Writing in the Majors Plan for **Chemical Engineering**

Comments from the University Writing Committee

Criterion	Comments, Questions, Suggestions
Principles 1 & 2: Provides opportunities for students to practice the kinds of writing most useful to the major	Yes. Writing outcomes are tied to learning outcomes with ABET accreditation.
Demonstrates that most students in the major have multiple writing experiences	Several courses are listed which include lab reports working with graphical displays, reports and oral presentations with visuals.
Principle 3: Provides opportunities for students to write for different purposes and audiences	Different audiences are implied by the types of problems/reports required. Industrial collaborators are specifically mentioned in the 4470 course.
Principle 4: Provides opportunities for feedback and revision	Yes, for lab reports feedback informs next assignments. In CHEN 3600 instructor feedback is provided on multiple assignments. Though it is not clear if students have a chance to resubmit for grade after feedback is received, the amount of direct instruction students are receiving on writing is impressive.
Principle 5: Assessment plan identifies what the department is working on in relation to writing	Several areas are identified where the department is assessing writing. In conversation with the department it is clear that attention to the quality of written expression and to various instructional interventions to improve student writing has been going on for some time. We understand that the focus on explain-type questions prior to the Concept Inventory Exam is only one strategy the department is using to improve student writing performance. Reworking the CHEN 3600 to focus on written communication and providing significant instruction linking writing to problem solving demonstrates how the department has used previous assessment data to inform instruction and curriculum.
Principle 5: Assessment plan identifies what data will be collected to aid in decisions related to writing	Identifies what data is currently being collected and ways the program has used data to strengthen communication instruction in the past. Because we understand that the department's overarching goal is to ensure that students are competent writers and can accurately explain concepts of the field, we appreciate the various approaches being used to gather data that can inform faculty decisions.
Identifies steps necessary for implementation	Seems to be an ongoing process with no need for implementation as a separate step.

Other Comments: The assessment component appears to be more of an account of what has been done in the past than an attempt to analyze specific efforts to improve writing instruction. In future reports it would be helpful to delineate what has been done from what is planned. We appreciate the serious effort this department is making to improve their majors' writing. We note a change in course content (CHEN 3600) which you will be submitting to the University Curriculum Committee.

___x___ Plan is approved and will be posted on the OUW website 3-11-11

Plan for Writing in the Chemical Engineering Major at Auburn University Auburn, AL

Date: February 2, 2011

Drs. Chris Roberts (844-2036) and Tim Placek (844-2022)
Department of Chemical Engineering

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1. Introduction

The Chemical Engineering program at Auburn University is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone: (410) 347-7700. ABET is recognized by the Council for Higher Education accreditation (CHEA) as the organization responsible for the accreditation of educational programs leading to degrees in applied science, computing, engineering, and engineering technology.

The Department of Chemical Engineering has recognized the desirability of effective written and oral communications skills in the major for many years and has sought to incorporate, by various means, these skills at appropriate points in the curriculum. The teaching of these skills is integrally a part of our courses with introductory-level coverage occurring in early classes, strong (comprehensive-level) coverage occurring in several mid-program courses, and reinforcement (application-level) coverage occurring in our capstone design and laboratory courses.

In conjunction with ABET accreditation requirements, the department assesses the success of students in employing these skills with a number of assessment tools (procedures such as rubrics). The particular portion of the ABET Criteria 3 (Program Outcomes) that applies to this issue has been subdivided into two Chemical Engineering Program Outcomes, namely:

AUCHEN (G1): Our graduates have acquired the ability to communicate effectively when employing written communications.
AUCHEN (G2): Our graduates have acquired the ability to communicate effectively when employing oral communications.

It is noted that this document presents a description of assessment activities of both written and oral communication skills since the two are integrally linked throughout our program. Many assignments in the Chemical Engineering curriculum involve both written and oral communication components.

All five of the Principles of Writing for All Majors are satisfied by the ABET accreditation assessment activites already employed by the department.

2. Administrative Contact Information

Contact Information	
Department Chair	**Undergraduate Program Chair**
Dr. Christopher B. Roberts Department Chair Department of Chemical Engineering Auburn University, AL 36849-5127 Office: 210 Ross Hall Telephone: (334)844-2036 Fax: (334)844-2063 E-mail: robercr@auburn.edu	**Dr. Timothy D. Placek** Undergraduate Program Chair Department of Chemical Engineering Auburn University, AL 36849-5127 Office: 228 Ross Hall Telephone: (334)844-2022 Fax: (334)844-2063 E-mail: placetd@auburn.edu

3. Overview of Writing-Relevant ABET Accreditation Requirements

Undergraduate students in the Department of Chemical Engineering at Auburn University can earn a Bachelor of Chemical Engineering degree. This degree program undergoes thorough review by the ABET accreditation process every six years, and the most recent ABET Site Visit was during the Fall 2010 semester. As part of the department's ongoing ABET continuous improvement process, several detailed assessment tools are employed to measure student success on eleven ABET prescribed program outcomes. Appendix A provides the full list of the eleven ABET prescribed outcomes. The department regularly collects assessment data for each of these outcomes. The table below (taken from the department's recent ABET self-study) provides a mapping of the degree of coverage of each outcome in the Chemical Engineering Curriculum. The highlighting in the table below denotes the required courses within the Chemical Engineering Curriculum which communication skills are developed and assessed. These courses will be discussed in more detail below.

Extent of Program Outcome Coverage in Curriculum

Coverage Legend
(I) Coverage is Introductory or Preparatory
(S) Strong Coverage to Develop Outcome
(R) Significant Coverage to Reinforce or Employ Outcome

Course Type Legend
che : core (CHEN)
pp : pulp and paper specialization
reqd: required service
tech: technical elective (CHEN)
spec: special undergraduate

Course	Required or elective course	Course Type (see Legend)	Knowledge of math, science and engineering	Experiments and data handling	Design with constraints	Teams and leadership	Problem solving	Professional ethics	Written communications	Oral communications	Impact of engineering	Life-long learning	Contemporary issues	Modern engineering tools
AUCHEN Outcome			A	B	C	D	E	F	G1	G2	H	I	J	K
CHEN 2AA0 Progress Assessment I	reqd	che												
CHEN 2100 Principles of Chemical Engineering	reqd	che	S	I	I	I	S	I	I	I	I	I	I	I
CHEN 2610 Transport I	reqd	che	S	I	I	I	S	I	I	I	I	I		
CHEN 3AA0 Progress Assessment II	reqd	che												
CHEN 3090 Pulp and Paper Technology	elect	pp	S										I	
CHEN 3370 Phase and Reaction Equilibria	reqd	che	S	S			R							I
CHEN 3600 Computer-Aided Chemical Engineering	reqd	che	S	S	I	R	S	I	S		I	S	R	S
CHEN 3620 Transport II	reqd	che	S	I	I		R							I
CHEN 3650 Chemical Engineering Analysis	reqd	che	S	S	I		S		R			S		S
CHEN 3660 Chemical Engineering Separations	reqd	che	S	S	S		R							R
CHEN 3700 Chemical Reaction Engineering	reqd	che	S	S	S		R						R	R

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CHEN 3820	Chemical Engineering Lab	reqd	che	R	S		S	R	I	S	S	I	I	I	I
CHEN 4100	Pulp and Paper Processing Laboratory	elect	pp	I	S		S		S						S
CHEN 4170	Digital Process Control	reqd	che	S	S	S		S				R			S
CHEN 4450	Process Economics and Safety	reqd	che	S	R	S	S	R	S	R	S	R	R	S	S
CHEN 4460	Process Simulation Synthesis and Optimization	reqd	che	S	R	S	R	R		I	I		I		S
CHEN 4470	Process Design Practice	reqd	che	R	R	S	S	S	R	S	S	S	S	R	S
CHEN 4860	Chemical Engineering Laboratory II	reqd	che	R	S		S	R	R	S	R	I	R		S
CHEN 4880	Pulp and Paper Engineering Laboratory	elect	pp	R	S										
CHEN 4930	Directed Studies	elect	spec	R											
CHEN 4970	Special Topics in Chemical Engineering	elect	spec	R											
CHEN 4980	Undergraduate Research	elect	spec	R											
CHEN 4997	Honors Thesis	elect	spec	R											
CHEN 5110	Pulp and Paper Engineering	elect	pp	S		S		R							
CHEN 5120	Surface and Colloid Science of Papermaking	elect	pp	S				S		S	S	S	R	R	
CHEN 5410	MacroMolecular Engineering	elect	che	S	R	R		S		R					R
CHEN 5430	Business Aspect of Chemical Engineering	elect	che	R	R	R	R	S	S	S	S	S		S	
CHEN 5800	Biochemical Engineering	elect	che	S	R	R		S		R					R
CHEN 5810	Biomedical Engineering	elect	che	S	R	I		R	S	S			R	R	S
CHEN 5970	Adv Special Topics in Chemical Engineering	elect	spec	R											
ENGR 1100	Engr Orientation	reqd	eng	I											
ENGR 1110	Introduction to Engineering	reqd	eng	I	I	I	S	I	I	I	I	I	I	I	I
ENGR 2010	Thermodynamics	reqd	eng	S	S			I							

The methods employed to perform regular assessment of the program outcomes include the use of several tools including assessment exams, various grading rubrics, student and faculty surveys, direct in class assessments, and several other means. As mentioned above, two of the outcomes, G1 and G2, pertain to written and oral communication skills. Several specific assessment tools have been developed to measure student achievement in the area of communications that have been utilized for more than ten years. Every semester information is collected using these assessment rubrics and tools (see Appendix D for examples) and the associated data is compiled and analyzed each semester by the Department of Chemical Engineering Curriculum and Accreditation Planning and Action Committee (CAPAC, a team of 5 faculty members).

The following table presents a mapping of the program outcomes against the various assessment tools used measure student achievement. It should be noted that some courses are not directly involved in the assessment, but rather serves as the locations in the curriculum where these skills are introduced and reinforced, with the primary assessment occurring at the later stages of the program.

Use of Available Assessment Tools to Evaluate Student Performance																	
Program Outcome	Description (short form)	Progress Assessment Exams	Senior Exit Survey	Junior Survey	Sophomore Survey	Student Course Surveys	Faculty Course Surveys	Course Embedded Assessments (CEAs)	Alumni Survey	Design Rubric	Written Communications Rubric	Oral Communications Rubric	Work Skills Rubric	Ethics, Safety, etc Rubric	Lab Assessment Rubric	EBI Survey	SGCOE Surveys
A	Knowledge of math, science and engineering	2AA0 3AA0	✓	T	T	T	T	✓	P	4470					4860	✓	A
B	Experiments and data handling		✓	T	T	T	T	✓	P						4860	✓	A
C	Design with constraints		✓	T	T	T	T	✓	P	4470				4470		✓	A
D	Teams and leadership		✓	T	T	T	T	✓	P				4470			✓	A
E	Problem solving	2AA0 3AA0	✓	T	T	T	T	✓	P	4470						✓	A
F	Professional ethics		✓	T	T	T	T	✓	P					4470		✓	A
G1	Written communications	3AA0	✓	T	T	T	T	✓	P		4470				4860	✓	A
G2	Oral communications		✓	T	T	T	T	✓	P			4470			4860	✓	A
H	Impact of engineering		✓	T	T	T	T	✓	P					4470		✓	A
I	Life-long learning		✓	T	T	T	T	✓	P				4470			✓	A
J	Contemporary issues		✓	T	T	T	T	✓	P					4470		✓	A
K	Modern engineering tools		✓	T	T	T	T	✓	P	4470					4860	✓	A

✓= Primary data using performance criteria
T = Textual data requiring interpretation
xxxx = CHEN Course number where assessment made
P = Post-tassel data acquired from alumni
A = Additional data (not administered by department)

As illustrated in this table, the Department of Chemical Engineering employs a comprehensive system of instruction and assessment (based on the ABET continuous improvement requirement) to ensure that students achieve all of the eleven outcomes.

4. Overview of Writing-Relevant Chemical Engineering Courses

In the following sections, the fashion in which writing is incorporated and assessed in the various chemical engineering courses. The syllabi for each of these courses are provided in Appendix C.

4.1 Laboratory Courses: CHEN 3820, CHEN 4860

CHEN 3820 (Chemical Engineering Laboratory I) and CHEN 4860 (Chemical Engineering Laboratory II) represent the two capstone laboratory experiences which reinforce technical concepts through detailed experimentation, data analysis, and technical reporting. Upon completing these required courses, each student in the program will have completed at least 8 major laboratory projects that require full laboratory reports writing using professional engineering writing standards. *(Fulfills Writing for All Majors Principle 1)*.

These lab reports are graded and returned to the students so that improvements can be incorporated in subsequent reports. (*Fulfills Writing for All Majors Principle 4).* In addition to written feedback provided by the instructor, the written communication and laboratory rubrics and also shared with the students so that they can further assess their strengths and weaknesses.

In addition, both of these courses require that the students make a formal oral presentation on the final project in each course with extensive feedback provided by the instructor and GTAs on their performance and methods for further improvement.

The laboratory reports, using the technical report format, represents one of the several types of written communication required in the Chemical Engineering Program (*Partially fulfills Writing for All Majors Principle 2).*

4.2 Lecture Courses: CHEN 2610, CHEN 3600, CHEN 3650

CHEN 2610 (Transport I): Consistent with the department's desire to distribute writing content widely throughout the curriculum, an introductory design project has been made part of the CHEN 2610 Transport I course. It is thought that providing the students with an open-ended, independent project requiring the use of transport principles would reinforce these important concepts. As such, an open-ended design project culminating in a technical report and poster competition has been incorporated into CHEN 2610. This allows early instruction and feedback on both written and oral communication skills. This report represents a different type of technical writing than the laboratory reports described above. (*Partially fulfills Writing for All Majors Principle 2).*

For the first few years after which this project activity was introduced, these projects centered on the design of a variety of fountains/pump systems. In an effort to also reinforce the biological engineering aspects of the program, recent projects have focused on the design of an artificial heart/lung machine.

CHEN 3600 (Problem Solving And Written Communications In Chemical Engineering): The department has revised the curriculum in CHEN 3600 Computer-Aided Chemical Engineering to formally include instruction in systematic problem solving, critical thinking, and writing. This course serves as a focal point for instruction in technical writing and departmental report formats and professional technical communication standards. Consistent with this change, a new name has been proposed for the course (Chemical Engineering Problem Solving and Communications). This change will be submitted to the University Curriculum Committee.

A short list of materials provided to the students in this course, along with a very brief description, is provided below. The complete documents can be viewed online at the associated link.

1. Format for Equations: Detailed instructions for producing equations in technical memorandums and lab reports using Microsoft Word's Equation Editor. This summary also details the proper way to cite equations and how to represent equations in technical documents.

   Web Link: http://eng.auburn.edu/cheweb/ABET/about-equations.docx

2. Citations and Reference Lists: Instructions about how outside resources used in writing memos and reports should be credited (cited) both "inline" (at the point of usage) and in the associated reference section.

   Web Link: http://eng.auburn.edu/cheweb/ABET/about-citations.docx

3. Format for Figures, Graphs and Charts: Provides instructions about effective graphical representation including display of equations as well as experimental data. Discusses how appropriate, well-drawn graphical visual aids can substantially increase comprehension of text and convey trends, comparisons, and relationships more clearly than text alone.

   Web Link: http://eng.auburn.edu/cheweb/ABET/about-graphs-charts-figures.docx

4. Format for Tables in Reports: Provides instructions about making effective tables as well as pointing out the pitfalls of commonplace cutting and pasting between Microsoft Excel and Microsoft Word.

   Web Link: http://eng.auburn.edu/cheweb/ABET/about-tables.docx

5. Short Memo Format: Engineers and scientists frequently use short memos to make requests, to give announcements, answer inquiries and as cover letters to transmit (accompany) technical reports. This document provides basic formatting and structural information about single-page memos.

   Web Link: http://eng.auburn.edu/cheweb/ABET/short-memo-format.docx

6. Specifications for Technical Memos: Technical memos are used to communicate short reports where a formal report is not warranted. Typically they would be employed to communicate the solution to a posed question or assignment involving a technical analysis. Technical memos often include equations, figures and illustrations, tables, data and attached appendices. Because of its frequent use in the curriculum and the relationship to effective written communications, this form of memo is carefully explained and practiced.

Web Link: http://eng.auburn.edu/cheweb/ABET/technical-memo-format.docx

The students in this CHEN 3600 course are provided multiple opportunities to write reports adhering to these different formats and standards, and the instructor provides copious detailed feedback throughout the semester. (*Fulfills Writing for All Majors Principles 1, 2, 3, and 4).*

Faculty have noted in End of Course Survey comments that students previously had very poor writing skills, especially in expressing engineering concepts as well when reporting their results of laboratory experiments. Prior to the year 2000, the department had as part of the curriculum a "technical writing course." This course was removed when the university implemented a revised core curriculum but maintained a cap on total credit hours.

Depending on the term, a number of different lectures and assignments help the students improve their ability to express technical content in a written communication format. Since computer solutions of chemical engineering problems frequently leads to graphical, tabular, and textual results it was felt that a "good home" for this material was the Computer-Aided Chemical Engineering course. The term-to-term variation in approach and assignments keeps the course "fresh" and avoids problems in students employing materials from previous terms.

Comments from faculty who teach subsequent courses have indicated a significant improvement in the effectiveness of students' written communications. The capstone-design project reports show markedly better communications skills as a result.

CHEN 3650 (Chemical Engineering Analysis): Since the spring of 2008, the CHEN 3650 course has contained a "make-it-real" experiment designed to involve a simple (individual) experiment design and modeling project culminating in a comprehensive written report that details the experiment, model results and conclusions. The engineering concept that the experiment focuses on is always selected from prerequisite course material with the point being to reinforce the concept and deepen the student's understanding of the relation of that concept to other engineering processes and to allow a formal opportunity for the students to engage in technical written communication using the standards learned in the previous course. (*Fulfills Writing for All Majors Principles 1 and 2).*

4.3 Progress Assessment Concept Inventory Course: CHEN 3AA0

During the past 4 years, the department has developed and implemented a progress assessment exam focused on the students ability to portray knowledge of key chemical engineering concepts, the Concept Inventory Exam (CHEN3AA0). The questions on this exam are conceptual in nature and several of them require that the students be able to explain, through written communication, important chemical engineering concepts. Based on the results obtained during the initial offering of this exam, a number of issues were identified and actions were taken to improve the students' preparedness in both the technical aspects and well as their ability to effectively communicate their thoughts and knowledge.

Issues identified:

1. Many students perform very poorly on the "explain-type" questions.
2. The poor performance may be because of the student failing to adequately learn and/or retain the subject matter.
3. The poor performance may be due to the students being unskilled in providing answers in "essay format" when typical course examination questions are provided in a significantly different format (i.e., calculation based).

It would be reasonable to expect these issues to be remedied if students were regularly provided opportunities to answer "explain-type" questions. The appearance of "explain-type" questions on regular exams would assist in convincing students that there is an expectation that engineers must provide "explanations" of their thinking "on the job." After considering the above issues, the CAPAC committee recommended to the faculty the following action to both improve student performance and develop an increased pool of questions to be used in conjunction with the CIE exam:

> *All faculty are requested to employ (as a normal component of their course exams, quizzes and finals) questions directly related to those course outcomes which require explanation or description. It is an expectation of our courses that students are able to put into words or explain concepts that they have encountered in their courses.*

The benefits expected by having faculty modify the exam question format include:

1. Students will develop more confidence in answering "concept problems" and also have a high likelihood of retaining the information. By providing feedback to the student on these questions, an improvement in their ability to communicate their thoughts in short form will also be achieved.
2. A new source of questions becomes available (questions created from existing course outcomes) by faculty teaching the course.
3. Faculty are able to better judge their effectiveness in students' acquiring an understanding of the topical materials associated with "explain-type" questions and their ability to effectively communicate these thoughts in written form.

4.4 Capstone Design Courses: CHEN 4450, CHEN 4460, CHEN 4470

In the fourth year, the senior design sequence starts with CHEN 4170 Process Control, CHEN 4450 Process Economics and Safety, and CHEN 4460 Process Synthesis, Simulation and Optimization. These courses provide an integrated breadth and depth of coverage of design-related subject matter aimed at providing the students with the knowledge and tools necessary to be effective in the capstone design class CHEN 4470 Process Design Practice. The objective of this sequence is to enable the students to experience the various issues of process design, synthesis, simulation and optimization while communicating about design issues such as safety, environmental acceptability, sustainability and operability.

CHEN 4450: In CHEN 4450, the principles of process economics and equipment sizing/costing methods are introduced. An integral part of this course involves a large project culminating in a written report that focuses on a detailed economic analysis of a typical chemical processing plant including cost/benefit analysis and clear articulation of financial performance metrics. The project reports are prepared according to the technical communication standards described above and are graded by the course professor and a graduate teaching assistant with comments provided back to the students for their improvement. In addition, the students are required to make a formal presentation of their report to the instructor and other members of the faculty. (*Partial fulfillment Writing for All Majors Principles 1, 2 and 3).*

CHEN 4460: In CHEN 4460, the students learn how to be effective using modern commercial process simulation software (ASPEN Plus) to solve complex chemical engineering problems. A small simulation project has been added to CHEN 4460 to teach the students how to prepare effective reports from simulation data. The reports are graded by the instructor of the capstone design class to provide feedback to the students relative to the expectations of the reports that the students will be preparing in the capstone class (CHEN 4470) the following semester. (*Partial fulfillment Writing for All Majors Principles 1, 2 and 3).*

CHEN 4470: In the capstone design course, CHEN 4470 Process Design Practice, a comprehensive design problem is assigned to a team of three or four students. Students must draw upon their previous knowledge and use the tools available to them to synthesize various process configurations and effectively communicate their results. Results are presented to peers, faculty and industry both orally and in written form with particular attention to engineering standards and realistic constraints. A significant amount of assessment data is generated from the students' performance in this course using the rubrics described above.

Apart from the lectures, the instructor meets with each team weekly to discuss progress and provide guidance on the project and their interim reports. Generally, the design projects focus on development of a complete plant design given specific product requirements. Each team prepares three progress reports during the semester, which are then combined in a final report encompassing all the work on the project. Detailed feedback relative to both technical content and communication is provided throughout the semester on each subsequent report allowing the student to continually revise and improve their writing effectiveness. (*Fulfills Writing for All Majors Principles 1, 2, 3 and 4).*

General Content of Design Reports	
Progress Report #1	Literature review on production, market and economics of the chemicals involved Description of the governing chemical/physical principles including phase behavior Identification of principal process units necessary to produce desired products Process flow diagram for the manufacturing process Mass and energy balances for process including turndown cases Preliminary economic analysis
Progress Report #2	Base case design in ASPEN Plus to refine material and energy balances Economic analysis of base case design including equipment cost Discussion of recycle potentials and their effects on the process economics Thermal pinch analysis to identify potential for energy recovery
Progress Report #3	Implementation of material and energy recovery strategies and design optimization Final energy analysis of process including turndown cases Complete control strategy to include on process flow diagram Propose a safety concept including inherently safe design considerations
Final Report	Combines the results from all progress reports into one comprehensive report Results from individual team assignment

The department has been committed to involving industrial collaborators in the design course, as it provides unique opportunities for the students to work on relevant problems and get feedback on the additional constraints and expectations they will be facing in the workplace. Having external evaluators read the students' reports and attend their oral presentations infuses additional professionalism to the project, which has been noted and appreciated by the industrial evaluators as well as the students on numerous occasions. (*Fulfills Writing for All Majors Principles 1, 2, 3 and 4).*

The external evaluators have consistently commented on how impressed they are with the quality of our students' design reports and presentations, and the department intends to maintain this level of achievement. We will continue to formulate interesting projects in collaboration with industry to ensure that our students are required to communicate through capstone projects that are technically challenging, timely and have broad societal impacts. (*Fulfills Writing for All Majors Principle 5).*

5. Writing-Relevent Student Assessment Methodology and Recent Results

As mentioned above, several assessment tools are employed to measure achievement of the G1 and G2 outcomes. Due to the complexity of data collection, we have developed a specific nomenclature to designate the extent to which data has been processed. The following definitions are observed:

- **Raw (Primary) Data.** This represents the data at its primary level, for example, the choices marked on a survey, the answers provided on a progress assessment exam, faculty input from teaching courses. This data is archived by the Undergraduate Program Chair.
- **Summary Data.** This represents a first cut in reducing the complexity of the data. In the case of survey forms, this could be the development of a spreadsheet with the individual responses entered as cell values or the bringing together of all student responses on an individual item from a survey question. At this point, the significance of the data has not been investigated. (Examples of this data for the Design Rubrics and Laboratory Rubrics are provided in the appendix materials).
- **Data Analysis Report.** This represents an analysis of summary data with the intention of developing a score to be compared to an appropriate criterion. This process might be fairly involved, as in the case of grading and considering the performance of students on the concept inventory exam where one would seek to understand why students might be missing key concepts or writing poorly. Generally, this work is performed by the CAPAC committee or a small number of faculty assigned this duty. A report with observations and possible recommendations would is provided to the CAPAC committee for further consideration.
- **Recommendations Report.** This represents the actions and policy changes recommended by the CAPAC committee to improve the curriculum and performance of students. Generally, this information is regularly shared with faculty during normal faculty meetings and faculty retreats as well as with the Alumni Advisory Council.

In the balance of this document, references will be made to the Department's "performance criteria for success." During the collection of assessment data, a rational means to interprete the results of assessment instruments is essential. The Department employs the following success criteria for all assessment methods that yield quantitative data (such as rubrics and numerical responses to survey questions). We seek to differentiate between those areas where we have met the program outcome target performance (success) and those areas needing minor or significant improvement. We denote these levels as "A", "B", "C" with the following characteristics:

- **Level A** – The assessment data for this program outcome is consistent with departmental performance expectations. Discussions with constituents will be conducted to continue to improve performance for this program outcome. Appropriate adjectives are "on target" and "satisfactory."
- **Level B** – The assessment data for this program outcome is slightly below the target value. Attention should be paid to this area by the department, and discussions with constituents to improve performance are appropriate. Minor changes to the curriculum should be

satisfactory to improve the situation. Appropriate adjectives are "below target" and "needs improvement".

- **Level C** – The assessment data for this program outcome is much below the target value. Significant attention should be paid to this area, and discussions with constituents are essential. Major and minor changes to the curriculum may be necessary to remedy the situation. Appropriate adjectives are "well below target" and "needs significant improvement".

The following sections present the results of the Department's assessment process related to written and oral communication at various points in the curriculum (using some of the tools described above).

5.1 Recent Results for Written Communication

The metric data for program outcome AUCHEN (G1) appearing in following table comes from:

- 3AA0 Exam (Concept Inventory)
- Written Communications Rubric
- Lab Assessment Rubric
- EBI Survey
- Senior Exit Surveys
- Alumni Survey

Assessment Criteria for Outcome AUCHEN (G1)						
Data Source	2004	2005	2006	2007	2008	2009
3AA0*	ND	ND	ND	ND	ND	ND
Written Communications Rubrics (G1)	A	B	A	A	A	A
Lab Rubric (G1)	TC	TC	C/C	B/C	C	C
EBI (G1)	A	A	A	A	A	A
Senior Exit	A	A	A	A	A	A
Alumni Survey	ND	ND	ND	ND	A[1]	ND

B/B, etc. =Two different tools employed this year.
ND=No Data (Tool not employed or not available)
TC = Tool Change (No data from old tool version)
1 = First offering of revised alumni survey (to be offered at 3 year intervals)
* = This tool will begin producing data starting in Fall 2010

Summary Statement: Data for AUCHEN (G1) indicates that departmental goals are currently being met with the exception of data derived from the CHEN 4860 Laboratory Assessment rubric. The department has made significant changes in the emphasis on writing skills and the preparation of technical reports. It is also noted that data collected in CHEN 4860 is not necessarily reflective of the capabilities of students leaving the program and that efforts put forth on lab reports may not represent the students "best efforts" (as in the case of a major design project report). Nonetheless, improvement in written communications remains a priority in the program.

5.2 Recent Results for Oral Communication

The metric data for program outcome AUCHEN (G2) appearing in following table comes from:

- Oral Communications Rubrics
- Lab Assessment Rubrics
- EBI Survey
- Senior Exit Surveys
- Alumni Survey

Assessment Criteria for Outcome AUCHEN (G2)						
Data Source	2004	2005	2006	2007	2008	2009
Oral Communications Rubric (G2)	A	C	A	A	A	A
Lab Rubric (G2)	TC	TC	A/ND	A/A	A	C
EBI (G2)	A	A	A	A	A	A
Senior Exit	A	A	A	A	B	A
Alumni Survey	ND	ND	ND	ND	A[1]	ND

B/B, etc. =Two different tools employed this year.
ND=No Data (Tool not employed or not available)
TC = Tool Change (No data from old tool version)
1 = First offering of revised alumni survey (to be offered at 3 year intervals)

Summary Statement: Data for AUCHEN (G2) indicates that departmental goals are currently largely being met.

An important issue was recently detected pertaining to the CHEN 4860 Laboratory Assessment rubric result. The assessment rating for calendar year 2009 shows a drop-off in comparison to previous years. This was entirely due to the Spring semester assignment of individual oral presentations instead of the usual group presentation at the end of the semester.

The data obtained from the Oral Communications rubric employed to assess the group presentations of the capstone design projects indicate that the department is meeting its goals for AUCHEN (G2). The table shows a consistent Level A performance since 2006, however it should be noted that an issue was identified in 2005, where the performance was significantly lower. A review of the raw data showed that the low scores were attributed to three main areas of concern; the students' ability to answer questions, their delivery/speaking skills, and the presentation length, i.e. presentation was much longer than the allocated time.

The increased emphasis throughout the curriculum on communication skills (particularly in CHEN3600) coupled with additional opportunities for giving oral presentations (e.g. CHEN3820, CHEN4450 and CHEN4860) has definitely had a positive impact on the students' presentation skills. Furthermore, a presentation rehearsal session with the instructor has become an integral part of the design course since 2005. Although Level A performance has been observed since 2006 (including the 2010 rubric data, which is not included in the table), there are still a few examples of students having difficulties with the delivery/speaking skills and keeping the presentation within the allotted time. The number of occurrences is too small to influence the overall assessment criteria, but effective oral communication remains a focus of the program and as such, we will continue to monitor this issue and work to improve the students' performance.

5.3 Future Plans Based on the Latest Assessment Results

It should be clear from the report above that the department has a rich history of data collection and actions taken for all program outcomes for the ABET accreditation process. The department plans to integrally link the AU Writing in the Majors Plan with our ongoing ABET accreditation process. This will avoid needless duplication of effort, while providing the maximum improvement in student achievement in the area of communication skills. (*Fulfills Writing for All Majors Principle 5).*

Assessment results for the past several years indicate that Chemical Engineering students are effective communicators and are successfully meeting departmental success criteria for Program Outcomes G1 and G2. Further, we believe that the data presented above fullfil each of the 5 Principles of the Writing in the Majors Plan.

APPENDICES

Appendix A – Department of Chemical Engineering Program Outcomes

The Auburn University Chemical Engineering Program is designed to produce graduates with the following attributes, skills and capabilities:

AUCHEN (A): Our graduates have acquired and can apply knowledge in the areas of mathematics, science and engineering to solve problems encountered in the practice of chemical engineering.

AUCHEN (B): Our graduates have acquired the ability to design and conduct experiments, as well as to analyze and interpret data.

AUCHEN (C): Our graduates have acquired the ability to design systems, components, or processes to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

AUCHEN (D): Our graduates have acquired an ability to function effectively on multidisciplinary teams.

AUCHEN (E): Our graduates have acquired an ability to identify, formulate, and solve engineering problems.

AUCHEN (F): Our graduates will understand and appreciate the need for professional integrity and ethical decision making in the professional practice of chemical engineering.

AUCHEN (G1): Our graduates have acquired the ability to communicate effectively when employing written communications.

AUCHEN (G2): Our graduates have acquired the ability to communicate effectively when employing oral communications.

AUCHEN (H): Our graduates have acquired the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

AUCHEN (I): Our graduates have acquired an appreciation of the need for continued education after graduation as well as possess the ability to engage in life-long learning to maintain and enhance their professional abilities.

AUCHEN (J): Our graduates have acquired an understanding of contemporary issues and their impact on the professional practice of chemical engineering.

AUCHEN (K): Our graduates have acquired the ability to utilize the techniques, skills, modern engineering tools and computer-based technologies necessary for effective chemical engineering practice.

Date of Last Revision: November 6, 2009

Appendix B – Chemical Engineering Curriculum

CHEMICAL ENGINEERING			CrHrs	Math Basic Sci	Engr Topics	Genl Educ	Other
Freshman Year		**Fall Semester**					
CHEM	1110	General Chemistry I	3	3			
CHEM	1111	General Chemistry Lab I	1	1			
ENGL	1100	English Composition I	3			3	
ENGR	1110	Introduction to Engineering	2		2		
MATH	1610	Calculus I	4	4			
		Core History	3			3	
Freshman Year		**Spring Semester**					
CHEM	1120	General Chemistry II	3	3			
CHEM	1121	General Chemistry Lab II	1	1			
COMP	1200	Computer Science	2		2		
ENGL	1120	English Composition II	3			3	
ENGR	1100	Engineering Orientation	0		0		
MATH	1620	Calculus II	4	4			
PHYS	1600	Engineering Physics I	4	4			
Sophomore Year		**Fall Semester**					
BIOL	1020	Principles of Biology	3	3			
BIOL	1021	Principles of Biology Lab	1	1			
CHEN	**2100**	**Principles of CHEN**	4		4		
MATH	2630	Multivariate Calculus	4	4			
PHYS	1610	Engineering Physics II	4	4			
Sophomore Year		**Spring Semester**					
CHEM	2070	Organic Chemistry I	3	3			
CHEM	2071	Organic Chemistry Lab I	1	1			
CHEN	**2AA0**	**Progress Assessment I**	0		0		
CHEN	**2610**	**Transport I**	3		3		
ENGL	2200	World Literature I	3			3	
ENGR	2010	Thermodynamics	3		3		
MATH	2650	Differential Equations	3	3			
Junior Year		**Fall Semester**					
CHEM	2080	Organic Chemistry II	3	3			
CHEN	**3370**	**Phase & Reaction Equil**	3		3		
CHEN	**3600**	**Computer - Aided CHEN**	3		3		
CHEN	**3620**	**Transport II**	3		3		
ENGL	2210	World Literature II	3			3	
Junior Year		**Spring Semester**					
CHEN	**3AA0**	**Progress Assessment II**	0		0		
CHEN	**3650**	**Applied ChE Analysis**	3		3		

CHEN	**3660**	**ChE Separations**	3		3	
CHEN	**3700**	**Chemical Reaction Engineering**	3		3	
CHEN	**3820**	**ChE Lab I**	2		2	
		Core History	3			3
Junior Year		**Summer Semester**				
CHEN	**4860**	**ChE Lab II**	2		2	
PHIL	1040	Business Ethics	3			3
		CHEN Technical Elective 1	3		3	
		Core Social Science Group II	3			3
Senior Year		**Fall Semester**				
CHEN	**4170**	**Digital Process Control**	3		3	
CHEN	**4450**	**Process Economics & Safety**	3		3 ✓	
CHEN	**4460**	**Process Simulation & Optimization**	2		2 ✓	
		CHEN Technical Elective 2	3		*	
		Advanced Chemistry Elective	3	3		
Senior Year		**Spring Semester**				
CHEN	**4470**	**Process Design Practice**	3		3 ✓	
		CHEN Technical Elective 3 or ROTC	3		*	
		CHEN Technical Elective 4 or ROTC	3		*	
		Core Fine Arts	3			3
		Core Social Science Group I	3			3
UNIV	4AA0	EN1 Undergraduate Graduation	0			0

* Electives, Technical Electives, Advanced Chemistry Elective: See adviser for approved course listing.

✓denotes courses with significant design content.

Appendix C – Chemical Engineering Course Syllabi

CHEN 2610 - TRANSPORT I (3)

Required Core Course

2009-2010 Catalog Data **Lec (3).** Introduction to fluid statics and dynamics; dimensional analysis; compressible and incompressible flows; design of flow systems; introduction to fluid-solids transport including fluidization, flow through process media and multiphase flows.

Prerequisites Pr: MATH 2630 or MATH 2637, PHYS 1600 or PHYS 1607, and completion of CHEN 2100 with grade of C or better; P/C: ENGR 2010

Schedule Three one-hour class sessions per week.

Course Objectives This course introduces students to fluid dynamics and the processes and phenomena associated with fluid and fluid-solid transport. Students learn and employ the concepts and equations for flowing systems important to chemical and biological processes.

Textbooks

Crowe, Engineering Fluid Mechanics, 9e, 2008, 9780470420867, Wiley

Topics Covered

1. Introduction to fluid dynamics (1 week)
2. Fluid statics (1 week)
3. Flowing fluids (2 weeks)
4. Control volume approach (1 week)
5. Momentum in fluid systems (1.67 weeks)
6. Energy in fluid systems (1 week)
7. Dimensional analysis and similitude (0.67 week)
8. Surface resistance and drag (1.67 weeks)
9. Flow through conduits (2 weeks)
10. Special topics (1 week)
11. Design and problem solving in fluid transport systems (1 week, during weeks 3, 7, and 11)
12. Exams (1 week, 3 exams given weeks 5, 9, 14)

Course Outcomes: Upon successful completion of this course, students should be able to:

1. Employ the hydrostatic equation to calculate the pressure and resulting forces acting on submerged objects.
2. Solve problems involving manometry concepts.
3. Solve problems involving buoyancy concepts.

4. Solve problems involving absolute and gauge pressure concepts.
5. Solve problems involving mass flow rate, volumetric flow rate, velocity profile, and average velocity concepts.
6. Employ the continuity equation for steady flow to calculate flow rates in conduits of constant and varying cross section including branched flow.
7. Explain the concepts of Newtonian and non-Newtonian fluid, viscosity, laminar and turbulent flow, shear, shear stress, shear rate, fluid momentum.
8. Develop force and momentum balances in potential flow and viscous flow situations.
9. Calculate the friction factor and losses for laminar and turbulent flow in pipe using the friction factor plot and appropriate equations.
10. Calculate the mechanical energy loss due to friction in a piping system containing various kinds of valves and fittings.
11. Employ a mechanical energy balance to calculate flow rates, pipe sizes, power requirements, and pump sizes for specific piping configurations.
12. Describe the characteristics of centrifugal and positive displacement pumps, and using pump curves select an appropriate pump to deliver a specified flow rate.
13. Employ the concept of dimensional analysis to develop dimensionless numbers used in fluid mechanics.
14. Explain the concepts of a boundary layer, skin drag, and form drag .
15. Calculate the drag on a submerged object of simple shape in a flowing fluid using drag coefficient correlations.
16. Explain the concepts of porosity, void fraction, specific volume, specific surface area, particle equivalent diameter.
17. Calculate pressure drop or flow rate for flow through packed beds in various flow regimes.

Relationship of Course to Program Outcomes (PO's)												
Program Outcome	**A**	**B**	**C**	**D**	**E**	**F**	**G1**	**G2**	**H**	**I**	**J**	**K**
Level of Coverage	S	I	I	I	S	I	I	I	I	I		

Date of Preparation and Person(s) Preparing This Description:
February 5, 2010: Elizabeth A. Lipke

CHEN 3AA0 – CHEMICAL ENGINEERING PROGRESS ASSESSMENT II (0)

Required Core Course

2009-2010 Catalog Data **Lab (0).** Progress assessment examination in thermodynamics, linear differential equations, chemistry, transport phenomena (fluid mechanics, heat, mass transfer), phase and reaction equilibria, reaction engineering, design and conduction of experiments, analysis and interpretation of data, professional, ethical, societal and contemporary issues.

Prerequisites Pr: CHEN 2AA0; (P/C: CHEN 3650, CHEN 3700, CHEN 3370 effective Jan 1, 2011)

Schedule Orientation session(s) and 1 or 2 exam offerings per term

Course Objectives Upon completion of this course, the student will have demonstrated:

1. The ability to apply thermodynamics, linear differential equations, chemistry, transport phenomena (fluid mechanics, heat, mass transfer), phase and reaction equilibria, reaction engineering to chemical engineering problems.
2. Analyze and interpret experimental results.
3. Demonstrate critical thinking skills.
4. Demonstrate proficiency in written communications.

Textbooks (None)

Topics Covered

Following an orientation meeting to explain the examination process, no other content is lectured on. One or two examination dates are announced.

Date of Preparation and Person(s) Preparing This Description:
February 5, 2010: W. Robert Ashurst, Timothy D. Placek,

CHEN 3600 – PROBLEM SOLVING AND WRITTEN COMMUNICATIONS IN CHEMICAL ENGINEERING (3)

Required Core Course

2009-2010 Catalog Data **Lec (2), Lab (3).** General and structured programming concepts, numerical methods, and introductory probability and statistics concepts. Application to chemical engineering problems involving material and energy balances and transport process, data validation, and analysis.

Prerequisites Pr: COMP 1200, MATH 2650 and completion of CHEN 2610 with a grade of C or higher

Schedule Two one-hour class sessions and two 75-minute lab sessions per week.

Course Objectives Systematic approach to solving chemical engineering problems using analytical and synthetic approaches. Effective communication of problem solution and recommendations using established formats for writing elements. General and structured programming concepts, introductory probability and statistics concepts. Application to chemical engineering problems involving material and energy balances and transport process, data validation and analysis.

Textbooks

Larsen, Engineering with Excel, 3e, 2008, 0136017754, Prentice-Hall
Hart, Engineering Communication, 2e, 2008, 9780136044208, Prentice-Hall

Lecture Topics Covered

1. Introduction, departmental format for graphs, tables, equations (1 week)
2. Introduction to problem solving (1 week)
3. Graphing with Excel (1 week)
4. Excel functions, programming concepts (structured programming) (1 week)
5. Matrix operations, linear regression, problem solving (Bloom's Taxonomy) (1 week)
6. Iterative solutions, using macros in Excel (1 week)
7. Optimization (Solver), programming concepts (stepwise improvement method) (1 week)
8. Technical writing, critical analysis, proofreading, professional expectations (2 weeks)
9. Programming with VBA (2 weeks)
10. Probability and statistics (1 week)
11. Sampling from distributions (simulation) (2 weeks)
12. Hypothesis testing (1 week)

Exams (3 exams given during week 6, 11, 14)

Lab Topics Covered

1. Example problems and laboratory projects draw from the chemical engineering field whereby the student learns to apply appropriate software or numerical methods. Problems will be taken from the areas of material and energy balances, thermodynamics, transport, kinetics, data fitting and analysis of experimental data and steady state and dynamic modeling. Review of technical writing elements and critical review of student writing(15 weeks)

Course Outcomes: Upon successful completion of this course, students should be able to:

1. Create effective graphs (x-y, scatter, line, surface) observing departmental format. Select appropriate trend lines. Graph parametric functions.
2. Employ Excel's standard and Advanced Tool Pack functions (basic math, advanced math, logical, text, time/date, random number generation) to solve general and chemical engineering problems.
3. Solve single and multiple variable linear regression problems using Excel's vector and array functions (transpose, inversion, determinants) and Excel's regression analysis package (including "best model" selection via F-statistic).
4. Record, modify and write Excel macros. Write VBA user defined functions and subprograms including transferring data to and from the spreadsheet using absolute and relative addressing methods as well as passing data via parameter lists.
5. Employ basic VBA programming concepts including data types, variables, and programming structures (IF-THEN-ELSE, SELECT CASE, FOR-NEXT, DO [WHILE/UNTIL] LOOP) to solve basic and intermediate level problems.
6. Employ systematic problem solving methods and critical thinking skills to set up the equations required to obtain a solution of various chemical engineering and general engineering problems.
7. Employ the "stepwise improvement method" to develop solutions for simple programming problems.
8. Explain structured programming concepts (with specific reference to the "Nassi-Schneiderman diagramming method") to prototype solutions for intermediate and complex level programming problems.
9. Employ one dimensional vectors and two-dimensional arrays to represent and store data collections including passing these as function and subprogram arguments.
10. Explain and employ probability concepts (including expectation, probability, likelihood, descriptive statistics, discrete and continuous random variables, probability distribution functions, cumulative distribution functions).
11. Apply discrete distribution functions (Bernoulli, binomial, Poisson, negative binomial, geometric, hypergeometric) and continuous distribution functions (standard normal, normal, exponential, Weibull) to solve problems involving random behavior.
12. Sample data (via simulation) from discrete and continuous distributions
13. Explain the concept of hypothesis testing and correctly set up and interpret the results of hypothesis tests involving the mean and proportion.
14. Prepare written communications (technical reports and memos) that effectively convey the thoughts of the writer to the intended audience in a form and at level of detail appropriate for the purpose of the communication (adhering to departmental formats for the presentation of equations, figures, tables, and citations).

Relationship of Course to Program Outcomes (PO's)												
Program Outcome	**A**	**B**	**C**	**D**	**E**	**F**	**G1**	**G2**	**H**	**I**	**J**	**K**
Level of Coverage	S	S	I	R	S	I	S		I	S	R	S

Date of Preparation and Person(s) Preparing This Description
February 5, 2010: Timothy D. Placek, W. Robert Ashurst

CHEN 3650- Chemical Engineering Analysis (3)

Required Core Course

2009-2010 Catalog Data **Lec (2), Lab (3).** Mathematical modeling, analytical, numerical and statistical analysis of chemical processes.

Prerequisites Pr: CHEN 2AA0 and completion of CHEN 3600 and CHEN 3620 with a grade of C or better.

Schedule Two one-hour class sessions and one three hour lab session per week

Course Objectives This course is designed to teach students methods to mathematically model and computer simulate any type of process or equipment based on fundamental transport, kinetic, and thermodynamic principles.

Textbooks

Cameron, Process Modelling and Model Analysis (Process Systems Engineering, vol 4), 1e, 2001, 9780121569310, Academic Press

Cutlip, Problem Solving in Chemical and Biochemical Engineering with POLYMATH, Excel, and MATLAB, 2e, 2007, 9780131482043, Prentice Hall

Lecture topics:

1. Class overview, intro to computational modeling, syllabus, grading (0.5 weeks)
2. Introduction to modeling (1 week)
3. Mathematical modeling (3.5 weeks)
4. Numerical methods (1.5 weeks)
5. Simulation (1.5 weeks)
6. Time domain dynamics (2 weeks)
7. Laplace domain dynamics (2 weeks)
8. Introduction to controls (0.5 weeks)
9. Data fitting and interpolation (1 week)
10. Exams (1 week)
11. Review for the final exam (0.5 week)

Lab Topics:

12. Introduction to numerical methods for DEQ (1 week)
13. Method of lines (1 weeks)
14. Process modeling and analysis (2 weeks)
15. Data regression (1 week)

Course Outcomes: Upon successful completion of this course, students should be able to:

1. Describe and classify models of low and intermediate complexity according to their properties. These classifications include type of model (linear/nonlinear, steady state/unsteady state, lumped parameter/distributed parameter), solution method, constituent equations and boundary/initial conditions.

2. Formulate mathematical models based on balances for conserved quantities and given or inferred physical phenomena that can be used to predict or explain the behavior of a simple chemical engineering operation or process. Example operations and processes include reactors, heat exchangers, fluid flow, tanks in series or parallel, heat conduction and convection.
3. Identify, explain and apply appropriate analytical or numerical methods (algebraic equations, differential equations, partial differential equations, iterative equations, Euler method, Runga-Kutta 4th order method, Newton-Raphson iteration) to solve common classes of engineering models.
4. Identify and formulate state-space (vector/matrix) and frequency-space representations for models of low complexity.
5. Apply Laplace transform methods to solve differential equation models in terms of transfer functions for low complexity chemical engineering systems.
6. Linearize nonlinear models using first order Taylor series expansion.
7. Employ deviation variables where appropriate.
8. Map the stability of linear models using eigenvalue methods.
9. Critically evaluate a model and its solution including issues such as accuracy, validity of assumptions, adequacy of description of phenomena, significance and limitations.
10. Prepare a technical report describing an engineering model, solution methodology and model predictions including a critical evaluation.

Relationship of Course to Program Outcomes (PO's)												
Program Outcome	**A**	**B**	**C**	**D**	**E**	**F**	**G1**	**G2**	**H**	**I**	**J**	**K**
Level of Coverage	S	S	I		S		R			S		S

Date of Preparation and Person(s) Preparing This Description
February 6, 2010: W. R. Ashurst, Timothy D. Placek

CHEN 3820 – CHEMICAL ENGINEERING LABORATORY I (2)

Required Core Course

2009-2010 Catalog Data **Lec (1) Lab (3).** Experimental study of chemical thermodynamics, heat and momentum transfer with analytical, numerical, and statistical analysis.

Prerequisites Pr: Completion of CHEN 3600 and CHEN 3620 with a grade of C or better.

Schedule One one-hour class session and one three-hour lab session per week

Course Objectives To provide students with an understanding of the relationship between chemical engineering theory and the performance of actual experimental laboratory operations. To provide students with the skills and experience of working in teams. To promote professional written reports and oral presentations.

Textbooks

Geankoplis, Transport Processes and Separation Process Principles, 4e, 2003, 9780131013674, Prentice-Hall

Taylor, An Introduction to Error Analysis, 2e, 1997, 9780935702750, Univ Science Books

Lecture Topics Covered:

1. Class overview (1 week)
2. Lab & industrial safety (1 week)
3. Analytical and statistical analysis of data (9 weeks)
4. Mid-term exam (1 week)
5. Practical engineering (1 week)
6. Final exam review (1 week)
7. Final exam (1 week)

Example Lab Topics:

1. Lab introduction / teaming exercise (1 week)
2. Explosive decompression (2 weeks)
3. Viscosity (2 weeks)
4. Friction losses in piping (2 weeks)
5. Centrifugal pump (2 weeks)
6. Fluidized bed (2 weeks)
7. Single effect evaporator (2 weeks)
8. Final presentation prep (1 week)
9. Final presentation (1 week)

Course Outcomes: Upon successful completion of this course, students should be able to:

1. Work in teams to conduct experiments in fluid dynamics and energy transport.
2. Analyze data from experiments and develop conclusions supported by the data.

3. Prepare laboratory reports (technical reports) that clearly convey pertinent background information, procedures, results, discussion and conclusions adhering to departmental formats.
4. Prepare and deliver an oral presentation that includes pertinent background information, procedures, results, discussion and conclusions.
5. Identify and describe and be familiar with the proper use of general laboratory equipment (process measurement devices) such as thermocouples, flow meters, balances, pressure gauges, etc.
6. Identify and describe and be familiar with the proper use of process hardware such as pipes, fittings, valves, rupture disks, pumps, etc.
7. Apply statistical methods and error analysis techniques to estimate the uncertainty in experimental results.
8. Apply safe laboratory practices by adhering to Auburn University "safe work guidelines" (SWG), adhering to specific laboratory/course "standard operating procedures" (SOP), and adhering to "personal protection equipment policies." (PPE)

Relationship of Course to Program Outcomes (PO's)												
Program Outcome	**A**	**B**	**C**	**D**	**E**	**F**	**G1**	**G2**	**H**	**I**	**J**	**K**
Level of Coverage	**R**	**S**		**S**	**R**	**I**	**S**	**S**	**I**	**I**	**I**	**I**

Date of Preparation and Person(s) Preparing This Description
February 6, 2010: William Josephson

CHEN 4450 – PROCESS ECONOMICS AND SAFETY (3)

Required Core Course

2009-2010 Catalog Data	**Lec (2), Lab (3).** Fundamentals and applications of process economics and design, computer-aided cost estimation, profitability analysis and process improvement. Application of chemical process safety, risk assessment and management, hazard and operability analysis, chemical engineering principles for risk reduction.
Prerequisites	Pr: CHEM 2080 and completion of CHEN 3370, CHEN 3650, CHEN 3660 and CHEN 3700 with grades of C or higher.
Schedule	Two one-hour class sessions and three one-hour lab sessions per week
Course Objectives	This course allows students to explore economic principles that play a role in process design. Learning objectives include understanding economic principles, estimating equipment and product costs, calculating interest and depreciation costs, evaluating capital investment profitability, and optimizing process designs based on economic objectives. Students experience working on teams and making oral technical presentations. Major emphasis is given to the incorporation of process-safety and environmental aspects into the design techniques and methodologies. Guest lectures on relevant design topics, individual and group case studies and formal reporting of results are elements of this course.

Textbooks

Peters, Plant Design & Economics for Chemical Engineers, 3e, 2003, 9780072392661, McGraw-Hill

Crowl, Chemical Process Safety: Fundamentals with Applications, 2e, 2001, 9780130181763, Prentice-Hall

Lecture Topics:

1. Introduction to process economics-financial algebra, cash flow, equipment cost indices (1 week)
2. Introduction to chemical process safety-industrial toxicology (1 week)
3. Methods for estimating fixed capital investment (1 week)
4. Industrial hygiene (1 week)
5. Gross and net profit, operating and product cost estimation (1 week)
6. Source and dispersion release models (2 weeks)
7. Interest, taxes and depreciation (1 week)
8. Flammability, inerting, static electricity, fires and explosions (2 weeks)
9. Profitability (1 week)
10. Relief systems (1 week)
11. Materials selection for process equipment (1 week)
12. Global economics (1 week)
13. Exams (1 week)

Laboratory Topics:

1. Professional development (2 weeks)

2. Computer methods for plant investment costs (3 weeks)
3. AIChE online industrial process safety modules and AIChE Safety Certificate program (1 week)
4. Project investment and operating costs with global raw materials, transportation and sales (7 weeks)
5. Final profitability and cost analysis with interest, depreciation and return on investment (1 week)
6. Student oral presentations (1 week)

Course Outcomes: Upon successful completion of this course, students should be able to:

1. Employ cost charts, historical data and cost indices to estimate and update equipment and plant costs.
2. Determine fixed, working, and total capital investment estimates for chemical manufacturing processes given process flowsheets, equipment specifications, and material and energy balances.
3. Find and apply resources to estimate raw material, product, labor, utilities, waste treatment, maintenance, royalties, administration and overhead costs.
4. Determine and use total product manufacturing and operating costs.
5. Explain and apply the concepts of simple and compound interest, present and future worth to determine the time value of money and incurred debt obligations.
6. Apply straight-line and MACRS depreciation methods with appropriate IRS recovery periods to determine project depreciation.
7. Calculate cash flow given sales income, operating costs, tax rates and depreciation.
8. Calculate profitability measures including rate of return on investment, net present worth, payback period, and discounted cash flow rate of return.
9. Apply modern financial analysis software, including ICARUS, to determine project profitability.
10. Analyze capital investment profitability in relation to corporate savings rate and/or minimum acceptable rate of return.
11. Apply both classical and modern financial analysis methods to sensitivity analysis of project profitability determining the effects of changes in raw material costs, plant size, process yields and royalties on profitability.
12. Assess the effects of global raw materials availability and cost on project profitability including geopolitical stability and global economics.
13. Apply probit analysis to determine the extent of damage from a causative variable.
14. Locate and apply resources to estimate in-plant toxicological hazards including MSDS, TLV-TWA, PEL, etc.
15. Determine worker exposures to toxic or corrosive vapors by material balances with diffusive and convective mass transport.
16. Determine appropriate methods to control potential health hazards by process modification, enclosures, local and dilution ventilation, wet methods, enhanced housekeeping and personal protection.
17. Apply source models to the release of liquid and vapor materials from holes or breaks in pipes, tanks and vessels.
18. Apply neutrally buoyant dispersion and source models to the release of toxins outside the plant boundary using Pasquill-Gifford models at varying distances, wind speeds, atmospheric and ground conditions to determine the most probable highest risk scenarios.
19. Find and apply toxic effect criteria for releases outside the plant boundary including ERPG, EEGL, Toxic Endpoint, etc.
20. Determine upper and lower flammability limits for process vapor mixtures in air and in oxygen.
21. Explain and employ flammability diagrams to determine limiting oxygen concentrations.
22. Analyze explosions by calculating the energy of chemical explosions, the resulting overpressure and

the effect of overpressure on structures at varying distances from the source in order to reduce potential damage.

23. Determine methods to prevent fires and explosions through process modification, inerting, controlling static electricity, employing explosion-proof electrical housing and employing ventilation.
24. Determine the proper relief guidelines and specify appropriate relief type. Determine sizes for liquid and vapor relief valves, flares and relief system knockout drums.
25. Analyze the venting of process vessels during a fire situation (external to the vessel) by applying energy balances and source models to the design of vapor relief valves.
26. Complete an on-line AIChE Safety Certificate on Safety in the Process Industries Module by Dr. Dan Crowl of Michigan Tech including corporate and lab safety, personal protective equipment, process area safety, DIERS, vent sizing, explosion experimental systems, and informal and formal safety reviews with study guide and on-line exam. Students must answer all questions correctly in order to receive a Safety Certificate.
27. Deliver an effective individual oral presentation with appropriate visual aids explaining a team oriented profitability assessment project. Prepare an effective technical report for the project.
28. Write an effective professional resume.
29. Explain professional standards for interviews and other contacts with prospective employers.

Relationship of Course to Program Outcomes (PO's)												
Program Outcome	**A**	**B**	**C**	**D**	**E**	**F**	**G1**	**G2**	**H**	**I**	**J**	**K**
Level of Coverage	**S**	**R**	**S**	**S**	**R**	**S**	**R**	**S**	**R**	**R**	**S**	**S**

Date of Preparation and Person(s) Preparing This Description
February 6, 2010: Robert P. Chambers

CHEN 4460 - PROCESS SIMULATION, SYNTHESIS, AND OPTIMIZATION (2)

Required Core Course

2009-2010 Catalog Data **Lec (1), Lab (3).** Fundamentals of computer-aided simulation and synthesis. Process integration and optimization principles including their applications in design, retrofitting and operation of chemical processes.

Prerequisites Pr: CHEM 2080 and completion of CHEN 3370, CHEN 3650, CHEN 3660, and CHEN 3700 with grades of C or higher.

Schedule One one-hour lecture session and two 75-minute lab sessions per week

Course Objectives This course is intended to introduce students to the fundamentals of computer-aided process synthesis, simulation, analysis and optimization. In particular, the course presents systematic tools for developing and screening potential process flowsheets. Students use a commercial process simulator (ASPEN PLUS) to aid in evaluating a variety of these process designs. Practical problems are used as examples. These problems include mass integration, heat-integration, separation processes and environmentally benign designs. Using a commercial solver package (LINGO) students are introduced to the formulation and solution of linear and nonlinear mathematical optimization problems for chemical engineering applications.

Textbooks

Seider, Seader, Lewin and Widagdo, Product and Process Design Principles: Synthesis, Analysis, and Evaluation, 3e, 2008, 9780470048955, Wiley
Eden, ASPEN Lab Notes, Auburn University

Lecture Topics:

1. Introduction to CHEN 4460: Course objectives, introduction of multimedia package, design and synthesis process (1 week)
2. Process creation: Preliminary database creation (1 week)
3. Heuristics for process synthesis: Reaction, mixing and recycle, separation, temperature – pressure - phase change, task integration (3 weeks)
4. Algorithmic methods for process synthesis: Reactor design, reactor network synthesis, synthesis of separation trains, sequencing of ordinary distillation columns (3 weeks)
5. Separation of non-ideal mixtures: Azeotropy, residue curve maps, distillation boundaries (2 weeks)
6. Heat and power integration: Thermal pinch analysis, heat exchanger network synthesis (3 weeks)
7. Mathematical optimization: Formulation and solution of LP, NLP, MILP, MINLP problems (2 weeks)

Lab Topics:

1. Principles of flowsheet simulation: Getting started in Aspen, problem set up, convergence (2 weeks)

2. Heat transfer: Pumps, compressors, expanders, shell-and-tube heat exchangers (2 weeks)
3. Thermodynamic analysis: Choosing property estimation methods, generating equilibrium diagrams, property data regression (2 weeks)
4. Separations: Flash operations, shortcut and rigorous fractionation/distillation models (2 weeks)
5. Reactions: Stoichiometric reactors, equilibrium reactors, PFR, CSTR (2 weeks)
6. Optimization: Introduction to LINGO, solution of LP, NLP, MILP, MINLP problems (2 weeks)
7. Simulation project: Flowsheet simulation with multiple unit operations, sensitivity analysis, heat integration and optimization (3 weeks)

Course Outcomes: Upon successful completion of this course, students should be able to:

1. Describe the more widely used industrial separation methods and their basis for separation.
2. Apply heuristics and systematic methods to narrow the search for a near-optimal sequence of distillation-type separations.
3. Sketch residue curve maps on a ternary phase diagram and define the range of possible distillation product compositions for a given feed composition.
4. Define the process flow diagram for a heterogeneous azeotropic distillation system.
5. Define the process flow diagram for a pressure swing distillation system.
6. Design and sequence distillation columns for azeotropic distillation of binary mixtures through analysis of residue curves and distillation boundaries.
7. Perform graphical and algebraic thermal pinch analysis to identify optimal heat recovery strategies for minimization of external heating and cooling requirements.
8. Synthesize heat exchanger networks that match specified process constraints and objectives with minimum total annualized cost and choose the best solution from the generated alternatives.
9. Apply state of the art mathematical programming techniques for solving LP, NLP, MILP and MINLP problems.
10. Set up a simulation model with the appropriate chemical components, unit specifications and choice of thermodynamic model and subsequently perform rigorous steady state simulation, using a commercially available process simulator, of individual process units such as compressors, flash columns, reactors, absorbers, strippers and distillation columns for binary as well as multi-component mixtures.
11. Optimize the individual units by identifying design variables available for manipulation and thereby evaluate and suggest design changes based on base case simulation results.
12. Simulate entire process flowsheets with multiple units and validate design suggestions obtained by performing energy pinch analysis.
13. Perform plant-wide sensitivity analysis to investigate the impact of certain process parameters on the overall performance.

Relationship of Course to Program Outcomes (PO's)												
Program Outcome	**A**	**B**	**C**	**D**	**E**	**F**	**G1**	**G2**	**H**	**I**	**J**	**K**
Level of Coverage	S	R	S	R	R		I	I		I		S

Date of Preparation and Person(s) Preparing This Description
February 6, 2010: Mario R. Eden

CHEN 4470 - PROCESS DESIGN PRACTICE (3)

Required Core Course

2009-2010 Catalog Data **Lec (2), Lab (3).** Flow sheet simulation and techno-economic analysis applied to complex, open-ended chemical processes. Screening of alternatives and economic optimizations. Capstone design course.

Prerequisites Pr: CHEN 3AA0, CHEN 4450 and CHEN 4460.

Schedule Two one-hour class sessions, and two 75-minute lab sessions per week

Course Objectives This course is designed to integrate chemical engineering concepts in designing complex industrial facilities.

Textbooks

Seider, Seader, Lewin and Widagdo, Product and Process Design Principles: Synthesis, Analysis, and Evaluation, 3e, 2008, 9780470048955, Wiley

Lecture Topics

1. Course introduction: project overview, report contents (1 week)
2. Mass integration: synthesis of mass exchange networks, graphical mass integration techniques, algebraic mass integration techniques (3 weeks)
3. Advanced column design: reactive distillation, reboiler selection and design, design of overhead condensers and air-cooled heat exchangers (1 week)
4. Physical property prediction and computer aided molecular design (0.5 weeks)
5. Managing and supervising major engineering projects (0.5 weeks)
6. Product design and six sigma (0.5 weeks)
7. Process risk assessment and inherently safe process design (1 week)
8. Integration of design and control (1.5 weeks)
9. Role of design engineers in technology development (0.5 weeks)
10. Final reports and oral presentations (1 week)
11. Additional project specific lectures are included each year, but the content varies depending on the project, e.g. in 2009 lectures on esterification processes were added, whereas in 2010 lectures on coal/biomass gasification were included. (4.5 weeks)

Laboratory Topics

1. Complex, open-ended design problem (15 weeks): Recent projects include:
    a. Design of acetic acid production from coal/biomass resources through gasification, methanol synthesis and carbonylation (2010)
    b. Design of butyl-acetate manufacturing process (2009)
    c. Design of sodium methylate process (2008)
    d. Design of a sustainable acrolein manufacturing process from dehydration of glycerin (2007).

Course Outcomes: Upon successful completion of this course, students should be able to:

1. Formulate and evaluate process and/or product design objectives and constraints for an open-ended problem.

2. Synthesize a process flowsheet capable of achieving the stated process and/or product objectives subject to a given set of constraints, by employing traditional as well as novel synthesis and design strategies.
3. Develop a rigorous steady state computer simulation of the process flowsheet, using commercially available software packages, capable of representing the process.
4. Evaluate chemical processing equipment alternatives for each processing step and select the appropriate candidates.
5. Perform equipment design using sizing methods provided by a process simulation package and perform cost estimation using computer aided tools as well as empirical correlations.
6. Identify the minimum cost potentials for mass and energy integration with special emphasis on sustainability, resource conservation, waste minimization and energy recovery.
7. Generate a broad range of feasible alternative designs capable of achieving the process and/or product objectives.
8. Perform economic sensitivity analysis in order to identify the primary process parameters affecting the economics of the process plant.
9. Utilize the understanding of process engineering, economics, environmental concerns as well as health and safety issues to select the optimum solution to a design problem from the generated alternatives.
10. Work in a team on solving an open-ended design project and exhibiting proficiency in developing effective task breakdowns and project plans, time management skills, task delegation and punctuality.
11. Prepare simulation memos and design reports that are properly organized and demonstrate concise, clear language, employing appropriately placed and constructed tables and graphs, with special emphasis on effective communication, neatness and punctuality.
12. Prepare and deliver a professional oral presentation with appropriate visual aids.
13. Identify and utilize traditional as well as novel sources of information such as the World Wide Web, databases, technical journals, and news.

Relationship of Course to Program Outcomes (PO's)												
Program Outcome	**A**	**B**	**C**	**D**	**E**	**F**	**G1**	**G2**	**H**	**I**	**J**	**K**
Level of Coverage	**R**	**R**	**S**	**S**	**S**	**R**	**S**	**S**	**S**	**S**	**R**	**S**

Date of Preparation and Person(s) Preparing This Description
February 6, 2010: Mario R. Eden

CHEN 4860 - CHEMICAL ENGINEERING LABORATORY II (2)

Required Core Course

2009-2010 Catalog Data **Lec (1), Lab (3)**. Experimental study of mass transfer, separations, and reaction engineering. Emphasis is on open-ended laboratory projects with electronic instrumentation; experimental design with analytical, numerical, and statistical analysis of data.

Prerequisites Pr: CHEN 3660 and CHEN 3820; P/C: CHEN 3700

Schedule One one-hour class session and one 3-hour lab session per week

Course Objectives To further develop the laboratory, data analysis, and communication skills learned in CHEN 3820. To teach students the safe operation of larger-scale chemical engineering equipment. To foster independent learning and synthetic thinking as related to engineering research.

Textbooks

Geankoplis, Transport Processes and Separation Process Principles, 4e, 2003, 9780131013674, Prentice-Hall

Taylor, An Introduction to Error Analysis, 2e, 1997, 9780935702750, Univ Science Books

Anderson, DOE Simplified w/CD, 2e, 1997, 1563273446, Taylor & Francis

Lecture Topics

1. Syllabus and expectations (1 week)
2. Experiments and related review (3 weeks)
3. Data analysis (4 weeks)
4. Feedback on first report (1 week)
5. Pre lab meetings for first lab (1 week)
6. Design of experiments (DOE) (5 weeks)

Lab Topics

1. Lab safety and equipment overview (1 week)
2. Reactions lab (1.5 weeks)
3. Distillation lab (1.5 week))
4. Drying lab (1.5 week)
5. Double effect evaporation lab (1.5 week)
6. Data analysis and pre-lab sessions (4 weeks)
7. Doe project meetings (3 weeks)
8. Doe project presentations (1 week)

Course Outcomes: Upon successful completion of this course, students should be able to:

1. Work in teams to plan and conduct experiments involving unit operations such as CSTR reactor, bioreactor, distillation column, dryer, double effect evaporator, ion exchange column and packed bed absorption column.

2. Apply statistical Design of Experiments (DOE) methodology to a simple 2-factorial experiment conceived of, designed and carried out by the student group, and to draw valid conclusions as to the statistical significance of factors from the output of a DOE software package.
3. Apply knowledge from prerequisite coursework and current technical literature to analyze and interpret experimental data from a proper statistical standpoint.
4. Determine parameters such as heat transfer coefficients, energy efficiency, heat loss, rates of mass transfer in unit operations equipment via the application of material and energy balance principles.
5. Apply appropriate software, statistical methods, and error analysis techniques to estimate the uncertainty in experimental results.
6. Prepare laboratory reports (technical reports) that clearly convey pertinent background information, procedures, results, discussion and conclusions adhering to departmental formats.
7. Prepare and deliver an oral presentation that includes pertinent background information, procedures, results, discussion and conclusions.
8. Apply safe laboratory practices by adhering to Auburn University "safe work guidelines" (SWG), adhering to specific laboratory/course "standard operating procedures" (SOP), and adhering to "personal protection equipment policies." (PPE)
9. Pass the Auburn University laboratory safety quiz.
10. Exhibit ethical lab practices in the recording of data, analysis of data, and reporting of results. Adhere to the chemical engineering honest policy.

Relationship of Course to Program Outcomes (PO's)												
Program Outcome	**A**	**B**	**C**	**D**	**E**	**F**	**G1**	**G2**	**H**	**I**	**J**	**K**
Level of Coverage	**R**	**S**		**S**	**R**	**R**	**S**	**R**	**I**	**R**		**S**

Date of Preparation and Person(s) Preparing This Description
February 6, 2010: Dave R. Mills

Appendix E1 – Chemical Engineering Progress Assessment II

CHEN 3AA0 Chemical Engineering Progress Assessment II

(Concepts Inventory Exam)

Instructions and Information for Students

(Revised August, 2010)

This document is intended to familiarize students with the Auburn University Department of Chemical Engineering Progress Assessment II which is also referred to as the Concept Inventory Exam (CIE). The following material discusses the nature of the CIE and the CHEN 3AA0 course including the manner in which they are administered.

Purpose: The purpose of the CIE is to improve the department's educational program by determining the extent to which students can successfully recall, apply and explain chemical engineering principles. The requirement that each student successfully pass this CIE with an acceptable score ensures that all graduates of this department have demonstrated adequate proficiency in chemical engineering principles and concepts. Furthermore, information from this exam process will allow the department to identify subject matter and content needing additional coverage or a different approach to its instruction.

Nature of Exam: The CIE consists of 15 multiple choice questions and 5 explain/describe questions each worth 5% credit for an overall total of 100%. These questions are generally non-numerical in nature (in that they usually will not have a numerical answer) but may involve processing some numerical data. You are permitted to use an approved calculator during the exam. No outside reference materials are allowed to be used during the exam. There are several equivalent versions of the exam which may be employed simultaneously to obtain the broadest information about student retention of important chemical engineering concepts.

In addition to each technical question, a short survey about the question itself (regarding its curriculum coverage, importance of the concept tested and question statement clarity) is provided and will be used to improve the exam.

Administration: The CIE is offered in CHEN 3AA0 and is part of the passing criteria in CHEN 3AA0. Students passing the CIE are eligible to pass CHEN 3AA0 and are thereby allowed into Senior Design (CHEN 4470). During the first few weeks of the fall term, the CHEN 3AA0 instructor(s) of record will administer the exam. Students who do not pass the first offering of the exam are eligible to take the exam at a later time during the fall semester. The second offering is scheduled during the late part of the term (exact date announced by the instructor) to provide time to study material and topics the student determines they need to review. The CIE will also be offered one time toward the end of spring and one time toward the end of summer semesters. Therefore, the CIE will be offered a maximum of four times per calendar year. Students should not enroll in CHEN 3AA0 unless they are concurrently enrolled in CHEN 3650 or have previously taken CHEN 3650.

Passing Criteria: The passing criteria for the CIE are evaluated by the faculty on a yearly basis. For recordkeeping purposes, the start of the CIE yearly cycle is the spring semester. Due to the evolving nature of the exam content, each yearly cycle of offerings may have differing passing criteria in order to maintain the departmental standard of excellence. It is anticipated that changes to the passing criteria will occur primarily on a yearly basis. For the 2010 calendar year offerings, the CIE passing criterion is 50% or greater in the overall exam score.

Scoring: It is the intention of this exam to accurately assess each student's retention and understanding of important concepts covered in previous courses. Students are expected to seriously attempt to provide an answer on all questions. The multiple choice questions will have 5 possible choices and one of them will be the single correct answer. Explain questions have free-form responses, and are generally expected to be answered in a short paragraph (or at most two). Responses to multiple choice questions are either correct or incorrect and a correct response adds 5% to the exam score. Responses to explain style questions are scored as "acceptable" or "unacceptable" and acceptable response add 5% to the exam score. Incorrect or unacceptable responses do not add to or subtract from the exam score. Several sample questions of each type are provided at the end of this information sheet.

CHEN 3AA0 and its relationship to CHEN 4470: CHEN 3AA0 has been and will continue to be a prerequisite course for CHEN 4470. It is expected that students will fulfill the prerequisite by passing the CIE.

Coverage: The subject matter tested on in the CIE includes major topics and course outcomes from the following courses:

ENGR 2010 Engineering Thermodynamics

CHEN 2100 Principles of Chemical Engineering (Material and Energy Balances)

CHEN 2610 Transport I (Fluid Mechanics)

CHEN 3370 Phase and Reaction Equilibria

CHEN 3600 Computer-Aided Chemical Engineering (Statistics)

CHEN 3620 Transport II (Heat and Mass Transfer)

CHEN 3650 Chemical Engineering Analysis

CHEN 3660 Chemical Engineering Separations

CHEN 3700 Chemical Reaction Engineering

CHEN 3820 Chemical Engineering Lab I

The course numbers above are clickable links to the corresponding course outlines. The course outcomes are contained within the course outline document.

Appendix D1 – Laboratory Assessment Rubric

[ ] CHEN3820 Student/Group Members: ____

[ ] CHEN4860 Reviewer: ___________________ Experiment: ____________________ Date: __________________

Outcome	Score	Exceptional (3)	Acceptable (2)	Marginal (1)	Unacceptable (0)
A. Our graduates have acquired and can apply knowledge in the areas of mathematics, science and engineering to solve problems encountered in the practice of chemical engineering.		Student groups apply knowledge with virtually no conceptual or procedural errors affecting the quality of the experimental results.	Student groups apply knowledge with no significant conceptual errors and only minor procedural errors.	Student groups apply knowledge with occasional conceptual errors and only minor procedural errors.	Student groups make significant conceptual and/or procedural errors affecting the quality of the experimental results.
B. Our graduates have acquired the ability to design and conduct experiments, as well as to analyze and interpret data.		Student groups design and conduct unit operations experiments with virtually no errors. Analysis and interpretation of results exceed requirements of experiment. Demonstrates significant higher-order thinking ability.	Student groups design and conduct experiment with virtually no errors. Analysis and interpretation of results meet requirements of experiment. Demonstrates some higher-order thinking ability.	Student groups design and conduct experiment with no significant errors. Results are analyzed but not interpreted. Demonstrates very limited evidence of higher-order thinking ability.	Student groups design and conduct experiments with major conceptual and/or procedural errors. No evidence of significant analysis and interpretation of results. Fails to meet requirements of the experiment. Demonstrates only lower-level thinking ability.
K. Our graduates have acquired the ability to utilize the techniques, skills, modern engineering tools and computer-based		Student groups demonstrated proficiency being able to use a provided spreadsheet or wrote their own spreadsheet to perform the necessary	Student groups demonstrated a reasonable understanding of the provided spreadsheet or wrote their own spreadsheet which adequately performs the necessary	Student groups demonstrated some unfamiliarity with the function and capabilities of the provided spreadsheet or the spreadsheets they wrote contain errors or approaches	Student groups did not demonstrate an understanding of the provided spreadsheet or could not write their own spreadsheet to perform the necessary engineering calculations Errors were

technologies necessary for effective chemical engineering practice.		engineering calculations which include some of the following: statistical analysis, processing and analysis of data, graphical analysis and presentation, etc. There is the highest degree of confidence in the computed results.	engineering calculations which include some of the following: statistical analysis, processing and analysis of data, graphical analysis and presentation, etc. There is a high degree of confidence in the computed results.	that would cause problems with the output. Errors were made in some of the following: statistical analysis, processing and analysis of data, graphical analysis and presentation, etc. There is some question about the accuracy of the computed results.	made in some or all of the following: statistical analysis, processing and analysis of data, graphical analysis and presentation, etc. The computed results contain obvious errors.
G1: Our graduates have acquired the ability to communicate effectively when employing written communications.		The Abstract/Summary is well-written and contains reference to all major aspects of carrying out the experiment and the results. The Introduction is complete and provides all necessary background principles for the experiment. The Experimental Procedure is well-written in paragraph format. All experimental details are covered. All figures, graphs, tables follow departmental format including numbering and appropriate titles/captions. All important trends and data comparisons have been interpreted correctly and discussed. A good understanding of results is conveyed. All important conclusions have been clearly brought forward. All grammar/spelling is correct. All sections are in order. Material is associated with the correct section. Formatting is excellent and report is highly readable.	The Abstract/Summary references most of the major aspects of the experiment, some minor details are missing. The Introduction is nearly complete, missing some minor points. The Experimental Procedure covers most important experimental details. Some minor details missing. All figures, graphs, tables are correctly drawn, but some have minor problems or could still be improved. Almost all of the results have been correctly interpreted and discussed. Only minor improvements are needed. All important conclusions have been brought forward, could be better stated A few grammar/spelling errors are present. The writing style is mature and readable. All sections are in order and most material is associated with the correct section. Formatting generally good but could still be improved.	The Abstract/Summary misses one or more major aspects of carrying out the experiment or the results. The Introduction contains overview information, but is missing some major points. The Experimental Procedure is missing some important experimental details. Most figures, graphs, tables are adequate but some are missing important or required features. Some of the results have been correctly interpreted and discussed; partial but incomplete understanding of results is evident. Conclusions regarding major points are drawn, but many are misstated, indicating a lack of understanding. Many grammar/spelling errors, generally readable with some rough spots in writing style Sections are in order but material is associated with the wrong section. Formatting is rough and readability suffers.	Student displays a lack of understanding about how to write an Abstract/Summary. Several major aspects of the experiment are missing. Very little background information provided or information is incorrect. The Experimental Procedure is missing many important experimental details. Figures, graphs, tables contain errors or are poorly constructed, have missing titles, captions or numbers, units missing or incorrect, etc. Very incomplete or incorrect interpretation of trends and comparison of data indicating a lack of understanding of results. Conclusions missing or missing the important points. Frequent grammar and/or spelling errors, writing style is rough and immature. Sections are out of order. Overall appearance is sloppy. Work is careless.

G2: Our graduates have acquired the ability to communicate effectively when employing oral communications.		Presentation is clear, logical and organized. Listener can follow line of reasoning. Level of presentation is appropriate for the audience. Presentation is a planned conversation, paced for audience understanding. It is not a reading of a paper. Speaker is clearly comfortable in front of the group and can be heard by all. Communication aids enhance the presentation. They are prepared in a professional manner. Font size on visuals is large enough to be seen by all. Information is organized to maximize audience understanding. Details are minimized so that main points stand out. Speaker provides an accurate and complete explanation of key concepts and theories, drawing upon relevant literature. Applications of theory are included to illuminate issues. Listeners gain insights. Sentences are complete and grammatical, and they flow together easily. Words are chosen for their precise meaning. Personal appearance is completely appropriate for the occasion and the audience. Consistently clarifies, restates, and	Presentation is generally clear and well organized. A few minor points may be confusing. Level of presentation is generally appropriate. Pacing is sometimes too fast or slow. The presenter seems slightly uncomfortable at times, and the audience occasionally has trouble hearing him/her. Communication aids contribute to the quality of the presentation. Font size is appropriate for reading. Appropriate information is included. Some material is not supported by visual aids. For the most part, explanations of concepts and theories are accurate and complete. Some helpful applications are included. For the most part, sentences are complete and grammatical, and they flow together easily. With a few exceptions, words are chosen for their precise meaning. Personal appearance is generally appropriate for the occasion and audience. However, some aspects of appearance reflect a lack of sensitivity to nuances of the occasion or expectations of the audience. Generally responds to audience comments, questions and needs. Misses some opportunities for	Listener can follow presentation only with effort. Some arguments are not clear. Organization seems haphazard. Aspects of presentation are too elementary or too sophisticated for audience. Presenter seems uncomfortable and can be heard only if listener is very attentive. Much of the time the presented material is read from the visual aids. Communication aids are poorly prepared or used inappropriately. Font is too small to be easily seen. Too much or too little information is included. Unimportant material is highlighted. Listeners may be confused. Explanations of concepts and/or theories are inaccurate or incomplete. Little attempt is made to tie theory to practice. Listeners gain little from the presentation. Listeners can follow the presentation, but they are distracted by some grammatical errors and use of slang. Some sentences are incomplete, and or vocabulary is somewhat limited or inappropriate. Personal appearance is inappropriate for the occasion and audience. Responds to questions inadequately.	Listener can rarely follow any part of the presentation. Most arguments are unclear. Little or no attempt at organization. The presentation is too elementary or too sophisticated for audience. Presenter seems uncomfortable and can be heard only if listener is very attentive. The presented material is read from the notes. Communication aids are poorly prepared or used inappropriately. Font is too small to be easily seen. Too much or too little information is included. Unimportant material is highlighted. Listeners may be confused. Explanations of concepts and/or theories are inaccurate or incomplete. No attempt is made to tie theory to practice. Listeners gain little from the presentation. Listeners cannot follow the Presentation. Grammatical errors and use of slang is completely distracting. Speakers sentences are incomplete, and or vocabulary is limited or inappropriate. Personal appearance is inappropriate for the occasion and audience. Responds to questions inadequately.

		responds to questions. Summarizes when needed.	interaction.		

Additional Comments: Please provide additional comments about any issues you felt were “marginal” or “unsatisfactory”.

Appendix D2 –Technical Report Rubric

Technical Report Rubric (Assessment of Written Communications)

Course No.: ____________________ Date: ____________________

Team/Student: ____________________ Reviewer: ____________________

Check only ONE box per row. DO NOT CHECK BETWEEN COLUMNS.

Item	Issue	Exceptional (3)	Acceptable (2)	Marginal (1)	Unacceptable (0)	Points
Writing Weight: 5	**Overall effectiveness of communication**	The writer's decisions about focus, organization, style/tone, and content made reading a pleasurable experience. Writing could be used as a model of how to fulfill the assignment. The purpose and focus of the writing are clear to the reader and the organization and content achieve the purpose well. Writing follows all requirements for the assignment.	The writer has made good decisions about focus, organization, style/tone, and content to communicate clearly and effectively. The purpose and focus of the writing are clear to the reader and the organization and content achieve the purpose well. Writing follows all requirements for the assignment.	The writer's decisions about focus, organization, style/tone, and/or content sometimes interfere with clear, effective communication. The purpose of the writing is not fully achieved. All requirements of the assignment may not be fulfilled.	The writer's decisions about focus, organization, style/tone, and/or content interfere with communication. The purpose of the writing is not achieved. Requirements of the assignment have not been fulfilled.	
Writing Weight: 3	**Clarity of writing**	Writing flows smoothly from one idea to another. The writer has taken pains to assist the reader in following the logic of the ideas expressed. Sequencing of ideas within paragraphs and transitions between paragraphs make the writer's points easy to follow.	Sentences are structured and word are chosen to communicate ideas clearly. Sequencing of ideas within paragraphs and transitions between paragraphs make the writer's points easy to follow.	Sentence structure and/or word choice sometimes interfere with clarity. Needs to improve sequencing of ideas within paragraphs and transitions between paragraphs to make the writing easy to follow.	Sentence structure, word choice, lack of transitions and/or sequencing of ideas make reading and understanding difficult.	
Writing Weight: 2	**Demonstration of knowledge**	Demonstration of full knowledge of the subject with explanations and elaboration.	Writer is at ease with content and able to elaborate and explain to some degree.	Writer is uncomfortable with content. Only basic concepts are demonstrated and interpreted.	No grasp of required subject matter. No understanding of major issues. No interpretation of results.	

Organization Weight: 1	**Flow of information**	Information is presented in a logical, interesting way, which is easy to follow.	Information is presented in a logical manner, which is easily followed.	Work is hard to follow as there is very little continuity.	Sequence of information is difficult to follow. No apparent structure or continuity.	
Organization Weight: 2	**Division of information**	All information is located in the appropriate section.	Some information is in the wrong section.	Many items are in the wrong section.	Lack of appropriate sections or many items are in the wrong section.	
Report Weight: 2	**Format & aesthetics**	Report format is consistent throughout including heading styles, fonts, margins, white space, etc.	Report format is generally consistent.	Many departures from required report format.	Work fails to follow required report format.	
Figures & Graphs Weight: 2	**Format & captions**	Departmental format is observed in all figures and graphs. Captions effectively communicate content.	Minor departures from required format or inconsistencies between figures and graphs. Captions effectively communicate content.	Many departures from required format or inconsistencies between figures and graphs. Captions are ineffective in communicating content.	Work fails to follow required format. Captions are ineffective in communicating content.	
Figures & Graphs Weight: 2	**Effectiveness**	All figures are effectively interpreted and discussed in the report.	Most figures are sufficiently properly interpreted and many important features noted.	Many figures are not interpreted. Important features are not communicated or understood.	Figures are not used effectively. Little understanding of important features or issues.	
Figures & Graphs Weight: 1	**Citations**	Citations consistent with format.	Minor inconsistencies referring to figures.	Many inconsistencies referring to figures.	Citations fail to follow required format.	
Tables Weight: 2	**Format & captions**	Departmental format is observed in all tables. Captions effectively communicate content.	Minor departures from required format or inconsistencies between tables. Captions effectively communicate content.	Many departures from required format or inconsistencies between tables. Captions are ineffective in communicating content.	Work fails to follow required format. Captions are ineffective in communicating content.	
Tables Weight: 2	**Effectiveness**	All tables are effectively interpreted and discussed in the report.	Most tables are sufficiently interpreted and many important features noted.	Many tables are not sufficiently interpreted. Important features are not communicated or understood.	Tables are not used effectively. Little understanding of important data or issues.	
Tables Weight: 1	**Citations**	Citations consistent with format.	Minor inconsistencies referring to tables.	Many inconsistencies referring to tables.	Citations fail to follow required format.	

Equations Weight: 2	**Format & Citation**	Departmental format is observed in all equations. Citations consistent with format.	Minor departures from required format or inconsistencies between equations. Minor problems with citation of equations. Some symbols not properly defined.	Many departures from required format. Many problems with citation of equations. Many symbols not properly defined.	Work fails to follow required format. Failed to use MS Equation Editor. Words used instead of symbols.	
Mechanics Weight: 1	**Spelling**	Negligible errors.	Minor errors.	Several errors.	Numerous errors.	
Mechanics Weight: 1	**Grammar**	Negligible errors.	Minor errors.	Several errors.	Numerous errors.	
Readability Weight: 2	**Noise-Free**	Report was free of "noise issues."	Some instances of "noise."	Many instances of "noise."	Report plagued with distractions and 'noise."	
References Weight: 2		Reference section complete, comprehensive and follows required format.	Minor inadequacies in references or inconsistencies in format.	Inadequate list of references or failure to follow required format.	No referencing system used.	
Overall Performance		**Exceptional**	**Acceptable**	**Marginal**	**Unacceptable**	**TOTAL**
Points Required		**76-95**	**56-75**	**36-55**	**0-35**	

Appendix D3 – Design Project Assessment Rubric

Design Project Assessment Rubric

Course No.: ______________________ Date: ______________

Team/Student: ______________________ Reviewer: ______________

Check only ONE box per row. DO NOT CHECK BETWEEN COLUMNS.

Topic	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	POINTS
ABET – C Design Problem and Boundaries Weight: 1	Little or no grasp of problem. Incapable of producing a successful solution.	Some understanding of problem. Major deficiencies that will impact the quality of solution.	Overall sound understanding of the problem and constraints. Does not significantly impair solution.	Clear and complete understanding of design goal and constraints.	
ABET – C Alternative Designs Weight: 2	Only one design presented or clearly infeasible alternative given.	Serious deficiencies in exploring and identifying alternative designs.	Alternative approaches identified to some degree.	Final design achieved after review of reasonable alternatives.	
ABET – K Use of Computer–Aided Tools Weight: 2	Serious deficiencies in understanding the correct selection and/or use of tools.	Minimal application and use of appropriate tools.	Computer–aided tools used with moderate effectiveness to develop designs.	Computer–aided tools are used effectively to develop and analyze designs.	
ABET – A Application of Engineering Principles Weight: 2	No or erroneous application of engineering principles yielding unreasonable solution.	Serious deficiencies in proper selection and use of engineering principles.	Effective application of engineering principles resulting in reasonable solution.	Critical selection and application of engineering principles ensuring reasonable results.	
ABET – C Final Design Weight: 3	Not capable of achieving desired objectives. No implementation of resource conservation and recycle strategies.	Barely capable of achieving desired objectives. Minimal utilization of resource conservation and recycle potentials.	Design meets desired objectives. Moderately effective utilization of resource conservation and recycle potentials.	Design meets or exceeds desired objectives. Effective implementation of resource conservation and recycle strategies.	
ABET – C Process Economics Weight: 1	No or totally erroneous cost estimates presented.	Reasonable cost estimates presented, but no profitability analysis included.	Reasonable profitability analysis presented, but no interpretation of the results.	Effective use of profitability analysis leading to improvement recommendations.	
ABET – E Interpretation of Results Weight: 2	No or erroneous conclusions based on achieved results.	Serious deficiencies in support for stated conclusions.	Sound conclusions reached based on achieved results.	Insightful, supported conclusions and recommendations.	
OVERALL PERFORMANCE	**Unacceptable**	**Marginal**	**Acceptable**	**Exceptional**	**TOTAL**

POINTS REQUIRED	0–9	10–19	20–29	30–39	

Appendix D4 – Ethics, Safety, Society, Environment Assessment Rubric

Ethics, Safety, Society, Environment Assessment Rubric

Course No.: ______________________ Date: ______________

Team/Student: ______________________ Reviewer: ______________

Check only ONE box per row. DO NOT CHECK BETWEEN COLUMNS.

Topic	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	POINTS
ABET – F Professional Integrity & Ethical Decision Making Weight: 1	No evidence of any appreciation and/or understanding of professional integrity and/or ethics. Incapable of answering any questions on the subject.	Serious deficiencies in appreciation and/or understanding of professional integrity and/or ethics. Only rudimentary questions are answered. Not able to elaborate or explain.	Sound understanding of and mostly effective in addressing issues related to integrity and ethics. Most decisions and recommendations are supported and can be justified. Some elaboration and explanations given.	Clear and complete understanding of and effective in addressing issues related to integrity and ethics. Decisions and recommendations are supported and discussed along with elaboration and explanation.	
ABET – J Safety & Health Issues Weight: 1	No understanding or appreciation of safety and health related issues.	Serious deficiencies in addressing health and safety issues leading to a unsupported and/or infeasible result.	Sound understanding of health and safety issues. Mostly effective in achieving supported results.	Complete understanding of health and safety issues leading to sound and supported results.	
ABET – J Environmental Aspects Weight: 1	No understanding or appreciation of the importance of environmental concerns.	Environmental aspects are addressed ineffectively with little or no effect on end results.	Sound understanding of environmental aspects. Mostly effective in addressing environmental issues.	Complete understanding of environmental aspects. Effective in addressing of environmental issues leading to a better result.	
ABET – H Public Interest & Societal Impact Weight: 1	No consideration of public interest or societal impact. None or erroneous evaluation of global effects of engineering project/product.	Serious deficiencies in understanding public interest and/or societal impact. Ineffective evaluation of impact of engineering project/product adversely affects result.	Sound understanding of public interest and societal impact. Mostly effective evaluation of engineering project/product impact leads to improved results.	Complete understanding of public interest and societal impact. Effective assessment of engineering project/product impact support and explain results.	
OVERALL PERFORMANCE	**Unacceptable**	**Marginal**	**Acceptable**	**Exceptional**	**TOTAL**
POINTS REQUIRED	**0–3**	**4–6**	**7–9**	**10–12**	

Appendix D5 – Written Communications Assessment Rubric

Written Communication Assessment Rubric

Course No.: ______________________ Date: ______________

Team/Student: ______________________ Reviewer: ______________

Check only ONE box per row. DO NOT CHECK BETWEEN COLUMNS.

Topic	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	POINTS
Organization & Style Weight: 2	Sequence of information is difficult to follow. No apparent structure or continuity. Purpose of work is not clearly stated.	Work is hard to follow as there is very little continuity. Purpose of work is stated, but does not assist in following work.	Information is presented in a logical manner, which is easily followed. Purpose of work is clearly stated assists the structure of work.	Information is presented in a logical, interesting way, which is easy to follow. Purpose is clearly stated and explains the structure of work.	
Content & Knowledge Weight: 3	No grasp of information. Clearly no knowledge of subject matter. No questions are answered. No interpretation made.	Uncomfortable with content. Only basic concepts are demonstrated and interpreted.	At ease with content and able to elaborate and explain to some degree.	Demonstration of full knowledge of the subject with explanations and elaboration.	
Format & Aesthetics Weight: 1	Work is illegible, format changes throughout, e.g. font type, size etc. Figures and tables are sloppy and fail to provide intended information.	Mostly consistent format. Figures and tables are legible, but not convincing.	Format is generally consistent including heading styles and captions. Figures and tables are neatly done and provide intended information.	Format is consistent throughout including heading styles and captions. Figures and tables are presented logically and reinforce the text.	
Spelling & Grammar Weight: 1	Numerous spelling and grammatical errors.	Several spelling and grammatical errors.	Minor misspellings and/or grammatical errors.	Negligible misspellings and/or grammatical errors.	
References Weight: 2	No referencing system used.	Inadequate list of references or references in text. Inconsistent or illogical referencing system.	Minor inadequacies in references. Consistent referencing system.	Reference section complete and comprehensive. Consistent and logical referencing system.	
OVERALL PERFORMANCE	**Unacceptable**	**Marginal**	**[ ] Acceptable**	**Exceptional**	**TOTAL**
POINTS REQUIRED	**0–6**	**7–13**	**14–20**	**21–27**	

Appendix D6 – Oral Communications Assessment Rubric

Oral Communications Assessment Rubric

Course No.: ______________________ Date: ______________

Team/Student: ______________________ Reviewer: ______________

Check only ONE box per row. DO NOT CHECK BETWEEN COLUMNS.

Topic	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	POINTS
Organization & Structure Weight: 1	Not possible to understand presentation due to absence of structure.	Difficult to follow presentation due to erratic topical shifts and jumps.	Most information is presented in logical order which is easy to follow.	All information is presented in a logical, interesting and novel sequence, which is easily followed.	
Content & Knowledge Weight: 3	No grasp of information. Unable to answer questions about subject.	Uncomfortable with information. Capable only of answering rudimentary questions.	At ease with content and able to elaborate and explain to some degree.	Demonstration of full knowledge of the subject with explanations and elaboration.	
Visual Aids & Neatness Weight: 2	No visual aids.	Occasional use of visual aids, however they barely support text or presentation. Several misspellings and/or grammatical errors on slides.	Visual aids are related to text and presentation. Minor misspellings and/or grammatical errors.	Text and presentation are reinforced by the use of visual aids. Negligible misspellings and/or grammatical errors.	
Delivery & Speaking Skills Weight: 2	Significant mumbling and incorrect pronunciation of terms. Voice level too low or too high. Monotonous, no eye contact, rate of speech too fast or too slow	Occasional mispronunciation of terms. Little eye contact, uneven rate, only little expression	Voice is clear and at a proper level. Most words pronounced correctly. Some eye contact, steady rate, excessively rehearsed	Clear voice and correct, precise pronunciation of terms. Good eye contact, steady rate, enthusiasm, confidence	
Presentation Length Weight: 1	Too long or too short. +/– 10 minutes	+/– 6 minutes	+/– 4 minutes	+/– 2 minutes	
OVERALL PERFORMANCE	**Unacceptable**	**Marginal**	**Acceptable**	**Exceptional**	**TOTAL**
POINTS REQUIRED	**0–6**	**7–13**	**14–20**	**21–27**	

Appendix D7 – Data Analysis / Experimental Design Assessment Rubric

Data Analysis / Experimental Design Assessment Rubric

Course No.: ______________________ Date: ______________

Team/Student: ______________________ Reviewer: ______________

Check only ONE box per row. DO NOT CHECK BETWEEN COLUMNS.

Topic	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	POINTS
Effectiveness of Experimental Design and/or Procedures Weight: 2	Very ineffective. Would not allow experimenters to achieve any goals.	Somewhat ineffective. Would allow experimenter(s) to achieve some goals.	Somewhat effective. Would allow experimenter(s) to achieve most goals.	Effective. Would allow experimenter(s) to achieve all goals.	
Execution of Procedures Weight: 1	Demonstrated little or no ability to conduct experiments. Did not collect meaningful data.	Demonstrated some ability to conduct experiments. Collected some meaningful data.	Demonstrated adequate ability to conduct experiments. Collected most of the needed data.	Demonstrated superior ability to conduct experiments. Collected all the appropriate data.	
Statistical Methods: Error Analysis, Regression, ANOVA Weight: 2	Statistical methods were completely misapplied or absent.	Statistical methods were attempted. Some methods were applied but with significant errors or omissions.	Statistical methods were attempted. Most methods were correctly applied but more could have been done with the data.	Statistical methods were fully and correctly applied.	
Focus of Results and Discussion Weight: 1	No insight. Entirely missed the point of the experiment.	Little insight. Analyzed only the most basic points.	Adequate insight. Missed some important points.	Excellent insight. Results and discussion well focused.	
Interpretation of Data Weight: 2	Little or no attempt to interpret data Or over-interpreted data.	Interpreted some data correctly. Significant errors, omissions, or over-interpreted data.	Interpreted most data correctly. Some conclusions may be suspect or over-interpreted.	Data completely and appropriately interpreted. Not over-interpreted.	
OVERALL PERFORMANCE	**Unacceptable**	**Marginal**	**Acceptable**	**Exceptional**	**TOTAL**
POINTS REQUIRED	**0–6**	**7–12**	**13–18**	**19–24**	

Appendix D8 – Other Work Skills Assessment Rubric

Other Work Skills Assessment Rubric

Course No.: ______________________ Date: ______________

Team/Student: ______________________ Reviewer: ______________

Check only ONE box per row. DO NOT CHECK BETWEEN COLUMNS.

Topic	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	POINTS
ABET – I Need for Life-Long Learning Weight: 1	Little or no awareness and/or use of external sources of information. Little or no initiative to explore new learning opportunities. Unwilling to take risks by undertaking challenging or unfamiliar assignments, e.g. no initiative to learn new software.	Some evidence of efforts to locate and use external resources. Some willingness to participate in learning activities and take risks. Some ability to use library/internet sources and e.g. new software packages.	Reasonable awareness and use of external resources. Reasonable willingness to participate in learning activities and take risks. Adequate ability to locate and use library and Internet resources. Shows reasonable attempt to, e.g. learn new software packages.	Fully aware of external sources of material. Effective use of supplementary resources. Actively seeks learning opportunities (reading, self-study, extra-curricular activities). Excellent ability to locate and use library and Internet resources. Seeks opportunities to learn new material, e.g. software packages.	
ABET – D Teamwork Weight: 1	Little or no distribution of work efforts and responsibilities. Little or no ability to work together in a professional and productive manner adversely affecting end result.	Minimal organization and planning with limited contributions of most team members. Significant deficiencies in leadership, cooperation and/or interaction. End result may suffer to some degree.	Adequate organization and planning with contributions from all members of the team. Some leadership, planning and interaction is evident.	Great organization and planning with full participation and technical contributions from all members. Utilizes technical strengths of each team member to full advantage leading to productive interaction.	
OVERALL PERFORMANCE	**Unacceptable**	**Marginal**	**Acceptable**	**Exceptional**	**TOTAL**
POINTS REQUIRED	**0–1**	**2–3**	**4-5**	**6**	

Appendix E – Rubric Summary Results (Summary Data)

Design Rubric Report - Spring 2009
CHEN 4470 - M.R. Eden

FINAL RESULTS	By Program Outcome												Success Criteria	
	A	B	C	D	E	F	G1	G2	H	I	J	K	Hi	Low
Exceptional or Acceptable	100%	ND	94%	88%	100%	100%	98%	96%	100%	100%	98%	100%		
Level A	✓				✓	✓	✓	✓	✓	✓	✓	✓	100	95
Level B			✓										95	90
Level C				✓									90	0

FINAL RESULTS	By Rubric Question																					
	Des 4 A	Des 1 C	Des 2 C	Des 5 C	Des 6 C	WS 2 D	Des 7 E	Env 1 F	WC 1 G1	WC 2 G1	WC 3 G1	WC 4 G1	WC 5 G1	OC 1 G2	OC 2 G2	OC 3 G2	OC 4 G2	OC 5 G2	Env 4 H	WS 1 I	Env 2 J	Env 3 J	Des 3 K
Exceptional or Acceptable	100%	100%	88%	88%	100%	88%	100%	100%	95%	100%	95%	100%	100%	100%	100%	92%	88%	100%	100%	100%	100%	96%	100%
Level A	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓
Level B																✓							
Level C			✓	✓		✓											✓						

Design Rubric Report - Spring 2008
CHEN 4470 - M.R. Eden

FINAL RESULTS	By Program Outcome												Success Criteria	
	A	B	C	D	E	F	G1	G2	H	I	J	K	Hi	Low
Exceptional or Acceptable	96%	ND	91%	89%	100%	100%	98%	95%	100%	100%	98%	93%		
Level A	✓				✓	✓	✓	✓	✓	✓	✓		100	95
Level B			✓									✓	95	90
Level C				✓									90	0

FINAL RESULTS	By Rubric Question																					
	Des 4 A	Des 1 C	Des 2 C	Des 5 C	Des 6 C	WS 2 D	Des 7 E	Env 1 F	WC 1 G1	WC 2 G1	WC 3 G1	WC 4 G1	WC 5 G1	OC 1 G2	OC 2 G2	OC 3 G2	OC 4 G2	OC 5 G2	Env 4 H	WS 1 I	Env 2 J	Env 3 J	Des 3 K
Exceptional or Acceptable	96%	89%	89%	89%	96%	89%	100%	100%	100%	100%	89%	100%	100%	100%	93%	100%	93%	89%	100%	100%	96%	100%	93%
Level A	✓				✓		✓	✓	✓	✓		✓	✓	✓		✓			✓	✓	✓	✓	

	Des 4 A	Des 1 C	Des 2 C	Des 5 C	Des 6 C	WS 2 D	Des 7 E	Env 1 F	WC 1 G1	WC 2 G1	WC 3 G1	WC 4 G1	WC 5 G1	OC 1 G2	OC 2 G2	OC 3 G2	OC 4 G2	OC 5 G2	Env 4 H	WS 1 I	Env 2 J	Env 3 J	Des 3 K
Level B															✓		✓						✓
Level C		✓	✓	✓		✓					✓							✓					

Design Rubric Report - Spring 2007
CHEN 4470 - M.R. Eden

FINAL RESULTS By Program Outcome	A	B	C	D	E	F	G1	G2	H	I	J	K	Success Criteria Hi	Low
Exceptional or Acceptable	100%	ND	99%	93%	96%	100%	97%	98%	100%	100%	94%	100%	Hi	Low
Level A	✓		✓		✓	✓	✓	✓	✓	✓		✓	100	95
Level B				✓							✓		95	90
Level C													90	0

FINAL RESULTS By Rubric Question	Des 4 A	Des 1 C	Des 2 C	Des 5 C	Des 6 C	WS 2 D	Des 7 E	Env 1 F	WC 1 G1	WC 2 G1	WC 3 G1	WC 4 G1	WC 5 G1	OC 1 G2	OC 2 G2	OC 3 G2	OC 4 G2	OC 5 G2	Env 4 H	WS 1 I	Env 2 J	Env 3 J	Des 3 K
Exceptional or Acceptable	100%	100%	96%	100%	100%	93%	96%	100%	96%	96%	93%	100%	100%	100%	89%	100%	100%	100%	100%	100%	96%	93%	100%
Level A	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
Level B						✓					✓											✓	
Level C															✓								

Design Rubric Report - Spring 2006
CHEN 4470 - M.R. Eden

FINAL RESULTS By Program Outcome	A	B	C	D	E	F	G1	G2	H	I	J	K	Success Criteria Hi	Low
Exceptional or Acceptable	100%	ND	100%	88%	100%	96%	95%	96%	100%	92%	98%	96%	Hi	Low
Level A	✓		✓		✓	✓	✓	✓	✓		✓	✓	100	95
Level B										✓			95	90
Level C				✓									90	0

FINAL RESULTS By Rubric Question	Des 4 A	Des 1 C	Des 2 C	Des 5 C	Des 6 C	WS 2 D	Des 7 E	Env 1 F	WC 1 G1	WC 2 G1	WC 3 G1	WC 4 G1	WC 5 G1	OC 1 G2	OC 2 G2	OC 3 G2	OC 4 G2	OC 5 G2	Env 4 H	WS 1 I	Env 2 J	Env 3 J	Des 3 K
Exceptional or Acceptable	100%	100%	100%	100%	100%	88%	100%	96%	100%	96%	100%	96%	84%	100%	88%	96%	96%	100%	100%	92%	96%	100%	96%
Level A	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓		✓	✓	✓

	Des 4 A	Des 1 C	Des 2 C	Des 5 C	Des 6 C	WS 2 D	Des 7 E	Env 1 F	WC 1 G1	WC 2 G1	WC 3 G1	WC 4 G1	WC 5 G1	OC 1 G2	OC 2 G2	OC 3 G2	OC 4 G2	OC 5 G2	Env 4 H	WS 1 I	Env 2 J	Env 3 J	Des 3 K
Level B																				✓			
Level C						✓							✓		✓								

Design Rubric Report - Spring 2005
CHEN 4470 - M.R. Eden

FINAL RESULTS	By Program Outcome												Success Criteria	
	A	**B**	**C**	**D**	**E**	**F**	**G1**	**G2**	**H**	**I**	**J**	**K**	**Hi**	**Low**
Exceptional or Acceptable	**90%**	**ND**	**91%**	**100 %**	**89%**	**95%**	**93%**	**85%**	**100 %**	**92%**	**92%**	**100 %**		
Level A				✓		✓			✓			✓	100	95
Level B	✓		✓				✓			✓	✓		95	90
Level C					✓			✓					90	0

FINAL RESULTS	By Rubric Question																						
	Des 4 A	**Des 1 C**	**Des 2 C**	**Des 5 C**	**Des 6 C**	**WS 2 D**	**Des 7 E**	**Env 1 F**	**WC 1 G1**	**WC 2 G1**	**WC 3 G1**	**WC 4 G1**	**WC 5 G1**	**OC 1 G2**	**OC 2 G2**	**OC 3 G2**	**OC 4 G2**	**OC 5 G2**	**Env 4 H**	**WS 1 I**	**Env 2 J**	**Env 3 J**	**Des 3 K**
Exceptional or Acceptable	**90%**	**92%**	**85%**	**97%**	**90%**	**100 %**	**89%**	**95%**	**95%**	**85%**	**95%**	**95%**	**97%**	**97%**	**67%**	**97%**	**79%**	**85%**	**100 %**	**92%**	**90%**	**95%**	**100 %**
Level A				✓		✓		✓	✓		✓	✓	✓	✓		✓			✓			✓	✓
Level B	✓	✓			✓															✓	✓		
Level C			✓				✓			✓					✓		✓	✓					

Design Rubric Report - Spring 2004
CHEN 4470 - M.R. Eden

FINAL RESULTS	By Program Outcome												Success Criteria	
	A	**B**	**C**	**D**	**E**	**F**	**G1**	**G2**	**H**	**I**	**J**	**K**	**Hi**	**Low**
Exceptional or Acceptable	**100 %**	**ND**	**100 %**	**98%**	**100 %**	**100 %**	**100 %**	**98%**	**98%**	**100 %**	**94%**	**100 %**		
Level A	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	100	95
Level B											✓		95	90
Level C													90	0

FINAL RESULTS	By Rubric Question																						
	Des 4 A	**Des 1 C**	**Des 2 C**	**Des 5 C**	**Des 6 C**	**WS 2 D**	**Des 7 E**	**Env 1 F**	**WC 1 G1**	**WC 2 G1**	**WC 3 G1**	**WC 4 G1**	**WC 5 G1**	**OC 1 G2**	**OC 2 G2**	**OC 3 G2**	**OC 4 G2**	**OC 5 G2**	**Env 4 H**	**WS 1 I**	**Env 2 J**	**Env 3 J**	**Des 3 K**
Exceptional or Acceptable	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**98%**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100%**	**98%**	**90%**	**98%**	**100 %**	**95%**	**93%**	**100 %**
Level A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓
Level B																		✓				✓	

Level C

Appendix E – Laboratory Assessment Rubric Results (Summary Data)

2009 Laboratory Assessment Data Fall 2009 (4860)		Assessment of Lab Related Outcomes (3=superior, 0=unacceptable)							
Students	Group Size	Experiment	Report Due	A	B	K	G1	G2	Type
	4	2 Effect Evaporator	14-Oct	2	2	2	3	NA	Written
	2	2 Effect Evaporator	14-Oct	0	1	0	1	NA	Written
	4	2 Effect Evaporator	30-Oct	2	2	2	2	NA	Written
	2	2 Effect Evaporator	4-Nov	1	2	2	1	NA	Written
	4	2 Effect Evaporator	11-Nov	3	3	2	2	NA	Written
	4	Distillation	28-Sep	0	1	1	0	NA	Written
	4	Distillation	14-Oct	2	2	2	2	NA	Written
	2	Distillation	26-Oct	1	1	2	1	NA	Written
	4	Distillation	28-Oct	2	2	2	2	NA	Written
	4	Distillation	11-Nov	2	2	2	2	NA	Written
	2	Distillation	11-Nov	2	2	2	2	NA	Written
	2	Dryer	28-Sep	2	2	2	1	NA	Written
	2	Dryer	12-Oct	1	2	2	1	NA	Written
	4	Dryer	14-Oct	1	1	2	1	NA	Written
	2	Dryer	26-Oct	3	3	3	2	NA	Written
	4	Dryer	28-Oct	3	2	3	3	NA	Written
	4	Dryer	11-Nov	2	1	2	1	NA	Written
	4	Reactions	1-Oct	3	3	3	2	NA	Written
	2	Reactions	12-Oct	3	2	2	3	NA	Written
	4	Reactions	14-Oct	3	3	2	3	NA	Written
	4	Reactions	28-Oct	3	3	2	3	NA	Written
	4	Reactions	11-Nov	2	2	3	2	NA	Written

Spring 2009 (4860)		Assessment of Lab Related Outcomes (3=superior, 0=unacceptable)							
Students	Group Size	Experiment	Report Due	A	B	K	G1	G2	Type

4	2 Effect Evaporator	9-Feb	2	1	2	2	NA	Written
3	2 Effect Evaporator	23-Feb	1	1	2	2	NA	Written
4	2 Effect Evaporator	9-Mar	1	2	2	3	NA	Written
4	2 Effect Evaporator	1-Apr	2	2	1	2	NA	Written
3	2 Effect Evaporator	13-Apr	2	2	2	3	NA	Written
4	Distillation	9-Feb	2	2	2	2	NA	Written
4	Distillation	23-Feb	2	2	2	2	NA	Written
3	Distillation	9-Mar	1	1	1	1	NA	Written
4	Distillation	30-Mar	2	1	1	2	NA	Written
3	Distillation	13-Apr	2	2	2	2	NA	Written
4	Dryer	9-Feb	1	2	1	1	NA	Written
3	Dryer	25-Feb	3	2	2	1	NA	Written
4	Dryer	11-Mar	2	1	2	0	NA	Written
3	Dryer	3-Apr	1	2	2	3	NA	Written
4	Dryer	16-Apr	3	2	3	3	NA	Written
3	Reactions	9-Feb	2	1	2	2	NA	Written
4	Reactions	23-Feb	2	1	1	1	NA	Written
3	Reactions	9-Mar	1	2	2	2	NA	Written
4	Reactions	30-Mar	1	1	1	2	NA	Written
4	Reactions	13-Apr	2	2	1	1	NA	Written
4	Dryer		1	2	2	NA	1	Oral
4	Reactions		2	0	3	NA	1	Oral
4	Distillation		2	2	3	NA	2	Oral
4	2 Effect Evaporator		2	2	1	NA	3	Oral
3	2 Effect Evaporator		1	2	2	NA	1	Oral
3	Dryer		2	2	3	NA	3	Oral
3	Reactions		2	2	2	NA	2	Oral
4	Distillation		0	1	1	NA	1	Oral
4	2 Effect Evaporator		2	1	2	NA	1	Oral
4	Dryer		2	2	1	NA	2	Oral
4	Reactions		3	3	2	NA	3	Oral
3	Dryer		2	2	2	NA	2	Oral
3	Reactions		3	2	3	NA	2	Oral
3	2 Effect Evaporator		2	2	1	NA	1	Oral
4	Distillation		3	3	3	NA	3	Oral
4	Reactions		1	2	1	NA	2	Oral
4	2 Effect Evaporator		2	2	1	NA	1	Oral

	4	Dryer	1	1	2	NA	2	Oral
	4	D.O.E.	3	3	2	NA	NA	D.O.E.
	3	D.O.E.	2	2	2	NA	NA	D.O.E.
	4	D.O.E.	3	2	3	NA	NA	D.O.E.
	3	D.O.E.	1	1	2	NA	NA	D.O.E.
	4	D.O.E.	2	2	2	NA	NA	D.O.E.

2009	AUCHEN	A	B	K	G1	G2
Unacceptable		3	1	1	2	0
Marginal		16	17	14	12	7
Acceptable		32	39	39	19	7
Superior		14	8	11	9	4
Total		65	65	65	42	18
%Acceptable		49%	60%	60%	45%	39%
%Superior		22%	12%	17%	21%	22%
%Acceptable + %Superior		71%	72%	77%	67%	61%
AUCHEN Criteria		C	C	B	C	C
A=>85%						
B=>75%						
C=<75%						

2008 Laboratory Assessment Data
Fall 2008 (4860) **Assessment of Lab Related Outcomes (3=superior, 0=unacceptable)**

Students	Group Size	Experiment	Report Due	A	B	K	G1	G2	Type
	3	Reactions	22-Oct	0	0	1	1	NA	Written
	3	Dryer	12-Nov	2	2	2	1	NA	Written
	3	Dryer	1-Oct	2	2	2	2	NA	Written
	3	Distillation	15-Oct	2	2	2	1	NA	Written
	3	2 Effect Evaporator	29-Oct	1	1	2	2	NA	Written
	3	Reactions	12-Nov	0	1	2	1	NA	Written
	3	2 Effect Evaporator	1-Oct	2	2	2	3	NA	Written
	3	Reactions	15-Oct	3	2	3	2	NA	Written
	3	Distillation	12-Nov	2	2	1	3	NA	Written
	3	Reactions	2-Oct	1	0	1	1	NA	Written

Students	Group Size	Experiment	Report Due	A	B	K	G1	G2	Type
	3	Dryer	27-Oct	1	2	2	2	NA	Written
	3	Distillation	7-Nov	1	2	2	3	NA	Written
	3	2 Effect Evaporator	18-Nov	1	1	2	2	NA	Written
	3	2 Effect Evaporator		1	1	2	NA	1	Oral
	3	Distillation		3	2	3	NA	2	Oral
	3	Reactions		3	2	3	NA	2	Oral
	2	Dryer		3	2	3	NA	3	Oral
	3	D.O.E.		2	1	1	NA	NA	DOE
	3	D.O.E.		3	2	1	NA	NA	DOE
	3	D.O.E.		2	3	3	NA	NA	DOE
	2	D.O.E.		2	1	2	NA	NA	DOE

Spring 2008 (4860) **Assessment of Lab Related Outcomes (3=superior, 0=unacceptable)**

Students	Group Size	Experiment	Report Due	A	B	K	G1	G2	Type
	3	Reactions - Batch & CSTR	7-Mar	2	2	1	2	NA	Written
	2	Reactions - Batch & CSTR	3-Mar	2	2	2	1	NA	Written
	3	Reactions - Batch & CSTR	1-Feb	1	2	2	1	NA	Written
	2	Reactions - Batch & CSTR	1-Feb	1	2	1	1	NA	Written
	2	Reactions - Batch & CSTR	5-Mar	3	2	3	3	NA	Written
	3	Reactions - Batch & CSTR	7-Mar	3	2	2	2	NA	Written
	3	Reactions - Batch & CSTR	29-Feb	1	1	1	1	NA	Written
	3	Reactions - Batch & CSTR	3-Mar	2	1	2	1	NA	Written
	3	D.O.E.		NA	NA	NA	NA	3	DOE
	3	D.O.E.		NA	NA	NA	NA	3	DOE
	3	D.O.E.		NA	NA	NA	NA	2	DOE
	2	D.O.E.		NA	NA	NA	NA	3	DOE
	2	D.O.E.		NA	NA	NA	NA	3	DOE
	2	D.O.E.		NA	NA	NA	NA	2	DOE

	3	D.O.E.		NA	NA	NA	NA	2	DOE
	3	D.O.E.		NA	NA	NA	NA	3	DOE

Annual Summary	2008	AUCHEN	A	B	K	G1	G2
Unacceptable			2	2	0	0	0
Marginal			9	8	8	10	1
Acceptable			11	18	15	7	5
Superior			7	1	6	4	6
Total			29	29	29	21	12
%Acceptable			38%	62%	52%	33%	42%
%Superior			24%	3%	21%	19%	50%
%Acceptable + %Superior			62%	66%	72%	52%	92%
AUCHEN Criteria			C	C	C	C	A
A=>85%							
B=>75%							
C=<75%							

2007 Laboratory Assessment Data

Summer 2007 (4860)		**Assessment of Lab Related Outcomes (3=superior, 0=unacceptable)**							
Students	**Group Size**	**Experiment**	**Report Due**	**A**	**B**	**K**	**G1**	**G2**	**Type**
	3	DOE		2	2	2		2	Oral
	3	DOE		2	2	2		2	Oral
	3	DOE		3	3	3		3	Oral
	3	Drying		2	1	2	2		Written
	3	Diffusion		2	1	2	2		Written
	3	Drying		0	1	1	1		Written
	3	Rxn/Kinetics		3	3	3	3		Written
	3	Bioreactor		3	3	3	3		Written
	3	Rxn/Kinetics		2	1	2	2		Written
	3	Rxn/Kinetics		2	3	3	2		Written
	3	Diffusion		1	2	2	2		Written
	3	Bioreactor		0	0	1	0		Written

Fall 2007 (4860) **Assessment of Lab Related Outcomes (3=superior, 0=unacceptable)**

Students	Group Size	Experiment	Report Due	A	B	K	G1	G2	Type
	4	Evaporator		3	2	2	2		Written
	3	Drying		3	3	2	3		Written
	4	Bioreactor		2	2	3	3		Written
	4	DOE		2	2	2		2	Oral
	3	DOE		2	2	2		2	Oral
	4	DOE		3	3	3		3	Oral

Annual Summary	**2007**	**AUCHEN**	**A**	**B**	**K**	**G1**	**G2**
Unacceptable			2	1	0	1	0
Marginal			1	4	2	1	0
Acceptable			9	7	10	6	4
Superior			6	6	6	4	2
Total			18	18	18	12	6
%Acceptable			50%	39%	56%	50%	67%
%Superior			33%	33%	33%	33%	33%
%Acceptable + %Superior			83%	72%	89%	83%	100%
AUCHEN Criteria			B	C	A	B	A
A=>85%							
B=>75%							
C=<75%							

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		Analysis (Data Sorted By Outcome)														
	Rubric	**DA**	**DA**	**DA**	**DA**	**DA**	**WC**	**WC**	**WC**	**WC**	**WC**	**OC**	**OC**	**OC**	**OC**	**OC**
	Topic	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
	Weight	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**
	Outcome	**3a**	**3b**	**3c**	**3d**	**3e**	**8a**	**8b**	**8c**	**8d**	**8e**	**9a**	**9b**	**9c**	**9d**	**9e**
Lab	**Grp**															
1		3	3	2	2	2	1	2	1	1	3					
2																
3	1											2	2	3	2	3

4																
5																
6		1	1	0	1	0	1	0	2	0						
1		3	3	2	3	2	3	3	3	3	3					
2																
3	**2**											3	3	2	3	3
4																
5																
6		2	3	2	3	3	2	3	2	3						
1		3	3	3	3	2	1	3	2	3	2					
2																
3	**3**											2	2	2	3	3
4																
5																
6		3	3	3	3	3	3	3	3	3						
1																
2																
3	**4**															
4																
5																
6		2	3	3	3	2	3	2	3	3						
1																
2												3	3	3	3	3
3	**5**															
4																
5																
6		2	2	2	2	3	2	2	3	3						
1																
2																
3	**6**											3	2	2	3	2
4																
5																
6																
1		3	3	1	1	0	2	1	1	1						
2		3	3	2	3	3	3	3	1	3						
3	**7**	3	3	2	2	1	1	1	1	3						
4		3	3	1	0	0	1	1	0	0						

5		3	3	3	3	3	3	2	3	3						
6		3	3	3	3	3	3	3	3	3						
1		3	3	2	1	0	1	1	1	1						
2		3	3	3	2	2	3	2	3	3						
3	**8**	3	3	0	1	1										
4																
5																
6																

Rubric Score Tally (By Rubric Question)															
0	0	0	2	1	4	0	1	1	2	0	0	0	0	0	0
1	1	1	2	4	2	6	4	5	3	0	0	0	0	0	0
2	3	1	7	4	5	3	5	3	0	1	2	3	3	1	1
3	13	15	6	8	6	7	6	7	11	2	3	2	2	4	4
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Rubric Score Totals			
Unacceptable	7	4	0
Marginal	10	18	0
Acceptable	20	12	10
Exceptional	48	33	15
Totals	85	67	25

FINAL RESULTS	**Outcome**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Exceptional or Acceptable	**ND**	**ND**	**80.0**	**ND**	**ND**	**ND**	**ND**	**67.2**	**100.0**	**ND**	**ND**
Level A									A		
Level B											
Level C			C					C			
AUCHEN	**A**	**E**	**B**	**K**	**C**	**F**	**H/J**	**G1**	**G2**	**D**	**I**

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CHEN 4860 - Placek

	Analysis (Data Sorted By Outcome)														
Rubric	**DA**	**DA**	**DA**	**DA**	**DA**	**WC**	**WC**	**WC**	**WC**	**WC**	**OC**	**OC**	**OC**	**OC**	**OC**

	Topic		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
	Weight		**2**	**2**	**2**	**1**	**2**	**2**	**3**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**
	Outcome		**3a**	**3b**	**3c**	**3d**	**3e**	**8a**	**8b**	**8c**	**8d**	**8e**	**9a**	**9b**	**9c**	**9d**	**9e**
Lab		**Grp**															
1			2	2	2	2	1	2	2	2	3	2					
2			2	2	1	2	2	2	2	2	2	1					
3		**1**	2	2	1	3	1	3	2	3	3	3					
4																	
5																	
6																	
1			2	2	1	2	2	1	1	2	3	0					
2			2	2	1	2	2	2	2	2	2	2					
3		**2**	1	2	2	2	2	3	1	3	3	3					
4																	
5																	
6																	
1			3	2	2	2	2	3	2	3	3	2					
2			2	2	1	2	2	2	2	2	2	1					
3		**3**	3	3	3	2	3	3	3	3	3	3					
4												3					
5																	
6																	
1			3	3	3	2	2	3	3	3	3	0					
2			3	3	0	2	2	3	2	2	2	2					
3		**4**	0	0	3	1	0	0	1	2	1	3					
4																	
5																	
6																	
1			2	1	1	2	1	3	2	2	2	2					
2			3	3	0	2	2	3	2	2	2	2					
3		**5**	3	3	2	2	2	2	2	3	3	3					
4																	
5																	
6																	
1			2	2	2	2	1	3	2	2	2	2					
2			2	3	2	3	2	3	2	3	3	3					
3		**6**	1	2	1	3	1	2	1	3	3	3					

4											
5											
6											
1		2	2	2	2	2	2	1	2	3	1
2		0	1	0	1	1	1	1	1	2	1
3	**7**	3	3	3	2	3	3	2	3	3	3
4											
5											
6											
1		1	1	1	1	1	1	1	2	2	0
2		0	1	0	1	1	1	1	1	2	1
3	**8**	2	3	3	2	3	3	2	3	3	3
4											
5											
6											
1		2	2	2	2	1	2	1	2	3	2
2		2	3	2	3	2	3	2	3	3	3
3	**9**	3	3	3	3	2	2	3	3	3	3
4											
5											
6											

Rubric Score Tally (By Rubric Question)															
0	3	1	4	0	1	1	0	0	0	3	0	0	0	0	0
1	3	4	8	4	9	4	9	2	1	5	0	0	0	0	0
2	13	12	9	18	14	9	15	13	10	8	0	0	0	0	0
3	8	10	6	5	3	13	3	12	16	12	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Rubric Score Totals			
Unacceptable	9	4	0
Marginal	28	21	0
Acceptable	66	55	0
Exceptional	32	56	0
Totals	135	136	0

FINAL RESULTS	**Outcome**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**

Exceptional or Acceptable	ND	ND	72.6	ND	ND	ND	ND	81.6	ND	ND	ND
Level A									ND		
Level B									ND		
Level C			C					C	ND		
AUCHEN	A	E	B	K	C	F	H/J	G1	G2	D	I

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		Analysis (Data Sorted By Outcome)														
	Rubric	DA	DA	DA	DA	DA	WC	WC	WC	WC	WC	OC	OC	OC	OC	OC
	Topic	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Weight	2	2	2	1	2	2	3	1	1	2	2	1	2	2	2
	Outcome	3a	3b	3c	3d	3e	8a	8b	8c	8d	8e	9a	9b	9c	9d	9e
Lab	**Grp**															
1		3	3	3	2	2	3	2	2	3	2					
2		3	3	2	2	3	3	2	3	3						
3	1															
4																
5																
6		2	3	3	3	2						3	2	2	2	3
1		3	3	3	3	3	3	3	3	3	3					
2		3	3	2	2	2	2	2	3	2						
3	2															
4																
5																
6		3	3	3	3	2						3	3	3	3	3
1																
2		3	2	3	2	2	2	2	3	3						
3	3															
4																
5																
6		2	3	2	3	3						3	3	2	3	2
1		2	2	1	1	0	1	0	1	2	2					
2		3	2	1	1	1	1	1	1	2						

3	**4**															
4																
5																
6		2	3	2	2	2						2	2	3	3	1

Rubric Score Tally (By Rubric Question)															
0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
1	0	0	2	2	1	2	1	2	0	0	0	0	0	0	1
2	4	3	4	5	6	2	4	1	3	2	1	2	2	1	1
3	7	8	5	4	3	3	1	4	4	1	3	2	2	3	2
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Rubric Score Totals			
Unacceptable	1	1	0
Marginal	5	5	1
Acceptable	22	12	7
Exceptional	27	13	12
Totals	55	31	20

FINAL RESULTS	**Outcome**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Exceptional or Acceptable	**ND**	**ND**	**89.1**	**ND**	**ND**	**ND**	**ND**	**80.6**	**95.0**	**ND**	**ND**
Level A									A		
Level B											
Level C			C					C			
AUCHEN	**A**	**E**	**B**	**K**	**C**	**F**	**H/J**	**G1**	**G2**	**D**	**I**

Appendix F – Principles of Writing for All Majors

Principles of Writing for all Majors Final version approved by Writing Committee April 23, 2010

Introduction:

The goal of implementing writing in the majors is to provide students with instruction in, and opportunities to practice, the kinds of writing most relevant to their field of study and future careers, and to have these experiences under the direction of faculty members who are experts in that major. Recognizing that no single plan will fit the needs of all departments, the University Writing Committee will review plans devised by departments to ensure that all plans satisfy the five principles identified below. Though not required, the Committee has also identified common practices that might serve to guide the development, implementation and assessment of programmatic plans. We ask that plans be presented in a format that makes sense to the department, that they provide a clear explanation of where the principles occur across the major, and that the assessment procedures be clearly connected to the kinds of writing outcomes the department articulates for its majors.

Criteria for evaluating writing in the majors:

The plan will:

1. Provide more than one opportunity for students to practice writing. While a program might want to designate a specific course or courses as "writing intensive," it is equally possible to weave opportunities to write throughout the curriculum so that no one course or faculty member shoulders the burden of teaching writing to all majors. The Writing Committee does NOT expect that every class will contain significant writing experiences.

2. Provide opportunities for students to practice producing more than one kind of writing. Programs should identify the types of writing that are a) most useful to students during the major, b) necessary to advanced study in the major, or c) expected in the professions students with the major typically enter. The opportunities provided might include using print and electronic forms as appropriate. Examples of types of writing to consider include: letters, memos, formal reports, research articles, field reports, annotations, summaries, reading responses, interviews, essays of critical analysis, position statements, design plans, research or design posters, original video scripts, websites, etc.

3. Provide opportunities for students to write for different purposes and audiences. Programs are encouraged to consider the range of purposes and audiences that their students need to address and to include opportunities for students to practice writing. Examples of different purposes and audiences include: to learn, to think critically, to inquire, to provide useful feedback to other writers, to communicate with clients outside the classroom, to reflect, to take a stance, to develop an argument, to present disciplinary research for a lay audience or for experts in the field, etc.

4. Provide opportunities for students to revise their written work based on individual feedback from the instructor and from peers to improve both the content and form of their work. Revision can take many forms and occur at different points in the writing process. Programs are encouraged to consider the most appropriate ways to include feedback and revision opportunities that support both writing and

other curricular objectives. For example, feedback on early assignments helps students revise their approach to later assignments of the same type, feedback from peer responders allows students to revise before the instructor sees the writing, feedback on component parts of a long assignment allows students to revise before submitting the compiled document, feedback on a draft allows students to revise to incorporate suggestions, feedback on finished work can encourage revisions that shift the audience or extend and deepen the project, etc.

5. Include an assessment plan that uses the data obtained to make decisions about what else needs to be done to enhance the writing experiences of students in the major. How programs assess their plan depends on what aspects of the student writing experience the faculty has decided to work on. Programs might select a specific issue to focus on such as: expanding types of writing, distributing writing over more courses, improving feedback and revision, incorporating extra-curricular writing components, improving peer responses, etc.

Common Program-level Practices

Identify the writing competencies expected of graduates of the major.

Engage faculty members in developing a plan for providing opportunities for students to practice and produce multiple kinds of writing for different purposes and receive feedback that allows students to work on their writing in courses across the major.

Identify and provide additional instruction to students whose writing is judged to be unacceptable in terms of standard written English.

Assess the plan and use the data obtained to make decisions about what else needs to be done to enhance the writing experiences of students in the major.

Common Course-level/Faculty-level Practices

Develop writing assignments or activities appropriate to the level and content of the course using print and electronic forms appropriate for the major.

Provide appropriate instruction in the features of writing necessary for the students to complete the writing assignments.

Provide students with peer and individual feedback, including feedback for all students writing collaboratively as part of a group, ensuring that the feedback reflects the goals of the writing assignment.

Provide opportunities for students to revise their work after receiving feedback.

Identify and provide additional instruction (perhaps by referring the student to the writing center) for those students who do not produce reasonably fluent, standard written English.

Common Student-level Practices

Build on writing experiences from core courses to produce writing relevant to the major

Be able to produce more than one kind of writing, for different purposes, using appropriate print and electronic forms.

Be able to use feedback from the instructors and peers to revise writing to improve both content and form.

Be able to produce writing that others will judge to be acceptable in terms of standard written English and that responds appropriately to the rhetorical situation (audience, purpose, genre, format, material).

Has strategies for working on writing, e.g. is able to use feedback from others to make decisions about revising a piece of writing, is able to shift to different audiences or formats, is able to manage technical issues like citation of sources, inclusion of visual materials, or proofreading, etc.

Office of University Writing
Margaret J. Marshall, Director
3436 RBD Library
334-844-7474
mmarshall@auburn.edu