Department: Biomedical, Chemical and Materials Engineering
Program: Chemical Engineering
College: Engineering
Website: http://bcme.sjsu.edu/

Check here if your website addresses the University Learning Goals. <If so, please provide the link.>

Program Accreditation (if any): ABET through 2016
Contact Person and Email: Melanie McNeil, Melanie.McNeil@sjsu.edu
Date of Report: February 28, 2017

Part A

List of Program Learning Outcomes (PLOs)
The student outcomes for the Chemical Engineering Program are the following:
1.) Ability to apply knowledge of mathematics, science and engineering
2.) Ability to design/conduct experiments and analyze/interpret data
3.) Ability to design system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability and sustainability
4.) Ability to function on multi-disciplinary teams
5.) Ability to identify, formulate and solve engineering problems
6.) Understanding of professional and ethical responsibility
7.) Ability to communicate effectively
8.) Understand the impact of engineering solutions in a global/societal context
9.) Recognition of the need for and an ability to engage in life-long learning
10.) Knowledge of emerging and new technologies and contemporary social issues
11.) Ability to use the techniques, skills and modern tools necessary for engineering practice

1. Map of PLOs to University Learning Goals (ULGs)
<table>
<thead>
<tr>
<th>PLO/ULG</th>
<th>Specialized knowledge</th>
<th>Broad Integrative knowledge</th>
<th>Intellectual Skills</th>
<th>Applied Knowledge</th>
<th>Social and Global Responsibilities</th>
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<td>a. Disciplinary knowledge</td>
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<td>b. Proficiency with experiments</td>
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<td>d. Multidisciplinary teamwork</td>
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<td>f. Ethics</td>
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<td>g. Communication skills</td>
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<td>h. Broad impacts of engineering</td>
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<td>i. Life-long learning</td>
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<td>j. Contemporary issues of engineering</td>
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<td>k. Modern tools</td>
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Alignment – Matrix of PLOs to Courses

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<tr>
<th>Course</th>
<th>1.0 (a)</th>
<th>2.0 (b)</th>
<th>3.0 (c)</th>
<th>4.0 (d)</th>
<th>5.0 (e)</th>
<th>6.0 (f)</th>
<th>7.0 (g)</th>
<th>8.0 (h)</th>
<th>9.0 (i)</th>
<th>10.0 (j)</th>
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<td>MATH 30 Calculus I</td>
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<td>CHE 190 Transport Phenomena</td>
<td>CHE 162 Statistics and Analysis</td>
<td>CHE 115 Industrial Chemical Calculations</td>
<td>ENGR 100W Engineering Reports</td>
<td>CHE 151 Process Engineering Thermodynamics</td>
<td>ADV GE Area S (Self, Society &amp; Equality in the US)</td>
<td>Chem 112B Organic Chemistry</td>
<td>CHEM 113A Organic Chemistry Laboratory</td>
<td>CHE 160A Unit Operations I</td>
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### 2. Planning – Assessment Schedule

Once a year, we carry out the assessment according to this schedule. Note the student (program) outcomes are numbered one to eleven as listed in Part A above, with the number after the decimal point identifying a performance indicator to define exactly what the students must do to achieve the outcome. The course numbers listed across the top of the table can be found in the above table. The courses to the left of the table are the junior courses and those on the right are the senior courses. The assessment of each outcome can be found below in part C of this report. Our annual assessment schedule includes the assessment of each outcome each year.

<table>
<thead>
<tr>
<th>Performance Criteria</th>
<th>115</th>
<th>190</th>
<th>151</th>
<th>160A</th>
<th>162</th>
<th>158</th>
<th>160B</th>
<th>161</th>
<th>161L</th>
<th>162L</th>
<th>165</th>
<th>185</th>
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<tr>
<td>1.1 Analyze systems through material and energy balances models</td>
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<td>1.2 Specify operating conditions for a heat exchanger to meet performance requirements</td>
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<td>1.3 Evaluate the design of a non-isothermal reactor for a chemical process.</td>
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<td>2.1 Analyze and interpret data for chemical reaction kinetics</td>
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<td>2.2 Design an experiment for a unit operation experiment</td>
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<td>2.3 Analyze and interpret data for a unit operation experiment</td>
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<td>3.1 Design an isothermal reactor for a chemical process.</td>
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<td>3.2 Complete process operating risk analyses for a plant and develop inherently safe system to minimize risk</td>
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<td>3.3 Analyze, design and evaluate mass transfer processes for specific</td>
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<td>4.1</td>
<td>Function effectively on multi-disciplinary teams</td>
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<td>5.1</td>
<td>Analyze a thermal system for appropriate heat transfer prediction</td>
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<td>5.2</td>
<td>Compare alternative reactor designs and select the most effective choice for a given process</td>
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<td>6.1</td>
<td>Students demonstrate knowledge of code of engineering ethics</td>
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<td>6.2</td>
<td>Identify the ethical issues in a case study</td>
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<td>6.3</td>
<td>Students can design a strategy to manage a situation where an employee/subordinate commits a violation of engineering ethics</td>
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<td>7.1</td>
<td>Write effectively</td>
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<td>7.2</td>
<td>Give an effective oral presentation</td>
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<td>8.1</td>
<td>Appraise the inherent safety strategies applied in an experiment or process</td>
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<td>8.2</td>
<td>Estimate the societal impact of a project on the surrounding community</td>
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<td>9.1</td>
<td>Evaluate a technical process based on a journal review article.</td>
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<td>10.1</td>
<td>Evaluate relative technical and economic merit for alternate process configurations</td>
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11. 1  Use simulation software to design a unit operation to meet specified performance criteria.  

11. 2  Use non-linear regression to evaluate kinetic mechanisms.

- 1,2 and 3 refer to levels of learning according to Bloom’s Taxonomy. Level 1 is up to level 2 in Blooms, Level 2 on this table refers to levels 3-4 in Blooms and Level 3 on this table refers to Blooms levels 5-6.

3.  **Student Experience**  
   
   On the first day of CHE 115, which is the first required core course taken before the other courses, a presentation is given to the students to explain the accreditation process and where the various outcomes are assessed throughout the required curriculum. As the courses progress, the faculty who are responsible for the individual outcomes may alert the students (especially if the assessment instrument is not assigned for a grade) what the purpose of the assignment is.

**Part C**

1.  **Closing the Loop/Recommended Actions**  

   **Changes based on evaluation of student outcomes.**  

   Our 2015/2016 report included recommended actions based on our assessment of student outcomes. We have begun the process of implementing the changes and have since had the following curriculum changes approved which will take place starting Fall 2017.

   1.  **Drop EE 98**

   Due to the impact of the reduction to 120 units and as part of the process of continuous improvement, the ChE Program faculty reviewed other CSU and UC Chemical Engineering Programs and found that they were not including EE 98 as a required course. Instead the small amount of directly pertinent material was added to Heat Transfer, and to Process Control, ChE 190 and ChE 185, respectively, for our program. To align with other ChE programs we elected to drop EE 98 as a required course. Nationwide, the ChE focus is on a broader array of industries such as biotech, environmental engineering, alternative energy, and biomedical engineering to name a few. As such the core curriculum has adjusted to accommodate this broader focus and EE 98 content is not required for the changed focus.

   2.  **Revise ChE 162 Engineering Statistics and Analysis**

   from a 3 unit lecture course to an applied 2 unit course with 1 hour lecture and a 3 hour hands on lab per week. As part of the process of continuous improvement inspired by ABET, the ChE Program reviewed other CSU and UC Chemical Engineering Programs and found that there was a movement from a lecture-based statistics course to an applied-based statistics course. The lecture-based course focuses on theorems and similar due to its math-based background. However, it is most useful for students to learn how to apply statistics to experimental data using e.g. MiniTab or Excel for ANOVA and similar type analyses. Thus, we think the applied format will allow our students to learn and apply statistics in a significantly enhanced manner.
3. Drop Engr 195A/195B and require students to take a stand alone Area S and Area V course. Due to other changes in the curriculum mentioned in (1) and (2) above, the overall impact keeps the ChE program at 120 units. After two years (2014/2015 and 2015/2016) trying the Engr 195A/195B curriculum we found that faculty and students felt like it negatively impacted their technical and their Areas V and S content. Chemical Engineering faculty felt they did not have the expertise to cover Areas S and V content at the level covered in stand alone S and V courses. They also felt a negative impact removing 30% technical content and adding instead 30% Areas S and V content. Students felt like Engr 195A and 195B and associated content was often redundant and poorly managed and ended up disparaging Area S and V content which is the opposite of how we expected them to consider it, appreciating those aspects in engineering design etc. Since both the technical and Area V and S content in the ChE curriculum was suffering, we decided the best approach that would resolve all serious issues was to have the students take stand alone Area V and Area S courses and keep the high level of technical engineering content in our senior project and related courses.

4. Convert the one semester senior project course, ChE 165 4 units (3 units lecture, 1 unit lab). to a two semester course: ChE 165A 1 unit lab in the Fall semester, and ChE 165B a 2 units lecture 1 unit lab course in the Spring. This would bring ChE in line with the majority of the senior project courses in other departments with a two semester experience. Upon assessing the course over the past few years we realized that students would have a much better chance at a more significant senior project design if they had a two semester experience. We also incorporate so many topics in the senior design project, such as environmental impact, safety, ethics, etc., that we could not do justice to all of them in a one semester experience.

ChE 2016 Assessment Data on Student Outcomes 1-11  NOTE: Due to the earlier report date, only Fall 2016 data is reported below.

Outcome: 1.0 Ability to apply knowledge of mathematics, science and engineering

Program Evaluation Component: 1.1 Analyze systems through material and energy balances models

Performance criteria (level 2 of 3): 1.1 Solve a material balance on a process with a chemical reaction

Grading strategy: Each calculation that is correctly done is given full credit. The solution is divided into individual calculations. If an error is made early in the calculation but the remainder is correctly done, they get credit for the correctly done calculations even though the numbers don't match the actual solution. Students who fail to meet the criteria most often either don't know where to start or get stuck early on, and so 60% represents a solution that has a lot correct in it and may be almost complete but with some calculation errors.

Fall '16 assignments:

Midterm I part c  Material Balance

1c) 20 pts. Calculate the composition, in mole fractions, of the gas leaving the reactor.

51/103 students met the criterion, or 49.5%
Final exam  Energy Balance

30 pts.  1b. For the propylene combustion, the reactants all enter at 25°C and exit at 500°C. If 12000 kW of heat is evolved during the process, what must be the ratio of CO/CO₂ in the product gas?

10/98 students met the criterion, or 10.2%

Final exam  Material balance

20 pts.  IIb. Determine the unknown flowrates in the fresh feed, separator and recycle streams.

40/98 students met the criterion, or 40.8% met the criterion

Recommendation: This result is clearly unacceptably low. In Fall of 2015 and 2016 there were over 80 students enrolled which was double the number from the previous time teaching the course. Due to the large enrollment the primary instructor did not teach the 3 hour class sections. To address this, we have reclassified the course as a standard 150 minutes per week course with C2 (primarily activity) class periods. The enrollment cap for the course has been set at 40 per course and additional sections will be opened so the problem solving can be better taught. Additional strategies for improving student problem-solving skills will be implemented in Fall of 2016, such as prepping all instructors of each of the 4 sections how to use the class materials most effectively such as “handouts with gaps” and Think-Aloud-Paired-Problem-Solving” Lectures on the basic material will be delivered as video so the in-class sessions will be problem solving with lecture-on-demand instruction. We will also monitor the students in each section more closely through the semester. We do think that the Fall 2016 students were not as prepared as in prior years as there was a significantly low GPA in all ChE classes for the Fall 2016 students. They did not seem as prepared as needed for starting engineering courses. We will be reviewing our advising of junior students to make sure they are performing adequately in lower division courses that are preparation for the major.

Outcome: 1.0 Ability to apply knowledge of mathematics, science and engineering

Program Evaluation Component: 1.2 Specify operating conditions for a heat exchanger to meet performance requirements

Performance criteria (level 2)

Analyze different heat exchangers and use concepts related to heat transfer area, corresponding rate of heat recovery, fluid outlet temperatures, overall heat transfer coefficients, to determine savings costs.

Assignment:

Grading rubric- Criteria 50 % of total points for an exam

Analysis  (How many students met the criteria)

Fall '16 77 of 91 ChE students, out of 94 enrolled, met the criteria. The highest score out of 100 points possible was 100, the lowest was 0 and the average was 73.

Recommendation (Is there something you can modify so that more of the students meet the criteria?)
Most students that know the conceptual ideology behind the problem demonstrated satisfactory competence. Some student errors may have occurred due to time limitations. There are currently no recommendations.

**Outcome:** 1.0 Ability to apply knowledge of mathematics, science and engineering

**Program Evaluation Component:** 1.3 Evaluate the design of a non-isothermal reactor for a chemical process.

**Performance criteria (level 3)**
The student can use the design equations in conjunction with the appropriate energy balance to solve non-isothermal problems.

**Assignment:** Solve various aspects of non-isothermal reactor problems on Exam 3.

**Grading rubric- Criteria 60% of total points (50 points)**

**Analysis**
Fall '16 54 of the 54 ChE students, out of 55 enrolled (one withdrew), met the criteria (100% of the students). The highest score out of 50 points possible was 50, the lowest was 30 and the average was 40.2 (80%).

**Recommendation**
The students are meeting this criteria in a satisfactory manner.

**Outcome:** 2.0 Ability to design/conduct experiments and analyze/interpret data

**Program Evaluation Component:** 2.2 Analyze and interpret data for chemical reaction kinetics (ChE 158)

**Performance criteria (level 3)**
The student can derive rate expressions from kinetics mechanisms for homogeneous and/or heterogeneous systems.

**Assignment:** Derive the rate expression from a mechanism.

**Grading rubric- Criteria 60% of total points (35 points) on Exam 4 problem.**

Fall '16 37 of 54 ChE students, out of 55 students enrolled (one withdrew), met the criteria (78% of the students). The highest score out of 35 points possible was 30, the lowest was 3 and the average was 25.9 (average 74%).

**Recommendation**
This was the first time the instructor was teaching the class and some students ran out of time partially due to poor time management. Additional strategies to complete these types of problems, which are math intensive, will be used in the future to better prepare students to speed up on the exam.

**Outcome:** 2.0 Ability to design/conduct experiments and analyze/interpret data
Program Evaluation Component: 2.3 Analyze and interpret data for a unit operation experiment (CHE 161L)

Performance criteria (level 2)
The student can analyze experimental data and reach conclusions substantiated by statistical analysis.

Assignment: Carry out a basic statistical analysis of the data collected.

a) Calculate the mean, variance, standard deviation, median, mode, and range from the data given.
b) Formulate appropriate null and alternative hypotheses for this data.
c) Test these hypotheses using $\alpha = 0.01$ and the one sample t-test. What you can conclude from the test?
d) Find the P-value for the test. Explain what significance of the P-value

e) Construct a 99% confidence interval on the mean weight. What is your conclusion?

Make sure to use appropriate units and significant figures for your results.

Grading rubric- Criteria 65% of the possible points for this problem.

Analysis:

Fall 2016 53 of 54 ChE students, out of 60 students enrolled (one student withdrew), met the criteria. The highest score out of 16 points possible was 16, the lowest was 9 and the average was 14.2 (average was 88.8 %). Five students did not complete the assignment.

Recommendation:
In previous analyses it was found to be hard to assess this PEC adequately because different labs required different analyses and some students did not perform the analysis adequately. So it became an in class assignment in the lecture portion of the laboratory. The one improvement is to make sure students are all aware of the homework due date as the students who did not turn in the first homework indicated they had been focusing on their lab reports and overlooked the homework due date. The students who attempted the problem in general did very well.

Outcome: 3.0(c) Ability to design system, component or process to meet desired needs

Program Evaluation Component: 3.1 (CHE 158) Design an isothermal reactor for a chemical process.

Performance criteria (level 3)
The student can solve simple single answer problems using the ideal reactor design equations.

Assignment: Determine the volumes of ideal plug flow reactor (PFR) to achieve the desired conversion on Exam 1.

Grading rubric- Criteria 60% of total points (30 points)

Analysis: Fall ’16 37 of 54 ChE students, out of 55 students enrolled (one withdrew), met the criteria (74% of the students). The highest score out of 30 points possible was 30, the lowest was 5 and the average was 23 (average 76.7%).
**Recommendation:** This was the first time the instructor was teaching the class and some students ran out of time partially due to poor time management. Additional strategies to complete these types of problems, which are math intensive, will be used in the future to better prepare students to speed up on the exam.

**Outcome:** 3.0(c) Ability to design system, component or process to meet desired needs

3.3 Analyze, design and evaluate mass transfer processes for specific applications (CHE 160B)

Program evaluation component 3.3 (level 3 of 3)

*Analyse, design and evaluate mass transfer processes for specific applications*

**Performance criteria:** Analyze and optimize unit operations using the simulator and objective functions.

**Assignment:** A through circulation dryer is used to dry spherical wet pellets with diameters of 12.0 mm. The pellets are in a bed 62.0 mm thick on a screen. The solids are being dried by air entering with a superficial velocity of 0.52 m/s at 80°C and a humidity of 0.015 kg H$_2$O/ kg dry air. The dry solid density is determined as 1650 kg/m$^3$, and the void fraction in the bed is 0.55. The equilibrium moisture content is 0.06 kg H$_2$O/ kg solid. The spherical pellets are to be dried from an initial moisture content of 0.91 kg H$_2$O/ kg solid to a final moisture content of 0.28 kg H$_2$O/ kg solid. The critical free moisture content is 0.45 kg H$_2$O/ kg dry solid.

a) Calculate the total time of drying for this material. For the falling rate period, assume the drying rate is proportional to the moisture content.

b) If the initial air velocity was increased to 0.7 m/s, calculate the time of drying during the constant rate period only.

**Grading criteria:** This question had 50 points; 30 points were assigned to part (a) and the other 20 points were given for part (b). The grading was based on the students’ knowledge of the concept, writing equations and calculations.

**Analysis/Result:** The class size was 64 students. The table below shows the number and percentage of students who did and did not meet the criteria.

<table>
<thead>
<tr>
<th>Did not submit assignment</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>Did not meet criteria</td>
<td>2 (3.0%)</td>
</tr>
<tr>
<td>Did meet criteria</td>
<td>62 (97%)</td>
</tr>
<tr>
<td>Total</td>
<td>55 (100.0%)</td>
</tr>
</tbody>
</table>

62 students out of the total 64 students met the criteria of 60% (C grade) for this question. The highest score was 50 out of the 50 points, the lowest score was 20, and the average was 38.6 (77.2%).
**Recommendations:** Students had a satisfying knowledge of the drying process. The students who were not able to meet the criteria may have had time limitations.

**Outcome:** 5.0(e) Ability to identify, formulate and solve engineering problems

**Program Evaluation Component:** Analyze a thermal system for appropriate heat transfer prediction. (ChE 190)

**Performance Criteria (level 2 of 3):** The student can analyze a thermal system. State the appropriate assumptions, state the correct governing equations, state the correct boundary conditions, solve the differential equations.

**Assignment 1:** Calculate heat transfer from a computer processing chip via heat sink in midterm 1.

**Grading rubric**- Criteria 50% of total points (30 points /100)

**Analysis:** Fall ’16, 60 of the 95 ChE students, out of 95 enrolled, met the criteria. The highest score out of 30 points possible was 30, the lowest was 0 and the average was 17.85 (60%).

**Assignment 2:** Evaluate the heat loss through natural convection in an exposed pipe in midterm 2.

**Grading rubric**- Criteria 50% of total points (40 points / 100)

**Analysis:** Fall ’16, 60 of 95 ChE students, out of 95 enrolled, met the criteria. The highest score out of 40 points possible was 40, the lowest was 0 and the average was 20.26 (50.6%).

**Assignment 3:** Analyze the heat transfer through a layered wall using thermal network method.

**Grading rubric**- Criteria 50% of total points (20 points / 100)

**Analysis:** Fall ’16, 64 of 95 ChE students, out of 95 enrolled, met the criteria. The highest score out of 20 points possible was 20, the lowest was 0 and the average was 12.4 (62%).

**Recommendation:** Students have been struggling with the material of the course. I would recommend adding an introductory course prior to the junior year courses in Chemical Engineering. This introductory course will give the students some basic tools in chemical engineering including math and programming and will make the transition to the core chemical engineering courses smoother.

**Outcome:** 5.0(e) Ability to identify, formulate and solve engineering problems

**Program Evaluation Component 5.2:** Compare alternative reactor designs and select the most effective choice for a given process (CHE 158)

**Performance criteria (level 2 of 3):** The student can evaluate different types of ideal reactor configurations, including multiple reactors, and determine which is optimal for a given reaction.
**Assignment:** Analyze which type of reactor PFR or CSTR would be best for a given situation as a question in Exam 1.

**Grading rubric:** Criteria 60% of total points (20 points)

**Analysis**
Fall '16 51 of 54 ChE students, out of 55 enrolled (one withdrew), met the criteria. The highest score out of 20 points possible was 20, the lowest was 10.0 and the average was 17.4 (86.7%).

**Recommendation:** Most students demonstrated satisfactory competence. No changes are recommended.

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**Outcome:** 6.0 Understanding of professional and ethical responsibility

**Program Evaluation Component (level 1 of 3)** 6.1 (CHE 161) Apply engineering ethics and professionalism in conducting projects

**Performance Criteria:** Demonstrate knowledge of code of engineering ethics.

**Program Evaluation Component (level 1 of 3)** 6.2 Students can identify the ethical issues in an ethics case study.

**Performance Criteria:** Identify the ethical issues in an engineering case study.

**Program Evaluation Component (level 3 of 3)** 6.3 Students can design a strategy to manage a situation where an employee/subordinate commits a violation of engineering ethics.

**Performance Criteria:** Design a strategy to manage a situation where an employee/subordinate commits an ethics violation.

**Assignment:**

**Midterm – Addresses 6.1, 6.2, 6.3**

You are one year into your first job as junior engineer in a big chemical processing plant, ABC Inc. There is a multi-billion dollar expansion and your manager has asked you to carry out some lab scale plant work on his design immediately. Time is money, and every week delayed costs ABC Inc. $1 million. The initial tests show in your opinion that the design is inadequate and significant design changes are required. When you go to your manager to discuss the results he points his finger at you and says “You made a mistake! Go back and redo the tests and bring me the results I am looking for!” When you ask for an explanation and to see his calculations, he yells even louder for you to get out and he doesn’t have time. He adds “I need those results now!”

You redo your tests three more time to make sure. The last time you run the test you notice that chrome parts of certain process equipment seem to be wearing thin. This may be chrome leaching into the process environment, although you are not entirely sure. Chrome-6 (Hexavalent Chrome) is known to cause cancer in humans, and if the material is Chrome-6, operators within the facility who work hands-on with
the process solution would be at risk. The material may also be Chrome-3 which is safe. In the weekly group meeting you present the results of your work. Even with the additional testing showing the suspected design defects, your manager says you made a mistake and is taking you off the job. He instead places senior engineer Sinister on the job. Your manager yells at you in the meeting in front of the group telling what an “incompetent engineer” you are with no explanation. To cap off the bad day, you sit around at work that evening surfing the internet looking at Monster.com trying to find another job. You notice that your manager is making very vulgar comments and tries inappropriately touching the young intern. She excuses herself and moves away till he leaves the office. You go talk to her after and she says that she doesn’t want to tell anyone what happened because she really needs the experience and doesn’t want to “rock the boat” or cause any problems. Two days later, in an urgent staff meeting, Sinister presents his test results. All his results fit perfectly into your manager’s design. You are sure this is impossible. When you go to talk to Sinister after, he states you made a mistake. When you ask to see the work, he says he doesn’t have time to explain this. Times are not going well for you. In the midst of all of this, your best friend and former classmate who works at a safety company calls you up to tell you that he has been offered a ”bonus” from a client of $50,000 to skip some safety tests, and what should he do? He thinks there will be no problem since the tests should not fail and no one will find out. He could use the money since his mother needs surgery. A day later, Sinister and your manager bring the completed report to you and ask that you sign the report as a reviewer. They have to submit it right away to meet the deadline and they give you minimal review time. As you flip through the report, you cannot tell where the data is and the report doesn’t show much of the test results. You are unsure of Sinister’s methodology, the tests don’t look anything like the tests you conducted and it seems like he missed the chrome wearing off the equipment altogether.

Please answer the following questions. Use complete sentences! Marks will be given for content, answering the question and overall clarity of your thought process. Write your name on each page.

Use only the space provided to answer the questions (do NOT write along the margins –write only on the lines provided). If you write in the margins, points will be deduced. Write in sentences (essay form) not point form and write clearly and neatly.

1) (50%) Do you sign the report? In answering this question, please consider the following questions in your response: What is the basis for your decision? How do you handle the situation? What are the possible legal, ethical and professional issues and what are the possible consequences for your choice? Are you prepared for these consequences?

2) Please write about one other legal issue presented in the facts above. In your discussion of the legal issue, full marks will be given for discussion of legal elements and well structured arguments. State the legal issue, any legal rules, the analysis and your conclusion.

3) Please write about one other ethical issue presented in the facts above. In your discussion of the ethical issue follow the methods discussed in class, present alternate theories and use the NSPE as your ethical standard. Marks are awarded based on content, clarity, and the writing.

4) Please write about one other professional issue presented in the facts above. In your discussion of the professional issue, discuss why it is a professional issue with respect to the NSPE code and what may have been done different. Marks are awarded based on content, clarity, and the writing.
5) Please list the NSPE Code of Ethics for Engineers – Part I Fundamental Canons.

**Analysis:** 69 of 69 students did the midterm. 68 of the 69 students met the criteria of 75% or above where 75% was equivalent to a C grade. The highest score out of 20 points possible was 20, the lowest was 14.5 and the average was 17.9 (average was 89.4%).

**Recommendation:** The students are generally mastering this assignment so no changes are planned.

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**Outcome:** 7.0 Ability to communicate effectively

**Performance Criterion 7.1 Write effectively**

This outcomes is assessed in Engr 100W. The performance criterion is to achieve a 7 on the Writing Skills Test. The students must obtain a score of 7 in order to pass the course, so 100% of the students meet the criterion.

**Performance Criterion 7.2 (CHE 160B) Give an effective oral presentation**

**Program evaluation component 7.2**

*Give an effective oral presentation*

**Performance criteria (Syllabus)**

*Give an effective oral presentation on a separation system design.*

**Assignment:** Give an individual oral presentation for the team project. There were three key components per project:

Fundamental equations; Simulation of process; Presentation of the design solution to the class. Each student had at least one presentation during the semester and was allowed 15 minutes for a presentation and 5 additional minutes for questions and answers

**Grading criteria:**

The rubric below was used for individual presentations. Students who received a 70% (average of 3.5 out 5) or higher fulfilled the grading criteria. Instructor comments for technical content and presentation style were given as they pertained to the individual presentations.
Analysis/Result: The class size was 55 students. The table below shows the number and percentage of students who did and did not meet the criteria.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Did not submit assignment</th>
<th>Did not meet criteria</th>
<th>Did meet criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>64 (100%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>64 (100.0%)</td>
</tr>
</tbody>
</table>

The highest score out of 5 points was 5, the lowest score was 3.5 and the average score was 4.2 (84%).

Recommendations: There are no recommendations made for future individual presentations other than the encouragement of instructors to give precise and complete recommendations to students to enhance their presentation style and content.

Outcome 8.0 Understand the impact of engineering solutions in a global/societal context

Program Evaluation Component (level 2 of 3) 8.1 Appraise the inherent safety strategies applied in an experiment or process.

Performance Criteria: Identify the hazardous compounds in a chemical process by employing prior experience along with technical reference literature sources.

Assignment: Determine how to sort various industrial and lab chemicals
GROUP ASSIGNMENT – Addresses 8.1

Your lab contains the following “normal” lab grade chemicals (Assume wt% when given % or 100% if given nothing); also assume small lab size quantity or “regular” gas cylinder where required.

<table>
<thead>
<tr>
<th>CHEMICAL NAME</th>
<th>CHEMICAL NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphine Gas</td>
<td>Sulfuric Acid</td>
</tr>
<tr>
<td>Ethylene glycol</td>
<td>Acetone</td>
</tr>
<tr>
<td>Sodium cyanide</td>
<td>Hydrofluoric Acid 10%</td>
</tr>
<tr>
<td>Acetone</td>
<td>Ammonium Perchlorate</td>
</tr>
<tr>
<td>Cobalt Sulfate Crystals</td>
<td>Glycerin</td>
</tr>
<tr>
<td>Arsine Gas</td>
<td>HCl 28-30%</td>
</tr>
<tr>
<td>NMP (N-Methyl-2-pyrrolidone)</td>
<td>Hydrocyanic Acid</td>
</tr>
<tr>
<td>Toluene</td>
<td>NaOH pellets</td>
</tr>
<tr>
<td>Boron Trifluoride</td>
<td>Nitric Acid 65%</td>
</tr>
<tr>
<td>Liquid Nitrogen</td>
<td>Chromic Acid</td>
</tr>
<tr>
<td>Sulfuric Acid 96%</td>
<td>NaOH 50%</td>
</tr>
<tr>
<td>Silane Gas</td>
<td>HF 50%</td>
</tr>
<tr>
<td>NMP</td>
<td>Hydrocyanic Acid (TMAH) 25%</td>
</tr>
<tr>
<td>Silane Gas</td>
<td>Acetonitrile</td>
</tr>
<tr>
<td>Liquid CO₂</td>
<td>Shipley S1813 Photo Resist</td>
</tr>
<tr>
<td>Methylene Chloride</td>
<td>Copper Sulfate Crystals</td>
</tr>
<tr>
<td>tert-butyllithium</td>
<td>Hydrogen Peroxide 30%</td>
</tr>
<tr>
<td>Methanol</td>
<td>Perchloric Acid 60-65%</td>
</tr>
</tbody>
</table>

1. Please determine how you would store them (i.e. by itself; fridge, cylinder in ventilated area, oxidizer cabinet, acid cabinet etc…) and why (1-2 sentences please for the why part of the question!)
2. Please note how to dispose of them (i.e. mention what waste container to place them in when completed – organic waste, acidic waste, by itself, immediate pick-up etc…)
3. Please list what PPE you should have on hand in the lab (total for all chemicals).

Analysis: 66 of 69 students did the group assignment. 66 of the students met the criteria of 75% or above where 75% of equivalent to a C grade. The highest score out of 10 points possible was 10, the lowest was 0 and the average was 10 (average was 100%).

Recommendation: There are 69 students and 1 professor. This is a class where many students like to have a discussion about the issues and scenarios presented. It is difficult to conduct this effectively in a large class.

Recommend smaller class sizes to facilitate a discussion.
Outcome: 9.0(i) Recognition of the need for and an ability to engage in life-long learning

Program Evaluation Component: Evaluate a technical process based on a journal review article

Performance criteria (level 3)
The student will be able to locate and critique kinetics and reactor design articles published in the current literature.

Assignment 1: Use Matlab programming to analyze a reactor problem.

Grading rubric- Criteria 60% of total points on Exam 2.

Fall '16, 50 of 54 ChE students who submitted the article critiques, out of 55 students enrolled (one withdrew), met the criteria. The highest score out of 50 points possible was 50, the lowest was 25 and the average was 42 (84%).

Recommendation
The students in general did well. No other changes are recommended at this time.

Outcome: 11.0 Ability to use the techniques, skills and modern tools necessary for engineering practice

Program Evaluation Component: 11.2 CHE 158 Use non-linear regression to evaluate kinetic mechanisms.

Performance criteria (level 3)
The student will be able to apply non-linear regression to evaluate the kinetic mechanism of various chemical reactions from a given set of data points.

Assignment 1: Use non-linear regression information to analyze the data for a given fit of a model to rate data.

Grading rubric- Criteria 60% of total points (35 points) on an Exam 4 problem

Fall '16 39 of 54 ChE students, out of 55 students enrolled (one withdrew), met the criteria (78% of the students). The highest score out of 35 points possible was 30, the lowest was 3 and the average was 25.9 (average 74%).

Recommendation
The students who did not achieve the performance criteria seemed to have time management issues more than issues understanding the subject. The instructor will remind students of the time and encourage them to move on and see if that helps the situation in the next go round.
12. Proposed changes and goals (if any)

We are considering changing ChE 161 Safety and Ethics to an activity section so that the instructor has time for discussion with the students. They work on group projects and one hour a week is limiting the impact these important topics can be covered.

We are reviewing our monitoring of the students prior to the start of their junior chemical engineering courses as Fall 2016 students in general performed much worse in all ChE classes (as per class and individual GPAs). We do not think they were prepared adequately to start their engineering classes so we are going to monitor their performance more closely as sophomores and transfer students.