits or 100%
Engineering Design: 0 credit

TOPICS:
• 1st Law Balances
• Entropy
• 2nd Law Balances
• Non idea Gas Behavior
• Thermodynamics Properties
• Heat Engines, ° Refrigeration Cycles

COMPUTER USAGE:
• Spreadsheets
• AspenPlus
**COURSE OUTCOMES:**
Students successfully completing ChE 222 are expected to have the following abilities:
1. To determine the thermodynamic properties of fluids using a variety of different sources.
2. To use energy balances on closed and open systems to analyze and predict energy effects in these systems.
3. To use the first and second laws of thermodynamics to analyze and optimize a variety of processes, including those with power and refrigeration cycles.

**RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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**LABORATORY:**
None

**ASSESSMENT AND EVALUATION:**
- Exams
- Homework
- In-class exercises
- Pop-quizzes

**PREPARED BY:**
James M. Munro, Spring 2004
CHE 250 COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING

(Required Course)

CATALOG DATA:
CHE 250 COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING
(2-0) 2 credits.
Prerequisites: CHE 117, CHE 217, concurrent with MATH 321 or permission of instructor.
The application of digital computer techniques to the solution of chemical engineering problems.

TEXTBOOK:

INSTRUCTOR:
Robb Winter, office – C220, 394-1237 (w), 394-2421 (sec.), robb.winter@sdsmt.edu
Office hours: C-220, TBA or by appointment

EXPECTATIONS:
Students entering this course are expected to know:
• spreadsheets (entering of formulas, cell options, formatting functions, and graphing);
• a programming language;
• college algebra and calculus I and II;
• English composition, word processing, and technical project reporting; and
• general chemical engineering unit operations.

COURSE OBJECTIVES:
(Knowledge the average student should have after taking this course)
The overall objective of this course is to introduce you to computational and numerical techniques that may be used to solve a variety of chemical engineering problems. Like the calculator, these too are tools for you to learn which will make solving problems in subsequent chemical engineering courses easier.

CLASS SCHEDULE:
C-303; M,W; 11:00-11:50 a.m.

PROFESSIONAL COMPONENT:
Engineering Science: 1.67 credits or 83.3%
Engineering Design: 0.33 credit or 16.7%

TOPICS:
• Computational errors
• Taylor Series
• Numerical analysis of:
  o Linear algebraic equations
  o Non-linear algebraic equations
  o Integration
  o Differentiation

COMPUTER USAGE:
• Math Cad
• Excel
• Polymath
• Visual Basic
**COURSE OUTCOMES:**

After completion of this course the average student is expected to be able to:

1. select a computational tool that is capable of solving a particular chemical engineering problem. Such tools include, EXCEL, POLYMATH, and Visual BASIC;
2. set up problems for solution by numerical methods;
3. understand and be able to implement key numerical routines for: solution of linear and non-linear algebraic equations, solution of ordinary and partial differential equations, solutions of systems of algebraic and differential equations, numerical integration and differentiation, regression, and optimization;
4. set up and solve problems using commercial and "canned" equation solvers; and
5. perform statistical analysis of data.

**RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**

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*For a list of Program Objectives and Program Outcomes, please go to [http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396](http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396)

**LABORATORY:**

None

**ASSESSMENT AND EVALUATION:**

- Exams
- Homework

**PREPARED BY:**

R. M. Winter, Spring 2004
CHE/ENVE 317 CHEMICAL ENGINEERING III
(Required Course)

CATALOG DATA:
CHE 317 CHEMICAL ENGINEERING III
(3-0) 3 credits.
Prerequisites: CHE 217, concurrent registration in MATH 321.
The third course on the theory and practice of Chemical Engineering with emphasis on heat transfer. Heat
transfer by conduction, convection, and radiation is studied. This course is cross-listed with ENVE 317.

TEXTBOOK:
York, 2002.

INSTRUCTOR:
Robb Winter, 394-1237, office – C220
Office Hours: TBA or by appointment (see Ms. Embrock); call 394-1237; or E-mail robb.winter@sdsmt.edu

EXPECTATIONS:
Students entering this course are expected:
• To be able to formulate energy and material balances
• To set up and solve algebraic and differential equations

COURSE OBJECTIVES:
• Use Excel to perform spreadsheet analysis
• Use Word to write reports
• Use visual Basic to solve numerical problems

CLASS SCHEDULE:
C303; M,W,F; 2:00 - 2:50 p.m.

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credits or 83.3%
Engineering Design: 0.5 credit or 16.7%

TOPICS:
• Conduction:
  o Fourier’s Law
  o Heat Diffusion Equation
  o Boundary and Initial Conditions
  o Steady-state Conduction
  o Transient Conduction
• Convection:
  o Boundary Layers
  o External Flow
  o Internal Flow
  o Phase Change
  o Heat Exchanger Design
• Radiation:
  o Radiation Equation
  o Black Body
  o Surface Absorption
  o Reflection and Transmission
  o View Factory
  o Grey Surfaces
COMPUTER USAGE:
- Word
- Excel
- Visual Basic

COURSE OUTCOMES:
After completion of this course the average student is expected to be able to:
1. Formulate and solve mathematical models representing heat transfer problems from problem descriptions.
2. Describe the three modes of heat transfer mathematically and physically.
3. Estimate the thermal conductivity, convective heat transfer coefficient and emissivity for any application.
4. Calculate convective heat transfer coefficients for forced, free, and phase change problems.
5. Apply numerical methods for solving heat transfer problems.
6. Write technical reports describing projects.
7. Design shell and tube and plate and frame heat exchangers using "Hand" methods and "ASPEN PLUS" where applicable.
8. Comment on solutions in context of safety, economics and societal impact.

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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<th>ChE 317</th>
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LABORATORY:
None

ASSESSMENT AND EVALUATION:
- Exams
- Reports
- Homework

PREPARED BY:
Robb Winter, Fall 2003
CHE/ENVE 318 CHEMICAL ENGINEERING IV  
(Required Course)

CATALOG DATA:
CHE 318 CHEMICAL ENGINEERING IV  
(3-0) 3 credits.  
Prerequisite: CHE 317.  
The fourth course on the theory and practice of Chemical Engineering with emphasis on molecular diffusion, membranes, convective mass transfer, drying, humidification, and continuous gas-liquid separation processes. This course is cross-listed with ENVE 318.

TEXTBOOK:  

INSTRUCTOR:  
Stan Smith  
Office: C-215  
Phone: 394-2491  
Office hours: MWF 2-3 pm or by appointment  
Email: (preferred method for contact): stanleysmith@bhsu.edu

EXPECTATIONS:  
Students entering this course are expected to know:  
• concept of overall heat transfer coefficients;  
• heat transfer by conduction, convection, and radiation;  
• energy balances, including systems with a phase change;  
• equilibrium relationships in vapor/gas-liquid systems;  
• fundamentals of fluid flow through porous beds;  
• boundary layer theory;  
• reaction rate expression;  
• unsteady state transport – fundamentals of partial differential equations;  
• basic knowledge of Aspen Plus software;  
• knowledge of numerical methods.

COURSE OBJECTIVES:  
To apply concepts of mass transfer to the analysis and design of separation units. It includes both rate-controlled and equilibrium staged operations.

CLASS SCHEDULE:  
C303; M, W, F; 1:00 - 1:50 p.m

PROFESSIONAL COMPONENT:  
Engineering Science: 2.0 credits or 66.7%  
Engineering Design: 1.0 credit or 33.3%

TOPICS:  
• Single-effect and Multiple-effect evaporators  
• Molecular diffusion in gasses, in liquids and solids  
• Unsteady-State Diffusion  
• Convective mass transfer coefficients  
• Molecular diffusion coupled with convection and chemical reaction  
• Gas-liquid separation processes and phase equilibrium  
• Mass transfer between phases – local transfer coefficients / overall mass transfer coefficients  
• Vapor pressure of water and humidity  
• Continuous humidification processes and design of water-cooling towers
- Design of absorption columns / pressure drop and flooding / liquid holdup
- Design of packed towers using transfer units
- Absorption of concentrated mixtures in packed towers
- Estimation of mass-transfer coefficients for packed towers
- Equilibrium moisture content of materials and rate of drying curves
- Constant-rate and falling-rate drying periods
- Introduction to adsorption processes / batch adsorption
- Design of fixed-bed adsorption columns and Ion-Exchange Processes
- Membrane separation processes
- Reverse osmosis design fundamentals

**Computer Usage:**
- Excel
- MathCad
- AspenPlus

**Course Outcomes:**
After completion of this course the average student is expected to be able to:
1) design single and multiple effect evaporators;
2) demonstrate the knowledge of fundamental aspects of diffusion and convective mass transfer;
3) analyze and design multi-effect evaporation systems;
4) analyze and design absorption and stripping columns (tray and packed bed systems);
5) estimate basic equipment dimensions for drying equipment;
6) estimate basic equipment dimensions for adsorption and ion exchange equipment;
7) analyze mass transport through membranes.

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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**Laboratory:**
None

**Assessment and Evaluation:**
- Homework
- Quizzes
- Exams
- Projects

**Prepared By:**
Stan Smith, Spring 2003
CHE 321 CHEMICAL ENGINEERING THERMODYNAMICS II
(Required Course)

CATALOG DATA:
CHE 321 CHEMICAL ENGINEERING THERMODYNAMICS II
(3-0) 3 credits.
Prerequisite: CHE 222.
A continuation of CHE 222 with emphasis on the second and third laws of thermodynamics. Emphasis on
thermodynamic properties of fluids, flow processes, phase and chemical equilibria.

TEXTBOOK:
2001

INSTRUCTOR:
Wei Chian
C-308, 394-1231 (w), Wei.Chian@sdsmt.edu
Office hours: MWF 11 am – 12: pm

EXPECTATIONS:
Upon entering this course, the students will be considered fluent in the following areas:
• College level calculus
• Application of the First Law of Thermodynamics and other basic concepts (enthalpy, internal energy,
volumetric work/shaft work etc) in closed or open systems
• PVT behavior of pure substances/Equation of State/Generalized Correlations
• Phase equilibrium of pure substances/ the phase rule
• Entropy and the Second Law of Thermodynamics/Reversibility
• Evaluation of thermodynamic properties (H, U, G and S) of pure fluids (gas and liquid)/Residual
properties

COURSE OBJECTIVES:
To enhance the knowledge of pure fluid thermodynamics with the emphasis on application and develop a
clear understanding and working knowledge of solution thermodynamics and the theories of phase,
chemical reaction equilibria.

CLASS SCHEDULE:
C 303, MWF 1:00 pm - 1:50 pm

PROFESSIONAL COMPONENT:
Engineering Science: 3 credits or 100%
Engineering Design: 0 credit

TOPICS:
• Thermodynamics of Pure Fluids
• Single Phase, Simple Systems of Mixtures
• Phase Equilibria of Binary Systems
• Chemical Reaction Equilibria

COMPUTER USAGE:
Students are expected to gain skills in complex calculus calculations using software.
**COURSE OUTCOMES:**

After completion of this course the average student is expected to be able to:

1) Evaluate changes in thermodynamic properties (P, V, T, U, H, S and G) when a pure fluid undergoes various processes (expansion, compression and pumping etc).

2) Make thermodynamic analysis of simple flow process and various thermodynamic cycles using T-S and/or H-S diagrams and estimate the thermodynamic efficiency.


4) Evaluate fugacity and fugacity coefficient of pure species and species in solution.

5) Perform various VLE calculations (equilibrium composition of liquid and vapor phases, dew/bubble point and L/V ratio) using the Gamma/Phi formulation and a variety of its simplifications.

6) Extract liquid phase properties from the deduction of experimental VLE data and appropriately set up gamma/composition correlations with thermodynamic consistency.

7) Understand the basics of LLE and the concept of stability.

8) Evaluate the chemical equilibrium constant for a specific reaction. Express the phase composition as a function of reaction extent for single/multiple reactions and homogeneous/heterogeneous reactions and evaluate the equilibrium reaction extent.

9) Analyze the shift of chemical reaction equilibria associated with the change in reaction conditions.

**RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**

The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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**LABORATORY:**

None

**ASSESSMENT AND EVALUATION:**

- Hourly exams
- Comprehensive
- Homework
- Quizzes

**PREPARED BY:**

Wei Chian, Fall 2003
CHE 333 PROCESS MEASUREMENTS AND CONTROL
(Required Course)

CATALOG DATA:
CHE 333 PROCESS MEASUREMENTS AND CONTROL
(1-0) 1 credit.
Prerequisite or corequisite: CHE 217.
A study of the equipment and techniques used in monitoring process measurements and in the design of
feedback control systems.]

TEXTBOOK:
Winter, R. M. and J. M. Munro, Chemical Engineering 233 (or 333) Process Instrumentation and Control,
SDSM&T 1997 (or 2003) Available from SDSM&T bookstore.

INSTRUCTOR:
Dr. James M. Munro
Phone: 394-2422
E-mail: james.munro@sdsmt.edu
Office: C-227
Office Hours: Mon., Wed., Fri. 3:00-4:00 p.m. Other times by appointment

EXPECTATIONS:
• Familiarity with chemical engineering unit operations
• Familiarity with process flow sheets
• Able to perform unit conversions

COURSE OBJECTIVES:
The objective of ChE 333 is to introduce students to the terminology, concepts and practices of process
measurements, valve sizing, and automatic process control.

CLASS SCHEDULE:
C-304, MWF 8:00-8:50 a.m., for first third of the semester

PROFESSIONAL COMPONENT:
Engineering Science: 0.5 credit or 50%
Engineering Design: 0.5 credit or 50%

TOPICS:
• Feedback Control
• Process and Instrumentation Drawings
• Controller actions
• Control algorithms
• Ratio, feedforward and cascade control

COMPUTER USAGE:
• Spreadsheets
• Control Station

COURSE OUTCOMES:
Each student successfully completing ChE 217 is expected to have the following abilities:
10. To configure simple feedback control loops, and identify the components of those loops.
11. To draw process and instrumentation drawings (P&ID’s) using standard ISA notation.
12. To determine the correct action of a feedback controller
13. To recognize feedback, feedforward, cascade and ratio control modes and for each will be able to:
   a) Draw the P&ID from a Process Flow Diagram and from a verbal or written description of the control
desired, b) Draw a simplified block diagram form a P&ID.
14. To use the P-only control equation to compute gains, proportional bands, or other control variables.
15. To describe the action of ON-OFF, proportional, and proportional-integral controllers.
16. To understand calibration curves and be able to prepare such curves from calibration data. Will be
   able to compute the gain of a transmitter and can compute either the output of a transmitter at a given
   input value or the input value at a given output value.
17. To describe the different types of control valves, and can identify the types by their inherent flow
   curves.
18. To compute flow rates through control valves from valve equations.
19. To identify sensors for temperature, pressure, and flow and will have a working understanding of how
   they operate.

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:
The following table indicates the relative strengths of each course outcomes in addressing the program
outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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LABORATORY:
None

ASSESSMENT AND EVALUATION:
- Homework Problems
- Exams

PREPARED BY:
James M. Munro, Fall 2003
CHE 343 CHEMICAL KINETICS AND REACTOR DESIGN
(Required Course)

CATALOG DATA:
CHE 343 CHEMICAL KINETICS AND REACTOR DESIGN
(3-0) 3 credits.
Prerequisites: CHE 217, CHE 321.
A study of chemical kinetics and reactor design, including techniques for analyzing kinetic data, choosing reactor operating parameters, economic optimization of homogeneous reactions, and reactor modeling.

TEXTBOOK:

INSTRUCTOR:
Wei Chian, C308, 394-1231 (w), Wei.Chian@sdsmt.edu
Office hours: 11:00-12:00 AM, MWF

EXPECTATIONS:
- College level calculus, ordinary differential equations (ODE) and practical knowledge of mathematical software (Polymath, Mathcad, MAPLE etc)
- Fundamentals of phase/chemical equilibria and chemical stoichiometry

COURSE OBJECTIVES:
To develop a clear understanding of the fundamentals of chemical reaction kinetics and a working knowledge of chemical reactor engineering with the emphasis on isothermal, homogeneous and heterogeneous systems.

CLASS SCHEDULE:
2:00-2:50PM, MWF, C303

PROFESSIONAL COMPONENT:
Engineering Science: 1.80 credits or 60%
Engineering Design: 1.20 credits or 40%

TOPICS:
- Mole Balances and Types of Reactors
- Conversion and Reactor Sizing
- Rate Laws (Elementary Reactions and Non-elementary Reactions)
- Reaction Stoichiometry
- Collection and Analysis of Rate Data
- Isothermal Reactor Design
- Isothermal Multi-reaction Kinetics
- Fundamentals of Catalytic Reactions
- Fundamentals of Non-isothermal Reaction Systems

COMPUTER USAGE:
Students are expected to gain skills in solving differential and non-linear equations using commercial software (e.g. polymath).

COURSE OUTCOMES:
After successful completion of this course a student is expected to be able to
1) Appropriately choose a reactor type for a specific chemical reaction
2) Analyze reaction rate data to determine an appropriate rate law expression
3) Set up and solve reactor design equations for an isothermal reaction carried out in a single reactor (batch, semi-batch, CSTR, PFR) or multiple reactors
4) Set up stoichiometric tables for constant and non-constant volume reaction systems
5) Demonstrate the algorithm for maximizing the desired product in multiple reactions
6) Have conceptual knowledge of catalysis and catalytic reactions

**RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**
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**LABORATORY:**
None

**ASSESSMENT AND EVALUATION:**
- Hourly Exams
- Comprehensive
- Homework
- Design Project

**PREPARED BY:**
Wei Chian, Spring 2004
CHE 361 CHEMICAL ENGINEERING LABORATORY II  
(Required Course)

CATALOG DATA:
CHE 361 CHEMICAL ENGINEERING LABORATORY II  
(0-2) 2 credits.
Prerequisite or corequisite: CHE 218 and CHE 333.
Laboratory experiments in process measurements, feedback control loops, industrial data acquisition and control, fluid flow, fluid flow measurements, and design of fluid handling systems.

TEXTBOOK:

INSTRUCTOR:
Dr. Patrick Gilcrease  
C306, 394-1239  
Patrick.Gilcrease@sdsmt.edu  
Teaching Assistants: Keith Flanagan and Giridhar Pydisetti

EXPECTATIONS:
Students should have a working knowledge of fluid dynamics. They should be able to apply Bernoulli's equation to the flow of liquids and gases in pipes and packed beds. They should be familiar with the various components of process piping systems. Finally, they should understand Newton's law of viscosity as it relates to momentum transport.

COURSE OBJECTIVES:
- Use the theories/models of momentum transport and fluid dynamics developed in ChE 218 to predict and/or interpret the performance of real flow processes. Evaluate the basis and range of validity for predictive models.
- Develop a practical understanding of feedback control loops, including hardware and software elements, as well as basic tuning procedures.
- Develop skills in experimental design and troubleshooting.
- Develop skills in data collection, analysis, and interpretation.
- Develop technical communication skills (written and oral).

CLASS SCHEDULE:
Tuesday & Thursday, 8:00-10:50 am.

PROFESSIONAL COMPONENT:
Engineering Science: 1.60 credits or 80%  
Engineering Design: 0.40 credit or 20%

TOPICS:
- Viscosity of fluids as a function of shear rate and temperature.
- Calibration and performance of various flowmeters.
- Pressure drop and behavior of fluidized beds.
- Pressure drop in piping systems.
- Performance and design of centrifugal pumps.
- Elements of feedback control loops.
- Math modeling of feedback control loops.
- Tuning of feedback control loops.
- Performance of feedback control loops.
- Residence time distribution in stirred tanks.
COMPUTER USAGE:
Students should be able to use Excel for tabulation, manipulation, and graphing of experimental data. Students should have a working knowledge of Pipeflo software.

COURSE OUTCOMES:
1. Students should be able to formulate a plan of investigation for studying/troubleshooting a piece of process equipment/unit operation.
2. Students should be able to collect quality raw data from an operation, and interpret it using statistics combined with an understanding of the engineering principles.
3. Students should be able to manipulate experimental data in a manner that optimizes interpretation and analysis using chemical engineering principles. As a result of this analysis, students should be able to compare observed with predicted performance, and recommend improvements to the system based on sound chemical engineering judgment.
4. Students should be able to communicate the results of their analysis effectively in written and oral reports, with the proper use of tables, graphs, and other visual aids.
5. Students should be able to function effectively in a lab team, and take leadership roles within the team.

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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*For a list of Program Objectives and Program Outcomes, please go to http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396

LABORATORY:
List of Experiments:
- Viscosity
- Fluidized bed
- Air flow in a duct
- Flowmeters
- MAPS fluid design
- Characteristics of feedback control elements
- Level control in a tank
- Temperature control in a mixer
- Characteristics of a control valve
- RTD in a stirred tank

ASSESSMENT AND EVALUATION:
- Memo Reports
- Oral Reports
- Pre-labs, notebooks
- Lab Final

PREPARED BY:
Patrick Gilcrease, Fall 2003
CHE 362 CHEMICAL ENGINEERING LABORATORY III
(Required Course)

CATALOG DATA:
CHE 362 CHEMICAL ENGINEERING LABORATORY III
(0-1) 1 credit.
Prerequisite: CHE 317.
Laboratory experiments on heat transfer.

TEXTBOOK:

INSTRUCTOR:
R.M. Winter, C220, 394-1237 (w), 394-2421 (secretary), robb.winter@sdsmt.edu
D. Gautam-Perumal, C213A, 394-1234 (w), deepasiri-12@yahoo.com
Office hours: C-220, TBA or by appointment

EXPECTATIONS:
Students entering this course are expected to know:
• modes of heat transfer and the applicable rate expressions
• how to apply energy balances and enthalpy balances to the solution of heat transfer problems
• how to formulate problems into mathematical models
• how to judiciously apply assumptions to the solutions of problems
• approximate values of thermal conductivities, heat transfer coefficients and emissivities
• how to estimate heat transfer coefficients

COURSE OBJECTIVES:
(Knowledge the average student should have after taking this course)
• To apply the concepts of heat transfer, fluid dynamics and thermodynamics to the design and operation of heat transfer experiments.
• To assess experimental data and compare to theoretical models to heat transfer experiments.
• To create higher level professional oral and written reports.

CLASS SCHEDULE:
C304 (lecture)/ C209-C137 (laboratory), Th 8 am – 10:50 am

PROFESSIONAL COMPONENT:
Engineering Science: 1.0 credit or 100%
Engineering Design: 0 credit

TOPICS:
Experimental and theoretical analysis of conduction, convection and radiation.

COMPUTER USAGE:
• Polymath
• Excel
• Word
• PowerPoint

COURSE OUTCOMES:
After completion of this course the average student is expected to be able to:
1) assess whether sensors and equipment used in the heat transfer labs are functioning appropriately
2) perform minor repairs of heat transfer equipment
3) apply theoretical models to the heat transfer experiments
4) assess the scientific and engineering basis of discrepancies between the experimental data and the applicable models
5) conduct heat transfer experiments in a timely fashion
6) create and present oral and written reports at a higher standard

**Relation of Course Outcomes to Program Outcomes:**
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**Laboratory:**
Conduct the following labs:
- Double-pipe heat exchange
- MAPS heat exchanger (shell and tuber, plate and frame)
- Conduction (through rods); natural convection to air; radiation
- Unsteady state conduction in a solid
- Rotary dryer (of a solid)

**Assessment and Evaluation:**
- Reports
- Pre-lab orals

**Prepared By:**
Robb M. Winter, Spring 2004
CHE 417 CHEMICAL ENGINEERING V
(Required Course)

CATALOG DATA:
CHE 417 CHEMICAL ENGINEERING V
(2-0) 2 credits.
Prerequisite: CHE 321.
The fifth course on the theory and practice of Chemical Engineering with emphasis on equilibrium staged separations.

TEXTBOOK:
Separation Process Principles by J.D. Seader and E. J. Henley Wiley 1998

INSTRUCTOR:
Dr. Gilcrease, Chemistry Bldg Room C 306, 394-1239
Patrick.Gilcrease@sdsmt.edu
Office hours TBA

EXPECTATIONS:
Students should have a working knowledge of material and energy balances and phase equilibrium calculations. They should also understand the principles of mass transfer in stagnant and turbulent systems. Finally, they should be familiar with absorber modeling and design, including practical aspects of packed tower equipment.

COURSE OBJECTIVES:
- Understand the phase equilibrium principles which govern staged chemical separations processes.
- Develop the ability to model chemical separation processes using material and energy balances combined with phase equilibrium expressions (equilibrium stage approach). Understand the advantages and limitations of this approach. Numerical solutions will be obtained by hand, by spreadsheet, and using steady-state simulators (ASPFEN RADFRAC).
- Obtain a practical, working knowledge of common separation operations such as distillation, absorption/stripping, and liquid-liquid extraction.
- Understand how stage efficiencies are used to approximate underlying mass transfer limitations. Recognize the differences and similarities between rate-based and equilibrium-stage models of separation processes.

CLASS SCHEDULE:
Lecture times: MW 2:00-2:50 pm, Room CB309
Recitation: F 2:00-2:50 pm Room CB 309 (optional)

PROFESSIONAL COMPONENT:
Engineering Science: 1.5 credits or 75 %
Engineering Design: 0.5 credit or 25 %

TOPICS:
- Single stage vapor-liquid equilibrium flashes (isothermal and non-isothermal).
- Cascades.
- Basic principles of distillation.
- McCabe-Thiele diagrams.
- Trayed tower design, including reboilers and condensers.
- Tray efficiencies in distillation.
- Shortcut methods for multicomponent distillation.
- Rigorous distillation modeling using RADFRAC in AspenPlus.
- Ternary diagrams for single stage liquid-liquid extraction.
- Principles and equipment for liquid-liquid extraction.
- Multistage countercurrent liquid-liquid extraction.
- Predicting equilibrium stage efficiencies using rate-based approaches.

**Computer Usage:**
Students should have a working knowledge of setting up and running AspenPlus Simulations.

**Course Outcomes:**
Upon successful completion of this course, the student should be able to:
1. Understand the physical principles and basic mechanical designs of fundamental separation operations (flashes, distillation, absorption-stripping, and liquid-liquid extraction).
2. Develop an equilibrium stage model of a separation process from first principles (material and energy balances, combined with phase equilibrium calculations).
3. Use various mathematical tools (hand calculations, graphical solutions, math software, and ASPEN software) to simultaneously solve the material balances, energy balances, and phase equilibrium expressions needed to model equilibrium-staged separations.
4. Use equilibrium stage model solutions to design and troubleshoot separation operations.
5. Combine equilibrium stage models with simple cost estimates to optimize separation designs from an economic standpoint.

**Relation of Course Outcomes to Program Outcomes:**
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**Laboratory:**
None

**Assessment and Evaluation:**
- 2 hour exams
- Final exam
- Homework
- Short quizzes
- Computer projects

**Prepared By:**
Patrick Gilcrease, Fall 2003
CHE/MET 433 PROCESS CONTROL
(Required Course)

CATALOG DATA:
CHE 433 PROCESS CONTROL
(3-0) 3 credits.
Prerequisite: MATH 321 and senior standing.
Analysis and design of process control systems for industrial processes, including controller tuning and design of multivariable control schemes. This course is cross-listed with MET 433.

TEXTBOOK:

INSTRUCTOR:
Dr. Stan Smith, Office: EP222, Email: stanley.smith@sdsmrt.edu

EXPECTATIONS:
Students are expected to have a fundamental understanding of:
• Energy and material balances;
• Application of ordinary differential equations.

COURSE OBJECTIVES:
The objective of this course is to provide students with the working knowledge required to understand and solve practical problems with require:
• Process dynamic analysis;
• Basic process-control theory.

CLASS SCHEDULE:
CB-309; MWF; 1:00-1:50 PM

PROFESSIONAL COMPONENT:
Engineering Science: 2.5 credits or 83.3%
Engineering Design: 0.5 credit or 16.7%

TOPICS:
• Development of P&ID’s;
• Feedback Control – controller action, On/Off control, P-only and PI algorithms
• Development of Mathematical models in time domain – 1st and 2nd order ODE’s, deviation variables, linearization;
• Analysis of models in LaPlace domain – LaPlace transforms, final value theorem, transfer functions;
• Analysis of 2nd order processes/systems with real and complex roots;
• Tuning strategies for PI-Control – Ziegler Nichols, minimum error and common tuning formulae;
• Basic cascade and feed forward control – concepts, implementation and tuning;
• Introduction to statistical analysis of a process – basic statistical concepts including measures of central tendency and variability and hypothesis testing;
• Introduction to statistical process control – construction of mean and range charts

COMPUTER USAGE:
• Control Station®/Simulation Software
• Excel
• MathCad

COURSE OUTCOMES:
A student successfully completing course is expected to have the following abilities:
1) Is able to configure feedback control loops on a Process Flow Diagram (PFD) in order to produce a Process & Instrumentation Drawing (P&ID).
2) Knows the characteristics of proportional, integral, and derivative control modes, and can sketch typical response curves for each mode or combination of modes.
3) Is able to use LaPlace transforms to create transfer functions describing the dynamic behavior of processes and control systems.
4) Can model the dynamic behavior of physical processes using algebraic and differential equations, and by using LaPlace transforms in block diagram representation of those equations.
5) Can determine the order of a transfer function and, from the order, can make inferences about how the underlying process would respond to input changes.
6) Understands and can use deviation variables in modeling the dynamic behavior of processes and control systems.
7) Can determine the roots of a transfer function, and can determine the response of the dependent variable for both real and complex roots.
8) Understands the effect of dead-time in a process, and knows when the dead-time term makes solution by partial fractions impossible.
9) Is able to linearize non-linear equations in order to analyze the equations using LaPlace transforms.
10) Can construct block diagrams from equations, and can write equations from block diagrams.
11) Can write open-loop and closed-loop transfer functions from block diagrams.
12) Knows the differences between overdamped, critically damped, underdamped, undamped and unstable systems, and can sketch responses for each of these modes applied to a specific control system.
13) Can model complex process behavior using empirical first-order-plus-dead-time (FOPDT) approximations.
14) Can determine values of tuning constants for feedback controllers based on the Ziegler-Nichols, Cohen and Coon, and Lopez formulas.
15) Is able to illustrate control techniques and response modes using Control Station® simulation software.
16) Understands the concept of cascade control, and is able to use block diagrams, P&ID’s and time-domain sketches to illustrate or analyze cascade systems.
17) Understands the concept of feedforward control, and is able to use block diagrams, P&ID’s and time-domain sketches to illustrate or analyze feedforward systems.
18) Understands the common measures of central tendency and variability, and can calculate those for a given sample of process data.
19) Understands the concept of statistical process control, and can construct mean and range charts for a sample of process data.

**RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**
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**LABORATORY:**
None

**ASSESSMENT AND EVALUATION:**
- Homework
- Quizzes
- Exams

**PREPARED BY:**
Stan Smith, Fall 2003
CHE 461 CHEMICAL ENGINEERING LABORATORY IV
(Required Course)

CATALOG DATA:
CHE 461 CHEMICAL ENGINEERING LABORATORY IV
(0-1) 1 credit.
Prerequisite: CHE 318.
Laboratory experiments on mass transfer.

TEXTBOOK:

INSTRUCTOR:
Dr. Patrick Gilcrease
C306
394-1239
Patrick.Gilcrease@sdsmt.edu
Teaching Assistants: Jason Herr and Bhavani Puli

EXPECTATIONS:
Students should have a working knowledge of the following processes/unit operations: molecular diffusion, interphase mass transfer in convective systems, multiple-effect evaporators, gas-liquid absorbers, and distillation. Students should have practical skills in experimental design, troubleshooting, data analysis, and data interpretation. Students should be proficient in preparing the proper oral and written reports.

COURSE OBJECTIVES:
• Use the theories/models of mass transfer and equilibrium stages developed in ChE 318 and ChE 417 to predict and/or interpret the performance of real separation processes. Evaluate the basis and range of validity for predictive models.
• Develop skills in experimental design and troubleshooting.
• Develop skills in data collection, analysis, and interpretation.
• Develop technical communication skills (written and oral).

CLASS SCHEDULE:
Thursday, 1:00-3:50 pm.

PROFESSIONAL COMPONENT:
Engineering Science: 0.80 credits or 80%
Engineering Design: 0.20 credit 20%

TOPICS:
• Unimolecular diffusion in gaseous systems.
• Multiple effect evaporators.
• Multistage distillation of a binary mixture.
• Gas-liquid mass transfer in an agitated fermentor.
• Design of a packed column gas-liquid absorber.
• Design, interpretation, and presentation of practical experiments.

COMPUTER USAGE:
Students should be proficient in the use of AspenPlus to simulate absorbers and distillation towers. Students should be able to use Excel for tabulation, manipulation, and graphing of experimental data.

COURSE OUTCOMES:
1. Students should be able to formulate a plan of investigation for studying/troubleshooting a piece of
process equipment/unit operation.

2. Students should be able to collect quality raw data from an operation, and interpret it using statistics combined with an understanding of the engineering principles.

3. Students should be able to manipulate experimental data in a manner that optimizes interpretation and analysis using chemical engineering principles. As a result of this analysis, students should be able to compare observed with predicted performance, and recommend improvements to the system based on sound chemical engineering judgment.

4. Students should be able to communicate the results of their analysis effectively in written and oral reports, with the proper use of tables, graphs, and other visual aids.

5. Students should be able to function effectively in a lab team, and take leadership roles within the team.

**Relation of Course Outcomes to Program Outcomes:**
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**Laboratory:**
Gas-liquid mass transfer in a fermentor replaced solid-liquid mass transfer in a stirred tank.

**Assessment and Evaluation:**
- Memo reports
- Oral reports
- Pre-lab, notebooks
- Lab Final

**Prepared By:**
Patrick Gilcrease, Fall 2003
CHE 464 CHEMICAL ENGINEERING DESIGN I
(Required Course)

CATALOG DATA:
CHE 464 CHEMICAL ENGINEERING DESIGN I
(4-0-4) credits. Prerequisites: CHE 317, CHE 318.
A comprehensive treatment of problems involved in the design of a chemical process plant. The design of plant equipment with emphasis upon the selection of materials and the elements of cost. Overall plant design with consideration of economics, political, and personnel factors.

TEXTBOOK:
- Turton, R., R.C. Bailie, W.B. Whiting, J.A. Shaeiwitz: Analysis, Synthesis, and Design

INSTRUCTOR:
Dr. Jan A. Puszynski
Tel: 605/394-1230, Fax: 605/394-1232; E-mail: Jan.Puszynski@sdsmt.edu
Office hours: MF: 2-3 pm, W: 10-11, or by appointment

EXPECTATIONS:
Students entering this course are expecting to know:
- design of absorbers and heat exchangers;
- fundamentals of unit operations;
- thermodynamics and fundamentals of reaction engineering;
- Aspen Plus software;
- inorganic and organic chemistry;
- numerical methods.

COURSE OBJECTIVES:
Students in this course will learn to:
- apply knowledge of chemical engineering, chemistry, mathematics, economics, and sociopolitical, and ethical factors to design of chemical plants;
- work effectively as design team members;
- obtain required data for a design from literature, industry, or experiments;
- critically review design alternatives.

CLASS SCHEDULE:
C303; M,W,F; 8:00 - 8:50 am

PROFESSIONAL COMPONENT:
Engineering Science: 4.0 credits or 100%
Engineering Design: 0 credit

TOPICS:
- Process design development
- Degree of freedom analysis
- Engineering economics
- Chemical process safety

COMPUTER USAGE:
- Knowledge of Aspen Plus and Excel
COURSE OUTCOMES:
After completion of this course the average student is expected to be able to:
1. Perform degree of freedom analysis for multi-unit systems with multiple recycles;
2. construct block and process flow diagrams;
3. estimate capital and manufacturing costs;
4. perform engineering economic and profitability analyses;
5. utilize experienced-base principles to confirm the suitability of a process design;
6. understand a role of different regulatory government institutions;
7. apply design concepts for fire and explosion protection;
8. select and design pressure relief systems;
9. perform hazards and operability studies and safety reviews;
10. search technical literature using Chemical Abstracts and other databases;
11. work both individually and as a group member (first semester of design project).

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:
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*For a list of Program Objectives and Program Outcomes, please go to http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396

LABORATORY:
Weekly 2 hour long design meetings.

ASSESSMENT AND EVALUATION:
- Homework
- Design reports
- Exams
- Senior exit survey
- Alumni survey

PREPARED BY:
Jan Puszynski, Fall 2003
CHE 465 CHEMICAL ENGINEERING DESIGN II
(Required Course)

Catalog Data:
CHE 465 CHEMICAL ENGINEERING DESIGN II
(3-0) 3 credits.
Prerequisite: CHE 464.
A continuation of CHE 464.

Textbook:
- Branan, C., Rules of Thumb for Chemical Engineers, Gulf Publishing Company Houston, TX, 1998

Instructor:
Dr. Jan A. Puszynski
Tel: 605/394-1230, Fax: 605/394-1232; E-mail: Jan.Puszynski@sdsmt.edu
Office hours: MWF 2-3 pm or by appointment

Expectations:
Students entering this course are expecting to know:
- pumps selection and design of piping systems;
- design of heat exchangers, absorbers, and distillation columns;
- fundamentals of unit operations;
- engineering economics;
- process control;
- thermodynamics and reaction engineering;
- PFD and PID
- Aspen Plus and Flow-Series software packages;
- fundamentals of chemical process safety;
- literature and patent search procedure.

Course Objectives:
(Knowledge the average student should have after taking this course)
To apply knowledge of chemical engineering, chemistry, mathematics, economics, and sociopolitical and ethical factors to design of chemical plants.

Class Schedule:
C303; M,W,F; 9:00 - 9:50

Professional Component:
Engineering Science: 3 credits or 100 %
Engineering Design: 0 credit

Topics:
- Optimization
- Heat exchanger network
- Solid-fluid separators
- Pumping systems
- Design of pressure vessels
- Mixing equipment
- Ethics
**Computer Usage:**
- Aspen Plus
- Flow Series
- Excel

**Course Outcomes:**
After completion of this course the average student is expected to be able to:
1. synthesize systems involving multi-units and multiple inputs/outputs;
2. select a proper construction material for specific applications;
3. perform simple optimization calculations;
4. design piping systems for process and utility fluids;
5. calculate basic dimensions for fluid-solid separators and mixing equipment;
6. design heat exchanger network and separation trains;
7. work both individually and as a group member (second semester of design project).

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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<tr>
<th>ChE 465 Course Outcomes</th>
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*For a list of Program Objectives and Program Outcomes, please go to [http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396](http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396)*

**Laboratory:**
Weekly one hour long design meetings.

**Assessment and Evaluation:**
- Homework
- Design reports
- Exams
- Formal oral presentations
- Poster presentations
- Senior exit survey
- Alumni survey

**Prepared By:**
Jan Puszynski, Spring 2004
GE 115/115L PROFESSIONALISM IN ENGINEERING AND SCIENCE  
(Required Course)

CATALOG DATA:  
GE 115/115L. PROFESSIONALISM IN ENGINEERING AND SCIENCE  
(1-1) 2 credit.  
A course based upon professional issues pertinent to engineers and scientists along with an overview of the various 
engineering and science disciplines. Case studies based upon actual technical problems will be presented by practicing 
engineers and scientists. These case studies will involve both societal and professional questions. The format for a 
particular case study will involve an overview of a particular engineering or science discipline, and introduction to an 
actual technical problem, and a discussion of the societal implications of decisions that result.

TEXTBOOK:  
Student Manual (CD available at the Tech Bookstore. Supplements online)  
References: Engineering Success, Peter Schiavone, Prentice Hall, 1999  
Engineering Ethics, Charles Fieddermann, Prentice Hall, 1999  
Introduction to Excel, David Kuncicky, Prentice Hall, 2001  
Introduction to Engineering Analysis, Kirk Hagen, Prentice Hall, 2001  
Design Concepts for Engineers, Mark Horenstein, Prentice Hall, 1999

INSTRUCTOR:  
Dr. Stetler, Dr. Kellar, Dr. Dixon, Dr. Stone, Dr. Simonson, Dr. Hladysz, Mr. Ash, Ms. Sieverding  
Dr. Dixon 394-1235  
Chemistry Building, Room C-218  
mailto:david.dixon@sdsmt.edu  
http://webpages.sdsmt.edu/~ddixon  
Office hours: M, W 11:00-11:50; Tu 14:00-14:50 - Or by appointment

EXPECTATIONS:  
This is a freshman course with no specific incoming expectations except a commitment to pursue a degree in 
gineering.

COURSE OBJECTIVES:  
To make the most of this course, it is recommended that students adopt the following five learning objectives to guide 
their priorities and actions during this term.  
• Be able to use technology tools (World Wide Web, Excel, PowerPoint, analysis software) to analyze, solve, and 
present solutions to engineering problems.  
• Become an effective team member.  
• Develop the communication skills necessary to package acquired technical and professional abilities that are 
required to succeed in engineering practice.  
• Understand the engineering profession enough to commit to a major and create an education/career plan.  
• Develop motivation for self-responsibility, life-long learning, and self-development of a person of good character.

CLASS SCHEDULE:  
M, W, & F, 2 pm – 2:50 pm  
Meeting Place: Because of the nature of this course, at times students will need to have access to a computer lab. At 
other times, they will need access to an experimental laboratory. Consequently, different topics will be held in 
different locations. Refer to the room assignment on the “2003 Classroom Schedule” from the Course Notes web page. 
Some assignments are subject to change. It is the student's responsibility to ensure they receive weekly room updates 
from their instructor.

PROFESSIONAL COMPONENT:  
Engineering Science: 1.50 credits or 75%  
Engineering Design: 0.50 credit or 25%

TOPICS:  
The course will cover the following engineering related topics:  
• Technical Library Orientation  
• Teams and Teaming  
• Webpage Development and Publishing  
• Professional Engineering Ethics  
• Dimensions, Units and Significant Figures  
• Technical Writing Overview
• Analytical Methods for Engineering
• Problem Solving and Chart Creation Using Excel
• Experimental Lab and Data Analysis
• Final Teaming Project

COMPUTER USAGE:
• Microsoft FrontPage
• Microsoft Excel
• Microsoft Word
• Microsoft PowerPoint
• Logger Pro

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
1. Document a rationale for selection in their chosen major.
2. Author a web page and post to the Internet.
3. Incorporate the rules of significant digits when solving problems and check for dimensional consistency.
4. Incorporate the 7-step approach to solving engineering problems.
5. Utilize Excel to solve fundamental problems in engineering.
6. Use a data acquisition system to collect experimental data.
7. Utilize Excel to analyze data and conduct a trend analysis on experimental data.
8. Utilize the fundamental principles of engineering design and team problem solving to design a rudimentary engineering system.
9. Utilize fundamental principles of technical writing to prepare a technical report, resume, and technical memorandum.
10. Utilize ethical principles in professional engineering decision making

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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<th>GE 115 Program Outcomes</th>
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*For a list of Program Objectives and Program Outcomes, please go to http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396

LABORATORY:
The students will utilize the Lab Pro data acquisition devices to measure the temperature in a coffee pot as a function of time from when the coffee pot is turned on. This data will be collected and analyzed by the students and then placed into a technical report. In addition, extensive lab work is used during the final team project.

ASSESSMENT AND EVALUATION:
• Homework
• Laboratory Project
• Writing, reports, presentation
• Professionalism/Attendance
• Portfolio
• FE Exam
• Exit Exam

PREPARED BY:
David Dixon, Fall 2003
CHEM 112 GENERAL CHEMISTRY I
(Required Course)

CATALOG DATA:
CHEM 112 GENERAL CHEMISTRY I
(3-0) 3 credits. Prerequisites Prerequisite or corequisite MATH 102. An introduction to the basic principles of chemistry for students needing an extensive background in chemistry (including chemistry majors, science majors, and pre-professional students). Completion of a high school course in chemistry is recommended. Duplicate credit for CHEM 106 and 112 not allowed.

TEXTBOOK:
2. Arrington, D. E., "General Chemistry I CD." This CD contains self-tests for this course. You will need an IBM-compatible computer, equipped with a CD-ROM drive, and Windows 9x or NT variants as the operating system.

INSTRUCTOR:
Dr. Dale Arrington, C-313 (394-1236)
E-mail: dale.arrington@sdsmt.edu
Office Hours: 10 a.m. MWF

EXPECTATIONS:
Students are expected to have a fundamental understanding of:
• Algebra
• Prior course in chemistry

COURSE OBJECTIVES:
Students will obtain a foundation in the fundamental principles and models of chemistry necessary for an understanding of the composition, structure, and properties of matter and the changes that matter undergoes.

CLASS SCHEDULE:
C-228 (sec. 1) Monday-Wednesday-Friday; 8:00 – 8:50 a.m.
C-228 (sec. 2) Monday-Wednesday-Friday; 9:00-9:50 a.m.

PROFESSIONAL COMPONENT:
Basic Science: 3 credits or 100%

TOPICS:
• Properties of matter
• Atomic structure
• Stoichiometry
• Reactions in aqueous solution
• Thermochemistry
• Electronic structure
• Periodic properties
• Bonding
• States of matter
• Intermolecular forces
• Properties of solutions
COMPUTER USAGE:
None

COURSE OUTCOMES:
Each student successfully completing Chem112 is expected to have the following abilities:

- Understand, and use correctly, the symbolic representations, chemical notation, formulas, and systematic rules of nomenclature that characterize the language of chemistry.
- Understand and apply the mole concept in a variety of chemical calculations, including calculating the number of particles in a given mass of substance (and vice versa), and the quantitative relationships between reactants and products in a chemical reaction.
- Recognize the different types of chemical transformations: acid-base, precipitation, combination, decomposition, single-replacement, oxidation-reduction, double replacement, and combustion.
- Understand the basic principles of energy transfer involving chemical systems, including the transfer of heat and work between system and surroundings, the qualitative and quantitative interpretation of thermochemical equations, and the application of Hess’s Law.
- Understand the various models of atomic structure, the basic principles of quantum theory, and the experiments that led to those principles.
- Write ground-state electron configurations for atoms and ions of any representative element and the 3d transition series elements.
- Understand the fundamental aspects of chemical bonding, including writing Lewis structures, describing the bonding in molecules by simple valence-bond theory, and using Valence Shell Electron Pair Repulsion Theory to predict the geometries of molecules and ions.
- Use modern atomic theory to understand and predict the properties of different elements.
- Recognize, and account for, in terms of the underlying electronic factors involved, the characteristic properties of the different groups in the periodic table.
- Understand the properties of the different states of matter.
- Qualitatively and quantitatively describe the properties of the gaseous state and the fundamental laws governing the behavior of gases.
- Understand, qualitatively and quantitatively, the behavior of solutions and their colligative properties.
- Understand how fundamental intermolecular interactions among particles determine the physical and chemical properties of a system.
- Understand the fundamental postulates of kinetic-molecular theory and use them to explain the physical behavior of the three states of matter.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 112, General Chemistry I, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

LABORATORY:
None

ASSESSMENT AND EVALUATION:
Cumulative percent average on the five hour exams is the sole determinant of the grade in this course.

PREPARED BY:
Dale Arrington, Fall 2003
CHEM 112L GENERAL CHEMISTRY I LAB
(Required Course)

CATALOG DATA:
CHEM 112L GENERAL CHEMISTRY I LAB
(0-1) 1 credit. Prerequisite or corequisite: CHEM 112. Laboratory designed to accompany CHEM 112.

TEXTBOOK:
1. Prepackaged set of experiments from the Modular Laboratory Program in Chemistry (Chemical Education Resources, Palmyra, PA). A complete set consists of the following numbered experiments: 368, 387, 388, 389, 394, 395, 399, 451, 455, 460, 484, and 498.
2. Approved safety goggles, which must be worn at all times while in the laboratory. Goggles may be purchased in the bookstore or at the first and second lab meetings.
3. Roll of paper towels. A roll of paper towels should be purchased by you and kept in your lab locker. Any budget brand will do.

INSTRUCTOR:
Dr. Dale Arrington, C-313 (394-1236)
E-mail: dale.arrington@adsmit.edu
Office Hours: 10 a.m. MWF

EXPECTATIONS:
Students are expected to have a fundamental understanding of:
- Algebra
- Prior course in chemistry

COURSE OBJECTIVES:
Students will gain familiarity with common chemical laboratory safety practices and the apparatus and experimental methods used in analyzing and investigating the properties and behavior of matter.

CLASS SCHEDULE:
C-204/201 (sec. 51 & 52) Tuesday; 8:00 – 9:50 a.m.
C-201/204 (sec 55 & 56) Thursday; 8:00 – 9:50 a.m.
C-204/201 (sec. 53 & 54) Tuesday 1:00-3:50 p.m.
C-201/204 (sec. 57 & 58) Thursday 1:00-3:50 p.m.

TOPICS:
- Safety Video. Locker check-out.
- Relating Mass and Volume (bring a metric ruler to lab).
- Detecting Signs of Chemical Change.
- Separating and Isolating the Components of a Binary Mixture of Solids.
- Empirical Formula of an Oxide.
- Single Replacement Reactions and Relative Reactivity.
- Percent Water in a Hydrate.
- Heat of Neutralization (partners; bring a watch with a second hand).
- Paper Chromatography of Selected Transition-metal Cations (bring a ruler to lab).
- Separating and Determining the Mass of Calcium Ion in a Calcium-Enriched Tablet.
- Paper Chromatography of Selected Transition-metal Cations (bring a ruler to lab).
- Determining the Molar Concentration of a Sodium Hydroxide Solution.
- Titrating Vinegar and locker check-in.

COMPUTER USAGE:
None
**COURSE OUTCOMES:**
Each student successfully completing Chem112L is expected to have the following abilities:
- Understand the distinction between qualitative and quantitative chemical analysis.
- Understand the fundamental and operational principles upon which common methods of separation and purification of chemical substances are based.
- Identify sources of error in chemical experiments.
- Interpret experimental results and draw reasonable conclusions.
- Analyze data in terms of the precision and accuracy of results.
- Learn and understand laboratory safety procedures.
- Anticipate, recognize, and respond to hazards of chemical materials and manipulations.
- Learn the importance of performing accurate and precise quantitative measurements.
- Keep legible and complete experimental records.
- Collaborate with peers in obtaining and interpreting data.
- Understand the concept of standardization.

**LABORATORY:**
100%

**ASSESSMENT AND EVALUATION:**
Pre-lab questions
Lab Reports

**PREPARED BY:**
Dale Arrington, Fall 2003
CHEM 114 GENERAL CHEMISTRY II
(Required Course)

CATALOG DATA:
CHEM 114 GENERAL CHEMISTRY II
(3-0) 3 credits. Prerequisite: CHEM 112 and MATH 102. Prerequisite or corequisite CHEM 114L. A continuation of CHEM 112. An introduction to the basic principles of chemistry for students needing an extensive background in chemistry.

TEXTBOOK:

INSTRUCTOR:
Dale Arrington, C 313 (394-1236)
Email: Dale.Arrington@sdsmt.edu

TOPICS:
Chemistry 114, General Chemistry II, is the second semester of a two-semester sequence that surveys the important concepts, principles, and models of chemistry. The main emphasis in the second semester is on the macroscopic properties of matter. The course content includes: chemical kinetics; chemical equilibrium; acids and bases; acid-base and solubility equilibria; chemical thermodynamics; and electrochemistry. The course is organized around Learning Guides that are written for each chapter. Each guide consists of two main parts:
1. A specific reading assignment that clearly specifies not only what you must read, but also what material, if any, should be omitted from the readings. The number of class periods devoted to each chapter is clearly indicated on each Learning Guide.
2. A set of carefully prepared learning objectives that describe the specific tasks that it is desirable to be able to do upon completion of each reading assignment. These learning objectives are the most important part of each guide and you should refer to them as you read the assigned material, do homework and prepare for examinations. Examinations will emphasize the most important of these objectives.

OBJECTIVES:
Students will obtain a foundation in the fundamental principles governing chemical reactivity: chemical kinetics, equilibrium (gas-phase, acid-base, and solubility equilibria), thermodynamics, and electrochemistry.

PROFESSIONAL COMPONENT:
Basic Science: 3 credits or 100%

COURSE OUTCOMES (more specific "outcomes" are indicated on the Learning Guides and are referred to by their correct name: learning objectives).
- Understand rates of reaction and the conditions affecting rates.
- Derive the rate equation, rate constant, and reaction order from experimental data.
- Use integrated rate laws.
- Understand the collision theory of reaction rates and the role of activation energy.
- Understand the nature and characteristics of chemical equilibria.
- Understand the significance of the equilibrium constant, K.
- Understand how to use the equilibrium constant in quantitative studies of chemical equilibria.
- Understand and use Le Châtelier's Principle in predicting the effects of stresses on equilibrium systems.
- Use the Bronsted-Lowry and Lewis concepts of acids and bases.
• Apply the principles of chemical equilibrium to acids and bases in aqueous solution.
• Understand the control of pH in aqueous solutions with buffers.
• Evaluate the pH in the course of acid-base titrations.
• Apply chemical equilibrium concepts to the solubility of ionic compounds.
• Understand the concept of entropy and how it relates to spontaneity.
• Use tables of data in thermodynamic calculations.
• Define and use free energy in predicting the spontaneity of chemical processes.
• Balance net ionic equations for oxidation-reduction reactions.
• Understand the principles of voltaic and electrolytic cells.
• Understand how to use electrochemical potentials.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 114, General Chemistry II, meets part of ABET Criterion 3, outcome (a):
   (a) Ability to apply knowledge of mathematics, science, and engineering.

Prepared by:  Dale Arrington and Arden Davis  May, 2004
CHEM 114L GENERAL CHEMISTRY II LAB
(Required Course)

CATALOG DATA:
CHEM 114L GENERAL CHEMISTRY II LAB
(0-1) 1 credit. Prerequisite or corequisite: CHEM 114. A laboratory designed to accompany CHEM 114. Qualitative analysis of cations and anions, pH and redox measurements, synthesis and properties of organics, polymers, and transition metal compounds. chemistry.

TEXTBOOK:
5. Approved safety goggles, which must be worn at all times while in the laboratory. Goggles may be purchased in the bookstore or at the first and second lab meetings.
6. Proper clothing and footwear (to be discussed during first scheduled lab period).
7. Roll of paper towels. A roll of paper towels should be purchased by you and kept in your lab locker.

INSTRUCTOR:
Dale Arrington, C 313 (394-1236)
Email: Dale.Arrington@sdsm.tiedu

TOPICS:
- Qualitative Analysis Group I Cations
- Qualitative Analysis Group III Cations
- Qualitative Analysis Group IV Cations
- General Cation Unknown
- Qualitative Analysis of Anions
- Chemical Kinetics
- Synthesis of Na₃Co(CO₃)₃

OBJECTIVES:
Course Objective: Students will gain familiarity with the principles and techniques of inorganic qualitative analysis, chemical kinetics, and the synthesis of selected chemical compounds.

PROFESSIONAL COMPONENT:
Basic Science: 1 credits or 100%

COURSE OUTCOMES: (more correctly called learning objectives):
- Perform procedures for the analytical separation and qualitative determination of selected anions and cations in an aqueous solution.
- Understand the fundamental and operational principles upon which common methods of separation and purification of chemical substances are based.
- Identify sources of error in chemical experiments.
- Interpret experimental results and draw reasonable conclusions.
- Practice laboratory safety procedures.
- Anticipate, recognize, and respond to hazards of chemical materials and manipulations.
- Learn the importance of following correct laboratory procedures.
- Keep legible and complete experimental records.
• Collaborate with peers in obtaining and interpreting data.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 114L, General Chemistry II Lab, meets part of ABET Criterion 3, outcome (a):
   (a) Ability to apply knowledge of mathematics, science, and engineering.

Prepared by:
Dale Arrington Fall 2003
CHEM 220 EXPERIMENTAL ORGANIC CHEMISTRY IA
(Required Course)

CATALOG DATA:
CHEM 220 EXPERIMENTAL ORGANIC CHEMISTRY IA
(0-1) 1 credit. Prerequisite: CHEM 114L. A one-semester laboratory course. Experiments
demonstrating techniques for the separation, characterization and synthesis of organic compounds
are performed. Functional groups are derivatized.

TEXTBOOK:
No text is required for this course. All experiments will be taken from the following:
Kenneth L. Williamson, Organic Experiments, 9th edition

INSTRUCTOR:
Cabot-Ann Christofferson (394-2421)

TOPICS:
- Recrystallization of an organic solid
- Purification of liquids by distillation
- Extraction with solvents
- Infrared spectroscopy
- Substitution synthesis
- Elimination synthesis
- Oxidation synthesis
- Grignard synthesis

OBJECTIVES:
The experiments in this laboratory are to facilitate your understanding of batch operations on the
bench scale that are performed routinely in many aspects of the chemical industry. The principles
which apply to a bench, batch scale are able to be extrapolated to larger scale chemical reactions
and operations.

PROFESSIONAL COMPONENT:
Basic Science: 1 credit or 100%

COURSE OUTCOMES: The student who successfully completes this course should be able to:
- Identify and work safely among the hazards inherent to the organic laboratory.
- Describe the set-up for the various technical operations of the organic laboratory
  including crystallization, simple distillation, fractional distillation, steam distillation and
  reflux.
- Keep an accurate laboratory notebook in accordance with standard laboratory practices.
- Acquire and interpret simple infrared and NMRA spectra.
- Have an appreciation of the molecular mechanism of synthetic experiments attempted in
  this course.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 220, Experimental Organic Chemistry IA, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

Prepared by: Cabot-Ann Christofferson               Spring, 2004
CHEM 230 ANALYTICAL CHEMISTRY FOR ENGINEERS
(Required Course)

CATALOG DATA:
CHEM 230 ANALYTICAL CHEMISTRY FOR ENGINEERS
(2-0) 2 credits. Prerequisite: CHEM 114. An introduction to modern analytical chemistry. Topics
include the theory and application of acid-base and solubility equilibria, titrimetric and
gravimetric analysis, statistical treatment of data, and an introduction to spectroscopy (UV-Vis,
IR, and AA).

TEXTBOOK:
Quantitative Chemical Analysis  Daniel C. Harris, Sixth Edition

INSTRUCTOR:
Dan Heglund C122 (394-1241)
Email: dan.heglund@sdsmt.edu

TOPICS:
The course will cover the traditional elements of quantitative chemical analysis. Within the scope
of this course, some of the material covered includes:
1. a basic understanding of statistics and how it relates to chemical determinations and
   errors,
2. equilibrium of completely and partially dissociated chemicals,
3. acid-base chemistry, including an understanding of pH and reactions of various strength
   acids and bases
4. many types of titrations, and
5. separations.

OBJECTIVES:
The objective of this course is to provide students with the working knowledge required to
formulate questions and analyze problems in analytical chemistry.

PROFESSIONAL COMPONENT:
Basic Science:  2 credits or 100%

COURSE OUTCOMES:
Upon completion of this course, students should demonstrate an ability to:
1. take statistics and errors and apply them to future classes and laboratories,
2. apply equilibrium, acid base rules, titrations and separation and toward future classes and
   laboratories.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 230, Analytical Chemistry for Engineers, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

Prepared by:
Dan Heglund    Fall, 2003
CHEM 326 ORGANIC CHEMISTRY I
(Required Course)

CATALOG DATA:
CHEM 326 ORGANIC CHEMISTRY I
(3-0) 3 credits. Prerequisite: CHEM 114. A systematic treatment of the chemistry of carbon compounds, including nomenclature, structure-reactivity relationships, reaction mechanisms, synthesis, and spectroscopy.

TEXTBOOK:

INSTRUCTOR:
David Boyles, C 319 (394-1276)
Email: david.boyles@sdsmt.edu

TOPICS:
- Carbon compounds
- Structure, preparation and reactions of aliphatic and alicyclic hydrocarbons
- Conformational analysis
- Isomerism
- Stereochemistry
- Chemical intermediate stability
- Nucleophilic substitution
- Elimination reactions
- Free-radical and ionic mechanisms

OBJECTIVES:
This course is an introduction to organic chemistry including classes of organic compounds, nomenclature, properties, and reactivity. This first semester corresponds to approximately the first twelve chapters of the text.

PROFESSIONAL COMPONENT:
Basic Science: 3 credits or 100%

COURSE OUTCOMES: The student who has successfully completed this course will be able to perform the following:
1. Describe the structure and bonding patterns of organic compounds in terms of common and technically correct nomenclature systems according to functional group classifications; accurately depict symbolic organic concepts;
2. Predict the chemical outcomes of organic reactions of various functional classes of compounds under specific conditions;
3. Design syntheses of complex molecules at an introductory level;
4. Given starting materials and products, describe in technical terminology the kind of organic reaction that is occurring in any particular example;
5. Relate organic reactions and products to kinetic and thermodynamic conditions and parameters;
6. Correctly spell and pronounce technical terms pertaining to organic chemistry;
7. Describe the origin of spectral methods and interpret spectra to determine organic molecular structure;
8. Describe the difference between radical and ionic mechanisms and the reactive intermediates and types of mechanisms inherent to both; and

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 326, Organic Chemistry I, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

Prepared by:
David Boyles Fall, 2003
CHEM 328 ORGANIC CHEMISTRY II
(Required Course)

CATALOG DATA:
CHEM 328 ORGANIC CHEMISTRY II
(3-0) 3 credits. Prerequisite: CHEM 326. A continuation of CHEM 326. A systematic treatment of the chemistry of carbon compounds, including nomenclature, structure-reactivity relationships, reaction mechanisms, synthesis, and spectroscopy.

TEXTBOOK:

INSTRUCTOR:
David Boyles, C 319 (394-1276)
Email: david.boyles@sdsmt.edu

TOPICS:
- Kinetic versus thermodynamic addition to conjugated dienes
- Diels-Alder reaction
- Aromatic compounds and aromaticity
- Electrophilic aromatic substitution
- Reactions of aromatic compounds—monosubstitution & disubstituted aromatics
- Aldehydes and ketones: nomenclature & reactions
- Tautomerism isomerization, Haloform reaction
- Aldol reaction
- Cyclic aldol reactions, lithium enolates from LDA—Kinetic and thermodynamic enolates
- Carboxylic Acids

OBJECTIVES:
To continue a study of organic chemistry in all aspects of the discipline including classes of organic compounds, nomenclature, properties, and reactivity. This second semester corresponds to approximately 12 more chapters of the text, from Chapter 10 on.

PROFESSIONAL COMPONENT:
Basic Science: 3 credits or 100%

COURSE OUTCOMES: The student who has successfully completed this course will be able to perform the following as presented in this, the first semester course:
1. Describe the structure and bonding patterns of organic compounds in terms of common and technically correct nomenclature systems according to functional group classifications, accurately depict symbolic organic concepts;
2. Predict the chemical outcomes of organic reactions of various functional classes of compounds under specific conditions;
3. Design syntheses of complex molecules at an introductory level;
4. Given starting materials and products, describe in technical terminology the kind of organic reaction that is occurring in any particular example;
5. Relate organic reactions and products to kinetic and thermodynamic conditions and parameters;
6. Correctly spell and pronounce technical terms pertaining to organic chemistry;
7. Describe the origin of spectral methods and interpret spectra to determine organic molecular structure;
8. Describe the difference between radical and ionic mechanisms and the reactive intermediates and types of mechanisms inherent to both;
9. Depict organic reaction mechanisms using arrow formalism

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 328, Organic Chemistry II, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

Prepared by:
David Boyles          Spring, 2004
CHEM 332L ANALYTICAL CHEMISTRY LAB
(Required Course)

CATALOG DATA:
CHEM 332L ANALYTICAL CHEMISTRY LAB
(0-1) 1 credit. Prerequisite or corequisites: CHEM 114L and CHEM 342 or CHEM 230.
Laboratory to accompany CHEM 332 and CHEM 230. Experimental methods and techniques of
gravimetry, titrimetry, pH, and UV-Vis and AA spectrometry.

TEXTBOOK:
Quantitative Chemical Analysis  Daniel C. Harris, Sixth Edition

INSTRUCTOR:
Dan Heglund C122 (394-1241)
Email: dan.heglund@sdsmt.edu

TOPICS:
- Use and Care of the Analytical Balances
- Practice weighing, use of burette, pipette
- Calibration of Volumetric Glassware
- 50 mL Burette, and 5 of 10 mL Class A Pipette
- Dry standard KHP for 1 hour, put in dessicator
- Standardize NaOH, Dry unknown KHP
- Titrate unknown KHP
- Acid Base Titration using a pH meter
- Gravimetric Determination of Chloride
- Spectrophotometric Determination of Iron
- Spec-20, determine solutions on instrument

OBJECTIVES:
Students will gain familiarity with the principles, techniques and the apparatus of quantitative
analysis.

PROFESSIONAL COMPONENT:
Basic Science: 1 credit or 100%

COURSE OUTCOMES:
Upon completion of this course, students should demonstrate an ability to
1. Perform analytical separation and qualitative determination of selected compounds in a
mixture.
2. Understand the fundamental operation of spectrophotometers.
3. Identify sources of error in chemical experiments
4. Interpret experimental results and draw reasonable conclusions.
5. Practice laboratory safety procedures.
6. Learn the importance of following correct laboratory procedures.
7. Keep legible and complete experimental records in a bound notebook
8. Collaborate with peers in obtaining and interpreting data.
9. Analyze data in terms of precision and accuracy of results.
10. Understand the concept of standardization.
11. Understand the concept of calibration.
RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 332L, Analytical Chemistry Lab, meets part of ABET Criterion 3, outcome (a):
   (a) Ability to apply knowledge of mathematics, science, and engineering.

Prepared by:
Dan Heglund  Fall, 2003
CHEM 341 PHYSICAL CHEMISTRY FOR ENGINEERS
(Required Course)

CATALOG DATA:
CHEM 341 PHYSICAL CHEMISTRY FOR ENGINEERS I
(2-0) 2 credits. Prerequisite: CHE 222. Prerequisite or corequisite: PHYS213. Physical transformations of pure substances; simple mixtures and phase diagrams; chemical equilibrium and equilibrium electrochemistry. Duplicate credit for CHEM 341 and CHEM 342 not allowed.

TEXTBOOK:

INSTRUCTOR:
Jacek J. Swiatkiewicz CP 217 (394-6071)
Email: jacek.swiatkiewicz@sdsmt.edu

TOPICS:
- Properties of gases
- Laws of thermodynamics
- Thermochemistry
- Physical transformations
- Solutions and phase diagrams
- Chemical equilibrium
- Equilibrium electrochemistry

OBJECTIVES:
The course is divided into 3 modules designed to expose the students to concepts in thermodynamics, chemical and phase equilibrium and the application of thermodynamics to solids and solutions.

PROFESSIONAL COMPONENT:
Basic Science: 2 credits or 100%

COURSE OUTCOMES:
Upon completion of this course, students should demonstrate an ability to
(1) understand and apply proper physical and mathematical description to predict properties of the systems in relation to:
- one component phase diagrams, thermodynamic background of phase stability and transitions,
- thermodynamic description of mixtures,
- properties of solutions, standard conditions, activity,
- phases components and degrees of freedom,
- phase diagrams of two component systems,
- spontaneous chemical reactions, the response of chemical reaction equilibrium to external conditions,
• thermodynamic properties of ions in solutions,
• electrochemical cells, application of standard potentials,
(2) be able to solve numerical problems within the scope of the relevant material.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 341, Physical Chemistry for Engineers, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

Prepared by:
Jacek Sziatkiewicz           Fall, 2003
CHEM 343 PHYSICAL CHEMISTRY FOR ENGINEERS II
(Required Course)

CATALOG DATA:
CHEM 343 PHYSICAL CHEMISTRY FOR ENGINEERS II
(2-0) 2 credits. Prerequisites: PHYS 213 and CHEM 341 or CHEM 342. Kinetic theory of gases; statistical thermodynamics and properties of solids; chemical kinetics and kinetics at interfaces. Duplicate credit for CHEM 343 and CHEM 344 not allowed.

TEXTBOOK:

INSTRUCTOR:
Grant Merrill, C 123 (394-2431)
Email: grant.merrill@sdsmt.edu

TOPICS:
- Kinetic theory of gases;
- Statistical thermodynamics and properties of solids;
- Chemical kinetics and kinetics at interfaces
- Quantum mechanics and spectroscopy.

OBJECTIVES:
The course offers an introduction to both atomic and molecular quantum mechanics, statistical thermodynamics, kinetics and dynamics.

PROFESSIONAL COMPONENT:
Basic Science: 2 credits or 100%

COURSE OUTCOMES:

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 343, Physical Chemistry for Engineers II, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

Prepared by:
Grant Merrill Spring, 2004
CHEM 345 PHYSICAL CHEMISTRY I and II LAB
(Required Course)

CATALOG DATA:
CHEM 345 PHYSICAL CHEMISTRY I AND II LAB
(0-1) to (0-2) 1 to 2 credits. Prerequisites: CHEM 220 or CHEM 326L, CHEM 332L, and CHEM
341 or CHEM 342. Corequisite: CHEM 343 or CHEM 344. Experimental methods used in
modern physical chemistry. Spectroscopic, kinetic, thermostatic, and electrochemical techniques
are studied. Chemistry majors must register for two (2) credits; chemical engineering majors
register for one credit.

TEXTBOOK:
None

INSTRUCTOR:
Grant Merrill, C 123 (394-2431)
Email: grant.merrill@sdsmt.edu

TOPICS:
• Binary Phase Diagrams
• Viscosity
• Determination of $\Delta H_{fus}$ Using Freezing Point Depression
• Helmholtz Free Energy Measurements
• Heat of Reaction/Calorimetry
• DCS Characterization of Polymeric Systems/TGA Chemical Analysis
• Determination of an Equilibrium Constant
• Enzyme Kinetics and Catalysis
• NMR Lectures
• NMR Determination of Paramagnetic Susceptibility
• Computational Experiments

OBJECTIVES:
• The laboratory serves to reinforce the material present in the lecture.
• The laboratory provides the student with an opportunity to develop experimental
techniques and skills.

PROFESSIONAL COMPONENT:
Basic Science: 1 credit or 100%

COURSE OUTCOMES:

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
CHEM 345, Physical Chemistry I and II Lab, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

Prepared by:
Grant Merrill Spring, 2004
CHE 474/574 POLYMER TECHNOLOGY

(Catalog Course)

CATALOG DATA:

CHE 474/574 POLYMER TECHNOLOGY
2 to 3 credits.
Prerequisite: Senior standing or permission of instructor.
A study of the engineering aspects of polymer synthesis and reactor design, polymer testing, polymer
characterization, rheology, macro-properties, and fabrication. Students may enroll for two (2) or three (3)
credits, depending upon the particular level of course matter that matches their interest. Students taking two
(2) credits will take two-thirds of the course material. The instructor, in conjunction with the Department
Chair, will monitor student credit hours. Course is not repeatable for credit. Students enrolling in CHE 574
will be held to a higher standard than students enrolling in CHE 474.

TEXTBOOK:


INSTRUCTOR:

Robb Winter, 394-1237, room C220
Office Hours: TBA or by appointment (contact Ms. Embrock 394-2421) or by email
(robb.winter@sdsmt.edu)

EXPECTATIONS:

An understanding of fluid dynamics, heat transfer, mass transfer, chemical kinetics, numerical methods,
and differential equations.

COURSE OBJECTIVES:

This course is a study of the engineering aspects of the polymer synthesis, testing, characterization,
rheology, macro-properties and fabrication. The focus of this course will be applied engineering and is
designed for the person with no polymer background.

CLASS SCHEDULE:

MWF; 10:00-10:50 a.m.; C304

PROFESSIONAL COMPONENT:

Engineering Science: 1.5 – 2.25 credits or 75%
Engineering Design: 0.5 – 0.75 credit or 25%

TOPICS:

- Types of Polymers and Bonding in Polymers
- Polymer Structure and Morphology
- Molecular Weight, Solubility and Solutions, and Thermodynamics
- Chemical Reaction Kinetics and Reactor Design in Polymer Systems
- Applied Rheology
- Heat Transfer in Polymer Systems
- Structure-Property Relationships
- Processing and Fabrication
- Linear Viscoelasticity
- Nano- and Micro- Composites

COMPUTER USAGE:

Excel
Polymath or similar linear equation and aid solver
COURSE OUTCOMES:
After completion of this course the average student is expected to be able to:
1. Differentiate between a variety of common resin systems
2. Relate polymer structure to observed properties
3. Formulate and solve chemical reactor design expressions for polymeric systems
4. Formulate and solve heat transfer correlations as they relate to polymeric systems
5. Formulate and solve fluid dynamics/rheology expressions as they relate to polymeric systems
6. Identify suitable fabrication techniques for a given part design
7. Identify key controlling factors for part performance in polymeric composites and key parameters available to the engineer for optimization

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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<tr>
<th>Course Outcomes</th>
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*For a list of Program Objectives and Program Outcomes, please go to [http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396](http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396)

LABORATORY:
None

ASSESSMENT AND EVALUATION:
- Exams
- Projects
- Papers
- Homework

PREPARED BY:
Robb Winter, Fall 2003
CHE 484/584 FUNDAMENTALS OF BIOCHEMICAL ENGINEERING
(Elective Course)

CATALOG DATA:
CHE 484/584 FUNDAMENTALS OF BIOCHEMICAL ENGINEERING
(3-0) 3 credits.
Prerequisite: Senior standing, or permission of instructor.
An introduction to the characterization of microorganisms, fermentation pathways, unit processes in fermentation,
biochemical kinetics, and batch and continuous fermentation. The basic engineering concepts of fermentation,
separation, control, and operations will be discussed. Students enrolling in CHE 584 will be held to a higher
standard than those enrolling in CHE 484.

TEXTBOOK:
Biochemical Engineering by Harvey Blanch and Douglas Clark. Marcel Dekker 1997
Supplemental:
Brock Biology of Microorganisms, 9th edition by Michael Madigan, John Martinko, and Jack Parker, 2000, Prentice
Hall;
Microbiology by L. Prescott, J. Harley, and D. Klein. 1990, Wm.C. Brown

INSTRUCTOR:
Dr. Gilcrease
C306
394-1239
Patrick.Gilcrease@sdsmt.edu

EXPECTATIONS:
Students should have a working knowledge of chemical kinetics and reactor design, as applied to batch, plug flow,
and CSTR reactors. A fundamental knowledge of microbiology and biochemistry is desired but not required.

COURSE OBJECTIVES:
• Develop a basic understanding of biological principles, as needed for bioprocesses.
• Understand enzyme synthesis, structure and function. Learn the basic enzyme kinetic models, and be able to
experimentally derive their rate parameters.
• Understand the fundamentals of cell metabolism and growth. Examine basic expressions for cell growth
kinetics.
• Apply enzyme/cell kinetic expressions towards the modeling and design of various bioreactor systems.
• Examine mass transfer issues associated with substrate supply and/or product recovery.

CLASS SCHEDULE:
MWF 10:00-10:50 am

PROFESSIONAL COMPONENT:
Engineering Science: 2.67 credits or 80%
Engineering Design: 0.33 credit or 20%

TOPICS:
• Fundamentals of cell biology for procaryotes.
• Basic biochemistry.
• Properties of enzymes.
• Kinetics of enzyme catalyzed reactions.
• Basic genetics and protein synthesis.
• Basic cell metabolism.
• Metabolic regulation and control.
• Nutrient requirements for procaryotes.
- Measurement of cell concentrations.
- Kinetics of cell growth.
- Modeling of batch, CSTR, PFR, and fed-batch bioreactors.
- Immobilized enzymes and cells.
- Packed bed bioreactors.
- Oxygen transfer.
- Nutrient transfer in biofilms.
- Overview of downstream separations.

**COMPUTER USAGE:**
Students should have a working knowledge of Polymath and Excel.

**COURSE OUTCOMES:**
After completion of this course the average student is expected to be able to:
1. communicate with microbiologists and biochemists about the fundamental properties of microorganisms, enzymes, and other biological molecules
2. given a list of the fundamental characteristics of a microorganism, students will be able to design/control a fermentation environment such that desired products are produced.
3. apply chemical engineering material and energy balances towards the modeling of enzyme reactors/fermentors.
4. apply chemical engineering kinetics and reactor design principles to the design and optimization of various enzyme/microbial reactors/fermentors.
5. apply chemical engineering mass transfer principles to predict oxygen transfer rates as well as nutrient transport rates through biofilms.
6. be familiar with chemical engineering separation/purification processes that are particularly amenable to the recovery of biological products

**RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**
The following table indicates the relative strengths of each course outcome in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis):

<table>
<thead>
<tr>
<th>ChE 484/584</th>
<th>ChE Program Outcomes*</th>
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<td>Program Outcomes</td>
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**LABORATORY:**
None.

**ASSESSMENT AND EVALUATION:**
- Hour exams & Final exam
- Homework and computer projects
- Short Quizzes
- Homework and computer projects
- Semester papers (written and oral)

**PREPARED BY:**
Patrick Gilcrease, Spring 2004
Catalyst Data:
CHE 484L/584L BIOCHEMICAL ENGINEERING LABORATORY
(0-1) 1 credit.
Corequisite: CHE 484/584.
Laboratory experiments in biochemical engineering. May include fermentation, dissolved oxygen mass
transfer measurements, bioseparations, and other experiments to correlate with selected lecture topics.
Students enrolling in CHE 585L will be held to a higher standard than those enrolling in CHE 485L.

Textbook:
Biochemical Engineering by Blanch and Clark
Supplemental:
Microbiology by L. Prescott, J. Harley, and D. Klein. 1990, Wm.C. Brown

Instructor:
Dr. Gilcrease
C306
394-1239
Patrick.Gilcrease@sdsmt.edu

Expectations:
Aseptic laboratory skills for the culturing of microorganisms is desired but not required. Students should
have practical skills in experimental design, troubleshooting, data analysis, and data interpretation.
Students should be proficient in preparing the proper oral and written reports.

Course Objectives:
- Learn basic skills for setting up a microbial fermentation: medium preparation, vessel preparation,
inoculum preparation, and proper aseptic techniques.
- Learn to setup and run instrumentation and control systems for benchtop fermentors. Use data logging
from these systems to troubleshoot and interpret the fermentation
- Learn basic techniques for quantitative analysis of fermentations, including optical density, dry
weight/protein analysis, glucose analysis, and analysis of metabolic products.
- Measure and predict oxygen transfer rates in aerobic fermentations.
- Use all of these skills to interpret and improve a real bench-scale microbial fermentation.

Class Schedule:
Thursday, 8-10AM, C304

Professional Component:
Engineering Science: 1.0 credit or 100%
Engineering Design: 0.0 credit or 0%

Topics:
Laboratory fermentations: All groups will run the same fermentation (ethanol fermentation) as a training
project to learn techniques and equipment. Individual groups may then select one of the following
fermentations for their second project:
- Biocatalysis of polymer precursors/indigo using a recombinant E. coli expressing monoxygenase
  enzymes.
- Sulfate reduction in a continuous stirred tank reactor (chemostat) via an alkaliphilic consortium.
- Lysine production with Corynbacterium glutamicum
- Bioreduction of TNT solids with Pseudomonas fluorescens
• Other systems with instructor consent.

**Computer Usage:**
Students should be able to use Excel for tabulation, manipulation, and graphing of experimental data.

**Course Outcomes:**
After completion of this course the average student is expected to be able to:
1) culture and transfer pure microbial cultures without contamination (proper sterilization and aseptic technique).
2) set up and prepare a bench scale fermentor (medium preparation, inoculum preparation, and instrumentation calibration/setup).
3) sample and control a bench scale fermentation.
4) properly analyze and interpret fermentation data, for the purpose of optimizing fermentation rates/yields.

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strengths of each course outcome in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis):

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**Laboratory:**
List of experiments:
• Yeast fermentation with ethanol
• Lysine production with Corynebacterium glutamicum
• Foreign protein production with a recombinant E.coli
• Measurement of Michaelis-menten kinetic parameters for an enzyme catalyzed reaction

**Assessment and Evaluation:**
• Ethanol oral reports
• Project oral reports
• Project written reports
• Prelab planning and participation

**Prepared By:**
Patrick Gilcrease, Spring 2004
CHE 492 TOPICS
(Elective Course)

CATALOG DATA:
CHE 492 TOPICS (CHE 492 / CHEM 492 ORGANOSILICON POLYMER CHEMISTRY & TECHNOLOGY)
1 to 3 credits.
Prerequisite: Permission of instructor.
Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of six (6) credits of special topics will be allowed for degree credit.

TEXTBOOK:
Course notes provided

INSTRUCTOR:
Mr. Byron E. Wolf
Adjunct Instructor, SDSM&T
Sr. Product Stewardship Specialist
Electronics & Advanced Technologies Industry
Advanced Technologies & Venture Business
Dow Corning Corporation

EXPECTATIONS:
Students entering this course are expected to have had formal instruction and abilities in the following areas:
• organic chemistry
• general laboratory / safety skills

COURSE OBJECTIVES:
Knowledge the average student should have after taking this course:
• to have a general knowledge or basic organosilicon chemistry and technology.

CLASS SCHEDULE:
Class and lab sessions will be held evenings during the week of February 2 – February 6, 2004. Tentatively, lectures starting 4pm until 6pm. Labs on Tu & Th evenings after lecture.

PROFESSIONAL COMPONENT:
Engineering Science: 1-3 credits or 100%
Engineering Design: 0 credit

TOPICS:
• History and Nomenclature of Si
• Bonding and Stereochemistry of Si
• Chemicals and Monomers
• Routes of Polymerization
• Fluids and Chemicals
• Resins
• Elastomers
• Cure Mechanisms
• Reinforcement
• Medical Applications
COMPUTER USAGE:
As needed for data analysis

COURSE OUTCOMES:
Average students completing the course should have the ability to:
- demonstrate basic knowledge of organosilicon chemistry nomenclature
- demonstrate basic knowledge of organosilicon reaction chemistry
- demonstrate basic knowledge of organosilicon laboratory reactions

RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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<tr>
<th>Chem/ChE 492</th>
<th>Objective 1</th>
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<td>Program Outcomes (1)</td>
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*For a list of Program Objectives and Program Outcomes, please go to [http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396](http://www.hpcnet.org/cgi-bin/global/a_bus_card.cgi?SiteID=403396)

LABORATORY:
Basic organosilicon reactions

ASSESSMENT AND EVALUATION:
- lab projects
- course examinations

PREPARED BY:
Byron Wolf, Spring 2004
CHE 492 Topics
(Elective Course)

CATALOG DATA:
CHE 492 TOPICS (CHE 492/692 Statistics and DOE for the Chemical Industry)
1 to 3 credits.
Prerequisite: Permission of instructor.
Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a specified field.
Course content is not wholly included in the regular curriculum. Guest artists or experts may serve as instructors.
Enrollments are usually 10 or fewer students with significant one-on-one student/teacher involvement. A maximum of six (6) credits of special topics will be allowed for degree credit.

TEXTBOOK:
Course notes will be provided during the on-site class.

INSTRUCTOR:
D. J. Dixon (coordinator) C-218, 394-1235 (w), 716-2932 (h), david.dixon@sdsmt.edu
S. S. Smith (instructor) stanley.smith@sdsmt.edu
Mr. Mark Anderson, Stat-Ease, Principal (instructor), Mark@StatEase.com
Mr. Patrick Whitcomb, Stat-Ease, President (instructor)

EXPECTATIONS:
Students entering this course are expected to know:
• the use of MS Windows, spreadsheet, general computer literacy
• simple statistics; average, standard deviation, normal distribution
• basic mathematics; use of formulas, algebra

COURSE OBJECTIVES:
(Knowledge the average student should have after taking this course)
• To apply concepts of statistics and design of experiments to chemical engineering problems; to set up and conduct experiments, for product development, or for process trials. Includes analysis of results of the experimental design.

CLASS SCHEDULE:
The schedule for this class is a little different, to accommodate the industrial instructors. It is arranged in four parts as follows:
Statistics Self-Assessment Test (~45 minutes of effort) This is done online. Details to be announced.
PreDOE – Basic Statistics (~12 hours of effort, including homework) This section of the course is designed to provide (or refresh) fundamental statistical skills needed for the next section.
On-Campus Experiment Design Made Easy (~30 hours) This class will be held on the campus and taught by Mr. Mark Anderson and Mr. Patrick Whitcomb from Stat Ease. Mr. Whitcomb has a BS and MS ChE. He worked for General Mills prior to founding Stat Ease. Mr. Anderson has a BS ChE and an MBA. He also worked for General Mills prior to joining Stat Ease. (see www.statease.com for more information). Location: CB 116
Meeting Times: 19-20 March 2004 (Fr 5-8pm; Sat 8-4pm) (refreshments provided); 2-3 April 2004 (Fr 5-8pm; Sat 8-4pm) (refreshments provided); 23-24 April 2004 (Fr 5-8pm; Sat 8-4pm) (refreshments provided); (all times are approximate)
Design of Experiment Project (~3 hours of effort) The details of this project will be announced later, but the project will be a team effort and incorporate materials presented in the on-campus portion of the course. It will be designed to reinforce (and give practice in) the skills learned in the class.

PROFESSIONAL COMPONENT:
Engineering Science: 2 credits or 100%
Engineering Design: 0 credit

TOPICS:
• Descriptive Statistics
• Z Charts
• T-Testing
- Hypothesis Testing
- Linear Regression
- ANOVA
- Statistical Design of Experiments
- DOE Software

**Computer Usage:**
- Math CAD
- Excel
- Design Expert 6.0

**Course Outcomes:**
After completion of this course the average student is expected to be able to:
1. Use and understand basic statistics
2. Apply hypothesis testing to data
3. Randomize, replicate and block out error
4. Perform simple comparative experiments
5. Interpret analysis of variance (ANOVA)
6. Discover hidden interactions
7. Exploit efficient fractional designs
8. Screen variables to find the vital few
9. Determine when to use transformations
10. Explore categorical factors with general factorials

**Relation of Course Outcomes to Program Outcomes:**
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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**Laboratory:**
None

**Assessment and Evaluation:**
- Homework
- Team Project

**Prepared By:**
David Dixon, Spring 2004
CHE 492 TOPICS
(Elective Course)

CATALOG DATA:
CHE 492 TOPICS (CHE 492/692 COMBUSTION OF SOLID FUELS)
1 to 3 credits.
Prerequisite: Permission of instructor.
Includes current topics, advanced topics and special topics. A course devoted to a particular issue in a
specified field. Course content is not wholly included in the regular curriculum. Guest artists or experts
may serve as instructors. Enrollments are usually 10 or fewer students with significant one-on-one
student/teacher involvement. A maximum of six (6) credits of special topics will be allowed for degree
credit.

TEXTBOOK:
Reference Texts: Steam/ its generation and use, Babcock & Wilcox, (multiple years). Combustion
Engineering, Otto de Lorenzi, ed., (multiple years).

INSTRUCTOR:
Dr. James M. Munro
Phone: 394-2422
E-mail: james.munro@sdsmt.edu
Office: C-227
Official Office hours: Mon., Wed., Fri. 3:00-4:00 p.m.
Unofficial: I have an open door policy and will often be able to see you at other times. Feel free to knock
on my office door if closed, as I may be available. For appointments outside of office hours please email
me or contact me in my office.

EXPECTATIONS:
Students entering this course are expected to have had formal instruction and abilities in the following
areas:
• Mass and energy balances
• Thermodynamics
• Heat transfer
• Stoichiometry

COURSE OBJECTIVES:
• To gain fundamental and practical knowledge in the field of solid fuel combustion.
• To provide students experiences of plant visits to solid fuel combustion facilities.

CLASS SCHEDULE:
C-304, Thursdays, 1:00-1:50 p.m.

PROFESSIONAL COMPONENT:
Engineering Science: 0.5 credit or 50%
Engineering Design: 0.5 credit or 50%

TOPICS:
• Characterization of fuels
• Combustion equipment
• Mass and energy balances
• Field trips
• Design projects
**COMPUTER USAGE:**
Students create Excel spread sheets for combustion mass and energy balances

**COURSE OUTCOMES:**
Students completing the course will have the ability to:
1. Identify the components of a solid fuel combustion facility.
2. Perform mass and energy balances around a combustion process.
3. Calculate stoichiometric air, and exhaust gas compositions and flow rates for a solid fuel combustor.
4. Describe, qualitatively and quantitatively, environmental concerns and pollutant emissions from a combustion process.
5. Design a solid fuel combustion process utilizing multiple fuels.
6. Identify and discuss current issues related to combustion processes for energy production.

**RELATION OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**
The following table indicates the relative strengths of each course outcomes in addressing the program outcomes (on a scale of 1 to 4 where 4 indicates a strong emphasis).

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**LABORATORY:**
None

**ASSESSMENT AND EVALUATION:**
- Homework Problems
- Exams
- Term Project
- Trip Reports

**PREPARED BY:**
James M. Munro, Spring 2004
ENG 101 COMPOSITION I
(Required Course)

CATALOG DATA:
ENGL 101 COMPOSITION I
(3-0) 3 credits. Appropriate student placement based on entry level assessment or completion of (or concurrent enrollment in) ENGL 031, 032, or 033. Practice in the skills, research, and documentation needed for effective academic writing. Analysis of a variety of academic and non-academic texts, rhetorical structures, critical thinking, and audience will be included.

TEXTBOOK:
Mims and Nollen, Mirror on America: Short Essays and Images, 2nd Edition
Raimes, Keys for Writers, third edition.

INSTRUCTOR:
Palmer, Morgan, Antonen, and Neumann
Humanities office phone: 394-1243. Leave a message if no one answers.

EXPECTATIONS:
None

COURSE OBJECTIVES:
At the conclusion of English 101, students should be able to:
• understand the basic principles of organization and development necessary to write an essay
• understanding writing as a process that requires analysis, interpretation, drafting and revision
• master basics of expository prose and use of rhetorical strategies to write effectively and critically for a variety of audiences
• know techniques of basic research in order to communicate knowledge and ideas professionally and ethically of the composition, structure, and properties of matter and the changes that matter undergoes.

PROFESSIONAL COMPONENT:
English: 3 credits or 100%

TOPICS:
• Critical Reading
• Argumentation
• Logical Fallacies
• Peer Review
• Brainstorming, Freewriting
• Titles, Topic Sentences, Thesis Statements
• Using & Citing Sources
• Textual Analysis
• Using the Library
• Research Writing, MLA Style
• Documentation
• Sentences, Punctuation, Analyzing Texts
• Portfolio Consultations

COMPUTER USAGE:
Word Processing
COURSE OUTCOMES:
In English 101 students will demonstrate effective communication by:
- designing and producing writing adapted to various audiences and purposes
- composing clear, effective sentences and combining them into focused, coherent paragraphs that support the purpose of their essays
- using basic research skills and appropriate documentation of sources
- exhibiting awareness of ethical standards by accurately using sources and formulating text
- practicing a prose style based on conciseness, clarity, and fluency
- using standard English grammar, punctuation, and other mechanical aspects

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
ENGL 101, Composition I, meets part of ABET Criterion 3, outcome (g):
(g) Ability to communicate effectively.

LABORATORY:
None

ASSESSMENT AND EVALUATION:
- Papers
- Quizzes & Assignments
- Oral Presentation
- Portfolio

PREPARED BY:
Sally Palmer, Spring 2004
ENG 279 TECHNICAL COMMUNICATIONS I
(Required Course)

CATALOG DATA:
ENGL 279 TECHNICAL COMMUNICATIONS I
(3-0) 3 credits. Prerequisites: ENGL 101 or equivalent and sophomore standing. Introductory written and oral technical communications with emphasis on research and explanations of scientific and engineering topics.

TEXTBOOK:
Companion Website to text: http://www.ablongman.com/lannontechcomm

Class WebCT Site: http://webct.sdsmt.edu:8900/

Other Materials: Computer disk for storing writing & videotape for recording speeches

INSTRUCTORS:
Sneller, Hudgens, Palmer, and Boysen,
Humanities office phone: 394-1243. Leave a message if no one answers.

EXPECTATIONS:
Students will have completed English 101, or equivalency.

COURSE OBJECTIVES:
At the conclusion of English 279, students should be able to
• understand the principles of organization and development that are required to produce a variety of short, basic technical documents,
• understand technical writing as a process requiring analysis, interpretation of data, drafting and revision;
• understand the basic components of planning and preparing effective oral presentation of technical and professional material;
• conduct basic technical research using both traditional and electronic methods to communicate in an ethical manner; and
• improve communication and problem solving skills by working on speaking and writing projects in teams.

PROFESSIONAL COMPONENT:
English: 3 credits or 100%

TOPICS:
• What is “technical communication” and what does it entail?
• Audience Analysis
• The “How To’s” of speaking in public
• “Students Take Charge” presentations
• Peer Review
• Summary Writing
• Research / Identifying Sources
• Ethics and/or technical communication
• Visual Aids
• Job Search
• Resumes
• Definitions & Descriptions
• Persuasive Speaking
COMPUTER USAGE:
- Word Processing
- PowerPoint

COURSE OUTCOMES:
Students will demonstrate effective technical communication by
- producing well organized and effectively designed short, basic technical documents;
- employing drafting, revision, and analytical skills to take a document from initial conception to final product;
- producing individual and collaborative documents and oral presentations for a variety of technical, professional, and general audiences;
- recognizing and using appropriate conventional formats and visuals for a variety of basic technical/professional documents;
- the basic research skills and documentation techniques necessary to produce effective written and oral technical communications;
- exhibiting awareness of ethical standards by accurately using sources and formulating text; and
- practicing a technical communication style based on conciseness, clarity, fluency; and using standard English grammar, punctuation, and other mechanical aspects.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
ENGL 279, Technical Communication I, meets part of ABET Criterion 3, outcome (d), (f), (g):
(d) Ability to function on multi-disciplinary teams
(f) Understanding of professional and ethical responsibility
(g) Ability to communicate effectively

LABORATORY:
None

ASSESSMENT AND EVALUATION:
- Formal writing assignments
- Formal speeches
- Quizzes
- Attendance & participation

PREPARED BY:
Judy Sneller, Spring 2004
ENG 289/289L TECHNICAL COMMUNICATIONS II
(Required Course)

CATALOG DATA:
ENGL 289/289L TECHNICAL COMMUNICATIONS II
(2-1) 3 credits. Prerequisites: ENGL 279 or equivalent and sophomore standing. Advanced written and oral
technical communications with emphasis on the research, preparation, and delivery of complex technical
documents.

TEXTBOOK:
Savage, Gerald J. and Dale L. Sullivan. Writing a Professional Life: Stories of Technical Communicators
On and Off the Job.

INSTRUCTORS:
Rice, Boysen, Lee, Westergaard, and Antonen
Humanities office phone: 394-1243. Leave a message if no one answers.

EXPECTATIONS:
Students will have completed ENGL 279 or equivalent.

COURSE OBJECTIVES:
At the conclusion of English 289, students should be able to
• Understand the advanced principles of organization and development that are required to produce
different types of complex technical documents,
• Understand technical writing as a process requiring analysis, interpretation of data, drafting and
revision;
• Understand the advanced principles of planning and preparing effective oral presentations of
technical and professional material;
• Conduct advanced technical research using a variety of traditional and electronic methods to
communicate in an ethical manner;
• Improve communication and problem solving skills by working on speaking and writing projects
in teams; and
• Use writing, speaking, researching, and networking skills to compete effectively in the job market.

PROFESSIONAL COMPONENT:
English: 3 credits or 100%

TOPICS:
• Elements of the proposal
• Formal reports: preliminary guidelines
• Style review
• Style: clarity
• Style: conciseness
• Summaries and abstracts
• Writing evaluations
• Proposal briefing
• Communication issues in professional writing
• Communication issues workshop
• Team communication problems
• Peer review
• Oral presentations
Computer Usage:
- Word Processing
- PowerPoint

Course Outcomes:
In English 289 students will demonstrate effective technical communication by:
- Producing well organized and effectively designed complex technical documents;
- Producing well organized and effectively designed resumes and other job application documents;
- Employing drafting, revision, and analytical skills to take a document from initial conception to final product;
- Producing individual and collaborative documents and oral presentations for a variety of technical, professional, and general audiences;
- Recognizing and using appropriate formats and elements of document design applicable to a variety of complex technical documents;
- Using appropriate, effective graphics in speaking and writing projects;
- Using the advanced research skills and documentation techniques necessary to produce effective written and oral technical communications;
- Exhibiting awareness of ethical standards by accurately using sources and formulating text;
- Adopting a technical communication style based on conciseness, clarity, fluency, and consistency;
- Using standard English grammar, punctuation, and other mechanical aspects.

Relationship of Course to Program Outcomes:
ENGL 289289L, Technical Communication II, meets part of ABET Criterion 3, outcome (d), (f), (g):

(d) Ability to function on multi-disciplinary teams
(f) Understanding of professional and ethical responsibility
(g) Ability to communicate effectively

Laboratory:
None

Assessment and Evaluation:
- Written Assignments
- Presentations
- Attendance & Participation

Prepared By:
Rodney Rice, Spring 2004
MATH 123 Calculus I
(Required Course)

CATALOG DATA:
MATH 123 CALCULUS I
(4-0) 4 credits. Prerequisite: MATH 115 or appropriate mathematics placement or permission of instructor. Prerequisite: MATH 115 completed with a minimum grade of “C.” The study of limits, continuity, derivatives, applications of the derivative, antiderivatives, the definite and indefinite integral, and the fundamental theorem of calculus.

Prerequisite: Pre-calculus.

INSTRUCTORS:
Math office phone: 394-2471. Leave a message if no one answers.

TEXT:
Calculus 2nd edition Smith and Minton.

TOPICS:
1) Functions
2) Limits and continuity
3) Derivatives of polynomial and trigonometric functions
4) Derivatives of logarithmic and exponential functions
5) Applications of derivatives
   i) Curve sketching
   ii) Related rates
   iii) Newton’s method
   iv) Velocity and acceleration
6) Applications of derivatives
   i) Optimization
7) Antiderivatives
8) Integration using u-substitution
9) Topics for Exam 4
10) Definite integrals
11) Applications of integration
    i) Area
    ii) Volume using disks, shells, and washers

COURSE OBJECTIVE:
This course is intended for students majoring in mathematics, physics, chemistry, engineering and related fields. Students will apply the concepts of limits, derivatives and integrals in solving problems in their respective disciplines. They will be able to identify, graph, integrate, and differentiate polynomial, trigonometric, logarithmic, exponential and algebraic functions.
PROFESSIONAL COMPONENT:
Mathematics  4 credits or 100%

OUTCOMES.
A student who successfully completes this should, at a minimum, be able to:

1. Understand functions.
2. Be able to use functional notation in manipulating mathematical expressions.
3. Understand the concept of a limit and how it applies to calculus.
4. Be able to compute limits using various methods.
5. Be able to determine where a function is continuous.
6. Understand the concept of the derivative.
7. Be able to compute derivatives using the power rule, product rule, quotient rule and chain rule.
8. Be able to use the concept of the derivatives in applications such as related rates, linear approximations, Newton’s Method, curve sketching, optimization, velocity and acceleration.
9. Understand the concept of an antiderivative.
10. Be able to manipulate expressions using sigma notation.
11. Be able to integrate using substitution and the power rule.
12. Understand and be able to apply the Fundamental Theorem of Calculus.
13. Be able to use the concept of the integral in applications such as area, volume, velocity and acceleration.
14. Understand the use of numerical integration techniques such as Trapezoidal and Simpson’s rules.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
MATH 123, Calculus I, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

PREPARED BY:  Laura Geary and Arden Davis  May, 2004
MATH 125 Calculus II
(Required Course)

CATALOG DATA:
MATH 125 CALCULUS II
(4-0) 4 credits. Prerequisite: MATH 120 completed with a minimum grade of "C" or appropriate score on departmental Trigonometry Placement Examination and MATH 123 completed with a minimum grade of "C." A continuation of the study of calculus, including the study of sequences, series, polar coordinates, parametric equations, techniques of integration, applications of integration, indeterminate forms, and improper integrals.

Prerequisite: Calculus I.

INSTRUCTORS:
Math office phone: 394-2471. Leave a message if no one answers.

TEXT:
Calculus (Smith, Minton 2nd ed.) We will cover Chapters 5-9.

OBJECTIVES:
1) The student will continue to learn differentiation and integration techniques, building on the skills learned in Calculus I.
2) The student will learn basic concepts dealing with infinite sequences and series.
3) The student will learn how to work with parametric equations and polar coordinates.

TOPICS:
1. Further applications of the definite integral
   a. Arc length
   b. Surface area
   c. Work
   d. Moments and center of mass
2. Properties of logarithms, exponentials, trig and inverse trig functions Derivatives and antiderivatives
   of exponential, logarithms, trig and inverse trig functions.
3. Evaluation of antiderivatives using:
   a. Trig integrals
   b. Trig substitutions
   c. Parts
   d. Partial fractions
4. L'Hospital's rule and improper integrals
5. Infinite series and convergence using:
   a. Definition
   b. Integral test
   c. Ratio test
   d. Comparison test
e. n Th term test
f. Alternating series, conditional and absolute convergence

6. Interval of convergence of power series
7. Taylor series expansions
8. Fourier series expansions
9. Parametric and polar graphs and equations, derivatives and integrals

PROFESSIONAL COMPONENT:
Mathematics  4 credits or 100%

OUTCOMES:
A student who successfully completes this course should, at a minimum:

1. Know how to differentiate exponential and logarithmic functions and integrate the corresponding functions.
2. Know how to differentiate inverse trigonometric functions and integrate the corresponding functions.
3. Know how and when to use various integration techniques, including integration by parts and partial fractions.
4. Know how to evaluate limits of infinite sequences, including how and when to use L’Hopital’s Rule.
5. Know how to evaluate improper integrals.
6. Recognize common infinite series, including the geometric and harmonic series.
7. Know how and when to use various tests for convergence of infinite series, including the Ratio Test, the Alternating Series Test, and Comparison Tests.
8. Know how to determine the interval of convergence for a power series.
9. Know how to use infinite series such as the Taylor Series or Fourier Series to approximate functions.
10. Know how to convert between rectangular and parametric form, graph parametric curves, find derivatives, and do other calculus applications using parametric functions.
11. Know how to convert between rectangular and polar coordinates, graph polar curves, and do calculus applications using polar coordinates.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
MATH 125, Calculus II, meets part of ABET Criterion 3, outcome (a):
  (a) Ability to apply knowledge of mathematics, science, and engineering.

PREPARED BY:  Don Teets, Harold Carda, and Arden Davis  May, 2004
MATH 225 Calculus III
(Required Course)

CATALOG DATA:
MATH 225 CALCULUS III
(4-0) 4 credits. Prerequisite: MATH 125 completed with a grade of “C.” A continuation of the study of calculus, including an introduction to vectors, vector calculus, partial derivatives, and multiple integrals.

Prerequisite: Calculus II.

INSTRUCTORS:
Teets, Burgoyne, Carda, Dahl, and Riley.
Math office phone: 394-2471. Leave a message if no one answers.

TEXT:
Calculus (Smith, Minton 2nd ed.) We will cover Chapters 10-14 with some omissions.

TOPICS:
• Vector and vector functions.
• Functions of several variables.
• Partial derivatives.
• Multiple and line integrals.
• Vector analysis.

OBJECTIVES:
1) The student will learn the basic tools and methods of multivariate calculus.
2) The student will understand applications of multivariate calculus.

PROFESSIONAL COMPONENT:
Mathematics: 4 credits or 100%

OUTCOMES:
A student who successfully completes this course should, at a minimum:
1. Know basic vector operations.
2. Know how to work with lines and planes in space.
4. Be able to compute position, velocity, and acceleration vectors.
5. Understand functions of several variables.
6. Be able to compute partial derivatives and gradients using multivariate chain rules
7. Be able to find extremals of constrained and unconstrained functions.
8. Understand iterated integrals.
9. Be able to set up and evaluate double and triple integrals in various coordinate systems.
10. Understand field vectors.
11. Be able to compute line integrals.
12. Understand the basic integral theorems of vector analysis.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
MATH 225, Calculus III, meets part of ABET Criterion 3, outcome (a):
   (a) Ability to apply knowledge of mathematics, science, and engineering.

PREPARED BY:  Don Teets, Kyle Riley, and Arden Davis       May, 2004
MATH 321 Differential Equations
(Required Course)

CATALOG DATA:
MATH 321 DIFFERENTIAL EQUATIONS
(4-0) 4 credits Prerequisites: MATH 125 with a minimum grade of "C." Selected topics from ordinary differential equations including development and applications of first order, higher order linear and systems of linear equations, general solutions and solutions to initial-value problems using matrices. Additional topics may include Laplace transforms and power series solutions. MATH 225 and 321 may be taken concurrently or in either order. In addition to analytical methods this course will also provide an introduction to numerical solution techniques.

Prerequisite: Calculus II.

INSTRUCTORS:
Geary, Burgoyne, Carda, and Dahl
Math office phone: 394-2471. Leave a message if no one answers.

TEXT:

TOPICS:
1) Basic definitions and terminology
2) Direction fields and solution curves
3) First order differential equations and their applications
   a) Separable
   b) Linear
   c) Exact
   d) Bernoulli
   e) Numerical Methods
4) Higher order differential equations...homogeneous and nonhomogeneous
5) Method of undetermined coefficients
6) Method of variation of parameters
7) Applications of higher order differential equations
   a) Simple harmonic motion
   b) Damped motion
   c) Forced motion
   d) Electric circuits and analogous systems
8) Basic Laplace transforms and their inverses
9) Laplace transforms
10) Inverse Laplace transforms
11) Operational Properties
12) Applications
13) Systems of linear first order equations
14) Matrices
15) Gauss elimination
16) Systems of ordinary differential equations
17) Eigenvalues
18) Variation of parameters
PROFESSIONAL COMPONENT:
Mathematics   4 credits or 100%

COURSE OBJECTIVES:

1) The student will learn how to apply basic techniques to solve ordinary differential equations.
2) The student will understand how to determine whether a function is a solution to a given ordinary differential equation or initial value problem.

STUDENT OUTCOMES:

A student who successfully completes this should, at a minimum, be able to:

1) Know how to use separation of variables.
2) Be able to solve first order ordinary differential equations.
3) Be able to solve second order linear ordinary differential equations.
4) Understand the difference between homogeneous and non-homogeneous linear systems.
5) Be familiar with at least one science or engineering application of differential equations.
6) Be able to compute the Laplace transform and inverse Laplace transform for simple functions.
7) Understand the basic process of how to use the Laplace transform to solve an initial value problem.
8) Be familiar with a numerical technique for solving an initial value problem, such as Euler’s Method or the Runge Kutta method.
9) Be able to carry out basic matrix addition and matrix multiplication.
10) Be able to solve a linear system in matrix form.
11) Be able to use matrices to solve simple linear first order systems of ordinary differential equations.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
MATH 321, Differential Equations, meets part of ABET Criterion 3, outcome (a):
   (a) Ability to apply knowledge of mathematics, science, and engineering.

PREPARED BY:   Laura Geary and Arden Davis      May, 2004
PHYS 211/211A UNIVERSITY PHYSICS I
(Required Course)

CATALOG DATA:
PHYS 211/211A UNIVERSITY PHYSICS I
(3-0) 3 credits. Prerequisite: MATH 123 or permission of instructor. This is the first course in a two (2)
semester calculus-level sequence, covering fundamental concepts of physics. This is the preferred sequence
for students majoring in physical science or engineering. Topics include classical mechanics and
thermodynamics. Credit will not be allowed in both Phys 111-113 and Phys 211-213

TEXTBOOK:
University Physics by Halliday and Resnick

INSTRUCTOR:
Dr. M. Foygel, EEP 219 (394-1227)
E-mail: michael.foygel@sdsmt.edu
Office Hours: 2:00 – 4:00 p.m. MW

EXPECTATIONS:
Students are expected to have a fundamental understanding of:
• Areas and volumes of simple geometric figures (example: circle, triangle, cylinder and sphere).
• Pythagorean Theorem.
• Solution of quadratic equations.
• Solution of simultaneous linear equations.
• Finding x and y components of a given vector.
• Find the magnitude and direction of a vector from the x and y component.
• Vector addition and subtraction.
• Scalar and vector products of two vectors.
• Integration and differentiation of linear equations.
Generally, most material from algebra, geometry, trigonometry, and calculus should be known thoroughly.

COURSE OBJECTIVES:
1. To present the basic concepts and principles of mechanics;
2. To strengthen an understanding of the concepts and principles through a broad range of interesting
applications in the real world.

To meet these objectives, emphasis is placed on sound physical arguments and problem-solving
methodology.

CLASS SCHEDULE:
C-228 Monday & Wednesday, 11:00 – 11:50 a.m.

PROFESSIONAL COMPONENT:
Basic Science: 3 credits or 100%

TOPICS:
The basic physical principles of Newton's laws of motion.
The conservation laws concerning momentum, energy and angular momentum are applied to the linear and
curvilinear motion of particles, simple harmonic motion and the rotation of rigid bodies.

COMPUTER USAGE:
None

COURSE OUTCOMES:
Upon completion of this course, students should demonstrate the ability to:
1. Use SI units and convert units from one system to another.
2. Perform basic operations on vectors such as adding and subtracting vectors geometrically and by components in the unit-vector notation; converting components into polar coordinates; multiplying a vector by a scalar and performing the dot and cross multiplication of vectors.
3. Given a position vector of a particle calculate its displacement, average and instantaneous velocity and acceleration; describe projectile motion and uniform circular motion; relate velocities in different frames of reference.
4. Use the free-body diagrams in solving dynamics problems; apply Newton’s laws to a system of several interacting bodies in order to find their accelerations.
5. Calculate work done by a constant or general variable force; calculate power given the force and instant velocity; use the work-energy theorem to relate a change in kinetic energy to the net work done on a system.
6. Calculate gravitational and elastic potential energy; apply energy conservation principle to systems involving gravity, springs, and friction.
7. Find the center of mass of a system of several particles; apply Newton’s second law to a system of particles in order to relate the net external force and the acceleration of the system’s center of mass.
8. Use conservation of linear momentum and of energy to relate velocities of colliding bodies before and after collision for the cases of elastic and purely inelastic collisions in one and two dimensions.
9. Calculate angular displacement, velocity and acceleration; relate angular and linear variables; calculate rotational kinetic energy; use the parallel-axis theorem to find the rotational inertia of a body; calculate torque; apply the Newton’s second law in angular form to relate the net torque and the angular acceleration.

RELATIONSHIP OF COURSE TO PROGRAM OUTCOMES:
PHYS 211/211A University Physics I, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

LABORATORY:
None

ASSESSMENT AND EVALUATION:
Quizzes
Homework
Special Projects
Exams

PREPARED BY:
Michael Foygel, Fall 2003
PHYS 213/213A UNIVERSITY PHYSICS II
(Required Course)

CATALOG DATA:
PHYS 213/213A UNIVERSITY PHYSICS II
(3-0) 3 credits. Prerequisite: PHYS 211. This course is the second course in a two (2) semester calculus-level
sequence, covering fundamental concepts of physics. This is the preferred sequence for students majoring in
physical science or engineering. Topics include electricity and magnetism, sound, light, and optics.

TEXTBOOK:

INSTRUCTOR:
Dr. Vladimir Sobolev, EEP 220 (394-1225)
E-mail: vladimir.sobolev@sdsmt.edu
Office Hours: open

EXPECTATIONS:
Students are expected to have a fundamental understanding of:
- Areas and volumes of simple geometric figures (example: circle, triangle, cylinder and sphere).
- Pythagorean Theorem.
- Solution of quadratic equations.
- Solution of simultaneous linear equations.
- Finding x and y components of a given vector.
- Find the magnitude and direction of a vector from the x and y component.
- Vector addition and subtraction.
- Scalar and vector products of two vectors.
- Integration and differentiation of linear equations.
- Knowledge of polar coordinate systems and its relation to Cartesian coordinate system.
- Ability to calculate indefinite and definite integrals of power and rational functions, and ability to
  use table of integrals.

Generally, most material from algebra, geometry, trigonometry, and calculus should be known thoroughly.

COURSE OBJECTIVES:
As a result of this course students will be familiar with basic terminology, processes and fundamental laws in
electricity and magnetism. Students will have an understanding of how the mathematical techniques of
complex numbers, vector analysis, differentiation and integration can assist in formulating and solving
physical problems and will then be able to use these techniques when studying other more-advanced courses
in Physics. Student will have also further developed generic problem-solving skills, and scientific world-
view.

CLASS SCHEDULE:
EP 252 Monday & Wednesday, 11:00 – 11:50 a.m.

PROFESSIONAL COMPONENT:
Basic Science: 3 credits or 100%

TOPICS:
- Electric Charge
- Electric Fields
- Gauss’ Law
- Electric Potential
- Capacitance
- Current and Resistance
- Circuits
• Magnetic Fields
• Magnetic Fields Due to Currents
• Induction and Inductance
• Magnetism of Matter; Maxwell’s Equations
• Electromagnetic Oscillations and Alternating Current

**Computer Usage:**
None

**Course Outcomes:**
Upon completion of this course, students should demonstrate the ability to:
• **use SI units for electric and magnetic physical quantities; know non-system units used in electricity and magnetism;**
• understand the basic concepts and laws of classical electrostatics and electrodynamics;
• quantitatively describe the forces between point charges; know major application of electrostatics and electrodynamics in modern technology;
• calculate the electric fields and electric potentials due to point charges and simple continuous charge distributions;
• understand the notions of capacitance and resistance, to find equivalent capacitances and resistances for capacitors and resistors connected in series and in parallel; know major application of capacitors and resistors in electric circuits;
• to apply the Kirchhoff’s laws for calculations of multi-loop circuits;
• understand the phenomena taking place in circuits contain resistor and capacitor and how these phenomena are described by corresponding equations;
• calculate magnetic fields due to electric currents;
• understand the laws of motion of charged particles in uniform electric and magnetic fields or combined electric and magnetic fields and applications of these phenomena in modern science and technology;
• understand the laws of electromagnetic induction and their role in modern technology;
• improve ability to use mathematics and problem solving skills

**Relationship of Course to Program Outcomes:**
PHYS 213/213A University Physics II, meets part of ABET Criterion 3, outcome (a):
(a) Ability to apply knowledge of mathematics, science, and engineering.

**Laboratory:**
None

**Assessment and Evaluation:**
Quizzes
Homework
Exams

**Prepared By:**
Vladimir Sobolev, Fall 2003