Part A

1. List of Program Learning Outcomes (PLOs)

The Program Learning Outcomes, which are consistent with the Accreditation Board for Engineering and Technology (ABET) disciplinary standards and requirements, and the Program Evaluation Components (PEC) for each PLO, are listed below. The PECs for each PLO was identified and developed to ensure that the assessment for each PLO would be relevant to materials engineering.

The faculty as a group decide and formulate, through several discussions, the specific PECs that are relevant to materials engineering, and the level of mastery required, keeping in mind the requirements that can be expected to be placed when our students graduate and enter the professional workforce. The PECs are reviewed annually and modifications made if the faculty as a group think that is warranted.

1. Ability to apply knowledge of mathematics, science and engineering
   1.1 Utilize the structure-properties relationship to predict the properties of a material.
   1.2 Select the materials and properties appropriate for a specific application.
   1.3 Apply thermodynamics and kinetics in the process design of materials system in order to produce desired structure and properties.

2. Ability to design/conduct experiments and analyze/interpret data
   2.1 Select appropriate materials characterization tools, utilize the tool safely, and interpret experimental results.
   2.2 Design and analyze appropriate experiments to measure or optimize specific engineering properties, incorporating statistical procedures.

3. Ability to design system, component or process to meet desired needs
   3.1 Select and evaluate appropriate materials and processing methods based on desired performance.
4. Ability to function on multi-disciplinary teams
   4.1 Contribute unique expertise to a multifaceted team

5. Ability to identify, formulate and solve engineering problems
   5.1 Assess needs, formulate problem statement, structure and evaluate solutions in solving real-world materials engineering problems.

6. Understanding of professional and ethical responsibility
   6.1 Formulate and address ethical issues which arise in solving engineering problems and in the workplace.

7. Ability to communicate effectively
   7.1 Communicate effectively through formal and informal written and oral means.

8. Understand the impact of engineering solutions in a global/societal context
   8.1 Optimize materials engineering products and processes to positively impact global and societal issues.

9. Recognition of the need for and an ability to engage in life-long learning
   9.1 Recognize that materials engineering is diverse and continuously evolving and that finding solutions may involve exploring new knowledge.
   9.2 Uncover, critically evaluate, and synthesize knowledge from multiple sources.

10. Knowledge of contemporary issues
    10.1 Demonstrate use of materials engineering in emerging applications.

11. Ability to use the techniques, skills and modern tools necessary for engineering practice
    11.1 Utilize modern tools and techniques to alter, characterize, and measure materials properties and to design processes according to accepted standards.
    11.2 Demonstrates advanced proficiency in pertinent software.

These were written by all program faculty at an assessment retreat. They are reviewed annually at an assessment retreat.

2. Map of PLOs to University Learning Goals (ULGs)

The five University Learning Goals are listed below:

1. ULG #1 - Specialized Knowledge: Depth of knowledge required for a degree, as identified by its program learning outcomes

2. ULG #2 - Broad Integrative Knowledge: Mastery of each step of an investigative, creative, or
practical project. Understanding of the implications of results or findings from a particular work in societal context

3. ULG #3 - Intellectual Skills: Fluency in the use of specific theories, tools, technology, and graphical representation. Skills and abilities necessary for life-long learning: critical and creative thinking effective communication, conscientious information gathering and processing, mastery of quantitative methodologies, and the ability to engage effectively in collaborative activities

4. ULG #4 - Applied Knowledge: Ability to integrate theory, practice, and problem-solving to address practical issues. Ability to apply their knowledge and skills to new settings or in addressing complex problems. The ability to work productively as individuals and in groups

5. ULG #5 - Social and Global Responsibilities: Ability to act intentionally and ethically to address a global or local problem in an informed manner with a multicultural and historical perspective and a clear understanding of societal and civic responsibilities. Diverse and global perspectives through engagement with the multidimensional SJSU community

Table 1: Mapping of Materials Engineering Program Learning Outcomes to University Learning Goals

<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>
</tr>
</thead>
<tbody>
<tr>
<td>a. Disciplinary knowledge</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>b. Proficiency with experiments</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>c. Design</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Multidisciplinary teamwork</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>e. Problem solving</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>f. Ethics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>g. Communication skills</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>h. Broad impacts of engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Life-long learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. Contemporary issues of engineering</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>k. Modern tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The connection of learning objectives to University learning goals were reviewed by faculty at an assessment retreat.
3. **Alignment – Matrix of PLOs to Courses**

The table on the next shows the alignment of the program learning outcomes to courses. Level 1 indicates lower levels of Bloom taxonomy (level 1-2), level 3 mid-level (level 3-4), and 5 is high level (level 5-6). The highlighted ones indicate the course the PLO is assessed in.
Table 2. A matrix showing specific courses and levels at which Program Learning Outcomes are assessed.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to apply knowledge of mathematics, science and engineering</td>
<td>1.1</td>
<td>Utilize the structure-properties relationship to predict the properties of a material.</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 Select the materials and properties appropriate for a specific application.</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3 Apply thermodynamics and kinetics in the process design of materials system in order to produce desired structure and properties.</td>
<td>2.1</td>
<td>Select appropriate materials characterization tools, utilize the tool safely, and interpret experimental results.</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2 Design and analyze appropriate experiments to measure or optimize specific engineering properties, incorporating statistical procedures.</td>
<td>3.1</td>
<td>Select and evaluate appropriate materials and processing methods based on desired performance.</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to design system, component, or process to meet desired needs</td>
<td>4.1</td>
<td>Contribute unique expertise to a multifaceted team.</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to reason, formulate and solve engineering problems</td>
<td>5.1</td>
<td>Assess needs, formulate problem statement, structure and evaluate solutions in solving real-world materials engineering problems.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsible engineering and ethical responsibility</td>
<td>6.1</td>
<td>Formulate and address ethical issues which arise in solving engineering problems and in the workplace.</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to communicate effectively</td>
<td>7.1</td>
<td>Communicate effectively through formal and informal written and oral means.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Ability to design/conduct experiments and analyze/interpret data</td>
<td>8.1</td>
<td>Optimize materials engineering products and processes to positively impact global and societal issues.</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recognize the need for and an ability to engage in life-long learning</td>
<td>9.1</td>
<td>Recognize that materials engineering is diverse and continuously evolving and that finding solutions may involve exploring new knowledge.</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.2 Uncover, critically evaluate, and synthesize knowledge from multiple sources.</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge of contemporary issues</td>
<td>10.1</td>
<td>Demonstrate use of materials engineering in emerging applications.</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to use the techniques, skills and modern tools necessary for</td>
<td>11.1</td>
<td>Utilize modern tools and techniques to alter, characterize, and measure materials properties and to design processes according to accepted standards.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.2 Demonstrates advanced proficiency in pertinent software.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Planning – Assessment Schedule

With our ABET process, all PLOs are assessed in at least one course per a year (the highlighted courses in the table above). The assessment results are written in a brief document that includes a description of the assignment, the performance criteria, the level at which the program outcome was met, and recommendations for changes. These assessment documents are reviewed by the program faculty at an annual assessment retreat. In this manner, we are collecting data on, reviewing as a department the implications, and implementing changes on all the program learning outcomes on an annual cycle. A sub-set of 5-6 of them will be reported in the University annual assessment report in a three year rotating cycle.

Year 1: (13-14, 16-17): 2.2, 5.1, 6.1, 7.1, 9.2
Year 2: (14-15, 17-18): 1.1, 2.1, 3.1, 8.1, 9.1, 10.1
Year 3: (15-16, 18-19): 1.2, 1.3, 4.1, 11.1, 11.2

5. Student Experience

The Program Learning Objectives and ABET Program Educational Objectives are available in the university catalog and posted on the Materials Engineering Program website at the following:

http://www.sjsu.edu/bcme/programs/materials-engineering-bs/abet-program-educational-objectives/


Part B

6. Assessment Data and Results

7. Analysis

Note: sections 6 and 7 are presented together for each of the six program learning outcomes being assessed in this cycle.

ABET Outcome:

(b) Ability to design/conduct experiments and analyze/interpret data

ABET Outcome:

2.1 Select appropriate materials characterization tools, utilize the tool safely, and interpret experimental results

SJSU Materials Engineering Performance criteria
Assessed in Course: MatE 143 (Fall 2017)

Performance criteria:

Level 2:
2.1 Apply the theories learned in class to successfully obtain a high-quality SEM image of an unknown conductive sample

Assignment(s):

2.1. Assignments that address this criterion are:

Using the final practical exam:
Exam requirement: Students were asked to obtain a high-quality SEM image of an unknown conductive sample.

Grading rubric/criteria

All written responses were graded on a numeric basis with partial credit where appropriate.

Analysis

14 out of 14 students who took the exam, out of 14 enrolled, met the criteria of 75% or above where 75% was equivalent to a C grade. The highest score out of 100 points possible was 95, the lowest was 80 and the average was 88.4%.

Recommendation

Continuation of the practice of providing students with two half-hour practice sessions on the SEM is recommended.

ABET Outcome: 3.0 ABILITY TO DESIGN SYSTEM, COMPONENT OR PROCESS TO MEET DESIRED NEEDS

SJSU Materials Engineering Performance Criteria

Assessed in course MatE195 Mechanical Behavior of Materials (Fall 2017)

3.1 Select and evaluate appropriate materials and processing methods based on desired performance.

Assessed in MatE195 Mechanical Behavior of Materials

Assignment: Perform experimental processing techniques and conduct tests on fiber reinforced composites
In fall semester 2017, 10 students (7 undergraduate and 3 graduate students) were enrolled in MatE195 course. A lab exercise (#7) was assigned to carry out five major lab objectives. They are: 1) to gain hands-on experience in manufacturing composite laminates using matched-die molding, 2) to select a material among glass, graphite and Kevlar fibers to reinforce polyester thermoset resin or polyethylene thermoplastic resin, 3) to study the behavior of fiber-reinforced polymeric composite under uniaxial loading, 4) to investigate the mechanics of deformation and the mode of failure of the fabricated composite laminate under loading, 5) to identify and determine the parameters affecting the material properties. All ten students were grouped into three teams. Except one team which consisted of one undergraduate and three graduate students, the other two teams were all undergraduate students.

<table>
<thead>
<tr>
<th>Team</th>
<th>Lab grades</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 points</td>
</tr>
<tr>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
</tr>
<tr>
<td>Average</td>
<td>24.33</td>
</tr>
</tbody>
</table>

Grading rubric criterion is based on 30 points for each written report.

**Mastery of the criteria is a B (80%).** Two undergraduate teams each received scores of 23 and 24 points, respectively. The combined team received the highest score 26 points. This seemed that the three graduate students and one undergraduate student had worked harmoniously in the lab report. Except a few points docked due to typos and grammatical errors, the team report which scored 23 points showed their understanding of the subject material. They were able to conduct the selection of material and conduct the manufacturing of composites based on desired properties. In addition, they had explained the deformation mechanisms along with failure modes of the fabricated composites. All students mastered the performance criteria as graded by the written reports.

**Future improvement.** No immediate change in the near future.

**ABET Outcome:** 5.0 Ability to identify, formulate and solve engineering problems

**SJSU Materials Engineering Performance criteria (level 3)**

5.1 Assess needs, formulate problem statement, structure and evaluate solutions in solving real world engineering problems
**ABET Outcome: 7.0 Ability to communicate effectively**

**SSJU Materials Engineering Performance Criterion (level 3)**

**7.1 Communicate effectively through formal and informal written and oral means.**

Both 5.1 and 7.1 were assessed in course MatE195 Mechanical Behavior of Materials (Fall 2017)

**Assignment:** Using the term project to assess this criterion. Perform experimental tests on various materials (including metals, polymers, and composites)

In fall semester 2017, 10 enrolled students (7 undergraduate and 3 graduate) were asked to work on a term project. For the term project, the students had to work in groups (no more than three members per group) to undertake the work of planning, reading, analyzing and writing an engineering problem related to a design, application, testing or characterization of material in a load bearing condition. This project is expected to involve motivation (background of the topic), literature search, problem identification, problem analysis, development of solution, significance of the study, and technical findings (conclusions) and future recommendation. Students also had to conduct actual experimental work to validate their hypothesis.

In practice, students working in teams had to meet first and identify and/or discuss a topic of their interest using the above criteria. Then, they needed to study the field of the interested topic thoroughly, develop a problem statement, conduct a series of tasks such as consult ASTM/Military Standards, textbook, application requirements, specifications, and apply their knowledge and training to the project. Then, the team would physically conduct an experiment to carry out the intended tasks. To support the project, the term project would have to include Internet and personal contact references, but the reference list must include at least three-five sources, which could be the books or journal articles (not from trade magazines). They had to submit a photocopy of the first page of the selected articles in the appendix section and refer the pages or chapters in the textbook to the context of the term project report in which they were closely related.

An oral presentation based on their term project was expected to last 15 minutes, followed by a 5-minute discussion period. All members of a team presented together, but graded separately. The presentation should be technical and in the Microsoft PowerPoint format. An evaluation form details the grading criteria with respect to the content, technical merit, and the significance of the study was used. Both peer students as well as the course instructor participated in the evaluation.

<table>
<thead>
<tr>
<th>Term Project</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Team</td>
<td>Written</td>
</tr>
<tr>
<td></td>
<td>100 points</td>
</tr>
</tbody>
</table>
Grading rubric criterion is based on 100 points for each written report and oral presentation.

**Mastery of the criteria is a B (80%).** All the students have mastered the performance criteria as graded by the written report scores (above 80) and oral presentation (above 16).

**Future improvement.** No changes soon.

**ABET Outcome:**

(a) Ability to apply knowledge of mathematics, science and engineering  
(b) Identify and be familiar with several engineering applications for ceramics

**Assessed in Course: MatE 185 (Fall 2017)**

**ABET Outcome: 10.1 Demonstrate use of materials engineering in emerging application**

**SJSU Materials Engineering Performance criteria**

**Program Evaluation Component:**  
10.1 Demonstrate use of materials engineering in emerging applications.

**Performance criteria:**  
An important objective of MatE 185 is to understand how the unique properties of ceramic materials can be used in engineering applications. One such application is electric power production by solid oxide fuel cells and the use of ceramic materials in several components of the cell.

**Assignments:**  
In lecture we reviewed the basic construction of several fuel cell types and explored the advantages and disadvantages of fuel cells for electric power generation. Additional reading material outside of the textbook was distributed to provide more background on this topic. During the lectures we explored in some detail the solid oxide fuel cell using ceramic materials for the anode, cathode, and electrolyte. An emphasis was placed on knowing how the properties of materials can be designed and selected to meet requirements.

We explored why diffusion was important to efficient operation of the cell, and the material properties that affect diffusion. Previous classes in the MatE curriculum cover diffusion and Fick’s Laws. We built
on the fundamentals and introduced a new concept of how ceramic materials can be designed to have selective diffusion to certain chemical ions. This is important to the operation of a fuel cell based on ceramic materials. The electrolyte will allow diffusion of the oxidizer ions, and yet will be a barrier to diffusion to the fuel ions. We used Kroger-Vink equations to show how aliovalent additives in oxide based ceramics meets this requirement.

We also covered the concepts of why the fuel cell must operate at high temperature, and how ceramic materials are able to meet this requirement.

Assignments that address this criterion are:

There were two midterm exams given in the class, and on the midterms there were three problems to evaluate student knowledge on the above concepts. A re-evaluation at the end of the semester was made with two problems in the final exam.

Midterm Problems:
4.b. What are two advantages of hot isostatic pressing (HIP) for sintering? (This is to evaluate knowledge that the solid oxide electrolyte must have small grain size and no porosity.)

6.b. Identify mass transport mechanisms that contribute to densification of the part during sintering. (This is to evaluate knowledge on processes that can achieve high density in ceramic components.)

10. Fill in and complete the following K-V equations showing a solid solution. Hints: Notice the valences of the solutes have been filled in. Do not consider that any solute ions move into interstitial positions, which is an unlikely reaction anyway.
   c. CaO substituted into Fluorite ZrO₂ (This is to evaluate knowledge that a particular aliovalent impurity can be selected to produce oxygen ion vacancies.)

Final Exam Problems:

5. Write K-V defect equations for the following: (A problem similar to midterm problem 10.c. is used to re-evaluate knowledge on effective use of aliovalent impurities to selectively produce vacancies. The final exam problem used a different solid oxide and different impurity additive.)
   a. MnO substituted into Rutile TiO₂:
6. Provide descriptions of the following SOFC components: (A problem similar to midterm problems 4.b. and 6.b. was given to re-evaluate knowledge on several components of SOFC using ceramic materials, and knowing the processing to achieve desired properties.)

   a. Name 3 primary functions of an SOFC electrolyte:
   
   b. The function of the anode:
   
   c. The function of the cathode:
   
   d. The function of the interconnect:
   
   e. The function of the manifold:
   
   f. The function of the reformer:

**Grading Criteria**

Both midterms and the final exam were graded on a numeric basis to 100 points on each exam with partial credit given where appropriate. Grade weighting distributions and expectations were given in the course description (greensheet).

**Analysis**

Midterm Problems: A total of 20 exam points was possible for the three midterm problems. (Each exam problem is worth 10 points, and these problems contained multiple sub-problems.) There were 15 students in the class.

- Nine out of 15 students received 16 or more points (80%) on these problems. This was similar to homework results on similar problems.
- Eleven out of 15 students received 14 or more points (70%) on these problems. This indicates the concept was understood, and most of the students were up to the Analysis Stage (Level 4) in Bloom’s Taxonomy. This was encouraging information.

Final Exam Problems: A total of 10 exam points was possible for the two final exam problems.

- Fourteen out of 15 students received 8 or more points (80%) on these problems.
- Fifteen out of 15 students received 7 or more points (70%) on these problems. This also indicates most of the students were up to the Analysis Stage (Level 4) in Bloom’s Taxonomy, and even more improvement was achieved with additional discussion time spent. This also was encouraging information, and indicates classroom discussions and problem solving during interactive class time was effective in student learning accompanied with analytic capability.
Recommendations

- The students were enthusiastic to study the use of ceramics in a clean power generation application. Additional ceramic material applications should be considered within time permitting, especially if diverse applications can be explored, such as using ceramics in composites. This also would extend knowledge from previous classes, such as using fracture toughness.
- Students understood the basic concepts of diffusion. When extending those concepts to the next level such as ionic conduction, selective ionic conduction, and then to an application of solid oxide electrolyte, it is effective to combine lecture discussion of new concepts with problem solving. Small discrete steps for introduction of new concepts, with having the students engaged by the instructor asking questions at each step, should be used.
- Collaborative learning and peer teaching was encouraged for homework problems, so lectures should be modeled with similar collaboration and positive feedback to students. Methods to more effectively engage all of the students, and not neglect anyone in the discussion need to be explored.

Continuous Improvement

Lectures and homework should emphasize working problems, doing analysis, and building from what is known into the unknown.

- An emphasis will be placed during lectures to ask more questions that draw connections of material properties to use in applications.
- An emphasis will be placed on homework problems that require students to solve problems that are similar but not identical to problems discussed in lecture.
- Encouragement will be given to use study groups with collaborative learning for homework and study for exams.

ABET Outcome:

(k) Ability to use the techniques, skills and modern tools necessary for engineering practice

Assessed in Course: MatE 143 (Fall 2017)

ABET Outcome:

11.1 Utilize modern tools and techniques to alter, characterize, and measure materials properties and to design processes according to accepted standards

SJSU Materials Engineering Performance criteria

Performance criteria:
11.1 Perform compositional analysis of an SEM specimen

Assignment(s):
Assessing 11.1 at level 3 using Question 5 on the midterm.
Midterm question: Consider the EDS spectra below.
   a. Indicate the background signal on the figure.
   b. Identify Peaks P1 and P2. Label them on the figure.
   c. The peak at around 1keV was identified as sodium (Na). Is Na actually present in the sample? Explain in the space below the figure.

Analysis:

For 11.1, 6 out of 14 students who took the exam, out of 14 enrolled, met the criteria of 75% or above where 75% was equivalent to a C grade. The highest score out of 10 points possible was 10, the lowest was 2 and the average was 6.43 (average was 64.3%).

Recommendation:

For 11.1, providing students with more in-class practice with various EDS spectra is recommended. Currently, the exposure to EDS spectra is limited to the ones obtained in the labs and those presented in the lecture slides and in the assigned text book readings. In-class exercises involving identification of EDS spectra should be designed and implemented to enhance students’ abilities to recognize the composition of samples and increase their abilities to perform compositional analysis.

8. Proposed changes and goals (if any)

Based on the course and program assessment data, it seems that all MatE students were able to meet ABET outcomes and SJSU Materials Engineering Program Outcomes. In lieu of MatE SSR, the MatE faculty made the following changes in the program. The goals for these changes are 1) to make the program more attractive to current and future students, 2) to prepare students for another career path, and 3) to improve the program by adding additive manufacturing (i.e. 3-D printing) and computational simulation.

Part C  Closing the Loop/Recommended Actions
Changes based on evaluation of student outcomes.

In 2017 ABET accreditation review, the MatE program received one deficiency, one weakness and two concerns. The deficiency is in the lab safety area, the weakness is in the program continuous improvement area and two concerns are in T/TT faculty and facilities, respectively.

ABET Program Deficiency - APPM
MatE Program issues (ENG 105, 223, 231, 235, 225)
Several MatE courses and research projects are currently conducted using room ENG 105, 223, 225, 231, and 235. The signage in all five labs have been posted in a visible place. (see attached) The radiation safety sign for room ENG 223 has been posted as well. The spill kit, PPE and Safety showers/eye wash access and signage are to be installed soon.
ABET Program Weakness- C4. Continuous Improvement

The ABET Assessment/Continuous Improvement meetings are being moved from once a year during the summer faculty retreat to a monthly meeting during the Fall and Spring Semesters. This will allow for a quick response due to the input from faculty and students. The Department meeting is on the first Tuesday of every month during the semester, curriculum meeting is on the second Tuesday of every month during the semester, and ABET meeting is on the third Tuesday of every month during the semester.

The basic process each semester will be to:

- Send out an Agenda of ABET action items during the first ABET meeting of each semester
- Review of previous semester assessment activities
- Develop plan for continuous improvement activities based on assessment results
- Develop ABET deliverables/timeline this semester
- Assign deliverables to faculty
- Review deliverables/timeline at subsequent ABET meetings during the semester and adjust as appropriate
- Review ABET activities during the last meeting of each semester
- Confirm deliverables have been met and develop plan to assess changes during the next semester.

ABET Program Concern- C6. Faculty

As part of their professional growth, two assistant professors (Drs. Keles and Oh) are included in assessment process. Updated continuous improvement process includes role for all TT/T faculty in the program; sufficient oversight in the event roles change in the future. Since MatE program is in a combined department, it will be benefited from sharing service roles with all department faculty members. There has been a plan to increase MatE undergraduate students to 10 frosh and 20 transfers with 10 students graduated in the upcoming year. This is done via a meeting with local community college councilors and presentations to undeclared majors in the College of Engineering. Strengthening the tie with community colleges will greatly enhanced the student enrollment in the major. Hence, it will justify a new hire of MatE faculty member. A request for a MatE faculty search during the 2018/2019 cycle to address the ABET faculty and continuous improvement weakness has been sent to the Charles W. Davidson College of Engineering for consideration.

ABET Program Concern - C7. Facilities

The MatE program joining with ChE program has discussed some strategic plans to repair and update the broken equipment needed for MatE 153, 154 and 195 courses. A list of equipment in ENG231 is being generated (see attached) for administrative review. Further actions in ENG 105, 223, 225, and 235 will be conducted by the end of February 2018.
## Materials Engineering Equipment Upgrade List and Justification

<table>
<thead>
<tr>
<th>Course number</th>
<th>Quote included</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATE 153, 180</td>
<td>Yes</td>
<td>This equipment was broken from 2016 and the lab class was replaced to dry lab without student’s involvement to measure conductivity. We claim to purchase one station instead of four, which is typical set of equipment for 16 students.</td>
</tr>
<tr>
<td>MATE 153, 180</td>
<td>Yes</td>
<td>This equipment is critical tool to determine the conductivity of metals, polymers and ceramics. We do not have this tool in SJSU limiting the determination of our circuit analysis for MatE 153.</td>
</tr>
<tr>
<td>MATE 154</td>
<td>Yes</td>
<td>These equipment sets were aged for more than 10 years and it is impossible to fix because it is outdated. The instructor and students have really hard time to proceed their experiments which take 2-3 weeks of class schedule.</td>
</tr>
<tr>
<td>MatE 154</td>
<td>Yes</td>
<td>MatE 154, 185, and 210 classes need a precision cutter to get a good sections from various samples including metal, ceramic, composite, and polymer. Current one does not work properly and cut at high precision. Precision cutter is a critical tool for sample preparation.</td>
</tr>
</tbody>
</table>

Here we include three major equipment requests that need an urgent purchase for the class held in spring 2018. MatE 153 is a service class that supports students not only from MatE students but from ME, EE, whose enrollment rates are rather higher than MatE. MatE 154 requires an extensive support in addition to this instrument update requested underneath. We appreciate your consideration and the spends will tremendously benefit our students primarily, staffs and faculties.

### Changes made in MatE curriculum

Our 2016-2017 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 Introduction to Circuit Analysis

Due to the reduction to 120 units for graduation requirement and as part of the process of continuous improvement, the MatE Program faculty reviewed other CSU and UC Materials Engineering Programs and found that they were not including EE 98 as a required course. As a result, we elected to drop EE 98 as a required course. Accordingly, the BS MatE degree curriculum and roadmap have been adjusted to accommodate this change.

2). Adopt the changes made in 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. MatE students are required to take ChE162 course.

3). Add 2-unit ME20 Design and Graphics course and 2-unit ME 30 Computer Applications course

Due to a total of 4 units dropped in the curriculum mentioned in (1) and (2) above, the overall impact must keep the MatE program at 120 units. In conjunction with a realization of strong need in additive manufacturing and computational simulation, the MatE faculty has decided to add two 2-unit courses (ME20 and ME30) to the curriculum. ME20 course will introduce students to design and graphical solutions to three-dimensional design problems involving points, lines, surfaces and solids. It helps students learn the computer-aided design via development of visualization and technical sketching skills in conjunction with orthographic and pictorial projections. ME30 focuses on using computer to solve engineering problems through programming and the use of engineering application procedures. This course will emphasize on procedural and informational problem-solving methods and practices applied to software design, application, programming and testing. We believe the addition of these two courses will greatly enhance the program strengths and, more importantly, prepare MatE students another career pathway in computational fields.

4). Impact of Engr 195A/B

A new proposal to revamp Engr 195A/B was submitted in Fall 2017. The impact will be reviewed during the next cycle of program review, presumably in MatE198A/B senior design projects courses.
5). Survey MatE alumni

This part was not executed during this cycle of review. It is listed to be an action item for the next cycle.

9. Program Learning Outcomes
What are your proposed closing-the-loop action items and completion dates?

Describe the progressive changes and the status in the table below.

<table>
<thead>
<tr>
<th>Proposed Changes and Goals</th>
<th>Status Update (what’s being done and results observed)</th>
<th>Date reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove EE98</td>
<td>Reflected in the 2018 catalog</td>
<td>Spring 2017</td>
</tr>
<tr>
<td>Add ME20 and ME30</td>
<td>Reflected in the 2018 catalog</td>
<td>Spring 2017</td>
</tr>
<tr>
<td>Modified Engr 195A/B</td>
<td>In progress</td>
<td>Summer 2017</td>
</tr>
</tbody>
</table>

10. Program planning action items

The direct web link to the MatE program is listed at http://www.sjsu.edu/gup/ugs/faculty/programrecords/Engineer/Materials/index.html

Describe the action items and the status in the table below.

<table>
<thead>
<tr>
<th>Action item description</th>
<th>Status Update (what’s being done and results observed)</th>
<th>Date reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>MatE faculty search</td>
<td>Submitted MatE T/TT faculty search justification and form</td>
<td>March 2018</td>
</tr>
<tr>
<td>MatE student recruitment</td>
<td>To host a conference with local community colleges</td>
<td>April 2018</td>
</tr>
<tr>
<td>MatE alumni contact</td>
<td>To connect to MatE alumni via web and student conference day</td>
<td>May 2018</td>
</tr>
</tbody>
</table>