**PURDUE UNIVERSITY**

REQUEST FOR ADDITION, EXPIRATION, OR REVISION OF AN UNDERGRADUATE COURSE

(10000-40000 LEVEL)

**DEPARTMENT:** School of Chemical Engineering

**EFFECTIVE SESSION:** Fall 2010

**PROPOSED:**

- Subject Abbreviation: CHE
- Course Number: 34800
- Long Title: Chemical Reaction Engineering
- Short Title: Chem Reaction Engr

**EXISTING:**

- Subject Abbreviation: CHE
- Course Number: 34800
- Long Title: Chemical Reaction Engineering
- Short Title: Chem Reaction Engr

**TERMS OFFERED:**

- Check All That Apply:
  - Summer
  - Fall
  - Spring

**CAMPUS(ES) INVOLVED:**

- Calumet
- N. Central
- Cont Ed
- Tech Statewide
- FL Wayne
- W. Lafayette
- Indianapolis

**CREDIT TYPE**

<table>
<thead>
<tr>
<th>1. Fixed Credit: Cr. Hrs.</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Variable Credit Range:</td>
<td></td>
</tr>
<tr>
<td>Minimum Cr. Hrs.</td>
<td></td>
</tr>
<tr>
<td>Maximum Cr. Hrs.</td>
<td></td>
</tr>
<tr>
<td>3. Equivalent Credit: Yes</td>
<td>No</td>
</tr>
<tr>
<td>4. Thesis Credit: Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**INSTRUCTIONAL TYPE**

| Lecture | 50 | 16 | 75% |
| Recitation | 50 | 1 | 75% |
| Interaction | 110 | 4 | 12.5% |
| Studio |   |   |   |
| Distance |   |   |   |
| Clinic |   |   |   |
| Experiential |   |   |   |
| Research |   |   |   |
| Ind. Study |   |   |   |
| Pract/Observ |   |   |   |

**COURSE ATTRIBUTES:**

- 7. Registration Approval Type
- 8. Department
- 9. Instructor
- 10. Repeatability
- 11. Variable Title
- 12. Credit by Examination
- 13. Designator Required
- 14. Remedial
- 15. Honors
- 16. Full Time Privilege
- 17. Off Campus Experience

**COURSE DESCRIPTION (INCLUDE REQUIREMENTS):**

Prerequisite: CHE 211, MA 262 Corequisite: CHM 261 For CHE students only. Application of kinetic rate equations, mass balances and energy balances to the analysis and design of chemical reactors involving homogeneous and heterogeneous chemical reactions. Chemical equilibria, kinetic rate equations for homogeneous and heterogeneously catalyzed reactions, design of ideal isothermal reactors, effects of non-isothermal operation, effects of diffusion in porous catalysts and non-ideal mixing in continuous flow reactors.

**Cross-Listed Courses:**

- Calumet Department Head
- Calumet School Dean
- Fort Wayne Department Head
- Fort Wayne School Dean
- Indianapolis Department Head
- Indianapolis School Dean
- North Central Department Head
- North Central Chancellor
- West Lafayette Department Head
- West Lafayette College School Dean
### PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION, OR REVISION OF AN UNDERGRADUATE COURSE
(10000-40000 LEVEL)

**DEPARTMENT**: School of Chemical Engineering  
**EFFECTIVE SESSION**: Fall 2010

**PROPOSED**:  
- [ ] New course with supporting documents  
- [ ] Add existing course offered at another campus  
- [ ] Expiration of a course  
- [ ] Change in course number  
- [ ] Change in course title  
- [ ] Change in course credit/type

**EXISTING**:  
- Subject Abbreviation: CHE

**PROPOSED COURSE**  
- **Course Number**: 34800
- **Long Title**: Chemical Reaction Engineering  
- **Short Title**: Chem Reaction Engr

**CREDITS**  
- **Fixed Credit**: Cr. Hrs: 4
- **Variable Credit**: Range:  
  - Minimum Cr. Hrs (Check One):  
  - Maximum Cr. Hrs
- **Equivalent Credit**: Yes ☐ No ☐
- **Thesis Credit**: Yes ☐ No ☐

**INSTRUCTIONAL TYPE**  
- **Lecture**: Minutes Per Min: 50  
- **Recitation**: Minutes Per Min: 50  
- **Presentation**: Minutes Per Min: 110

**CREDIT TYPE**  
- **1. Fixed Credit**:  
- **2. Variable Credit Range:**  
- **3. Repeatability**: Maximum Repeatable Credit:

**COURSE ATTRIBUTES**  
- **1. Pass/Not Pass Only**  
- **2. Satisfactory/Unsatisfactory Only**  
- **3. Credit by Examination**  
- **4. Designator Required**  
- **5. Full Time Privilege**  
- **6. Off Campus Experience**

**COURSE DESCRIPTION (INCLUDE PREREQUISITES):**

Prerequisite: CHE 211, MA 262  
Corequisite: CHM 261  
For CHE students only. Application of kinetic rate equations, mass balances and energy balances to the analysis and design of chemical reactors involving homogeneous and heterogeneous chemical reactions. Chemical equilibria, kinetic rate equations for homogeneous and heterogeneously catalyzed reactions, design of ideal isothermal reactors, effects of non-isothermal operation, effects of diffusion in porous catalysts and non-ideal mixing in continuous flow reactors.

---

**OFFICE OF THE REGISTRAR**
To: Faculty of the College of Engineering

From: Faculty of the School of Chemical Engineering

RE: Curriculum Change for the B.S. degree in Chemical Engineering

The faculty of the School of Chemical Engineering has approved the following changes in the curriculum for the B.S. degree in Chemical Engineering effective for students entering Purdue in the fall semester 2008. These changes will allow for the incorporation of the Fundamentals Lab components into the required courses CHE 348, 377, and 378 and also to allow changes in the number of credit hours in CHE 211, 348, 377 and 378. This action is now submitted to the Engineering Faculty with a recommendation for approval. Attached you will find the current plan of study followed by the proposed plan of study with the changes in bold print. Because only 3 credits from ENGL 106 or 108 will count toward graduation, this hour is no longer needed. This reduces the total hours needed for graduation to 130 hours.

Change 1: Addition of 1 credit hour to CHE 211

From:

CHE 211 Introductory Chemical Engineering Thermodynamics
Sem 1, 2, Class 3, cr. 3
Prerequisites: CHE 205, MA 261
Basic principles and concepts of thermodynamics applied to chemical engineering problems; use of basic thermodynamic functions of enthalpy, entropy, free energy to solutions, phase equilibria, and chemical equilibria; thermodynamic processes and efficiencies; equations of state; and relation of macroscopic to molecular properties.

To:

CHE 211 Introductory Chemical Engineering Thermodynamics
Sem 1, 2, Class 3, Rec 1, cr. 4
Prerequisites: CHE 205, MA 261
Basic principles and concepts of thermodynamics applied to chemical engineering problems; use of basic thermodynamic functions of enthalpy, entropy, free energy to solutions, phase equilibria, and chemical equilibria; thermodynamic processes and efficiencies; equations of state; and relation of macroscopic to molecular properties.

Rationale: This will allow for a recitation in this course to accommodate more problem solving experience early in the program.

Change 2: Addition of 1 credit hour to CHE 377

From:

CHE 377 Momentum Transfer
Sem 1, 2, Class 3, cr. 3
Prerequisite: CHE 205
Corequisites: CHE 211, MA 303

To:
CHE 377  Momentum Transfer
Sem 1, 2, Class 3, lab 2, cr. 4
Prerequisite: CHE 205
Corequisites: CHE 211, MA 303

Rationale: The additional credit hour is to allot 2 hours per week of time for inclusion of Fundamentals Lab components.

Change 3: Addition of 1 credit hour to CHE 348
From:
CHE 348  Chemical Reaction Engineering
Sem 1, 2, Class 3, cr. 3
Prerequisites: CHE 211, MA 262
Corequisite: CHM 261
Application of kinetic rate equations, mass balances and energy balances to the analysis and design of chemical reactors involving homogeneous and heterogeneous chemical reactions. Chemical equilibria, kinetic rate equations for homogeneous and heterogeneously catalyzed reactions, design of ideal isothermal reactors, effects of non-isothermal operation, effects of diffusion in porous catalysts and non-ideal mixing in continuous flow reactors.

To:
CHE 348  Chemical Reaction Engineering
Sem 1, 2, Class 3, lab 2, cr. 4
Prerequisites: CHE 211, MA 262
Corequisite: CHM 261
Application of kinetic rate equations, mass balances and energy balances to the analysis and design of chemical reactors involving homogeneous and heterogeneous chemical reactions. Chemical equilibria, kinetic rate equations for homogeneous and heterogeneously catalyzed reactions, design of ideal isothermal reactors, effects of non-isothermal operation, effects of diffusion in porous catalysts and non-ideal mixing in continuous flow reactors.

Rationale: The additional credit hour is to allot 2 hours per week of time for inclusion of Fundamentals Lab components.

Change 4: Addition of 1 credit hour to CHE 378
From:
CHE 378  Heat and Mass Transfer
Sem 1, 2, Class 3, cr. 3
Prerequisites: CHE 211, CHE 377

To:

**CHE 378  Heat and Mass Transfer**
Sem 1, 2, Class 3, lab 2, cr. 4
Prerequisites: CHE 211, CHE 377


**Rationale:** The additional credit hour is to allot 2 hours per week of time for inclusion of Fundamentals Lab components.

**Change 5:** Removal of IE 343, Engineering Economics (3 cr.) from required curriculum

**Rationale:** Relevant information will be taught in CHE 449 (see below).

**Change 6:** New Design Course numbered CHE 449

**CHE 449  Fundamental Process Design**
Sem 1, Class 3, cr. 3
Prerequisites: CHE 378
Corequisites: CHE 306, CHE 348
Use of process and product synthesis methods and concepts; detailed design of unit operation equipment, the economics of chemical plants and flow sheet optimization methods.

**Rationale:** In order to incorporate chemical engineering-appropriate cost analysis information into the senior design course, as well as further expand the information taught in senior design, it will now be a two course sequence with CHE 449 taught in the fall and CHE 450 still in the spring.

**Change 7:** Removal of 1 credit hour from CHE 450

From:

**CHE 450  Design And Analysis Of Processing Systems**
Sem 2, Class 2, computer lab. 2, cr. 3
Prerequisites: CHE 306, 348, 378
Corequisite: CHE 435
Use of flowsheet balance calculations, chemical kinetics and thermodynamics, and transfer operations in designing chemical processing systems. Analysis of design alternatives using case studies and optimization methods.

**To:**

**CHE 450  Design And Analysis Of Processing Systems**
Sem 2, Class 1, computer lab. 2, cr. 2
Prerequisites: CHE 449
Corequisite: CHE 435
Synthesize, develop, and evaluate a preliminary design of a chemical process that meets market requirements for a specific product. Analysis of design alternatives using case studies and optimization methods.
Rationale: With reinstatement of CHE 449, there will now be a two semester design course sequence in which material previously covered in CHE 450 will be covered. There is only a need for this course to be 2 credit hours.

Change 8: Removal of CHM 376, Physical Chemistry Laboratory (2 cr.) from required curriculum

Rationale: With the implementation of the Fundamentals Lab components, students will gain much more lab experience within the CHE courses than ever before. Some of the topics covered in CHM 376 will be addressed in the lab.

Change 9: Removal of 1 credit free elective

Rationale: Because only 3 credits from ENGL 106 or 108 will count toward graduation, this hour is no longer needed. This reduces the total hours needed for graduation to 130 hours.

A. Varma, Head
School of Chemical Engineering
Date: 2/1/07

APPROVED FOR THE FACULTY
OF THE SCHOOLS OF ENGINEERING
BY THE ENGINEERING CURRICULUM COMMITTEE

ECC Minutes #25
Date 5/19/08
Chairman ECC [Signature]
# CURRENT PLAN OF STUDY
## SCHOOL OF CHEMICAL ENGINEERING
Purdue University
*Students beginning Fall 2006*

## FRESHMAN YEAR

<table>
<thead>
<tr>
<th>First Semester</th>
<th>Second Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4) CHM 123 or 115&lt;sup&gt;a&lt;/sup&gt; Gen. Chemistry</td>
<td>(4) CHM 124 or 116 Gen. Chemistry</td>
</tr>
<tr>
<td>(4) ENGL 106 or 108 (3) English Comp I</td>
<td>(3) COM 114 Fund. of Commun</td>
</tr>
<tr>
<td>(1) ENGR 100 Freshman Engr Lec</td>
<td>(4) MA 166 or 162 Geom &amp; Calc II</td>
</tr>
<tr>
<td>(3) ENGR 126 Intro to Engr Prb Solv&amp;Comp</td>
<td>(4) PHYS 172 Mechanics</td>
</tr>
<tr>
<td>(4) MA 165 or 161&lt;sup&gt;c&lt;/sup&gt; Geom &amp; Calc I</td>
<td>15</td>
</tr>
</tbody>
</table>

## SOPHOMORE YEAR

<table>
<thead>
<tr>
<th>Third Semester</th>
<th>Fourth Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0) CHE 200 Chem Engr Seminar</td>
<td>(3) CHE 211 Chem Engr Thermo</td>
</tr>
<tr>
<td>(3) CHE 205&lt;sup&gt;d&lt;/sup&gt; Chemical Engr Calc</td>
<td>(3) CHE 320 Statistical Modeling</td>
</tr>
<tr>
<td>(3) CHM 261 Organic Chemistry I</td>
<td>(3) CHEM 262 Organic Chemistry II</td>
</tr>
<tr>
<td>(1) CHM 263 Organic Chem Lab I</td>
<td>(1) CHEM 264 Organic Chem Lab II</td>
</tr>
<tr>
<td>(4) MA 261 Multivar Calculus</td>
<td>(4) MA 262 Linear Algebra &amp; Diff Eq.</td>
</tr>
<tr>
<td>(3) PHYS 241 Electricity &amp; Optics</td>
<td>(3) Gen-Ed Elective</td>
</tr>
<tr>
<td>(3) Gen-Ed Elective</td>
<td>17</td>
</tr>
</tbody>
</table>

## JUNIOR YEAR

<table>
<thead>
<tr>
<th>Fifth Semester</th>
<th>Sixth Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3) CHE 306 Staged Separations</td>
<td>(0) CHE 300 Chem Engr Seminar</td>
</tr>
<tr>
<td>(3) CHE 377 Momentum Transfer</td>
<td>(3) CHE 330 Prin of Molec Engr</td>
</tr>
<tr>
<td>(3) CHM 370 Physical Chemistry</td>
<td>(3) CHE 348 Chem Reaction Engr</td>
</tr>
<tr>
<td>(2) CHM 376 Physical Chem Lab</td>
<td>(3) CHE 378 Heat &amp; Mass Transfr</td>
</tr>
<tr>
<td>(3) BIOL 295E Biology of the Living Cell</td>
<td>(3) I E 343 Engr Economics</td>
</tr>
<tr>
<td>(3) MA 303 Diff Eqs for Engr</td>
<td>(3) Gen-Ed Elective</td>
</tr>
<tr>
<td>17</td>
<td>(3) Engineering Elective</td>
</tr>
</tbody>
</table>

## SENIOR YEAR

<table>
<thead>
<tr>
<th>Seventh Semester</th>
<th>Eighth Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0) CHE 400 Chem Engr Seminar</td>
<td>(3) CHE 435 Chem Engr Lab II</td>
</tr>
<tr>
<td>(3) CHE 434 Chemical Engr Lab I</td>
<td>(3) CHE 450 Des. &amp; Anal. Proc. Sys</td>
</tr>
<tr>
<td>(3) CHE 456 Process Dyn &amp; C'trol</td>
<td>(3) Gen-Ed Elective</td>
</tr>
<tr>
<td>(3) Gen-Ed Elective</td>
<td>(3) Gen-Ed Elective</td>
</tr>
<tr>
<td>(3) Technical Elective</td>
<td>(3) CHE Elective</td>
</tr>
<tr>
<td>(3) CHE Elective</td>
<td>(1) Free Elective</td>
</tr>
<tr>
<td>15</td>
<td>16</td>
</tr>
</tbody>
</table>

---

<sup>a</sup> CHE prefer that students take the CHM 123/124 sequence. Students who have taken CHM 115/116 will also be accepted into the School of Chemical Engineering.

<sup>b</sup> If ENGL 108 is taken, must take 1 cr. of free elective for a total of 4 hours.

<sup>c</sup> The MA 165/166 (4 cr. each) sequence is preferred; however, the MA161/162 (5 cr. each) sequence may be taken. If MA 161 and/or 162 is taken, these courses will be accepted as only 4 credit hours each toward meeting the graduation requirements for CHE.

<sup>d</sup> A “C” or better must be earned in CHE 205 to continue to enroll in CHE courses.
# PROPOSED PLAN OF STUDY
## SCHOOL OF CHEMICAL ENGINEERING
Purdue University

*Students entering Purdue Fall 2008 and after*

## FRESHMAN YEAR

<table>
<thead>
<tr>
<th>First Semester</th>
<th>Second Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4) CHM 123 or 115&lt;sup&gt;a&lt;/sup&gt; Gen. Chemistry</td>
<td>(4) CHM 124 or 116 Gen. Chemistry</td>
</tr>
<tr>
<td>(3) ENGL 106 or 108 (3) English Comp I</td>
<td>(3) COM 114 Fund. of Commun</td>
</tr>
<tr>
<td>(1) ENGR 100 Freshman Engr Lec</td>
<td>(4) MA 166 or 162 Geom &amp; Calc II</td>
</tr>
<tr>
<td>(3) ENGR 126 Intro to Engr Prb Solv&amp;Comp</td>
<td>(4) PHYS 172 Mechanics</td>
</tr>
<tr>
<td>(4) MA 165 or 161&lt;sup&gt;b&lt;/sup&gt; Geom &amp; Calc I</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

## SOPHOMORE YEAR

<table>
<thead>
<tr>
<th>Third Semester</th>
<th>Fourth Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0) CHE 200 Chem Engr Seminar</td>
<td>(4) CHE 211 Chem Engr Thermo</td>
</tr>
<tr>
<td>(3) CHE 205&lt;sup&gt;c&lt;/sup&gt; Chemical Engr Calc</td>
<td>(3) CHE 320 Statistical Modeling</td>
</tr>
<tr>
<td>(3) CHM 261 Organic Chemistry I</td>
<td>(3) CHM 262 Organic Chemistry II</td>
</tr>
<tr>
<td>(1) CHM 263 Organic Chem Lab I</td>
<td>(1) CHM 264 Organic Chem Lab II</td>
</tr>
<tr>
<td>(4) MA 261 Multivar Calculus</td>
<td>(4) MA 262 Linear Algebra &amp; Diff. Eq.</td>
</tr>
<tr>
<td>(3) PHYS 241 Electricity &amp; Optics</td>
<td>(3) Gen-Ed Elective</td>
</tr>
<tr>
<td>(3) Gen-Ed Elective</td>
<td>18</td>
</tr>
<tr>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>

## JUNIOR YEAR

<table>
<thead>
<tr>
<th>Fifth Semester</th>
<th>Sixth Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3) CHE 306 Staged Separations</td>
<td>(0) CHE 300 Chem Engr Seminar</td>
</tr>
<tr>
<td>(4) CHE 377 Momentum Transfer</td>
<td>(3) CHE 330 Prin of Molec Engr</td>
</tr>
<tr>
<td>(3) CHM 370 Physical Chemistry</td>
<td>(4) CHE 348 Chem Reaction Engr</td>
</tr>
<tr>
<td>(3) BIOL 295E Biology of the Living Cell</td>
<td>(4) CHE 378 Heat &amp; Mass Transf</td>
</tr>
<tr>
<td>(2) MA 303 Diff Eqs for Engr</td>
<td>(3) Gen-Ed Elective</td>
</tr>
<tr>
<td>16</td>
<td>(3) Engineering Elective</td>
</tr>
<tr>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

## SENIOR YEAR

<table>
<thead>
<tr>
<th>Seventh Semester</th>
<th>Eighth Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0) CHE 400 Chem Engr Seminar</td>
<td>(3) CHE 435 Chem Engr Lab II</td>
</tr>
<tr>
<td>(3) CHE 434 Chemical Engr Lab I</td>
<td>(2) CHE 450 Des. &amp; Anal. Proc. Sys</td>
</tr>
<tr>
<td>(3) CHE 456 Process Dyn &amp; C'trol</td>
<td>(3) Gen-Ed Elective</td>
</tr>
<tr>
<td>(3) CHE 449 Fund. Process Des.</td>
<td>(3) Gen-Ed Elective</td>
</tr>
<tr>
<td>(3) Gen-Ed Elective</td>
<td>(3) CHE Elective</td>
</tr>
<tr>
<td>(2) CHE Elective</td>
<td>(3) Technical Elective</td>
</tr>
<tr>
<td>15</td>
<td>17</td>
</tr>
</tbody>
</table>

---

<sup>a</sup> CHE prefers that students take the CHM 123/124 sequence. Students who have taken CHM 115/116 will also be accepted into the School of Chemical Engineering.

<sup>b</sup> The MA 165/166 (4 cr. each) sequence is preferred; however, the MA161/162 (5 cr. each) sequence may be taken. If MA 161 and/or 162 is taken, these courses will be accepted as only 4 credit hours each toward meeting the graduation requirements for CHE.

<sup>c</sup> A "C" or better must be earned in CHE 205 to continue to enroll in CHE courses.
Supporting Documentation – CHE 211

Level: Undergraduate
Course Instructor: You-Yeon Won


Course Outline:

<table>
<thead>
<tr>
<th>Week(s)</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Course introduction, The first law and other basic concepts</td>
</tr>
<tr>
<td>2</td>
<td>Volumetric properties of pure fluids</td>
</tr>
<tr>
<td>3</td>
<td>Heat effect</td>
</tr>
<tr>
<td>4</td>
<td>The second law of thermodynamics</td>
</tr>
<tr>
<td>5-6</td>
<td>Thermodynamic properties of fluids</td>
</tr>
<tr>
<td>7</td>
<td>Applications of thermodynamics to flow processes, Production of power from heat, Refrigeration and liquefaction</td>
</tr>
<tr>
<td>8</td>
<td>Vapor/liquid equilibrium</td>
</tr>
<tr>
<td>9-10</td>
<td>Solution thermodynamics: theory</td>
</tr>
<tr>
<td>11</td>
<td>Solution thermodynamics: applications</td>
</tr>
<tr>
<td>12</td>
<td>Chemical reaction equilibria</td>
</tr>
<tr>
<td>13-14</td>
<td>Phase equilibrium and stability</td>
</tr>
<tr>
<td>15</td>
<td>Review and problem solving</td>
</tr>
</tbody>
</table>

Recitations: Each week students will meet for a 1 hour recitation period. These will be run by the TAs and will focus on reinforcing concepts, solving problems, and preparing for exams.

Course Objectives: Develop a fundamental understanding of the key principles of macroscopic thermodynamics and apply this understanding to solve problems of practical importance in chemical engineering and allied fields.

Course Outcomes: (numbers in parentheses refer to related educational outcomes of our undergraduate chemical engineering program shown in a separate handout)
1. Understand the concepts of work and heat and their interconnection (1).
2. Use the First Law of thermodynamics and energy balances in the analysis of closed and open systems (1, 3).
3. Use the Second Law of thermodynamics and the application of the concept of entropy in the analysis of reversible and irreversible processes (1).
4. Derive and apply thermodynamic relations and relationships between thermodynamic potentials (1).
5. Analyze thermodynamic power and refrigeration cycles (1, 3).
6. Predict, understand and apply the properties and phase equilibrium behavior of ideal and non-ideal fluids (1).
7. Understand the concepts of fugacity and chemical potential (1).
8. Apply thermodynamic principles to chemical reactions and equilibrium (1).
9. Practice clear, effective and concise written and oral communication of problem solutions (7).
10. Use computational tools in the solution of thermodynamics problems (5).

Assessment Methods for Outcomes: Each of the outcomes will be assessed by giving the students appropriate assignments and by quizzes and exams.
Supporting Documentation – CHE 348

Level: Undergraduate  
Instructor: Chelsey D. Baertsch  

Course Outline:

<table>
<thead>
<tr>
<th>Week(s)</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Course introduction, definitions, general mole balance</td>
</tr>
<tr>
<td>2</td>
<td>PFR, CSTR, and batch reactors</td>
</tr>
<tr>
<td>3</td>
<td>Definition of conversion, application of design equation</td>
</tr>
<tr>
<td>4</td>
<td>Kinetics, reversible reactions, stoichiometric table for batch and flow systems</td>
</tr>
<tr>
<td>5-6</td>
<td>Solving problems without using conversion, membrane and semibatch reactor</td>
</tr>
<tr>
<td>7-9</td>
<td>Data analysis and parameter estimation</td>
</tr>
<tr>
<td>10</td>
<td>Multiple reactions, algorithm for solution of complex reactions</td>
</tr>
<tr>
<td>11</td>
<td>Quasi-state state approximation, enzymatic reactions</td>
</tr>
<tr>
<td>12-13</td>
<td>Heterogeneous catalysis, definitions, kinetics, mechanisms</td>
</tr>
<tr>
<td>14</td>
<td>Non-isothermal reactors, derivation of energy balance equation</td>
</tr>
<tr>
<td>15</td>
<td>Diffusion and reaction in porous catalysts</td>
</tr>
</tbody>
</table>

Fundamentals Laboratory:
There will be 5 lab sessions (each session is two hours) for this class. The lab experience will consist of 4 required experiments as follow:

1) Chemical kinetics - students will study a transient gas - solid reaction that produces CO₂ as a product, and will monitor CO₂ production as a function of time. From this data, they will be able to test models for chemical reaction rates that they learn in class, and will learn how to extract reaction rate constants

2) Isothermal reactor - students will study the same chemical reaction system as in 1. It will be maintained at constant temperature by removing heat from the reactor. Students will measure the rate of heat removal and compare this with the theoretical amount they would expect to see released during the reaction.

3) Nonisothermal Effects in Chemical Reactors - students will study the same chemical reaction system as in 1, but temperature will not be maintained constant. Students will study effects of the changing temperatures on the reactor and reaction dynamics

9
4) Effectiveness Factors - students will study the same chemical reaction system as in 1, but the internal surface area/volume ratio of the solid catalyst will be varied, and students will see how an effectiveness factor is used to describe the effects of these changes on the reaction rates.

Recitations:
In the weeks when the labs are not in session, one-hour long recitation sessions led by the TAs will be held. These will focus on reinforcing concepts, solving problems, and preparing for exams.

Course Objectives:
Students should gain sufficient understanding of rates of chemical reactions and heat and mass transfer to be able to couple that knowledge with material and energy balances to model any systems in which chemical reactions are taking place.

Course Outcomes (numbers in parentheses refer to related program educational outcomes)

1. Derive and apply design equations for CSTR, PFR, PBR, and batch reactors using either concentration or conversion (1).
2. Combine material and energy balances with kinetic data to design isothermal and non-isothermal reactors (1).
3. Derive rate expressions from elementary steps for both homogeneous and heterogeneous reactions (1).
4. Be able to include equilibrium constraints on reaction analysis (1).
5. Derive intra-particle and inter-particle effectiveness factors governing diffusion/reaction coupling in heterogeneously catalyzed reactions and apply those concepts to the design of isothermal reactors and the prediction of their behavior (1).
6. Research technical literature and apply materials from previous courses to solve open-ended reactor problems (1, 9).
7. Apply appropriate computational tools for the solution of chemical reaction engineering problems (5).
8. Work professionally and ethically in teams to obtain, analyze, and report on chemical reaction kinetics (2, 3, 4, 5, 6, 7).

Assessment Methods for Course Outcomes: Each of the outcomes will be assessed by giving the students the appropriate homework problems, exams, team projects, peer evaluation, and lab reports.
Supporting Documentation – CHE 377

Level: Undergraduate
Course Instructor: Steve Beaudoin


Course Outline:

<table>
<thead>
<tr>
<th>Week(s)</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Course introduction, definitions</td>
</tr>
<tr>
<td>2</td>
<td>Behavior of stationary fluids</td>
</tr>
<tr>
<td>3-7</td>
<td>Microscopic momentum balances</td>
</tr>
<tr>
<td>8-10</td>
<td>Macroscopic momentum balances</td>
</tr>
<tr>
<td>11-12</td>
<td>Momentum balances in idealized piping systems</td>
</tr>
<tr>
<td>13</td>
<td>Mass conservation</td>
</tr>
<tr>
<td>14</td>
<td>Particle settling</td>
</tr>
<tr>
<td>15</td>
<td>Flowmeters</td>
</tr>
</tbody>
</table>

Fundamentals Laboratory:
There will be 5 lab sessions (each session is two hours) for this class. The lab experience will consist of 4 required experiments as follow:

1) Viscosity in Laminar Flow - students will study the rate of motion of a metal sphere falling through oils of different viscosity and will learn of the role of viscosity and drag in fluid motion

2) Pressure Drop and Flow Rate Measurements - students will study the rate of flow and the pressure drop when water flows through a cylindrical pipe and will use their data to validate momentum balance models

3) Turbulent Pipe Flow - students will study pressure drop and fluid flow rates for motion of water through a cylindrical pipe in the turbulent flow regime and will learn how the flow regime changes the friction between the water and the pipe walls

4) Pump Characteristics and a Pipe Network - students will learn how to characterize the performance of a pump and how changes in the flow impedances in a piping network will influence the flowrates, pressure drops, and pump work required to pump water through a piping system

Recitations:
In the weeks when the labs are not in session, one-hour long recitation sessions led by the TAs will be held. These will focus on reinforcing concepts, solving problems, and preparing for exams.
Course Objectives
Develop a fundamental understanding of fluid mechanics through theoretical analysis and observation of physical phenomena and apply these concepts using logical problem-solving techniques to chemical engineering (or related) situations.

Course Outcomes (numbers in parentheses refer to related program educational objective)
1. Perform macroscopic and differential mass, momentum, and mechanical energy balances (1).
2. Apply momentum balances to fluid statics (1).
3. Apply mass, momentum, and energy balances to laminar and turbulent flow of incompressible fluids in conduits and past submerged bodies (1).
4. Understand and apply dimensional analysis and kinematic similarity to engineering design (1, 3).
5. Design of fluid transfer equipment (pipelines, agitated vessels, pumps, etc.) and analysis of its operation (1, 2, 3)

Assessment Methods for Course Outcomes: Each of the outcomes will be assessed by giving the students the appropriate homework problems, exams, team projects, peer evaluation, and lab reports.
Supporting Documentation – CHE 378

Level: Undergraduate
Course Instructor: Dave Corti


Course Outline:

<table>
<thead>
<tr>
<th>Week(s)</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Course Introduction</td>
</tr>
<tr>
<td>2-4</td>
<td>Steady-State Heat Transfer by Conduction</td>
</tr>
<tr>
<td>5-6</td>
<td>Transient Heat Transfer by Conduction</td>
</tr>
<tr>
<td>7</td>
<td>Fundamentals of Diffusive Mass Transfer</td>
</tr>
<tr>
<td>8</td>
<td>Steady and Quasi-Steady-State Mass Transfer</td>
</tr>
<tr>
<td>9-10</td>
<td>Unsteady State (Transient) Mass Transfer</td>
</tr>
<tr>
<td>11-12</td>
<td>Convective Heat and Mass Transfer</td>
</tr>
<tr>
<td>13</td>
<td>Simple Heat Exchangers</td>
</tr>
<tr>
<td>14-15</td>
<td>Continuous Gas/Liquid Contactors</td>
</tr>
</tbody>
</table>

Fundamentals Laboratory:
There will be 5 lab sessions (each session is two hours) for this class. The lab experience will consist of 4 required experiments as follow:

1) Heat Conduction - students will study a system of a cold reservoir and a hot reservoir connected by a highly conductive and then a highly insulating rod. The students will measure the rate at which energy must be put into the hot reservoir to maintain a steady state temperature difference between the two reservoirs, and will learn how quickly the two different rods conduct heat

2) Heat exchange - students will study a system in which an inner tube of flowing steam passes through an outer tube of flowing cold water, and will measure the rates at which the temperatures of the two streams change. Students will compute the rate of heat exchange as a function of the system operating conditions

3) Diffusive Mass Transfer - students will study the rate of CO₂ diffusion from a well mixed reservoir through a circular pipe into a well mixed reservoir of N₂

4) Convective Mass Transfer - students will study the rate of dissolution of CO₂ into a well mixed solution. The limiting step of the dissolution is the concentration of CO₂ into solution

Recitations:
In the weeks when the labs are not in session, one-hour long recitation sessions led by the TAs will be held. These will focus on reinforcing concepts, solving problems, and preparing for exams.
**Supplemental Reading:**  


**Course Objectives:**  
Develop a sound fundamental understanding of heat and mass transfer through theoretical analyses and consideration of the physical phenomena. Integrate the concepts of momentum, heat and mass transfer to acquire an understanding of the interrelation of these physical phenomena. Apply the concepts to solve problems of practical importance in chemical engineering and allied fields. Continue the development of problem-solving and self-learning skills.

A majority of the concepts presented in this course form the basis for a large number of chemical engineering unit operations, some of which are developed further in, for example, CHE 434 (Chemical Engineering Laboratory I). Thus, the material covered in this course is an essential component of the chemical engineering practice and is essential that you have a clear understanding of this material.

**Course Outcomes** (numbers in parentheses refer to related program educational objective)  
1. Perform microscopic and macroscopic mass, thermal energy, and species mass balances (1).  
2. Understand the mechanisms of heat transfer -- conduction, convection, and radiation (1).  
3. Apply thermal energy balances and Fourier’s Law to steady state and transient conduction (1).  
4. Apply thermal energy balances and Newton’s Law of Cooling to convective heat transfer (1).  
5. Design of heat transfer equipment and analysis of its operation (1, 2, 3).  
6. Apply species mass balances and Fick’s Law to steady state and transient diffusion (1).  
7. Apply species mass balances and relevant rate equations to convective mass transfer (1).  
8. Understand and apply the analogies between transport of momentum, heat, and mass (1, 9).  
9. Design of continuous mass transfer equipment and analysis of its operation (1, 2, 3).

**Assessment Methods for Course Outcomes:** Each of the outcomes will be assessed by giving the students the appropriate homework problems, exams, team projects, peer evaluation, and lab reports.
Supporting Documentation – CHE 449

Level: Undergraduate
Course Instructors: Professors R. Agrawal, J. Pekny, G. Reklaitis, and V. Venkatasubramanian

Course Outline

<table>
<thead>
<tr>
<th>Week(s)</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>Process and Product Synthesis methods, concepts and heuristics</td>
</tr>
<tr>
<td>4-5</td>
<td>Process synthesis incl. introduction to algorithmic methods</td>
</tr>
<tr>
<td>6-7</td>
<td>Design of major unit operation equipment</td>
</tr>
<tr>
<td>8-9</td>
<td>Cost accounting and capital cost estimation</td>
</tr>
<tr>
<td>10-11</td>
<td>Flow sheet optimization methods</td>
</tr>
<tr>
<td>12</td>
<td>Design of batch and continuous processes</td>
</tr>
<tr>
<td>13-14</td>
<td>ASPEN simulation methods</td>
</tr>
<tr>
<td>15</td>
<td>Review</td>
</tr>
</tbody>
</table>

Course Objectives
To understand process and product synthesis methods and concepts; detailed design of unit operation equipment, the economics of chemical plants and flow sheet optimization methods.

Course Outcomes (numbers in parentheses refer to related program educational objective)
1. Apply systematic strategies for synthesizing chemical process designs that involve conventional unit operations (1, 3).
2. Understand the difference between steady state and batch chemical processes and the implication on their design and operation (1, 3).
3. Know where and how to obtain information on industrial chemical processes, process operating parameters, equipment costs, cost of chemicals and materials, and associated safety and environmental hazards (6, 8, 9).
4. Understand the role of physical property estimates on process design and be able to use appropriate physical property estimation methods in unit operations design (1, 2, 3, 5).
5. Estimate the capital and operating cost of a process and to assess its profitability (1, 8).
6. Perform detailed hands-on work with tools that ultimately lead to the design of a chemical plant (1, 5).

Assessment of Course Outcomes: Each of the outcomes will be assessed by giving the students appropriate assignments and exams.
Supporting Documentation – CHE 450

Level: Undergraduate
Course Instructors: Professors R. Agrawal, J. Pekny, G. Reklaitis, and V. Venkatasubramanian

Course Outline:

<table>
<thead>
<tr>
<th>Week(s)</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Course Introduction</td>
</tr>
<tr>
<td>2-3</td>
<td>Adv. material &amp; energy balances for process flow sheets with recycle</td>
</tr>
<tr>
<td>4-6</td>
<td>Synthesis and design of process flow sheets</td>
</tr>
<tr>
<td>7-8</td>
<td>Advanced equipment costing</td>
</tr>
<tr>
<td>9-10</td>
<td>Process flow sheet economic evaluation</td>
</tr>
<tr>
<td>11-15</td>
<td>Advanced Aspen simulation methods</td>
</tr>
</tbody>
</table>

Course Objectives:
Synthesize, develop, and evaluate a preliminary design of a chemical process that meets market requirements for a specific product.

Course Outcomes: (numbers in parentheses refer to related program educational objective)

1. Apply systematic strategies for synthesizing chemical process designs that involve conventional unit operations (1, 3).
2. Create process flow sheet through conceptualization, process synthesis, process design and assessment (1, 3, 5).
3. Know where and how to obtain information on industrial chemical processes, process operating parameters, equipment costs, cost of chemicals and materials, and associated safety and environmental hazards (8, 9).
4. Estimate the capital and operating cost of a process and to assess its profitability (1,8).
5. Communicate project progress and final results in a professional manner orally and in written form (7).
6. Work effectively in a team to execute open-ended design projects with time-bound deliverables in a professional and ethical manner (1, 3, 4, 6, 9).

Assessment Methods for Course Outcomes: Each of the outcomes will be assessed by giving the students the appropriate homework problems, exams, team projects, and peer evaluation.
Prerequisite: CHE 205
Corequisites: CHE 211, MA 303
For CHE students only.
Differential (microscopic) and integral (macroscopic) mass, momentum, and energy balances. Newtonian and non-Newtonian fluids, fluid statics, one-dimensional steady and transient laminar flows, turbulence, dimensional analysis and similarity, friction factors and drag coefficients. Applications to engineering, analysis of practical problems, and introduction to numerical analysis and visualization of flows.
**PURDUE UNIVERSITY**
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF AN UNDERGRADUATE COURSE
(10000-40000 LEVEL)

**DEPARTMENT**  School of Chemical Engineering  **EFFECTIVE SESSION**  Spring 2011

**PROPOSED:**  Please check the item below which describe the purpose of this request.

- [ ] 1. New course with supporting documents
- [X] 2. Add existing course offered at another campus
- [ ] 3. Expiration of a course
- [ ] 4. Change in course number
- [ ] 5. Change in course title
- [X] 6. Change in course credit/type
- [ ] 7. Change in course attributes (department head signature only)
- [ ] 8. Change in instructional hours
- [ ] 9. Change in course description
- [ ] 10. Change in course requisites
- [ ] 11. Change in semesters offered (department head signature only)
- [ ] 12. Transfer from one department to another

**PROPOSED TO EXISTING:**

<table>
<thead>
<tr>
<th>Subject Abbreviation</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE</td>
<td>37800</td>
</tr>
</tbody>
</table>

**Long Title:**  Heat and Mass Transfer

**Short Title:**  Heat and Mass Transfer

Abbreviated title will be entered by the Office of the Registrar if omitted. (22 CHARACTERS ONLY)

**CREDIT TYPE:**

<table>
<thead>
<tr>
<th>Minimum Cr. Hrs</th>
<th>Maximum Cr. Hrs</th>
<th>Equivalent Credit</th>
<th>Thesis Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Check One)</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructional Type</th>
<th>Minutes Per Week</th>
<th>Meetings Per Week</th>
<th>Weeks Offered</th>
<th>% of Credit Allocated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>50</td>
<td>3</td>
<td>16</td>
<td>70%</td>
</tr>
<tr>
<td>Recitation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Hospitality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Studio</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiential</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ind. Study</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pract/Observ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COURSE ATTRIBUTES:**

- [ ] 7. Registration Approval Type
  - [ ] Department
  - [ ] Instructor
- [ ] 8. Variable Title
- [ ] 9. Remedial
- [ ] 10. Honors
- [ ] 11. Full Time Privilege
- [ ] 12. Off Campus Experience

**COURSE DESCRIPTION (INCLUDE REQUISITES):**


**Cross-Listed Courses:**

**Calumet Department Head**  Date  **Calumet School Dean**  Date

**Fort Wayne Department Head**  Date  **Fort Wayne School Dean**  Date

**Indianapolis Department Head**  Date  **Indianapolis School Dean**  Date

**North Central Department Head**  Date  **North Central Chancellor**  Date

**West Lafayette Department Head**  Date  **West Lafayette College/School Dean**  Date  **West Lafayette Registrar**  Date
REQUEST FOR ADDITION, EXPIRATION, OR REVISION OF AN UNDERGRADUATE COURSE (10000-40000 LEVEL)

DEPARTMENT: School of Chemical Engineering  EFFECTIVE SESSION: Spring 2010

INSTRUCTIONS: Please check the items below which describe the purpose of this request.

- New course with supporting documents
- Add existing course offered at another campus
-Expiration of a course
- Change in course number
- Change in course title
- Change in course credit/type

PROPOSED:

- Subject Abbreviation: CHE
- Course Number: 21100
- Long Title: Introductory Chemical Engineering Thermodynamics
- Short Title: CH Engr Thermodynamics

EXISTING:

- Subject Abbreviation: CHE
- Course Number: 21100
- Long Title: Introductory Chemical Engineering Thermodynamics
- Short Title: CH Engr Thermodynamics

TERMS OFFERED:

- Summer
- Fall
- Spring

CAMPUS(ES) INVOLVED:

- Calumet
- Cont Ed
- Ft. Wayne
- Indianapolis
- N. Central
- Tech Statewide
- W. Lafayette

CREDIT TYPE

<table>
<thead>
<tr>
<th>Credit Type</th>
<th>Minutes Per Week</th>
<th>Meetings Per Week</th>
<th>% of Credit Allocated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>50</td>
<td>3</td>
<td>75%</td>
</tr>
<tr>
<td>Recitation</td>
<td>50</td>
<td>1</td>
<td>25%</td>
</tr>
</tbody>
</table>

COURSE ATTRIBUTES:

- Registration Approval Type
- Instructor

Pre-requisites: CHE 205, MA 281 For CHE students only. Basic Principles and concepts of thermodynamics applied to chemical engineering problems; use of basic thermodynamic functions of enthalpy, entropy, free energy to solutions, phase equilibria, and chemical equilibria; thermodynamic processes and efficiencies; equations of state; and relation of macroscopic to molecular properties.

Cross-Listed Courses:

Calumet Department Head: [Signature]  Date: 10-7-09
Calumet School Dean: [Signature]  Date: 11/9/09

Fort Wayne Department Head: [Signature]  Date: 10-7-09
Fort Wayne School Dean: [Signature]  Date: 11/9/09

Indianapolis Department Head: [Signature]  Date: 10-7-09
Indianapolis School Dean: [Signature]  Date: 11/9/09

North Central Department Head: [Signature]  Date: 10-7-09
North Central Chancellor: [Signature]  Date: 10/4/09

West Lafayette Department Head: [Signature]  Date: 10-7-09
West Lafayette College/School Dean: [Signature]  Date: 10/4/09

OFFICE OF THE REGISTRAR