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Board 139: Work in Progress: Mechanical Engineering Curriculum Renewal Process at a Ohio State University

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Work in Progress: Mechanical Engineering Curriculum Renewal Process at Ohio State University

Abstract

In late 2019, the faculty of the Department of Mechanical and Aerospace Engineering at Ohio State University began a long-range initiative to redesign the undergraduate mechanical engineering curriculum. The aim was to develop a new set of goals for the program independent from the current curriculum, with a focus on meeting the needs and challenges of modern students as they enter a constantly changing professional environment.

While updating and renewing a mechanical engineering curriculum is not a novel concept, performing a complete redesign of the curriculum is a major undertaking and can be completed utilizing any of many tools and approaches. There are reports in the literature from similar recent efforts, each of which utilized specific methods and tools that were appropriate for their goals and objectives [1, 2, 3, 4, 5, 6].

In this Work in Progress report, we describe the approach currently being utilized at Ohio State, and report on the progress to date and future plans. The approach used in this report began with an initial faculty workshop that was used to generate discussion and solicit input to better understand the perceived strengths and weaknesses of the current curriculum, as well as assessing the perceived needs of the faculty regarding curriculum redesign.

Following that initial workshop, a committee of department faculty was formed and began working with a professional from the University Teaching Center, to help ensure they were following best practices in instructional design. The committee employed the Backward Design Process [7] to ensure that the focus was on student learning outcomes and proficiencies, rather than specific course content.

At present, the committee has developed a document summarizing the program goals, student learning objectives, and student proficiencies, which will be a basis for the revised curriculum. These have been mapped to the ABET required student learning outcomes [8]. This information was shared with the larger faculty of the department in November 2023 and feedback was collected and integrated into the document.

Much work is still to be done on this project. The committee is currently gathering additional feedback and input from a variety of program stakeholders and has begun the process of widening involvement and engagement within the department faculty. Part of this process includes completing additional training in the Backward Design process for the department faculty, which is targeted for completion prior to the beginning of the autumn semester of 2024.

Following the training process, the committee plans to work in collaboration with the program interest groups and individual faculty to utilize the developed program goals, student learning objectives, and student proficiencies to develop the specific courses that will make up the new curriculum.

Acknowledgements

This paper is reporting on work done by a committee over the course of several years. The authors would like to acknowledge all of the past and current faculty members who have put in the work to move this project forward. Thank you to Carlos Castro, Rebecca Dupaix, Jung Hyun Kim, Russell Marzette, Sandra Metzler, Satya Seetharaman, Rob Siston, Manoj Srinivasan, Vish Subramaniam, and David Talbot for serving on the committee over the course of the project to date. Additional thanks go to all of the other members of the mechanical engineering faculty who have given input to the process.

Background and Motivation for the Work

The curriculum of Mechanical Engineering programs at ABET accredited institutions is guided by the requirements published in the ABET document "Criteria for Accrediting Engineering Programs." [8] The document details the necessary criteria that ABET utilizes to assess institutions for accreditation purposes, and it is organized under eight individual criteria. While all of the criteria are relevant to the development of the organization and practices of an ABET accredited engineering program, several of the ABET criteria particularly impact the content and organization of the curriculum for undergraduate engineering programs, including Criterion 3, *Student Outcomes*, and Criterion 5, *Curriculum*.

The current set of Student Outcomes went into effect in the 2019-2020 academic year, and they continue to utilize the concepts of change within the profession and outcome-based education that were first implemented as part of the Engineering Criteria 2000 (EC2000) standards, which ABET began adopting in 1996 [9]. EC2000 shifted the focus from specific inputs, such as the specific content that was taught in the program, to outputs, which are the learnings that students take with them when they leave the program.

Another significant aspect of ABET-accredited programs is that they employ a practice of continuous improvement. This process is implemented at OSU's Department of Mechanical and Aerospace Engineering in large part under the auspices of a Continuous Quality Improvement Committee (CQIC), which reviews feedback from current students, alumni, employers of our students, and an External Advisory Board, as well as the performance of currently enrolled students to continuously refine and improve the program. The CQIC meets regularly throughout each academic year and presents summary data of the feedback it monitors to the larger faculty annually. This feedback is utilized to make changes within the curriculum, primarily at the individual course level although it has been occasionally utilized in larger-scale curriculum modifications. The entire mechanical engineering curriculum at Ohio State University, an ABET accredited institution, was last revised in a significant manner in the 2012-2013 academic year, primarily to accommodate a structural change in the university from a quarter-based calendar and curriculum to a semester-based schedule.

This constant review and improvement process, as well as the awareness of the larger faculty of societal trends within the profession and the mechanical engineering higher education community, naturally generates discussion as to best practices, and areas for growth, change, and development within our curriculum and its implementation. It was out of these discussions and conversations, as well as the support of the department administration, that a curriculum renewal process was undertaken, beginning in 2019. The goal of the curriculum renewal process was to develop a comprehensive mechanical engineering curriculum unconstrained by adherence to the existing curriculum structure, and with a focus on meeting the needs and challenges of modern students as they enter a constantly changing professional environment.

Approach and Progress to Date

Following the best practices in instructional design and working with a professional from the University Teaching Center, a faculty committee composed of members of the Mechanical Engineering Department has employed the Backward Design Process [7] to ensure that the process began with a focus on student learning outcomes and proficiencies, rather than specific course content.

To begin the curriculum redesign process, a retreat was held in December of 2019 to gather input from faculty and staff of the department, with a focus on the question, "*What do we want our students to be able to do, know, and care about after successfully completing the ME program?*" The output of this retreat was six guiding "areas" that would guide a department committee in (eventually) redesigning the curriculum: Problem Solving; Communication; Professional Identity and Ethics; Teamwork, Leadership, and Inclusivity; Information Literacy, Judgement, and Critical Thinking; Character Traits and Self-Directed Learning.

As all readers will know, the Covid-19 pandemic caused many workplace plans and initiatives to grind to a screeching halt. This curriculum renewal initiative of the mechanical engineering program at Ohio State University was no exception. Over the course of 2020-2022, slow progress was made on writing specific program goals to match each of the six guiding areas developed during the 2019 retreat. Next, progress was made on developing the student learning outcomes that would comprise each program goal. Starting in 2022, the curriculum committee was finally able to move the project off the back burner and work with more focus and purpose to build out the student proficiencies, which are the fine-grained skills that make up student learning objectives.

At present, the curriculum committee has developed and documented the program goals, student learning objectives, and student proficiencies (see Appendix A). These have been mapped to the ABET required student learning outcomes (see Appendix B).

The set of drafted program goals, student learning objectives, and corresponding student proficiencies were shared with the larger faculty body in the department in November 2023. The committee facilitated discussion with the faculty members and encouraged them to leave feedback in the form of specific comments tied to one of the program goals, student learning objectives, or student proficiencies.

This information was shared with the larger faculty of the department in November 2023 and their feedback was collected. The faculty members who participated with feedback provided insightful comments and ideas that helped the committee integrate That feedback was reviewed and incorporated into the central document containing the program goals, student learning objectives and student proficiencies, which is included as an appendix.

Much work is still to be done on this project. The committee plans to complete the following work by April 2024:

- Solicit feedback the department external advisory board, current undergraduate students in the program, recent graduates of the program, and representative industry professionals who frequently hire entry-level mechanical engineers.
- Perform research and benchmarking activities with respect to the mechanical engineering curriculum of other universities.
- Determine which mechanical engineering topics should be core parts of the curriculum, and which topics might be optional or included in the curriculum as areas of specialization. This will be informed by information gathered from a variety of sources including benchmarking of peer institutions, consulting with the core competencies represented on the FE exam, and by consulting with our department's faculty interest groups (e.g., sub-groups of the faculty who share similar disciplinary interest and expertise)
- Working with faculty interest groups to train all faculty members on the Backward Design Process, so that all faculty will be able to focus on curricular redesign without focusing on a given topic, class, or subject area.

Future work that the committee plans to embark on in fall of 2024 includes using the developed program goals, student learning objectives, and student proficiencies to develop the specific courses that will make up the new curriculum.

This curriculum renewal process is being presented under the Work in Progress designation at ASEE with the goal of making connections with other mechanical engineering faculty who are interested in or have experience with such an undertaking, to further the shared knowledge of the mechanical engineering higher education community. We look forward to the discussion and insights that will be gained from this experience at ASEE.

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Appendix A: Background and Terminology

Terminology used by the Curriculum Renewal Committee

Program Goals: Together, program goals make up a broad description of what our students will be able to do, know, and care about after completing the full academic program. The goals articulate the concepts, theories, knowledge, and/or skills that students will possess upon graduation. To achieve a given goal, students need to master the constituent *learning outcomes*. A program goal is typically comprised of multiple student learning objectives.

Student Learning Outcomes: These are measurable indicators of student learning and achievement. Student Learning Outcomes describe desired changes in skill, knowledge, or behaviors related to a desired program goal. Outcomes should be specific and focus on a single achievement at a time, so multiple outcomes will be associated with any given program goal. To successfully achieve an outcome, students often (but not always) need to master specific *proficiencies*. [Note: Student Learning Outcomes are sometimes referred to as *Expected Learning Outcomes*, or *Student Learning Objectives*. These phrases all describe the same thing.]

Student Proficiencies: These are fine-grained skills, knowledge, behaviors, and attitudes that are necessary for the student achieve the student learning outcomes. A proficiency should describe a singular learning accomplishment or mastered skill.

Process & Best Practices

The committee has followed best practices of instructional design to define the program goals, student learning outcomes, and student proficiencies in a manner that largely transcends the specifics of mechanical engineering topics. This will allow freedom in curriculum redesign so that a specific goal, outcome, or proficiency is not tied to a given topic, class, or subject area. This approach can be used to design either an entire curriculum or an individual course.

The methodology that the committee has utilized is known as Backward Design (*Understanding by Design,* Wiggins and McTighe, 2005). The work has been performed with assistance from Dr. Teresa Johnson, originally of the OSU University Center for Teaching and Learning, who is experienced in this work. Specifically, Dr. Johnson has extensive experience using Backward Design in the development of entire curriculums. While Dr. Johnson has moved into another position within OSU, we are fortunate that she will be continuing to support us in this process.

Background on ABET

ABET is the engineering accreditation body for undergraduate engineering programs. ABET requires that an engineering program:

> *"… must have published* ***program educational objectives*** *that are consistent with the mission of the institution, the needs of the program's various constituencies, and these criteria. There must be a documented, systematically utilized, and effective process, involving program constituencies, for the periodic review of these program educational objectives that ensures they*

> *remain consistent with the institutional mission, the program's constituents' needs, and these criteria.*"

Notably, ABET does **not** stipulate what the program educational objectives should be, so there is latitude for programs to tailor them according to their needs.

Furthermore, ABET stipulates "The program must have documented student outcomes that support the program educational objectives… **Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program**." This means programs must show that students are at minimum meeting ABET outcomes 1-7, and programs may add additional outcomes as desired.

Details of ABET's student outcomes 1-7, as well as other details of accreditation can be found here.

Appendix B: Proposed Program Goals, Student Learning Outcomes, and Student Proficiencies

A. Problem Solving

Program Goal: The successful student will be able to identify, define, formulate, and solve complex engineering problems by applying tools, methods, and principles of engineering, science, and mathematics.

To meet this program goal, the successful student will be able to:

1. **Identify and analyze problems, ask appropriate questions, and define the success criteria.**
    a. Identify knowns and unknowns of a given problem
    b. Deduce the knowns and unknowns that are implied by specialized vocabulary terms
    c. Infer the relevant assumptions for a given problem
    d. Define the relevant scope/boundaries of an open-ended problem
    e. Translate the problem goals and objectives specified in informal language into more precise engineering terms
    f. Extract/define success criteria for a given problem
    g. Account for different stakeholders' needs while defining a problem
    h. Synthesize information from different sources to define a problem statement

2. **Identify the interactions and interconnectivity within a problem.**
    a. Identify components of the problem.
    b. Describe the relationships of the components of the problem.
    c. Identify the relevant disciplines outside of ME.
    d. Identify how it involves subject areas within ME.
    e. Identify the impact on people and organizations.
    f. Describe how the problem interacts with and impacts adjacent components, systems, or processes.

3. **Develop an appropriate strategy and methodology in pursuing a solution.**
    a. Identify potential solution techniques for a given articulated problem
    b. Articulate potential solution techniques for a given articulated problem
    c. Identify and understand the current state of the art
    d. Categorize an activity for various levels of technical development (e.g., fundamental research, applied research, technology application & best practices)
    e. Determine the relevant scientific and engineering principles

   f. Evaluate the effectiveness and viability of a solution technique subject to constraints
   g. Articulate the rationale behind the selection of a proposed strategy
   h. Articulate a structured solution strategy

4. **Solve problems across mechanical engineering with analytical methods.**
   a. Determine the appropriate physical principles
   b. Determine an appropriate conceptual model of a device, system, or process.
   c. Apply the appropriate governing equations to create a mathematical model.
   d. Apply appropriate mathematical techniques and tools to solve the problem.

5. **Solve problems across mechanical engineering with computational engineering tools:**
   a. Basic programming skills with lower-level programming languages (e.g. C or C++) and higher-level programming and scripting packages (e.g., MATLAB or Python)
   b. Solve governing equations (e.g., ODEs, PDEs, simultaneous algebraic equations, optimality) using appropriate numerical methods
   c. Basic parametric study: expand on theoretical paper/pencil calculations
   d. Design a component on paper vs. geometric/CAD software (e.g., Solid Works)
   e. Solve mechanics problems vs. exposure to FEA software (e.g., ANSYS)
   f. Solve fluid/thermal problems on paper vs. exposure to CFD (e.g., FLUENT)
   g. Solve electromechanical and mechatronic systems problems on paper vs. exposure to software (e.g., Simulink, Simscape)
   h. Multi-domain systems, e.g., fluid-structure interaction (A)
   i. Understand and identify the abilities, limitations, and appropriate applications of machine learning and AI

6. **Solve problems with manufacturing and engineering tools to create a tangible artifact or product.**
   a. Implement solutions utilizing a variety of classical and modern fabrication techniques
   b. Consider approaches and strategies for assembly
   c. Navigate the challenges of integration with complex systems
   d. Evaluate the solutions through verification, validation, and assessment

7. **Relate and apply underlying principles of science and engineering to conduct engineering experiments:**
   a. Establish a hypothesis to be tested or quantities to be characterized
   b. Design the experiment conceptually

c. Design the physical experiment
d. Realize the physical experiment
e. Experiment and collect data
f. Analyze it with statistics or other computational tools

8. **Synthesize solutions, knowledge, or approaches from multiple disciplines.**

B. Communication

Program Goal: The successful student will be able to communicate effectively with various audiences, using various forms of written, visual, and verbal communication.

To meet this program goal, the successful student will be able to:

1. **Verbally communicate knowledge of science and engineering methodology, results, and implications to technical and non-technical audiences.**
    a. Evaluate the different venues or outlets available for communicating specific concepts or research
    b. Select the most appropriate oral communication venue(s) for a specific topic or research
    c. Select the most appropriate media or technology for communicating orally to a specific audience
    d. Create effective and purposeful presentations for technical and non-technical audiences
    e. Deliver a clear full-length presentation with content and format selected for a target audience
    f. Recognize and describe, orally, the implications of one's professional work to society on local, regional, and global scales
    g. Create an "elevator pitch" that succinctly describes a project's goals, results, and impacts

2. **Demonstrate writing skills for technical and non-technical communications and appropriate level of documentation.**
    a. Evaluate different audiences for communicating proposed ideas or results.
    b. Writing thoughtful and informative emails and potentially other social media
    c. Write clear electronic documentation for ongoing project management and completed projects (e.g., readme files in folders containing files)
    d. Use written format to clearly explain current or proposed work in non-technical terms and to a scientific audience, including how work contributes to the discipline and society at large

3. **Demonstrate visual communication skills for technical and non-technical communications and appropriate level of detail.**
    a. Create effective graphs, charts, and other visual representations of data
    b. Create a poster that succinctly describes a project's goals, results, and impacts
    c. Create an effective visual presentation to communicate a project's goals, results, and impacts

4. **Receive and respond to critical feedback from varied sources.**
    a. Receive and interpret critical feedback in verbal and written forms
    b. Respond in writing to critical feedback of written work (e.g.,manuscripts, proposals, reports, etc.)

5. **Engage in productive and professional dialogue online and in-person.**
    a. Ask appropriate questions to probe for new knowledge
    b. Develop competency to respond verbally to unanticipated questions
    c. Demonstrate professionalism, courtesy, and transparency in all communication methods
    d. Make good faith attempts to understand opposing points of view

C. Professional Identity and Ethics

Program Goal: The successful student will be able to understand the profession in relation to self and society and be able to operate professionally, ethically, and with societal awareness and integrity.

To meet this program goal, the successful student will be able to:

1. **Fully describe the discipline of engineering and the sub-discipline of mechanical engineering.**
    a. Initiate a clear career path utilizing discipline

2. **Discern the ethical considerations and implications of engineering decisions, in the context of their environment, profession, and society at large.**
    a. Consider multiple viewpoints
    b. Engage in meaningful debate with others about difficult/controversial topics
    c. Reflect upon their own professional identity and personal ethical values and the intersection with the discipline

3. **Demonstrate ethical decision-making.**

4. **Demonstrate societal awareness through an ability to identify needs, challenges, and problems in a local, regional, and global context.**
    a. Engage as a citizen leader professionally and academically
    b. Demonstrate engagement in professional societies
    c. Demonstrate the consideration of social justice in decision-making

D. Teamwork, Leadership, and Inclusivity

Program Goal: The successful student will be able to contribute to a successful team by taking on different roles within the team, and through creating a collaborative and inclusive environment.

To meet this program goal, the successful student will be able to:

1. **Demonstrate positive communication while working within a team.**
    a. Practice active listening
    b. Demonstrate empathy
    c. Respect other viewpoint
    d. Utilize professional techniques and styles across all communication mediums

2. **Demonstrate effective time management to meet or exceed required outcomes.**
    a. Establish a comprehensive project plan and timeline
    b. Demonstrate appropriate team and individual time management skills
        i. Structuring of team meeting times.
        ii. Demonstrate accountability for individual responsibilities and work
    c. Practice delegation of responsibilities (or ask for assistance) when appropriate
    d. Perform delegated duties in a conscientious manner
    e. Demonstrate accountability to teammates

3. **Promote inclusivity and collaboration amongst the team and stakeholders.**
    a. Demonstrate an understanding of the importance and benefits of diversity, equity, and inclusion
    b. Interact productively and professionally with people from different cultural and technical backgrounds
    c. Understand how inclusivity positively contributes to a highly functional team

4. **Participate in mentorship as both mentee and mentor.**
    a. Give feedback
    b. Process feedback
    c. Proactively contribute to the relationship

5. **Practice appropriate individual and team leadership skills.**
    a. Demonstrate flexibility by operating cross functionally
    b. Demonstrate ability to discern whether team needs require leadership or support
    c. Understanding the balance between individual contribution and team collaboration

6. **Understand the unique roles and interactions of individual team members on interdisciplinary teams.**

E. Information Literacy, Judgement, and Critical Thinking

Program Goal: The successful student will be able to use engineering judgement in evaluating data, evaluating external information, evaluating their own capabilities and limitations, and will use that judgement to arrive at sound conclusions.

To meet this program goal, the successful student will be able to:

1. **Apply the principles information literacy to discern the quality, utility, and relevance of existing information.**
    a. Recognize "how and why information has value"
    b. Recognize "what makes a source authoritative"
    c. Demonstrate "persistence and flexibility when searching" for information
    d. Demonstrate competent use of information search tools

2. **Discern the quality, utility, and relevance of data, independent of source.**
    a. Choose appropriate tools or methods for the evaluation of data
    b. Use appropriate engineering equations and estimation techniques to perform common sense checks of data
    c. Assess the appropriateness of assumptions, input, and outputs
    d. Confirm the validity of engineering solutions
    e. Assess the plausibility and reasonableness of data
    f. Verify and validate simulation data
    g. Confirm the validity of experimental data

3. **Assess their own capabilities, limitations, and performance as individuals or team members.**
    a. Engage in reflection to self assess their own capabilities and performance
    b. Identify the skills needed to successfully tackle a given engineering problem
    c. Identify their own role in the solution strategy
    d. Recognize and describe the need for outside expertise on a given project

F. Character Traits and Self-Directed Learning

Program Goal: The successful student will be able to exhibit a growth mindset, persevere through learning experiences, and exhibit resilience when facing challenges.

To meet this program goal, the successful student will be able to:

1. **Demonstrate meta-cognition through critical awareness and reflection on their growth and development as a learner.**
    a. Interrogate their own thinking and explain it to others
    b. Explain how they best learn
    c. Monitor and assess their own depth and quality of learning
    d. Identify how their thought processes have evolved

2. **Demonstrate their agency as learners**
    a. Demonstrate the ability to plan a successful learning strategy
    b. Set learning objectives, initiate action, reflect on progress, and adjust towards accomplishing that objective
    c. Co-create path of learning that aligns technical electives, extracurricular, and other experiential learning opportunities with future career goals

3. **Persevere in the face of challenges (but also know when to change strategy)**
    a. Evaluate the nature of challenges (ex. Technical, interpersonal, time, resources, mental, physical)
    b. Identify a potential path forward
    c. Selection a reasonable course of action
    d. Embrace setbacks and challenges and view them as opportunities to evolve thought processes and learn

4. **Demonstrate a balance between divergent and convergent thinking.**
    a. Cultivate different perspectives
    b. Explore a diverse set of perspectives and alternatives when appropriate
    c. Identify the scenarios that benefit from divergent vs. convergent thinking
    d. Integrate aspects of diverse perspectives and alternatives into a cohesive concept or action

5. **Navigate ambiguous situations**
    a. Acknowledge ambiguous elements of situations
    b. Appropriately communicate ambiguity in a timely manner
    c. Identify relevant knowledge domains
    d. Identify resources
    e. Generate assumptions

f. Develop multiple plans
g. Assess risk
h. Take action to reduce uncertainty
i. Periodically evaluate the situation

6. **Apply existing knowledge to unfamiliar problems.**
    a. Use engineering judgement to appropriately extrapolate from existing knowledge to approach novel problems
    b. Identify relevant knowledge domains
    c. Demonstrate an ability to extend their current knowledge base and incorporate new knowledge

7. **Acquire new knowledge, skills, and expertise.**
    a. Stay current with technological advances
    b. Be aware of resources for continuing education

Appendix C: Mapping of Current ABET Outcomes to Proposed Program Goals

A. Problem Solving

Program Goal: The successful student will be able to identify, define, formulate, and solve complex engineering problems by applying tools, methods, and principles of engineering, science, and mathematics.

Relates to ABET Outcome 1: an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Relates to ABET Outcome 6: an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

B. Communication

Program Goal: The successful student will be able to communicate effectively with various audiences, using various forms of written, visual, and verbal communication.

Relates to ABET Outcome 3: an ability to communicate effectively with a range of audiences.

C. Professional Identify and Ethics

Program Goal: The successful student will be able to understand the profession in relation to self and society and be able to operate professionally, ethically, and with societal awareness and integrity.

Relates to ABET Outcome 2: an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Relates to ABET Outcome 4: an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

D. Teamwork, Leadership, and Inclusivity

Program Goal: The successful student will be able to contribute to a successful team by taking on different roles within the team, and through creating a collaborative and inclusive environment.

Relates to ABET Outcome 3: an ability to communicate effectively with a range of audiences.

Relates to ABET Outcome 5: an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

E. Information Literacy, Judgement, and Critical Thinking

Program Goal: The successful student will be able to use engineering judgement in evaluating data, evaluating external information, evaluating their own capabilities and limitations, and will use that judgement to arrive at sound conclusions.

Relates to ABET Outcome 4: an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

Relates to ABET Outcome 6: an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

F. Character Traits and Self-Directed Learning

Program Goal: The successful student will be able to exhibit a growth mindset, persevere through learning experiences, and exhibit resilience when facing challenges.

Relates to ABET Outcome 6: an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Relates to ABET Outcome 7: an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.