Institutional Effectiveness
2023-2024

Program: Mechanical Engineering BSME
College and Department: College of Engineering, The Mechanical Engineering (ME) Department
Contact: Dr. Mohan Rao
Mission:

Mission: The Mechanical Engineering (ME) Department, within a regional and global context, will prepare its students for productive careers in a competitive, dynamic, technologically-based society; will advance the knowledge of mechanical engineering principles and applications; and will serve the public.

Vision: The Mechanical Engineering Department at Tennessee Tech aspires to be recognized globally for outstanding education and research, leading to well-qualified engineers who are adaptive professionals, inquisitive, entrepreneurial and successful in engineering practice, research, and public service.

The B.S. in Mechanical Engineering (BSME) at Tennessee Tech is a traditional, on-campus lecture/laboratory program with on-ground course delivery offered almost exclusively during the day. There currently are no distance learning courses offered by the Mechanical Engineering Department. A co-op program is available through the Tennessee Tech Center for Career Development as an optional (but very popular) choice.

Attach Curriculum Map (Educational Programs Only):
Attached Files: See Appendix 1

SO1: Identify, Formulate and Solve Engineering Problems

Define Outcome:
It is expected that by the time of graduation, Tech's ME students will have an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Assessment Methods:
Direct Measure

- AEC Plan and Departmental Rubrics
    - In Fall 2021, the ME Department adopted a new paradigm for continuous improvement. The AEC Plan is based on a two-year cycle for assessing, evaluation, and change. The AEC Plan designates that four of the seven outcomes (SO1, SO3, SO4, SO5) are assessed during Fall 2021-Spring 2022, and

again in Fall 2023-Spring 2024. The assessment stage is followed by evaluation and change in Fall 2022-Spring 2023, then again in Fall 2024-Spring 2025. The remaining three outcomes (SO2, SO6, SO7) are assessed during Fall 2022 – Spring 2023 and again in Fall 2024-Spring 2025, followed by evaluation and change in Fall 2023-Spring 2024 and again in Fall 2025-Spring 2026. New departmental rubrics were developed by the faculty to assess student artifacts from the Senior Capstone projects and applied during faculty retreats. The rubrics are provided in separate documents. The assessment stage is described in a Standard Operating Procedures (SOP), and attached in a separate document.

Additional Measures

Four survey instruments (Alumni Survey, Co-op Employer Survey, Instructional Outcome - Student Survey and Senior Exit Interview Written Survey) and a faculty instrument (Instructional Outcome - Faculty Assessment) are conducted each year and have been kept active during the transition to implementation of the AEC Plan.

- Alumni Survey
    -
- Co-op Employer Survey
    -
- Instructional Outcome - Faculty Assessment
    -
- Instructional Outcome - Student Survey
    -
- Senior Exit Interview Written Survey
    -

Attached Files: See Appendix 2

Criteria for Success (Thresholds for Assessment Methods):
Direct Measure

Additional Measures

The expected level of attainment of Student Outcomes is scored with a 0-4 point level of attainment scale where each level is defined as 4 = Excellent, 3 = Good, 2 = Satisfactory, 1 = Low, and 0 = Negligible. Data from the assessment instruments are combined according to the evaluation plan to determine the final scored value each year for each Student Outcome.

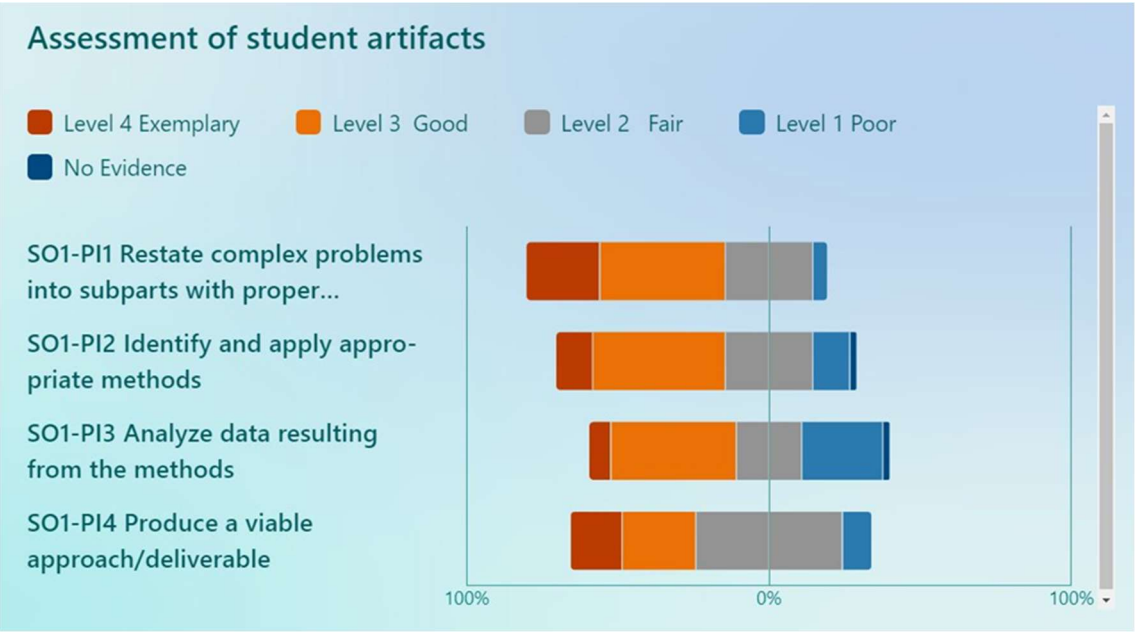
A score of 3-to-4 is the desired level of attainment for each Student Outcome. A score between 2-to-3 is cause for review by the ME Goals and Assessments Committee, with possible actions and/or continued monitoring recommended to the ME faculty. A score lower than 2 requires

corrective action to be taken by the ME faculty after review and recommendations for change by the ME Goals and Assessments Committee.

Link to 'Tech Tomorrow' Strategic Plan:
1.A Experiential Learning,2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:

SO1: Identify, Formulate and Solve Engineering Problems		
	2022-23	**2023-24**
Alumni Survey	3	3.6
Co-op Employer Surveys	3.2	3.3
IOSS	3	3
Senior Exit	3.4	3.1
AVERAGE	**3.2**	**3.2**



Use of Results to Improve Outcomes:

SO2: Apply Engineering Design to Produce Solutions That Meet Specified Needs

Define Outcome:
It is expected that by the time of graduation, Tech's ME students will have 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.

Assessment Methods:

- Alumni Survey
- External Evaluation of Senior Design Projects
- Instructional Outcome - Faculty Assessment
- Instructional Outcome - Student Survey
- Senior Exit Interview Written Survey

Criteria for Success (Thresholds for Assessment Methods):
The expected level of attainment of Student Outcomes is scored with a 0-4 point level of attainment scale where each level is defined as 4 = Excellent, 3 = Good, 2 = Satisfactory, 1 = Low, and 0 = Negligible. Data from the assessment instruments are combined according to the evaluation plan to determine the final scored value each year for each Student Outcome.

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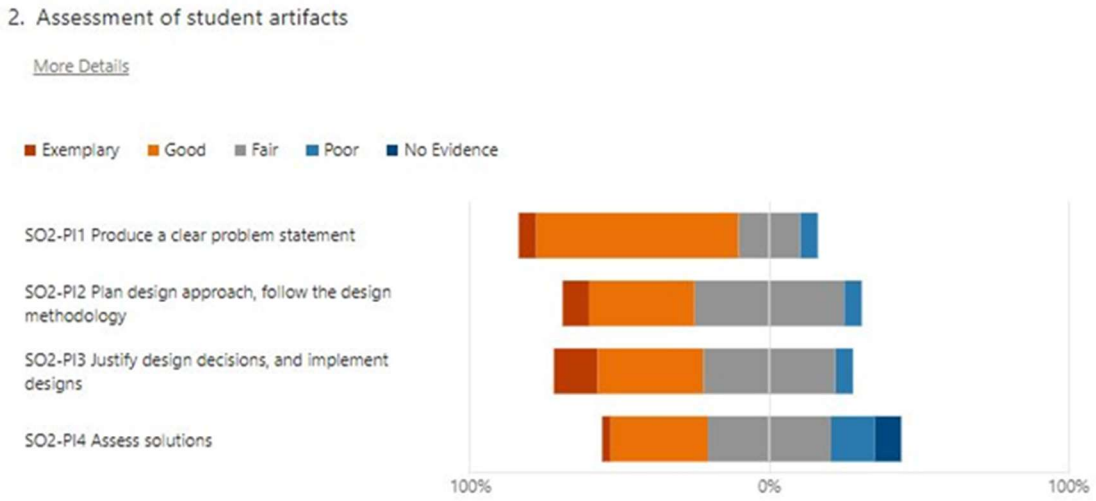
Link to 'Tech Tomorrow' Strategic Plan:
1.A Experiential Learning

Results and Analysis:

SO2: Apply Engineering Design to Produce Solutions that Meet Specified Needs		
	2022-23	**2023-24**
Alumni Survey	3	3.6
Co-op Employer Surveys	3.3	3.3
IOSS	2.9	2.9
Senior Exit	3.2	3.1
AVERAGE	**3.1**	**3.1**



Use of Results to Improve Outcomes:

SO3: Communicate Effectively

Define Outcome:

It is expected that by the time of graduation, Tech's ME students will have an ability to communicate effectively with a range of audiences.

Assessment Methods:

- Alumni Survey
- Co-op Employer Survey
- External Evaluation of Senior Design Projects
- Instructional Outcome - Faculty Assessment

- Instructional Outcome - Student Survey
- Senior Exit Interview Written Survey
- Overall Level of Attainment

Criteria for Success (Thresholds for Assessment Methods):
The expected level of attainment of Student Outcomes is scored with a 0-4 point level of attainment scale where each level is defined as 4 = Excellent, 3 = Good, 2 = Satisfactory, 1 = Low, and 0 = Negligible. Data from the assessment instruments are combined according to the evaluation plan to determine the final scored value each year for each Student Outcome.

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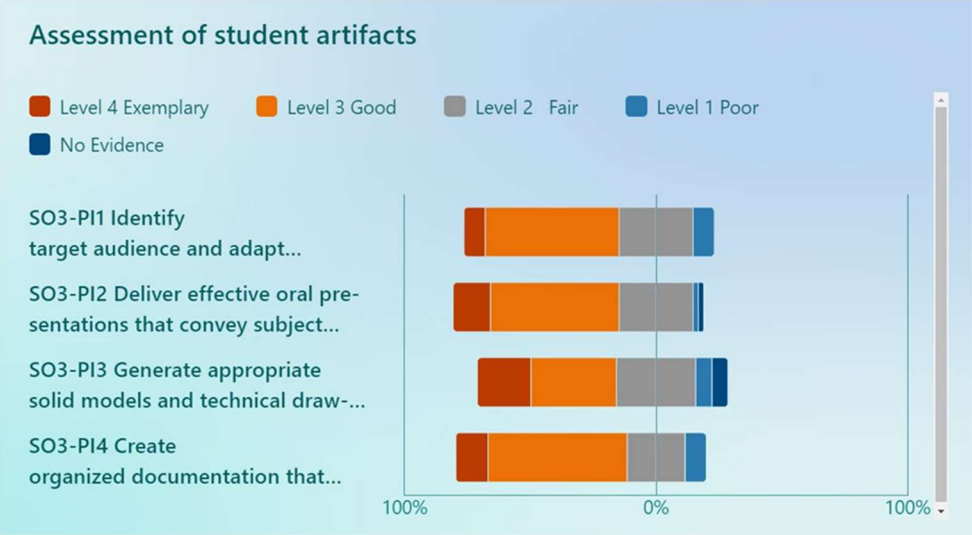
Link to 'Tech Tomorrow' Strategic Plan:
1.A Experiential Learning,4.D Alumni/Friend Engagement

Results and Analysis:

SO3: Communicate Effectively		
	2022-23	**2023-24**
Alumni Survey	3	3.1
Co-op Employer Surveys	3.3	3.2
IOSS	2.9	2.9
Senior Exit	3.3	3.2
AVERAGE	**3.1**	**3.1**



Use of Results to Improve Outcomes:

SO4: Recognize Ethical and Professional Responsibilities and Make Informed Judgments

Define Outcome:
It is expected that by the time of graduation, Tech's ME students will have an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

Assessment Methods:

- Alumni Survey
- Co-op Employer Survey
- External Evaluation of Senior Design Projects
- Instructional Outcome - Faculty Assessment
- Instructional Outcome - Student Survey
- Senior Exit Interview Written Survey
- Overall Level of Attainment

Criteria for Success (Thresholds for Assessment Methods):
The expected level of attainment of Student Outcomes is scored with a 0-4 point level of attainment scale where each level is defined as 4 = Excellent, 3 = Good, 2 = Satisfactory, 1 = Low, and 0 = Negligible. Data from the assessment instruments are combined according to the evaluation plan to determine the final scored value each year for each Student Outcome.

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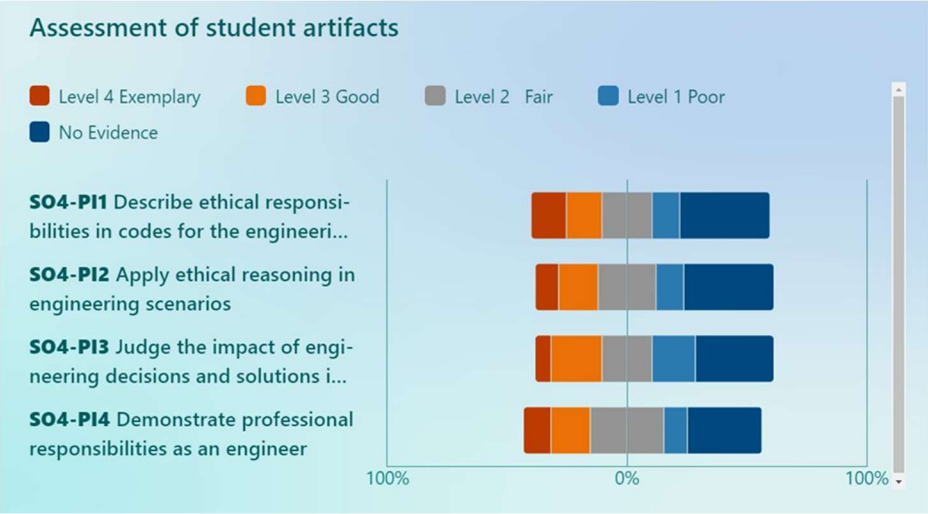
and/or continued monitoring recommended to the ME faculty. A score lower than 2 requires corrective action to be taken by the ME faculty after review and recommendations for change by the ME Goals and Assessments Committee.

Link to 'Tech Tomorrow' Strategic Plan:
1.B General Education Curriculum,1.C Diversity

Results and Analysis:

SO4: Recognize Ethical and Professional Responsibilities and Make Informed Judgements		
	2022-23	**2023-24**
Alumni Survey	2.9	3.4
Co-op Employer Surveys	3.3	3.2
IOSS	2.9	2.9
Senior Exit	3.5	3.3
AVERAGE	**3.2**	**3.2**



Use of Results to Improve Outcomes:

SO5: Teamwork

Define Outcome:
It is expected that by the time of graduation, Tech's ME students will have 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.

Assessment Methods:

- Alumni Survey
- Co-op Employer Survey
- External Evaluation of Senior Design Projects
- Instructional Outcome - Faculty Assessment
- Instructional Outcome - Student Survey
- Senior Exit Interview Written Survey
- Overall Level of Attainment

Criteria for Success (Thresholds for Assessment Methods):
The expected level of attainment of Student Outcomes is scored with a 0-4 point level of attainment scale where each level is defined as 4 = Excellent, 3 = Good, 2 = Satisfactory, 1 = Low, and 0 = Negligible. Data from the assessment instruments are combined according to the evaluation plan to determine the final scored value each year for each Student Outcome.

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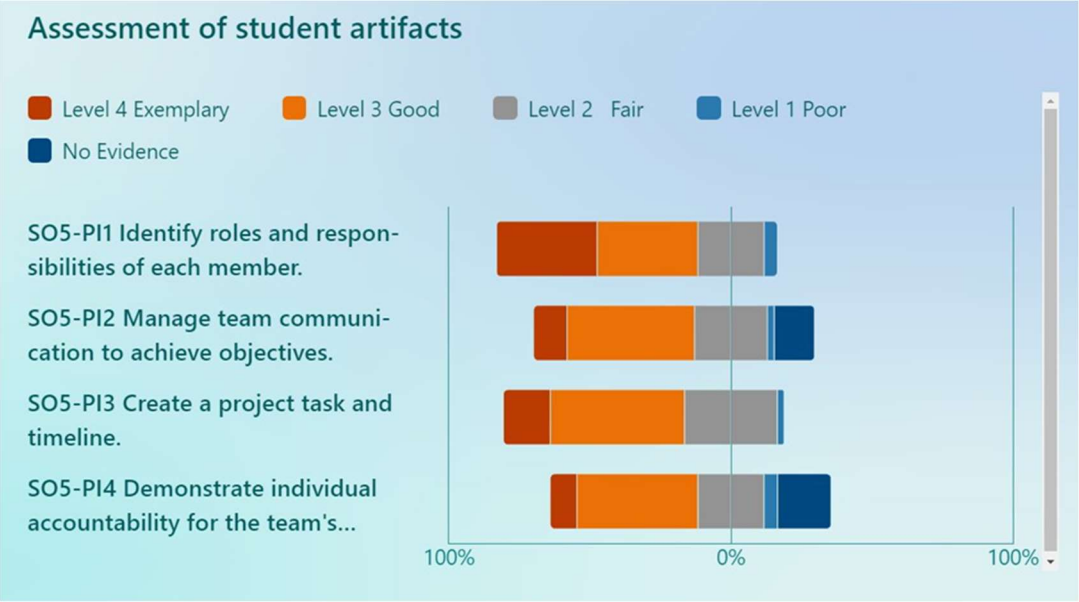
Link to 'Tech Tomorrow' Strategic Plan:
4.C Network of Scholars,4.D Alumni/Friend Engagement

Results and Analysis:

SO5: Teamwork		
	2022-23	**2023-24**
Alumni Survey	3.4	3.6
Co-op Employer Surveys	3.5	3.5
IOSS	3	3
Senior Exit	3.5	3.5
AVERAGE	**3.4**	**3.4**



Use of Results to Improve Outcomes:

SO6: Experiment, Interpret Data, and Use Engineering Judgment

Define Outcome:

It is expected that by the time of graduation, Tech's ME students will have an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Assessment Methods:

- Alumni Survey
- Co-op Employer Survey
- Instructional Outcome - Faculty Assessment
- Instructional Outcome - Student Survey
- Senior Exit Interview Written Survey
- Overall Level of Attainment

Criteria for Success (Thresholds for Assessment Methods):
The expected level of attainment of Student Outcomes is scored with a 0-4 point level of attainment scale where each level is defined as 4 = Excellent, 3 = Good, 2 = Satisfactory, 1 = Low, and 0 = Negligible. Data from the assessment instruments are combined according to the evaluation plan to determine the final scored value each year for each Student Outcome.

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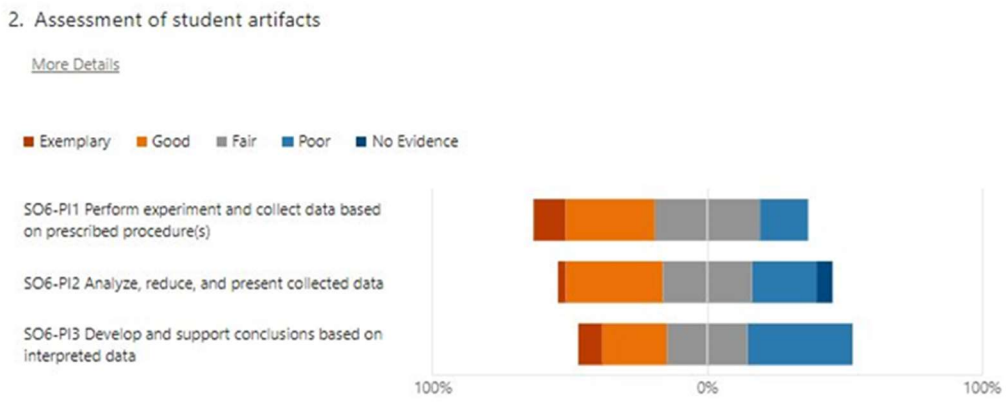
Link to 'Tech Tomorrow' Strategic Plan:
1.A Experiential Learning,1.D High Impact Practices

Results and Analysis:

SO6: Experiment, Interpret Data, and Use Engineering Judgement		
	2022-23	**2023-24**
Alumni Survey	3.1	3.4
Co-op Employer Surveys	3.2	3.3
IOSS	2.9	2.9
Senior Exit	3.2	3.2
AVERAGE	**3.1**	**3.1**



Use of Results to Improve Outcomes:

SO7: Ability to Acquire and Apply New Knowledge

Define Outcome:
It is expected that by the time of graduation, Tech's ME students will have an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Assessment Methods:

- Alumni Survey
- Co-op Employer Survey
- External Evaluation of Senior Design Projects
- Instructional Outcome - Faculty Assessment
- Instructional Outcome - Student Survey
- Senior Exit Interview Written Survey
- Overall Level of Attainment

Criteria for Success (Thresholds for Assessment Methods):
The expected level of attainment of Student Outcomes is scored with a 0-4 point level of attainment scale where each level is defined as 4 = Excellent, 3 = Good, 2 = Satisfactory, 1 = Low, and 0 = Negligible. Data from the assessment instruments are combined according to the evaluation plan to determine the final scored value each year for each Student Outcome.

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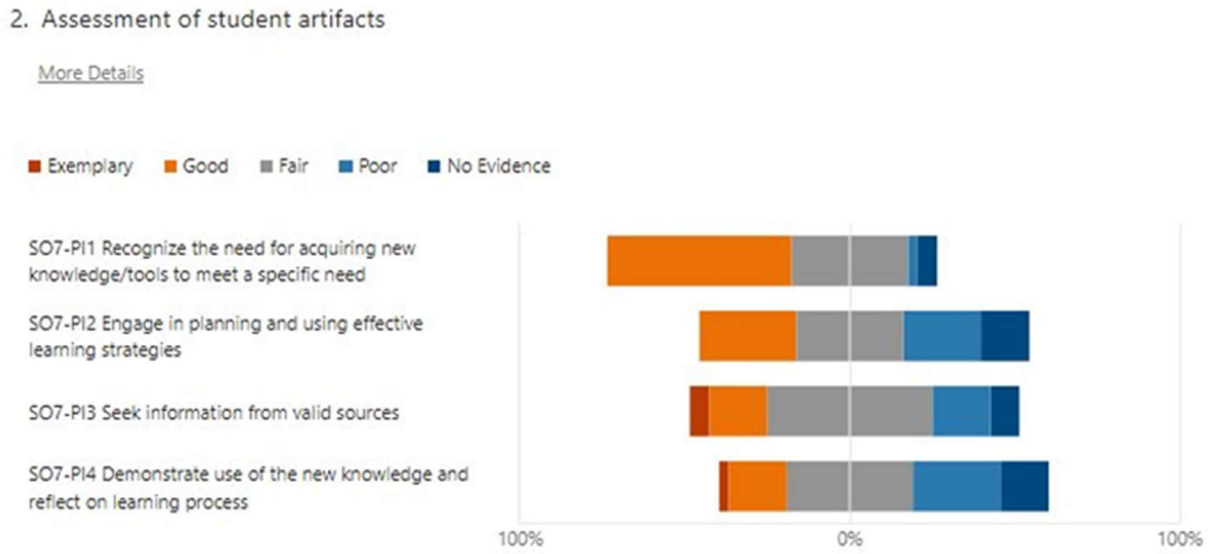
Link to 'Tech Tomorrow' Strategic Plan:
1.A Experiential Learning,1.D High Impact Practices

Results and Analysis:

SO7: Ability to Acquire and Apply New Knowledge		
	2022-23	**2023-24**
Alumni Survey	3.4	3.6
Co-op Employer Surveys	3.5	3.5
IOSS	2.9	2.9
Senior Exit	3.5	3.4
AVERAGE	**3.3**	**3.3**



Use of Results to Improve Outcomes:

Summative Evaluation:
The detailed breakdown of performance indicators in the rubrics for each student outcome as presented in the report demonstrates consistently high levels of achievement across all areas with areas of improvements identified in some. In a majority of case, students achieved "Exemplary" or "Good" or “Fair” ratings, far surpassing the 80% performance target. This

exceptional performance reflects the students' strong preparation and readiness to meet the challenges of the engineering profession, with mostly positive sentiment across all outcomes and performance indicators.

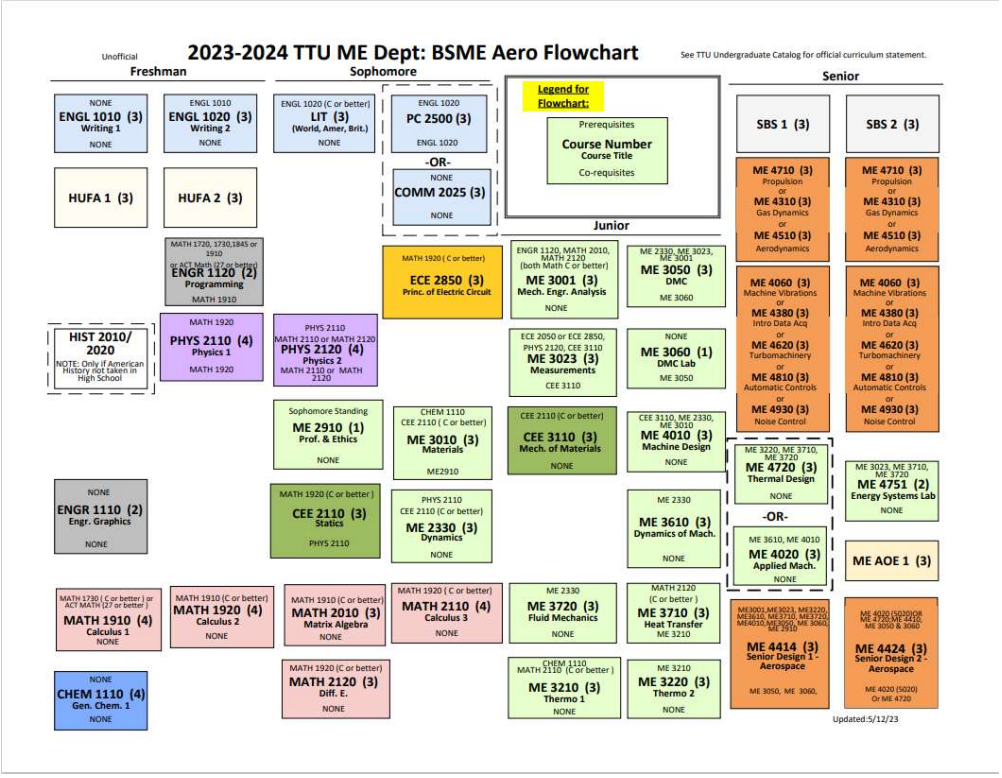
Assessment Plan Changes:
General Assessment Notes:

- The department adopted a revised plan in Fall 2021 for an overall change in process for assessment, evaluation, and change (AEC Plan). The two-year implementation cycle of the new AEC Plan impacts our data collection and tracking and reporting on outcomes in the transition years (2021-2024).
- We continue collection of data for four instruments reported on in the Table above, (Alumni Survey, Coop Employer Surveys, Instructional Outcomes Student Survey, and Senior Exit Survey),
- The Capstone Review has been replaced by the Faculty Review of Capstone Artifacts, see a later section for a new way of presenting data.
- The Instructional Outcomes Faculty Assessment (IOFA) is being piloted in its revised form during Fall 2024-Spring 2025; no IOFA data are available to share until next IE cycle.

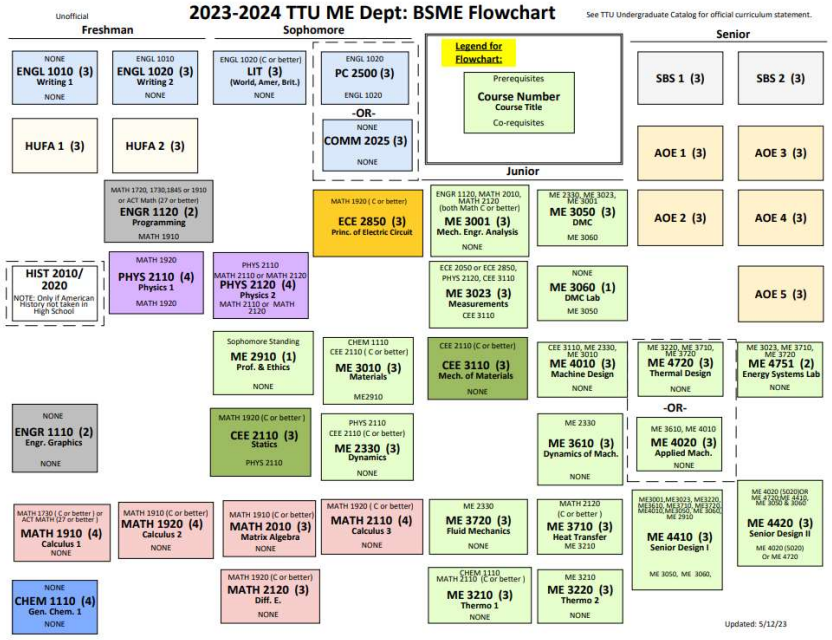
List of Appendices:
Appendix 1: Mechanical Engineering BSME Curriculum Map
Appendix 2: SLO1 Assessment Methods

Appendix 1: Mechanical Engineering BSME Curriculum Map

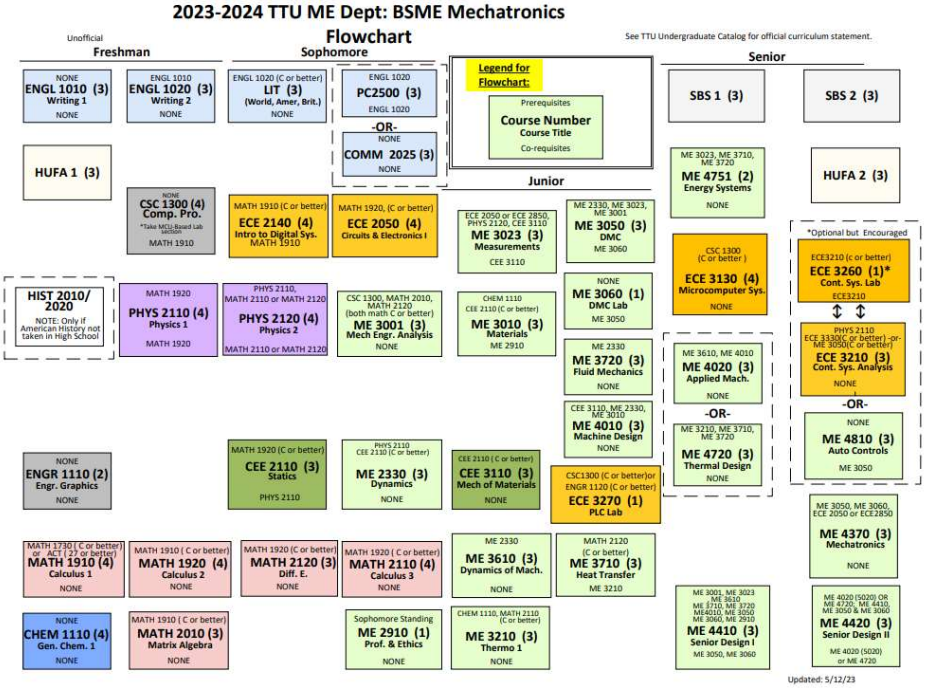
2023-2024 TTU ME Dept: BSME Aero Flowchart



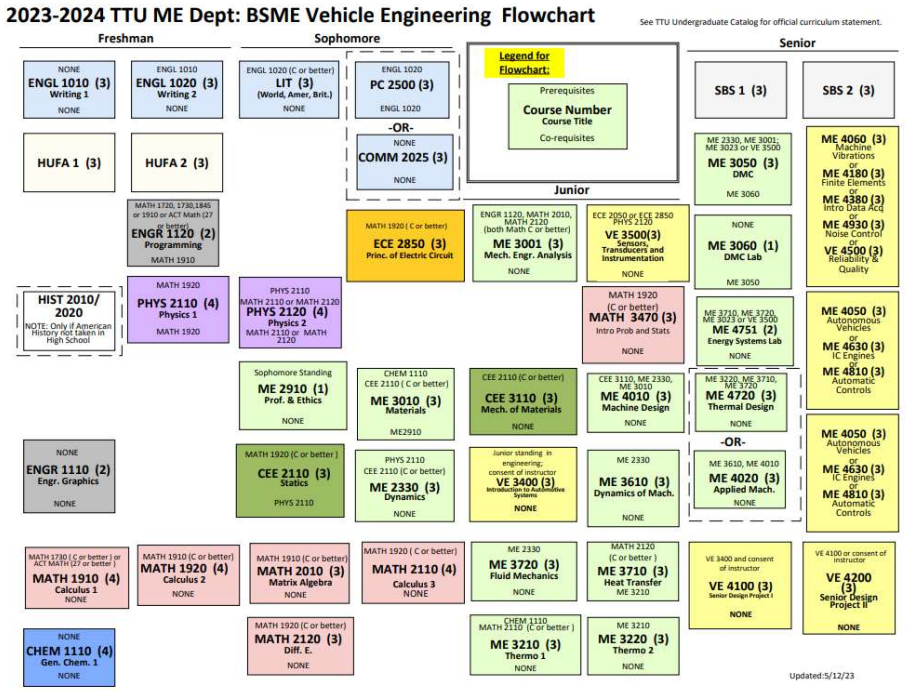
2023-2024 TTU ME Dept: BSME Flowchart



2023-2024 TTU ME Dept: BSME Mechatronics Flowchart



2023-2024 TTU ME Dept: BSME Vehicle Engineering Flowchart



Appendix 2: SLO1 Assessment Methods

SO1 Departmental Rubric

SO1 - The ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Performance Indicators	Level 4 (Exemplary)	Level 3 (Good)	Level 2 (Fair)	Level 1 (Poor)	Level 0 (No Evidence)
SO1-PI1 Restate complex problems into subparts with proper assumptions	• Identify all influential knowns, including those directly provided in the problem statement and those requiring one to interpret a figure, table, or any other object[1] • Break the problem into smaller parallel or consecutive components[2] • Make reasonable assumptions to simplify the problem and understand how the assumptions affect the findings[3] • Identify all major constraints[4]	• Identify the influential knowns directly provided in the problem's description and partially interpret the figures, tables, and other available information • Breaking the problem into major components but missing some minor ones (see footnote 1) • Make some of the major assumptions while understanding their impact or making all the required assumptions without understanding their impact • Recognize most of the major constraints	• Identifying only those influential knowns that are provided directly but being incapable of interpreting the hidden information • Missing some of the major and minor components but understanding the need to break down the problem • Make some of the necessary assumptions without understanding their impact • Recognize some of the major constraints	• Uncapable of extracting the knowns • A failed, confused attempt to solve a complex problem as a whole without recognizing a need for restating the problem into subparts • Not recognizing the need or lacking the knowledge to make the required assumptions • Failing to identify all major constraints	• No evidence
SO1-PI2 Identify and apply appropriate methods	• Identify and apply appropriate equations • Simplify the equations by using the identified assumptions and constraints • Employ and implement proper techniques to solve the equations • Apply appropriate unit conversions • Apply appropriate mathematics, including basic algebra[5]	• Identify and apply most of the appropriate equations • Partial simplification of the equations by applying *most* of the identified assumptions and constraints • Making some minor[6] mistakes throughout the implementation of the employed technique • Correct unit conversions all along except the final conversion • Apply appropriate mathematics	• Identify and apply some of the appropriate equations • Partial simplification of the equations by applying *some* of the identified assumptions and constraints • Making some major mistakes throughout the solution[7] • Some incorrect unit conversions • Making minor math mistakes	• Struggle to identify the appropriate equations • Failing to simplify the equations by applying the identified assumptions and constraints • Adapting the wrong technique to solve the equations • Wrong unit conversions • Making major mistakes in applying the mathematics	• No evidence

[1] Example: The acceleration is not spelled out in the problem statement, but it is known via the slope of a given velocity diagram
[2] Example: A water flow goes through a pipeline. Students are asked to compute the force exerted on the knee that turns the flow by 90 degrees. Students are expected to know that this problem needs to be broken into two parallel components, i.e., the "continuity" and "Bernoulli," followed by a "conservation of momentum" problem, as three major components of the solution. A minor component of the solution would be "computing energy losses caused by pipe fittings, such as valves, expansions, etc." Developing this understanding is what this PI aims to evaluate. Proper implementation of the respected equations to solve each of these components is within the scope of the next PI.
[3] Example: A "steady-state" assumption in heating up a plate with a candle would lead to larger local temperatures within the plate; A "frictionless" assumption for the problem of flow through a pipe would "underestimate" the required pump power
[4] Examples: Cycle efficiency in Thermodynamics, Betz limit in Aerodynamics, Resources in Senior Design
[5] Example: In Heat Transfer, $\frac{1}{U} = \frac{1}{h_h} + \frac{1}{h_c}$, where U is the overall heat transfer coefficient, and h_h, and h_c are convective heat transfer coefficients of the hot and cold fluids. Based on this equation, some students conclude $U = h_h + h_c$.
[6] Example: Mistakes in integrating terms, etc.
[7] Employing a wrong solution to a differential equation

SO1 - The ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

SO1-PI3 Analyze data resulting from the methods	• Perform data analysis by employing an appropriate technique, such as qualitative techniques, statistical methods, or predictive analysis • Identify and apply appropriate methods to visualize[8] and interpret the results • Validate and verify the solution	• Data analysis is mostly correct • Data visualization and interpretation is mostly correct • Most of the required validation/verification elements exist	• Data analysis is mostly wrong • Data visualization and interpretation is mostly wrong • Most of the required validation/verification elements are missing	• No or completely wrong data analysis • Results are not visualized and interpreted correctly • No appropriate validation and verification	• No evidence
SO1-PI4 Produce a viable approach/deliverable	• Produce a final deliverable that meets all the predefined criteria[9]	• Produce a final deliverable that meets most of the predefined criteria	• Produce a final deliverable that meets some of the predefined criteria	• Failed to produce the expected deliverable	• No evidence

[8] Example: Know that y needs to be plotted versus x to allow a meaningful interpretation
[9] Applicable to courses with projects and Senior design

AEC Plan Overview

Mechanical Engineering Department - Assessment Evaluation Change (AEC) Plan Overview

In Fall 2021, the ME Department adopted a new paradigm for continuous improvement. The AEC Plan is based on a two-year cycle for assessing, evaluation, and change. The AEC Plan designates that four of the seven outcomes (SO1, SO3, SO4, SO5) are assessed during Fall 2021-Spring 2022, and again in Fall 2023-Spring 2024. The assessment stage is followed by evaluation and change in Fall 2022-Spring 2023, then again in Fall 2024-Spring 2025. The remaining three outcomes (SO2, SO6, SO7) are assessed during Fall 2022 – Spring 2023 and again in Fall 2024-Spring 2025, followed by evaluation and change in Fall 2023-Spring 2024 and again in Fall 2025-Spring 2026. New departmental rubrics were developed by the faculty to assess student artifacts from the Senior Capstone projects and applied during faculty retreats. The rubrics are provided in separate documents. The assessment stage is described in a Standard Operating Procedures (SOP), and attached in a separate document.

Student Outcome	20-21	21-22	22-23	23-24	24-25	25-26
SO 1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.		A	E C	A	E C	A
SO 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.			A	E C	A	E C
SO 3. An ability to communicate effectively with a range of audiences.		C A	E C	A	E C	A
SO4. 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.		A	E C	A	E C	A
SO5. 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.		A	E C	A	E C	A
SO 6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.			A	E C	A	E C
SO 7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.			A	E C	A	E C