

## BS Industrial Engineering

### Annual Program Report Template

Year:	2023-2024
Program:	BS Industrial Engineering
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#### Summary of Continuous Improvement Efforts since Last Report

*Provide a brief description of how assessment results have been used for program improvement. Point to a specific example of how an assessment provided the program with data it could use for improvement and what that improvement was, if possible, also show evidence of the improvement. You may look at data from the two previous academic years to support this case.*

### 1. Assessment Process

The student outcomes used by the industrial engineering program are those published in the ABET “Criteria for Accrediting Engineering Programs” document. Student outcomes define what students must learn by the time they graduate. The department periodically reviews student performance in these areas as part of our continuous improvement process. The outcomes are as follows:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
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.
3. an ability to communicate effectively with a range of audiences.
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.
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.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
8. to design, develop, implement, and improve integrated systems that include people, materials, information, equipment and energy.
9. The in-depth instruction to accomplish the integration of systems using appropriate analytical, computational, and experimental practices.

These outcomes are taught across the courses in the IE department. See the following table 1 for where the outcomes are primarily taught. While all outcomes are taught in each class at some level, table 1 highlights the courses that focus on specific outcomes.

Table 1. Assessment calendar (P is primary instructional goal and S is secondary).

	1	2	3	4	5	6	7	8	9
CVEN 2301 – Statics	P								
ELEN 2310 - Fundamentals of Electrical Engineering	P								
INEN 1101 - Introduction to Engineering			S	P			P		
INEN 2360 - Computer Applications in I.E.	S						S		
INEN 3320 - Probability and Statistics for Engineering	P					P			P
INEN 3322 - Engineering Materials and Processes	S	P			P				
INEN 3380 - Work Design		P	S			S		P	
INEN 4300 - Quality Improvement	P					P			P
INEN 4315 - Industrial Management		P	P	P	P		S	P	
INEN 4316 - Industrial and Product Safety				P					
INEN 4320 - Statistical Decision Making in Engineering	P					P			P
INEN 4323 - I.E. Systems Design	P	P	P	P	P	P	P	P	P
INEN 4345 - Computer Integrated Manufacturing		P							
INEN 4350 - Production and Inventory Control	P	S						P	P
INEN 4370 - Operations Research	P	S					S		S
INEN 4375 - Simulations of I.E. Systems	S					P		P	P
INEN 4385 - I.E. Design	P	P	P	P	P	P	P	P	P
INEN 4396 - Automated System Engineering	P							S	P

The industrial engineering program assesses student outcomes primarily using direct measures based on student work including projects, presentations, tests, and assignments. The department also use indirect assessment of student surveys and employment outcomes. The method of assessment for each outcome is determined by our Assessment Committee with feedback and input from the entire industrial engineering (IE) faculty. The BSIE Program uses an assessment calendar (Table 2) where a subset of outcomes is measured in each long semester.

## Assessment Process Prior to 2023 - 2024

The steps of the historic process are as follows. 1. Assessment Committee, with input from the faculty and constituency group, constructs rubrics. For consistency, all rubrics are designed with a 4-point scale, including specific performance criteria, and have a minimum performance standard set to an average above 2.5 on the 4-point scale (see Appendix A for rubrics). 2. The faculty discusses the performance criteria in the rubrics. 3. The course instructor grades the student work to be included in the students' course grade. 4. The faculty Assessment Committee then independently assesses the student work with the rubric for that outcome(s). A minimum of three faculty members must evaluate the student work. 5. The results of the assessments are tabulated. 6. Improvement plans are written for every area not meeting the performance standard. Improvement plans can also be generated to improve items meeting our standards. 7. The Faculty Assessment Committee and appropriate faculty members review the assessment data and develop suggest continuous improvement plans when applicable. Four courses are used in this assessment process. The program selected courses that best demonstrate how well an outcome is being achieved. While the outcomes are taught in earlier courses including courses outside of our department, the program generally selected courses towards the end of the degree plan to focus our analysis on outcomes achieved by students who are near graduation.

The steps of the process are: 8. Assessment Committee, with input from the faculty and constituency group, constructs rubrics. For consistency, all rubrics are designed with a 4-point scale, including specific performance criteria, and have a minimum performance standard set to an average above 2.5 on the 4-point scale. 9. The faculty discusses the performance criteria in the rubrics. 10. The course instructor grades the student work to be included in the students' course grade. 11. The faculty Assessment Committee then independently assesses the student work with the rubric for that outcome(s). A minimum of three faculty members must evaluate the student work. 12. The results of the assessments are tabulated. 13. Improvement plans are written for every area not meeting the performance standard. Improvement plans can also be generated to improve items meeting our standards. 14. The Faculty Assessment Committee and appropriate faculty members review the assessment data and develop suggest continuous improvement plans when applicable.

The program's Assessment Committee developed rubrics for all outcomes (see Appendix A). With assistance from Lamar University's Campus Planning and Assessment Office, a 4-level scale was developed with performance criteria. Performance criteria are a breakdown of the abilities identified in the outcomes. The levels of each performance criteria have unique descriptions that clearly distinguish one level from another. These clear distinctions allow for an accurate and reliable assessment of a student's abilities. While these rubrics are continuously refined, the Assessment Committee tries to maintain standard performance criteria to allow for multiyear comparisons to determine the effectiveness of improvement plans. The rubrics were also critiqued by Lamar University's assessment specialists. Their comments provided valuable improvements to the rubrics. The Assessment Committee updates and improves the rubrics as they are used in the process. The department has maintained a consistent process with only minor modifications to the rubrics since 2008. The Assessment Committee set a minimum standard of an average of 2.5 for all performance criteria. If the average assessment of students' work falls below this standard, then an improvement plan or justification for the low assessment is mandatory to correct or explain the deficiency. If the average assessment of students' work is above the standard, an improvement plan is optional.

The program employs a wide variety of student work including labs, senior design projects, practicum exams, self-assessment, design projects written projects, and oral presentations to measure student outcomes. For several outcomes, students are assessed in our team project-based capstone engineering courses INEN 4323 (IE Systems Design) and INEN 4385 (IE Design). Most student team projects address a real-world problem sponsored by a local company. Teams of typically 2-4 students are assigned to the projects. When developing our assessment calendar, the program assessed outcomes in a range of courses to avoid a concentration of measurement in senior design. Our assessment calendar for the next four years is in the following table. In year 2022-2023, assesement is done in senior design. In the following year, assessment will be done in senior design and INEN 4320 Engineering Management, INEN 4350 PIC, and INEN 4370 Operations Research based on projects and tests. This pattern will be continued to make a two-year cycle. Senior design is assessed every year due to the

importance of the class and senior design presentation being major events in the department's calendar with all faculty attending plus project sponsors and advisory council members.

#### **Assessment Process After 2023 - 2024**

The IE department did a major overall of our assessment process in 2024. The reasons were to focus on individual work, measure percent achievement as opposed to average performance, and develop assessment based on a wide range of student work.

The new process is based on a wide variety of student work:

1. Senior design projects
2. Closed book Program Review Test
3. Specific assignment, projects, and test questions in several class and labs before senior design.

The new process is based on percentage of students achieving the outcome with a goal of 80% achievement. For rubric based assessment on projects, the goal is 80% of student work is in the top 2 categories of Exemplary and Acceptable using the prior rubrics. For objective question or assignments, a score of 80% correct answers on questions related to specific outcomes is used as our target.

Students are assessed in our team project-based capstone engineering courses INEN 4323 (IE Systems Design) and INEN 4385 (IE Design). In senior design, project presentations and final written report are used for assessment. Most student team projects address a real-world problem sponsored by a local company. Team size is typically 1-4 students. Senior design is assessed every year due to the importance of the class and senior design presentation being major events in the department's calendar with all faculty attending plus project sponsors and advisory council members. See Table 4-2 for our assessment calendar.

The departments outcome evaluation has historically been based on student projects (mostly senior design). In Spring 2024, the department added a **program review test** given at the end of senior design. The program review test is a closed book, closed note test questions that are inspired by the Fundamentals of Engineering (FE) test for Industrial Engineering. The FE test allows the NCEES-supplied reference handbook with 4 minutes per question, where as our program review test is closed book and closed note with one minute per question. The topics are similar, and the difficulty of the questions is adjusted for the reduced time and closed book requirement. The assessment committee choose the closed book closed note format, so that the test examines information remembered as opposed to the ability to look up information. The exam is designed to both prepare student for interviews and aid them in FE study. Performance on the exam is not directly used in senior design, but a self-assessment based on the exam is graded as part of the class participation grade. Most of the question on the exam are multiple choice with a standard expectation that 80% of students should be able to answer the questions on any topic area. The exam was added in spring 2024 as an improvement to our assessment process that had become too focused on group projects where quality is graded based on a rubric as opposed to knowledge of fundamentals.

Several faculty members expressed concern about the design of the program review test results due to poorly worded and subjective questions. Future versions of the test will avoid opinionated questions. Faculty members were informed of the results and reviewed the performance. Several course improvements were developed from this test. See appendix J for the questions and results of the program review test.

**Table 2. Assessment calendar.**

Outcome	2022-2023	2023-2024	2026-2027	2027-2028
an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	INEN 4385 Senior Design\	INEN 4385 Senior Design / /INEN 4370 Operations Research/ Program Review Test	INEN 4385 Senior Design/ Program Review Test	INEN 4385 Senior Design / /INEN 4370 Operations Research/ Program Review Test
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	INEN 4385 Senior Design	INEN 4385 Senior Design / INEN 4315 Engineering Management/ Program Review Test	INEN 4385 Senior Design / Program Review Test	INEN 4385 Senior Design / INEN 4315 Engineering Management/ Program Review Test
an ability to communicate effectively with a range of audiences	INEN 4385 Senior Design	INEN 4385 Senior Design / INEN 4315 Engineering Management/ Program Review Test	INEN 4385 Senior Design / Program Review Test	INEN 4385 Senior Design / INEN 4315 Engineering Management/ Program Review Test
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	INEN 4385 Senior Design	INEN 4385 Senior Design / INEN 4315 Engineering Management	INEN 4385 Senior Design / Program Review Test	INEN 4385 Senior Design / INEN 4315 Engineering Management
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	INEN 4385 Senior Design	INEN 4385 Senior Design / INEN 3322 Engineering Materials and Processes/ Program Review Test	INEN 4385 Senior Design / Program Review Test	INEN 4385 Senior Design / INEN 3322 Engineering Materials and Processes/ Program Review Test
an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	INEN 4385 Senior Design	INEN 4320 Statistical Decision Making/ Program Review Test	INEN 4385 Senior Design / Program Review Test	INEN 4320 Statistical Decision Making/ Program Review Test
an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	INEN 4385 Senior Design	INEN 4385 Senior Design / INEN 4370 Operations Research	INEN 4385 Senior Design / Program Review Test	INEN 4385 Senior Design / INEN 4370 Operations Research

Table 3 presents the outcome assessment direct instruments employed during the assessment schedule. The table includes a program review tests and assessments from INEN 4385 senior design, INEN 4320 Statistics, INEN 4370 Operations Research and INEN 4315 Engineering Management. Tests are used for the program review test and assessment in INEN 4320. Projects are used for the other assessment.

**Table 3. Assessment Results and Analyses for Current Cycle.**

Departmental Student Learning Goal	Program Student Learning Outcome	Assessment	Assessment Method/	Benchmark Expectations	Data Results	Actions/Goals Based on Data Results* What do the data tell you? How will you use this data? How were data from the last cycle used to make changes during this cycle, and What were the results of those changes?
			Location			
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	STEM Concepts	Senior Design Project	Final Report	80%	7 / 8 (87.5%)	Meet Standard
	Formulation	Senior Design Project	Final Report	80%	7 / 8 (87.5%)	Meet Standard
	Diagrams and Sketches Use	Senior Design Project	Final Report	80%	7 / 8 (87.5%)	Meet Standard
	Terminology and Notation	Senior Design Project	Final Report	80%	7 / 8 (87.5%)	Meet Standard
	Strategy and Procedures	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Constraints	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Objective and Goals	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Regulations and Standards	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	All elements of rubric	INEN 4370	Final Report	80%	80%	Meet Standard
	All elements of rubric	Program review test	Test	80%	68%	The assessment led to program improvement 7 and 8 and course improvement 43 in improvement section.
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	Global and Welfare	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Economic	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Environmental	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Societal	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Health and Safety	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Cultural	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Global and Welfare	Senior Design Project	Final Report	80%	10 out of 11 (91%)	Meet Standard
	Economic	Senior Design Project	Final Report	80%	8 out of 11 (73%)	Meet Standard
	Environmental	Senior Design Project	Final Report	80%	9 out of 11 (82%)	Meet Standard
	Societal	Senior Design Project	Final Report	80%	9 of 11 (82%)	Meet Standard

	Health and Safety	Senior Design Project	Final Report	80%	10 of 11 (91%)	Meet Standard
	Cultural	Senior Design Project	Final Report	80%	5 of 11 (45%)	Monitor item. Historically no issue with this rubric item.
	All elements of rubric	Program review test	Program Review Test	80%	63%	The assessment led to program improvement 7 and 8 and course improvement 43 in improvement section.
3. an ability to communicate effectively with a range of audiences	Organization	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Amount of Information	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Quality of Information	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Mechanics	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Paragraph Construction	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Diagrams and Illustrations	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Speaks Clearly	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Posture and Eye Contact	Senior Design Project	Final Report	80%	7 / 8 (87.5%)	Meet Standard
	Content	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Volume	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Preparedness	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Enthusiasm	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Organization	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Graphics	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Elocution	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	All	Program Review Test	Report / Test	80%	100%	Meet Standard
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	Ethical and professional responsibilities	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Identifies global, economic, environmental, and societal issues	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Considers Stakeholders	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Ethical and professional responsibilities	INEN 4315	Class Report	80%	9 of 11 (82%)	Meet Standard
	Identifies global, economic, environmental, and societal issues	INEN 4315	Class Report	80%	10 of 11 (91%)	Meet Standard
	Considers Stakeholders	INEN 4315	Class Report	80%	8 of 11 (73%)	Monitor item. Historically no issue with this rubric item.

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	Faculty Evaluated	INEN 4385 Senior Design	Class Project	80%	6/8 (75%)	The course instructor added an improvement plan for the course to add additional lecture material on leadership and teamwork (Course Improvement Plan 42.
	Student Evaluated	All courses	Suvey	80%	96%	Meets standard
	Faculty Evaluated	INEN 3322	All Items	80%	100%	Meets standard
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Data Collection	Senior Design Project	Final Report	80%	5 / 8 (62.5%)	Meet Standard
	Variables	Senior Design Project	Final Report	80%	7 / 8 (87.5%)	Meet Standard
	Description of Procedure	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Hypothesis Development	Senior Design Project	Final Report	80%	3 / 8 (37.5%)	Meet Standard
	Conclusion/Summary	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	All Elements	INEN 4320	Tests	80%	20/22 (96%)	Meet Standard
	All Elements	Program Review Test	Test	80%	67%	The assessment led to program improvement 7 and 8 and course improvement 43 in next section.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	Recognize need to learn	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Ability to learn	Senior Design Project	Final Report	80%	8 / 8 (100%)	Meet Standard
	Citation	Senior Design Project	Final Report	80%	7 / 8 (87.5%)	Meet Standard
	Recognize need to learn	INEN 4370 Operations Research	Article Review	80%	9/10 (90%)	Meet Standard
	Ability to learn	INEN 4370 Operations Research	Article Review	80%	9/10 (90%)	Meet Standard
	Citation	INEN 4370 Operations Research	Article Review	80%	9/10 (90%)	Meet Standard



## Employment and Time to Graduation Data (indirect measure)

An important indirect outcome measure is student employment and career success. Employment performance reflect the performance across all outcomes especially Outcome 3 communication. A problem in employment data would indicate a significant issue with the program that impact one or more outcomes. The finding of employment issues would trigger a significant program review due to the importance of this indirect measure. The Chair closely monitors employment performance.

Texas CREWS data from the higher education coordinating board and the Texas Workforce Commission that joins tax data with financial aid data shows that the BSIE degree is the highest starting salary in Texas based on 2022 (Table 4) and 2021 (Table 5) graduates that is the most recent data available. LU IE also has the **smallest student loans** at graduate and the **best ratio of first year wages to loans**. The median wage was \$77,519 that is the highest in the state. The loan to first year wage ratio was 0.15 that is the lowest in the state. The department is pleased with employment success of our graduates.

The average time to graduation is slightly longer at Lamar (5.86 years compared to a minimum of 4.17 years at Texas A&M Commerce). This result is due to the percentage of students who work full time, students doing co-ops, and lower admission requirements with less prepared students than flagship universities (such as Texas A&M). Many of our students are non-calculus ready when they start their educational career.

**Table 4. Texas CREWS salary data by school for 2023.**

2023 Data	# of Grads	Avg Tuition (Undergrad)	Avg Time to Degree (Years)	% of Grads with Loans	Avg Loan at Graduation	2022 Median Wages	Loan as % of Year 1 Wages
Statewide 2-Year and 4-Year Institutions	415	No data	4.76	49%	\$27,296	\$70,376	38%
Statewide 4-Year Universities and Health Institutions	415	\$9,844	4.76	49%	\$27,296	\$70,376	38%
<b>Lamar University</b>	<b>18</b>	<b>\$10,463</b>	<b>5.86</b>	<b>50%</b>	<b>\$10,710</b>	<b>\$77,519</b>	<b>15%</b>
Texas A&M University	191	\$11,404	4.4	46%	\$25,913	\$72,419	37%
Texas A&M University-Commerce	15	\$9,820	4.17	60%	\$21,043	\$50,356	36%
Texas State University	35	\$11,540	5.12	66%	\$32,475	\$72,036	45%
Texas Tech University	48	\$11,600	5.41	60%	\$38,764	\$72,431	50%
The University of Texas at Arlington	31	\$11,620	5.31	42%	\$26,759	\$70,147	44%
The University of Texas at El Paso	44	\$8,652	5.17	43%	\$21,075	\$56,952	26%
University of Houston	33	\$11,569	4.93	39%	\$27,253	\$77,106	36%

**Table 5. Texas CREWS salary data by school for 2022.**

2022 Data	# of Grads	Avg Tuition (Undergrad)	Avg Time to Degree (Years)	% of Grads with Loans	Avg Loan at Graduation	2021 Median Wages	Loan as % of Year 1 Wages
Statewide 4- Average	399	9502	4.94	0.5	28982	63020	0.41
<b>Lamar University</b>	<b>27</b>	<b>10340</b>	<b>5.79</b>	<b>0.52</b>	<b>17726</b>	<b>73690</b>	<b>0.28</b>
Texas A&M University	153	10562	4.43	0.47	26088	65399	0.35
Texas A&M University-Commerce	17	8958	4.94	0.35	29980	59841	0.43
Texas State University	39	11240	5.59	0.69	30001	60851	0.50
Texas Tech University	67	11320	5.28	0.54	44549	54508	0.56
The University of Texas at Arlington	20	11040	5.49	0.25	43882	68182	0.50
The University of Texas at El Paso	39	8340	5.56	0.51	18961	46029	0.38
University of Houston	37	11276	5	0.49	23314	70903	0.34

Overall, we are happy with career success and will continue to closely monitor for continuous improvement purposes and for indirect evaluation of program educational outcomes. Note, the above wage data is only for students who apply for financial aid and many working students might not apply for aid especially when their employer is paying for school.

### **Course and Program Surveys Outcome Assessment (indirect measure)**

Our course evaluation surveys ask students specific questions related to the outcome. The faculty review these surveys and note them in their annual review report (F2.08). For each course, they must complete the template in Figure 1. The student surveys ask a wide range of questions beyond the outcome in the course that are reviewed by the faculty and chair during annual review.

The senior exit survey also asks about outcome achievement. The survey results show no reported issues from students about their learning of outcomes. Based on the top 2 Likert scale categories of good and excellent, the self-reported learning of the outcomes was 95% outcome 1, 97% outcome 2, 92% outcome 3, 92% outcome 4, 93% outcome 5, 93% outcome 6, and 93% outcome 7 during the past 3 years.

The survey are indirect measures. The department anticipates generally positive results from students. Survey data is not a primary source of information about student learning for process improvement, but the results do provide some feedback from the student's point of view about individual courses and the overall program.

Cou rse #	INEN 4385-48	Title	IE Design (Online)					Semester		Spring 2023
Number of students enrolled	20	Grades	A	B	C	D	F	Q	W	OTHER
How many students completed course evaluation form?	16							0	0	0
What was your average overall evaluation item #10?			4.13							
How will you increase the percentage of students completing online course evaluations in future?										
I will explain how I use the evaluation results, why it is important, and I will encourage students to complete it.										
What did you learn from reviewing the evaluations for this course?										
Most students had a positive experience in the course, but a few students had an extremely negative experience. The course is intended to force students to take a leadership role in defining, prosecuting, and completing their project. It is stressful for nearly all students, but those who put in the effort usually have good results and a positive experience. I believe the negative experience reported by the student on this evaluation is not reflective of a deficiency in the course.										
How will you use what you learned to improve the course and student learning of course outcomes in future?										
I will review the course material and update it for clarity. More often I will remind students to reach out to me if they feel lost or frustrated. I will remind students that course evaluations are official documents and inappropriate words should not be used on them.										
What are the primary ABET outcomes for this course and what was the percentage of student self evaluations in the top three categories for each of these outcomes? If any are below 80% corrective action will be taken.										
<p>OUTCOME 1: an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. Question 25. Avg 4.13. Top Three: 88%. No action needed at this time.</p> <p>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. Question 26. Avg 4.13. Top Three: 88%. No action needed at this time.</p> <p>OUTCOME 3: an ability to communicate effectively with a range of audiences. Question 27. Avg 4.13. Top Three: 88%. No action needed at this time.</p> <p>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. Question 28. Avg 4.13. Top Three: 88%. No action needed at this time.</p> <p>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. Question 29. Avg 4.13. Top Three: 88%. No action needed at this time.</p> <p>OUTCOME 6: an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. Question 30. Avg 4.13. Top Three: 88%. No action needed at this time.</p> <p>OUTCOME 7: an ability to acquire and apply new knowledge as needed, using appropriate learning strategies. Question 31. Avg 4.13. Top Three: 88%. No action needed at this time.</p>										

Figure 1. Annual faculty assessment course review.

## 2. Improvements

The department made 4 program level and 10 course improvements in 2023-2024. Section 2.1 discuss program level improvements and section 2.2 discuss course level improvements. The department also monitored the status of improvements made in the last 6 years, so prior improvements are included in this report as the results of the improvements are monitored and updated.

### 2.1 Program Level Improvements

Eight program level improvement was made since the last ABET visit. These improvements are still being monitored or initiated in 2023-2024. The program improvements that were identified and implemented in 2023-2023 are:

1. Program Improvement 4 – Assessment Criteria Update (2023-2024)
2. Program Improvement 5 – Human Machine Separation (Safety)
3. Program Improvement 7 – Focus on FE Test Items
4. Program Improvement 8 – Gap Analysis

#### **Program Improvement 1 – Replacing MEEN 2302 Dynamics with INEN 4396 Automated System Engineering**

**Identification:** After discussion with advisory council and review of manufacturing trends, the faculty determined that automation was a key skill for all graduates. In our local job market, automation specifically process controls is critical to the chemical industry. A review of popular press also demonstrated the growing importance of robotic automation in manufacturing and warehousing.

**Improvement:** The primary reason for adding INEN 4396 Automated System Engineering is that the course teaches skills used by the local industry. The course also introduces control logic that is missing from the other courses in the degree plan.

The reason for removing MEEN 2302 Dynamics is that the topics covered in the courses are not required for later IE coursework and the material is not required for IE students. Students can use Dynamics as an INEN elective. Few students choose to take Dynamics as an elective.

A review of IE programs determined that dynamics is not on many degree plans in Texas and Nationwide.

The faculty voted 6 to 0 via email to support this degree plan update with requested submitted to university curriculum committee on 10/22/2019 and approved in spring 2020. This change was also supported by feedback from our advisory council about the growing emphasis on automation in industry.

**Result:** The course was well received with high evaluations. Several senior design projects related to robotics and automation have been done recently.

#### **Program Improvement 2 – Making Continuous Improvement part of Faculty Evaluation**

**Identification:** Faculty were not documenting improvements in courses.

**Improvement:** Required faculty to document course improvements if any in annual performance review (F2.08) under teaching section.

**Result:** Improved documented of course level improvements. These improvements are shared among the faculty to share best practices and understand updates in courses at the instructor level. Beyond improved documentation, reporting places emphasis on continuous improvement.

### **Program Improvement 3 – Improving Assessment Process (Program Review Test) (2024)**

**Identification:** The faculty determined that our assessment process was overly reliant on senior design project and other group project based assesment. Given that many students are transfers, we need to do assessment of their full preparation. While LU has procedures to ensure that the courses are equivalent to course taught at our campus, we do not assess students about their understanding of lower division courses.

**Improvement:** Require a program review exam in senior design. This test consists of questions from across the curriculum inspired by Fundamentals of Engineering test questions. The format of the test is 1-minute questions that is closed book and closed note. After the test, students submit a self-assessment of their performance that is graded. The test also has several brief case study questions inspired by technical interview questions. The results of the test are used to measure outcome using individual student work that is closed book and note. This test complements our other assessments that are project based and mostly group work activities. The assessment is also an indicator of student learning of basic facts.

**Results:** The team implemented the test in senior design. Student performance was used in our assessment process. Several faculty members voiced concerns that the questions on the test were too specific, and vocabulary focused. Future versions of the test will try to reduce wording confusion and include more problem-based questions.

### **Program Improvement 4 – Assessment Criteria Update (2023-2024)**

**Identification** – The faculty determined that the assesment in prior years was focused on average performance and too focused on senior design group work. In prior years, a 2.8 average on a 4-point scale rubric (mostly based on senior design) was used as the standard for achieving the goals. This approach did focus on individual student achievement.

**Improvement** - The IE program updated our standard to 80% achievement in all items being assessed to focus on student success percentage as opposed to average performance. The program also expanded assessment to 4 courses and a program review test. The program also focused more on individual work as opposed to group work by creating a program review test and using individual assignments in the assessment in 3 courses.

**Results-** This approach resulted in more students not meeting our criteria. This resulted in more improvement plans being generated directly related to assessment results.

### **Program Improvement 5 – Human Machine Separation (Safety) (2022-2024)**

**Identification:** The lathes used in our machine shop did not have adequate separation from users during operation.

**Improvement:** The department spent over \$20,000 to add shields with automatic shutoffs in 2022. In Spring 2024, the department redesigned our machine shop labs to only use CNC equipment that are full enclosed.

**Results:** No students have access to machine tools that are not completely enclosed when operating.

### **Program Improvement 6 – Offer Additional Senior Design Sections (Spring / Summer)**

**Identification:** The program had too many requests for pre-requisite waivers to get into senior design. The program reviews pre-requisite waivers requests. Requests are only granted if the student can demonstrate sufficient background to take the course. The most common justification is taking a related courses as elective or not applied to degree plan.

**Improvement:** Starting in Summer 2023, the department adopted a policy of offering spring / summer senior design courses.

**Result:** This dramatically reduced the number of requests for pre-requisites waiver. A student missing a pre-requisite can now delay one semester and take senior design in spring / summer instead of waiting until fall / spring saving 8 months for time till graduation. To date, we have had 8 students take advantage of this summer course offering to graduate earlier.

### **Program Improvement 7 – Focus on FE Test Items (2024)**

**Identification:** The program review test demonstrated that students had issues with concepts related to Fundamentals of Engineering (FE) test for Industrial Engineers as part of our outcome assessment process. While several faculty members questioned the wording of the program review test, all faculty members were made aware of the results and encouraged to review FE materials to closer align their courses.

**Improvement:** As a group, the faculty reviewed the results of the program review test. Faculty were also asked to review FE test questions and modifications to their course assessments as need to better prepare students. FE test books were purchased for all faculty members.

**Result:** Courses will be updated in the 2024-2025 year as determined appropriate by the individual faculty members. The results of these updates will be included in the F2.08 to be submitted in January 2025.

## **Program Improvement 8 – Gap Analysis**

**Identification:** The program review test demonstrated that students had issues with concepts related to Fundamentals of Engineering (FE) test for Industrial Engineers as part of our outcome assessment process. While several faculty members questioned the wording of the program review test, all faculty members were made aware of the results and encouraged to review FE materials to closer align their courses.

**Improvement:** As a group, the faculty reviewed where topics were taught in the curriculum at a faculty meeting in Spring 2024. The faculty determine that all topics were covered. However, layout and human factors were two topics that were identified as being split between courses. Layout is covered in Operations Research (QAP for part of one lecture), INEN 4396 Automation (several lectures) and INEN 4350 Production and Inventory Control (1 lecture). Human factors are covered in INEN 3380 Work Design and INEN 4316 Safety. The faculty agreed to place greater emphasis on these topics.

**Result:** Courses will be updated in the 2024-2025 year as determined appropriate by the individual faculty members based on the finding that layout and human factors need additional coverage. The results of these updates will be included in the F2.08 to be submitted in January 2025.

## Course Level Improvements

A total of 43 course level improvements were implemented in the past 5 years. These improvements are being monitored or implemented this year. The result section is also updated. Therefore, we include all improvement made in the last 5 years. The following improvements were identified and implemented this year:

1. Course Improvement 33 – Operations Research Topics (2024)
2. Course Improvement 34 - INEN 3322 Lab Sections Engineering Materials/Process (Spring 2024)
3. Course Improvement 36 - INEN 3322 Engineering Materials/Process (Spring 2024)
4. Course Improvement 37 - INEN 3322 Engineering Materials/Process (Spring 2024)
5. Course Improvement 38- INEN 2373 47F and 46F Engineering Economics (Summer 2023)
6. Course Improvement 39 - INEN 2373 Engineering Economics (Summer 2024)
7. Course Improvement 40- INEN 4380 Project Management Software Delivery (Fall 2023)
8. Course Improvement 41 - INEN 4315 Industrial Management (Fall 2023)
9. Course Improvement 42 – INEN 4323 / 4385 Senior Design Leadership (2024 Spring)
10. Course Improvement 43 – Capacity Planning in Production and Inventory Control

### Course Improvement 1 – Senior Design Methodology

**Identification:** In the 2019-2020 academic year, students' ability to establish constraints in senior design (INEN 4323 & INEN 4385) were determined to be acceptable but very close to our minimum standard based on our evaluation rubrics. The course instructor while reflecting on the assessment data concluded that many students struggled in this area and developed an improvement plan based on assessment.

**Improvement:** Exercises focusing on developing unambiguous, testable, project constraints will be incorporated into the fall semester of senior design (INEN 4323) with a refresher in the spring (INEN 4385). These will give students practice developing constraints for a variety of projects and will include class discussion to help students calibrate themselves with their peers.

**Result:** At the beginning of the Fall 2020 Semester, in INEN 4323, all students were given an independent assignment to design a pencil holder. Students were required to write a report graded using the following scale.

- Design Concept Requirement/Constrain Analysis 10pts
- Design Inputs
- Sufficient 15pts
- Testable 15pts
- Design Inputs Requirement/Constrain Analysis 10pts
- Design Outputs 10pts
- Verification Testing



- All Design Inputs are Tested 10pts
- Tests are appropriate 10pts
- Overall Quality of Work 20pts

The assignment was based on the FDA waterfall design process. Students were asked to identify requirements and constraints at the Design Concept and Design Input level. They were also required to articulate design inputs as a list of testable statements that aligned with their verification tests.

Students were also required to discuss three of their design inputs and corresponding verification tests. In Spring 2021 (INEN 4385), concepts of requirements, constraints, design inputs, and verification tests were discussed independently with each team within the context of the team's specific project.

Faculty scored the senior design teams based on their presentations given in spring after they had completed their projects. A standard rubric with a scale of 1 to 4 was used. The average overall score for Constraints was 3.17, well above our established threshold of 2.5. Related criteria include Objectives and Goals with an average score of 3.25 and Hypothesis Development 3.25.

### **Course Improvement 2 - Senior Design Preparation Citation**

**Identification:** In the 2019-2020 academic year, students' ability to cite sources in senior design (INEN 4323 & INEN 4385) were determined to be acceptable via our evaluation rubrics, but according to the course instructor many students were not academically prepared and only became successful after receiving intervention support via emails and online meetings with the instructor.

**Improvement:** Exercises focusing on citation styles, proper formatting of references and in-text citations, and use of bibliography software will be incorporated into the fall semester of senior design (INEN 4323) with a refresher in the spring (INEN 4385).

**Result:** At the start of the Fall 2020 semester (INEN 4323) students were given an assignment in which they had to write a one-page report based on one of the senior design projects from the previous year. They were required to cite at least 6 sources using APA style. The assignment included instruction on using Zotero for reference management as well as online tools.

Use of proper in-text citation and references were reviewed as part of the fall report and the final report in the spring. Faculty scored the senior design teams based on their presentations given in spring after they had completed their projects. A standard rubric with a scale of 1 to 4 was used. The average overall score for Citation was 3.08, which was well above the 2.5 threshold for needs improvement.

### **Course Improvement 3 - Senior Design Economic, Cultural and Environmental Impact**

**Identification:** The 2019-2020 academic senior design projects (INEN 4323 & INEN 4385) were determined to be acceptable via our rubric with regard to ABET Outcome 2 which generally relates to economic, cultural and environmental impact. Likewise, identification of regulations and standards under Outcome 1 was also evaluated as acceptable. Some projects focused heavily in these areas, while others addressed them indirectly or not at all. Based on the assessment being close to our standard, the instructor identified cultural and environmental impact as areas for improvement.

**Improvement:** To insure students have the opportunity to showcase their abilities in this area, all teams will be required to include an assessment of the global, economic, environmental, societal, health & safety, and cultural impact of their project as well as an assessment of regulations and standards relating to the topic of their project in their Fall and Spring reports.

**Result:** All teams were required to include a section on Social and Environmental Impact in their reports. Each team was encouraged to consider direct and indirect ramifications of their project. They were encouraged to consider laws, regulations, and standards that could relate to their project. They were also encouraged to consider the environmental impact as well as social impact of their project.

Faculty scored the senior design teams based on their presentations given in spring after they had completed their projects. A standard rubric with a scale of 1 to 4 was used. The average overall score for relevant criteria were as follows:

- Regulations and Standards: 3.25
- Global and Welfare: 3.15
- Environmental: 3.13
- Societal: 3.23
- Health and Safety: 3.17
- Cultural: 3.19
- Identifies global, economic, environed, and societal issues: 3.34

All were well above the 2.5 threshold for needs improvement.

#### **Course Improvement 4 - New Reading Assignments for INEN 2373 Engineering Economics**

**Identification:** After teaching this course in the Spring 2021, I found that most students did not spend extra time in solving additional textbook problems. Just solving the homework problems is not enough for students to succeed and get good grades in this course.

**Improvement:** With the help of Textbook- McGraw Hill online learning management service, I assigned 10% credits to students who completes the Reading Assignments for each chapter. In addition to the Homework, students started spending time and solving reading assignment problems which helps understand the conceptual knowledge.

**Result:** Including the Reading Assignments under the final grades significantly increased the student participation in solving the textbook problems and very well understood the conceptual knowledge for each chapter. The student participation in completing reading assignment was 30% in the Spring 2021 semester which jumped up to 80% in the Spring 2022 semester. This way students got better conceptual understand and improved the ability to solve homework and exam problems.

### **Course Improvement 5 - INEN 4331 Technology Entrepreneurship**

**Identification:** The instructor developed the Technology Entrepreneurship course to provide engineering students with knowledge about how technology-based startup companies are founded and grow. The course was originally developed in collaboration with the Center for Innovation Commercialization and Entrepreneurship (CICE) and was intended to be a starting point for students to become engaged in CICE events and activities. Unfortunately, due primarily to COVID, most activities never came about and CICE was recently restructured and brought under the new Entrepreneurship Institute at LU. There was a need to work with the new executive director and other stakeholders to connect the course into the Entrepreneurship Institute ecosystem.

**Improvement:** Through a series of meetings over Summer of 2022 the instructor, along with collaborators at the Entrepreneurship Institute and community stakeholders, developed a plan to coordinate course activities with events such as the Entrepreneurship Institute speaker series and, most importantly, the new Cardinal Ideas Pitch Deck Competition.

**Result:** Students taking the course worked in small teams to develop an initial idea into a product design, and then into a business model. The pitch deck competition was timed to correspond with the point in the course when students were making their pitch decks, in this way all the teams could apply to enter the competition. Teams who were not accepted were still allowed to give practice talks, while those who were accepted competed for \$10,000 in prizes! Students not only learned about entrepreneurship, but also learned about the resources and connections available to them through the Entrepreneurship Institute, and they will be invited to future events such as an entrepreneurship bootcamp and an entrepreneurship field trip planned for spring 2023.

### **Course Improvement 6 - INEN 2373 Engineering Economics**

**Identification:** The instructor noted students tend to forget the homework due dates and don't quite remember what needs to be done on weekly basis.

**Improvement:** The instructor created a simple to read To-Do list with bullet points on blackboard. Each weekly folder has its own To-Do List with a list of things to do for the week including the due dates and Click Here links to help them easily navigate to the right content of the course.

**Results** - Students developed a habit of referring to the To-Do List to simply keep track of their weekly tasks and activities on the course. I did notice that most students tend to complete the homework way before the due date, rather than submitting their work at the last minute in the previous semesters.

### **Course Improvement 7 - INEN 4380 Project Management Fall 2018 to Fall 2019**

**Identification:** INEN 4380 "Project Management" is for the online BSIE, BSIE 2+2 and BSIT programs. This course has been introduced as special topic course. Using MS Project Software is the main purpose of the course. Availability of MS Project to all students was the main concern.

**Improvement:** Instructor had meetings with technical people to make sure MS Project had been installed on some campus computers and got the directions to install MS Project for individual computers.

**Result:** The project management course received good enrollment. The instructor changed the special topic course to a permanent course addition for the department. Even though instructor had some software problem, installation of the software to some campus labs was very helpful. Students were used these labs to access MS Project.

#### **Course Improvement 8 - INEN 4380 Project Management Fall 2019 to Fall 2020 (Elective)**

**Identification:** The instructor realized that the number of chapters for undergraduate students are too much and learning software and the theory was overwhelming for the students.

**Improvement:** The instructor decided to reduce the number of chapters for the course. For the MS Project use, our department admin created the remote desktop connection for the student who had an issue to use MS Project. It was helpful for students who had Mac computers since MS Project only works in windows environment.

**Result:** The instructor did not see much of the complaints in the course evaluation regarding the number of chapters. Feedback was very positive about the content of the course. For the MS Project use, our department admin created the remote desktop connection for the student who had an issue to use MS Project. It was helpful for students who had a Mac computer since MS Project only works in windows environment.

#### **Course Improvement 9 - INEN 4380 Project Management Fall 2020 to Fall 2021 (Elective)**

**Identification:** The instructor realized that students had struggle on the solution of the problems in homework assignments. Instructor realized that explanation of issues with recorded videos and live session would be good.

**Improvement:** Instructor developed videos explaining more examples for the preparation of HW and Project. Instructor created some live sessions to explain MS Project software as well. Attendance was not mandatory for this session, but the sessions were recorded via collaborate ultra. In this case, students can watch the live session videos and do not miss the opportunity to learn from the live sessions.

**Result:** Homework and project quality were significantly improved.

#### **Course Improvement 10 - INEN 4380 Project Management Fall 2021 to Fall 2022 (Elective)**

**Identification:** Instructor realized that students need more interaction even though the course listed as an online course.

**Improvement:** Instructor created more live sessions to increase interactions for the class during nighttime since many of the students had full time jobs. The focus was more on use of theory behind MS Project and use of MS project. Attendance was not mandatory for these sessions, but the sessions were recorded via collaborate ultra. In this case, students can watch the live sessions.

**Result:** Feedback from the students were great, they liked the live sessions and even they stated that they would like to have more live sessions in their course evaluations.

#### **Course Improvement 11 - INEN 4315 Industrial Management Fall 2018 to Fall 2019**

**Identification:** The outcomes for the course include contemporary issues, life-long learning, ethics and impacts of engineering solutions. All these topics were covered with Project 1 (Ethics related project) and Project 2 (contemporary issues). However, the instructor had seen some obstacles finishing these two projects on time based on students' evaluations.

**Improvement:** To ensure clear understanding of Project 1 and 2, the instructor recorded lecture videos and provided some example projects from previous years. It was given good, medium and bad examples of the previous projects. Additionally, another ethics video had been prepared for Project 1. All the project expectations were listed and explained, and a brief template had been prepared.

**Result of Improvement:** The students are positive about the changes. They were able to review the videos about projects. Their quality of the projects significantly improved.

#### **Course Improvement 12 - INEN 4315 Industrial Management Fall 2019 to Fall 2020**

**Identification:** The outcomes in the course include contemporary issues, life-long learning, ethics and impacts of engineering solutions. All these topics were covered with Project 1 (Ethics related project) and Project 2 (contemporary issues). However, the instructor understood that the main obstacle was for completing Project 1 and 2 on time because undergrad students got too overwhelmed to see two projects due at the same time. In addition, students were complaint about the huge number of chapters that we covered in the course.

**Improvement:** The instructor decided to reduce the amount of project numbers for the course. She decided to include the short version of the Project 1 as part of Homework 2. The instructor rearranged the chapters to cover Project 1. In the meantime, Project 2 was remained same. In addition, the instructor adapted the new version of the book, updated the videos and slides, and reduced the number of chapters based on the critical evaluation of the chapters.

**Result:** Completion of the Project on time was increased. The instructor did not see much of the complaints in the course evaluation regarding the overwhelming number of the deliverables.

#### **Course Improvement 13 - INEN 4315 Industrial Management Fall 2020 to Fall 2021**

**Identification:** Project given in this course is related to contemporary issues and contemporary issues. Instructor realized that explanation of contemporary issues with live session would aid student learning.

**Improvement:** Instructor created some live sessions to explain project expectations. Attendance was not mandatory for this session, but the sessions were recorded via collaborate ultra. In this case, students can watch the live session video for project requirements.

**Result:** Project writing quality as well as the selection of topic for projects were significantly improved.

#### **Course Improvement 14 - INEN 4315 Industrial Management Fall 2021 to Fall 2022**

**Identification:** Instructor realized that students need more interaction even though the course listed as an online course.

**Improvement:** Instructor created some live sessions to increase interactions for the class during nighttime since many of the students had full time jobs. Attendance was not mandatory for these sessions, but the sessions were recorded via collaborate ultra. In this case, students can watch the live sessions.

**Result of Improvement:** Feedback from the students were great, they liked the live sessions and even they stated that they would like to have more live sessions in their course evaluations.

#### **Course Improvement 15- INEN 4354 Lean Manufacturing Spring 2018 to Fall 2019**

**Identification 1:** As general course improvement, the instructor explored ways of making the course more relevant.

**Improvement 1:** Instructor had meetings with one of the Industrial Engineering Advisory Council Members who has experience in teaching Lean Manufacturing at another ABET accredited program. He came to the class as a guest speaker as well. Instructor improved chapters after these interactions such as in core concepts of Lean such as VSM, JIT, takt time, cellular manufacturing, etc. New improved videos had been developed.

**Result:** The lean manufacturing course received good enrollment and interest from students.

#### **Course Improvement 16 - INEN 4354 Lean Manufacturing Spring 2019 to Spring 2020**

**Identification:** The instructor realized that project was needed to be explain with live session along with some examples of previous year's projects. In addition, the instructor published a book with Dr. Phillips who helped to improve the class.

**Improvement:** The instructor decided to hold live sessions about project expectations. Attendance was not mandatory for this session, but the sessions were recorded via collaborate ultra. In this case, students can watch the live session videos and do not miss the opportunity to learn from the live sessions. Moreover, new book had been introduced as a supplementary book and new slides had been added to the course. One of the authors of the new book is the course instructor.

**Result:** The quality of the project deliverable significantly improved. Students were very satisfied with the addition of the material.

#### **Course Improvement 17 - INEN 4354 Lean Manufacturing Spring 2020 to Spring 2021**

**Identification:** The instructor realized that students had struggle on the solution of the problems in homework assignments. Instructor realized that explanation of issues with recorded videos and live session would be good.

**Improvement:** Instructor developed some videos explaining more examples for the preparation of HW. Instructor created some live sessions.

**Result:** Homework quality was significantly improved.

### **Course Improvement 18 – Handouts for Multiple Courses (INEN 2373 Engineering Economics, INEN 4300 Quality Control, INNE 4375 Simulation) from 2021 to 2022**

**Identification:** A common comment in student evaluations has been that the textbook is not the most appropriate resource for studying for the test. Students have consistently rated the use of textbook poorly for several courses.

**Improvement:** During 2021 and 2022, over 100 original documents were integrated into the courses INEN 2373, INEN 4300, INEN 4375, and INEN 4357. Among them are 23 practice tests, 23 study guides, 45 lecture notes, 3 practice quizzes, and 11 lab assignments. This is due to the fact that the textbook does not include all of the necessary material for students to adequately prepare for their tests. The additional documents and resources provide students with the necessary information and practice needed to understand the material and excel in the course.

**Result:** Guides were well received by the students.

### **Course Improvement 19 - INEN 4385 IE Design (2022-2023)**

**Identification:** The department strongly encourages students to engage with industry and the community, and there was a need to increase the number of industry-hosted senior design projects. In 2021-2022, the number and choice of industry-hosted projects was not enough to cover all teams, so design studies and academic projects were used.

**Improvement:** The instructor and other faculty actively sought out industry partners and asked them to volunteer to host senior design projects. The advisory council was also asked.

**Result:** Students appreciated the connections, and some students told the instructor that working with a host company helped them with job interviews. Some teams did, however, have a difficult time because their projects were internal to the company, and they encountered bottlenecks that were beyond their control. In the future host companies will be encouraged to provide a theme for an external project as well as expert advice/support. Internal projects will be sought as well, but they will be carefully vetted.

### **Course Improvement 20 - INEN 1101 Intro to Engineering (Fall 2022)**

**Identification:** INEN 1101 is a seminar course that helps introduce students to industrial engineering and engineering in general. Students are often interested in earning potentials for different branches of engineering.

**Improvement:** The instructor added a module to the seminar to show students the latest data from the U.S. Bureau of Labor Statistics. Students were shown where the information could be found and provided with a summary covering the engineering disciplines taught at LU.

**Result:** Students were interested in the salary data as well as the number of people employed in the various disciplines. In addition to helping them understand their earning potential it also opened the door to discussions about data and data distributions since salaries were displayed based off mean, median, and various percentiles.

#### **Course Improvement 21 - INEN 4323 IE Systems Design (Face-to-Face & Online Sections) (2022-2023)**

**Identification:** Previous improvements were put in place to ensure teams covered ABET and departmental outcomes that were being somewhat neglected including societal impacts and environmental impacts. While all outcomes were being addressed, taking all projects together, individual teams still missed certain outcomes. Additionally, teams often struggled while trying to define their projects during the first semester. There was a need to provide more structure for teams while still leaving room for decision making and leadership.

**Improvement:** The instructor adopted many of the tools and strategies described in the book “Product Design and Development Handbook”, by Trimble and Shuaib. In terms of system design and planning, teams have a much more similar experience to one another, and all teams are required to cover activities that span the ABET and department outcomes. The book by Trimble and Shuaib is intended for product design projects, but the instructor was able to adapt it to cover the broad range of project types that the IE students pursue. A few examples of tools that were added to the course include house of quality, functional block diagram, and morphological analysis. In particular, students are now required to submit meeting minutes that include a Gantt chart updated each week to show hours pledged and hours worked, as well as cumulative chart that tracks the total hours worked by the team vs. their total pledged hours. These greatly help with team accountability.

**Result:** The course evaluations indicate a positive experience from the students and a number of faculty commented that students performed very well at the fall 2022 symposium. Teams who started using the new course format will finish their projects at the end of the spring 2022 semester and more results we be learned at that time.

#### **Course Improvement 22- Question Banks for INEN 2373\_48F Engineering Economics**

**Identification:** After teaching this course in the Spring 2021, the instructor found that most students did not spend extra time in solving additional textbook problems. Just solving the homework problems is not enough for students to succeed and get good grades in this course.

**Improvement:** With the help of Textbook- McGraw Hill online learning management service, the instructor assigned 10% credits to students who completes the Reading Assignments for each chapter. The instructor developed addition to the Homework, students started spending time and solving reading assignment problems which helps understand the conceptual knowledge.

**Result:** Including the Reading Assignments under the final grades significantly increased the student participation in solving the textbook problems and very well understood the conceptual knowledge for each chapter. The student participation in completing reading assignment was 30% in the Spring 2021 semester which jumped up to 80% in the Spring 2022 semester. This way students got better conceptual understand and improved the ability to solve homework and exam problems.



### **Course Improvement 23- To Do List for Homework in INEN 2373\_48F Engineering Economics**

**Identification:** Students tend to forget the homework due dates and don't quite remember what needs to be done on weekly basis.

**Improvement:** The instructor created a simple to read To-Do list with bullet points on blackboard. Each weekly folder has its own To-Do List with a list of things to do for the week including the due dates and Click Here links to help them easily navigate to the right content of the course.

**Results:** Students developed a habit of referring to the To-Do List to simply keep track of their weekly tasks and activities on the course. I did notice that most students tend to complete the homework way before the due date, rather than submitting their work at the last minute in the previous semesters.

### **Course Improvement 24- INEN 3322\_48F Engineering Materials/Process**

**Identification:** I found that students tend to miss the weekly quizzes. Especially the weeks on which there were more than 2 quizzes due.

**Improvement:** Started making the weekly quizzes available to the students 2 weeks before the due date. This gave students a fair amount of time to plan and work on the weekly quizzes.

**Result:** Had a great quiz completion rate. Students appreciated the idea as it helped them plan ahead of time in their busy schedule to complete the quiz. A student's comment- "Giving students two weeks to complete the quiz assignment was much appreciated. This gave me an opportunity to plan ahead and balance my assignments for my full course load. Thank you!".

### **Course Improvement 25- INEN 3322 Lab Sections Engineering Materials/Process**

**Identification:** Some students faced difficulty understanding the CNC manufacturing class that was traditionally delivered using a process manual.

**Improvement:** The instructor implemented the use of a dry erase white board during the CNC manufacturing class. That improved the student's ability to understand the concept as they can see me drawing the sketch on the board rather than just visualizing it.

**Result:** The instructor noticed an increase in the student's ability to understand the concept. That decreased the number of students coming up with a same conceptual question. This significantly increased the student's ability to work on a much-complicated manufacturing process on the CNC milling machine.

### **Course Improvement 26- INEN 3322 Lab Sections Engineering Materials/Process**

**Identification:** The robots with the gripper arm in the lab were quite old and were showing signs of wear and were not efficiently performing the task.

**Improvement:** The instructor implemented the use of new multifunction robots which not only can be used with a gripper arm but can also be used with the wide variety of included attachments and applications. The included small air compressor is used to operate the gripper, rather than an electric motor in case of

the old robots. This gives a much better clamping force, is quicker to operate and is much more accurate. Students use the attached computer application to control the robot and is also capable to run with a basic Python code.

**Result:** Increased the overall experience of the students in the Robotics lab. Students now have a variety of operations to perform on the robot and enjoy doing their projects on the new robots. These faster and efficient robots let students to spend more time learning and performing experiments on the robots.

#### **Course Improvement 27- INEN 3380 – Work Design (Online, Face-to-Face)**

**Identification 1:** Laboratories are required in the course. Students have struggled with writing an Executive Summary. Executive Summaries are an essential skill that needs to be mastered for their capstone project and working in industries.

**Improvement 1:** A new laboratory was created for students to practice and improve writing an Executive Summary.

**Result 1:** The new Executive Summary laboratory average grade was 83 for the Spring 2022 semester and 86 for Fall 2022. Comparing these scores to the Executive Summary portion of the first laboratory assignment in Fall 2021, there was a 55% improvement. The Executive Summary lab was successful in achieving the goal of improving the student's skills in writing an Executive Summary.

**Identification 2:** The Time Study laboratory video was five years old. Students had difficulty conducting accurate time studies because some of the elements were very short and challenging to time accurately.

**Improvement 2:** A new Time Study video was produced with longer element times and an embedded timer.

**Result 2:** Students were able to conduct a more accurate time study.

**Identification 3:** Most data collected in these Laboratories are in small quantities. Students were having difficulty analyzing the small amounts of data.

**Improvement 3:** I gave a tutorial on how to analyze the data that they collected.

**Result 3:** Students had a higher understanding of how to analyze the data they collected. The average score on the analytical portion of the lab was 79 for Spring 2022 and 81 for Fall 2022. Comparing these scores to the Executive Summary portion of the first laboratory assignment in Fall 2021, there was a 23% improvement.

#### **Course Improvement 28 - Technology in INEN 4396 Automated Engineering Systems**

**Identification 1:** PLC (Programmable Logic Controller) is the brain of the automated industrial control systems and is an important chapter in the course. Prior to 2020, a low-cost PLC Trilogi (made in Canada) was adopted due to the free software license it offered to students. But the software was outdated, and not widely used in industry.

**Improvement 1:** In 2020, the instructor decided to use a much more popular Allen-Bradley MicroLogix1100, an entry level, but extremely popular industrial PLC as the lab equipment, and developed a teaching panel equipped with the PLC and various I/Os. Detailed instruction of download, installation and configuration

of a complete programming/debugging/simulation environment was shared with students in blackboard, which consists of RSLogix 500, RSLogix 500 Emulate & RSLinx, and all of them are free for educational purpose. Students had exposure to the latest and industrial standard PLC hardware and software.

**Results of improvement 1:** The quality of the answers to the homework assignments on PLC programming was significantly improved. Students seem to be more motivated to learn, knowing that the technology was widely used in industry. A recent graduate found a job as an PLC programming partially because of the PLC programming skills she acquired from the course.

**Identification 2:** Distributed Control Systems (DCS) is widely used in the local petrochemical industries and is the forefront of the development in automation control at system or plant level. In the past, the course only conceptually discussed Distributed Control Systems (DCS) and Supervisory Control and Data Acquisition (SCADA) with no lab for it.

**Improvement 2:** With the establishment of the Emerson Advanced Technology Lab in November 2021, we have the latest Emerson DeltaV DCS system and the Performance Learning Platform (PLP) installed on campus. The PLP platform pumps water from tank 1 to tank 2 and measures flow, tank level, pressure and temperature through Rosemount, Micro Motion and Fisher devices controlled by the newest DeltaV PK controller. The instructor took the advantage of the access to the latest DCS system, and developed two lab sessions for the students, to give students hands-on experience on configure and control of DCS.

**Results of improvement 2:** The labs were well received by students. Some students expressed strong desire to learn more about the DCS controller, which motivated the instructor to develop and taught a new course on ENGR 5301 Special topic: DeltaV DCS Control System Implementation and Control in Spring 2023 with three undergraduate students, all of them find a job as control engineers in a control system design firm after graduation.

### **Course Improvement 29- Technology in INEN 4345/5345 Computer Integrated Manufacturing**

**Identification 1:** Almost all modern CAD/CAM systems are built upon feature-based parametric 3D modeling approach, 2D drawings become a less used design tool. While in manufacturing industry, 2D engineering drawings still play an important role in the communication between designer and machinists, especially on the dimensions and tolerances. Proper training on 2D drawing is important but not adequately addressed.

**Improvement 1:** The course material has been revised with emphasis on design methodology and drafting specifications so that students can be more job ready for design and manufacturing related jobs. The general principle on design for manufacturing and design for assembly were introduced to students.

**Results 1:** The instructor require students to make 2D drawing for every 3D modeling assignment (2 per week). The quality of the drawing keep improving week over week. This practice also helps students improve their skills in reading 2D drawings, is expected to have positive impact on their competitiveness in job search for design/manufacturing jobs.

**Identification 2:** 3D printing becomes increasingly important in not only prototyping, but also in production. However, this relatively new manufacturing technology was not included in the course before. The new release of the CAD/CAM software such as Fusion 360 start to integrate 3D printing function in recent years, which make it much easy and nature to add this important content in the course.

**Improvement 2:** 3D printing using Fusion 360 was added to the course, so that students understand the working principle of 3D printing, as well as the steps it involves to turn the design model into the CNC codes that drive the 3D printer to make the part layer by layer.

**Results of improvement 2:** The instructor require students to make 2D drawing for every 3D modeling assignment (2 per week). The quality of the drawing keep improving week over week. This practice also helps students improve their skills in reading 2D drawings, which is expected to have positive impact on their competitiveness in job search for design/manufacturing jobs.

### **Course Improvements 30- INEN 2373 Engineering Economics Fall 2021 to Fall 2022**

**Identification:** INEN 2373 is required for most engineering students. Most students found it very difficult: complex concepts and difficult problems. After investigation, the instructor realized that most students never worked on the problems except homework.

**Improvements:** The instructor developed an in-class-practice session. It was around 10 minutes in the beginning of each class, in which the instructor worked on one problem together with students. The question was carefully selected from the textbook or was developed by the instructor. It is usually an intermediate level question and contains the most important concepts in a real-life scenario. The instructor will make sure all students in class can solve the problem by themselves.

**Results:** Students enjoyed the in-class-practice session. They said they found it easier to do the homework after attending the in-class-practice session. Working on the problem together with students also helps the instructor to check the quality of teaching.

### **Course Improvement 31- INEN 4320 SDM online Spring 2020 to Spring 2021**

**Identification:** More students are taking INEN 4320 SDM online. The instructor found that students have more questions than face-to-face session and can't use the office hours effectively.

**Improvements:** To improve the interaction between the students and the instructor, one interactive session was offered on Blackboard after each chapter. It was usually in the afternoon of the weekend to accommodate more students. The instructor will review the chapter briefly, then answer the questions from students. The interactive session was recorded each time and uploaded on Blackboard for those who can't attend the session.

**Results:** The students give positive feedback about the interactive session. They were able to discuss with the instructor and other students. Through the session, students feel more comfortable about the statistical concepts and could work on the homework more efficiently.

### **Improvement 32 – Integrating Multiple tools to Make Supply Equal Demand in Production and Inventory Control (2021 Fall)**

**Identification:** The instructor talks about individual ways to make supply equal demand, but do not fully describe how you can use multiple approaches to achieve this goal. Also, the interrelationships between lead time, inventory, price, capacity, and demand were not fully presented.

**Improvement:** The instructor redesigned several lectures in the course including the introduction lecture to discuss multiple ways to make supply equal demand. The theme is now the multiple ways to make supply equal demand with one additional lecture on price (revenue management) and marketing. The theme of making supply equal demand is now stressed in the first lecture and occurs in multiple lectures in the course.

**Result:** The student evaluations in the course are generally positive and the change did not impact the evaluations.

### **Course Improvement 33 – Operations Research Topics**

**Identification:** As a result of the program review test, the faculty conducted a review of where topics were covered in the program. This review indicated that queueing was covered in both INEN 5475 Simulation and INEN 5350 Operations Research. The review also indicated that reliability was covered in INEN 4350, INEN 4301 Quality Improvement, and INEN 5350 Operations Research.

**Improvement:** Reduce the time spent on queueing and reliability in INEN 4370 Operations Research. Use this class time to focus on formulation with focus on layout.

**Results:** Improvement will be implemented in Spring 2025.

### **Course Improvement 34 - INEN 3322 Lab Sections Engineering Materials/Process (Spring 2024)**

**Identification:** We recognized the advancement of the current manufacturing technologies and the growing demand for skilled CNC operators, the need to enhance the existing manufacturing course became evident. After a few meetings, discussions and some analysis, it became apparent that integrating America's Cutting Edge CNC manufacturing program into the existing curriculum presented a promising opportunity to modernize and enhance the students' manufacturing experience. This initiative will equip students with the practical skills and knowledge required to excel in the rapidly evolving field of CNC machining, enhancing the current hammer lab course content with the latest industry standards and emerging technological trends.

**Improvement:** To enhance the current hammer manufacturing lab curriculum, a positive effort is made to integrate the America's Cutting Edge (<https://www.americascuttingedge.org/>) HAAS Automation CNC manufacturing program seamlessly into the existing lab curriculum. Collaborating with licensed technicians at the SciTech Makerspace and program administrators, a comprehensive plan and schedule is developed to integrate and make use of the ACE certification program. This will complement the basic CNC programming class and replace the intensive manufacturing of metal hammer on a lathe machine. The ACE program modules consists of a diverse array of topics, ranging from use of Autodesk Fusion 360 CAM software, advanced CNC machining techniques to innovative manufacturing methodologies, which meets the objectives of the course. Leveraging cutting-edge instructional resources and hands-on learning opportunities, students get the opportunity to gain practical experience and proficiency in CNC machining, thereby enhancing their employability and career readiness in the competitive manufacturing landscape.

**Result:** The integration of ACE CNC manufacturing program into the existing manufacturing course is yielded several significant outcomes. Firstly, students have a more comprehensive and relevant educational experience, gaining practical skills and knowledge that are directly applicable to the modern manufacturing practices in the current industry. With enhanced proficiency in CNC machining techniques and technologies, students are expected to demonstrate increased confidence and competence in operating HAAS Automation CNC machines, programming complex parts, and optimizing manufacturing processes. Furthermore,

the alignment of course content with industry standards and emerging technological trends will enhance the competitiveness and employability of students in the job market, positioning them as valuable assets to prospective employers in the manufacturing sector. The students received HAAS certification as part of the lab. Student feedback is mixed. While the students were grateful for the certification, several students were disappointed about missing the manual equipment experience and making the hammer (A Lamar Tradition). The lab also was less organized compared with several lectures requiring significantly less time than the allotted class period to our prior lab that had been unchanged for 20 years. The lab organization will be improved in future semesters.

#### **Course Improvement 35 - INEN 3322 Lab Sections Engineering Materials/Process (Fall 2023)**

**Identification:** Some students faced difficulty understanding the CNC manufacturing class that was traditionally delivered using a process manual.

**Improvement:** The instructor implemented the use of a dry erase white board during the CNC manufacturing class. That improved the student's ability to understand the concept as they can see me drawing the sketch on the board rather than just visualizing it.

**Result:** The instructor noticed an increase in the student's ability to understand the concept. That decreased the number of students coming up with a same conceptual question. This significantly increased the student's ability to work on a much-complicated manufacturing process on the CNC milling machine.

#### **Course Improvement 36 - INEN 3322 Engineering Materials/Process (Spring 2024)**

**Identification:** I receive requests from many students asking to reschedule the test due to the conflicting exam time with their work schedule. And I work with them to reschedule the test to their available time.

**Improvement:** I found it might be troublesome for students as they have to communicate with the instructor and/or their supervisors at work to reschedule the test time/date or their work schedules. Instead, I extended the time window that the students can appear for the test from 30 minutes to 24 hours. This gave students a fair amount of time to plan according to their work schedules and appear for the test at the time of the day that is most convenient for them.

**Result:** With this flexible test time window, students literally stopped emailing the instructor to reschedule the test. This significantly improved the number of students appeared for the test during this semester. Which indirectly improved their overall performance in the course.

#### **Course Improvement 37 - INEN 3322 Engineering Materials/Process (Spring 2024)**

**Identification:** The instructor found that students tend to miss the weekly quizzes. Especially the weeks on which there were more than 2 quizzes due.

**Improvement:** Started making the weekly quizzes available to the students 2 weeks before the due date. This gave students a fair amount of time to plan and work on the weekly quizzes.

**Result:** Had a great quiz completion rate. Students appreciated the idea as it helped them plan ahead of time in their busy schedule to complete the quiz. A student's comment- "Giving students two weeks to complete the quiz assignment was much appreciated. This gave me an opportunity to plan ahead and balance my assignments for my full course load. Thank you!".

#### **Course Improvement 38- INEN 2373 47F and 46F Engineering Economics (Summer 2023)**

**Identification:** After teaching this course in the Spring, the instructor found that most students did not spend extra time in solving additional textbook problems. Just solving the homework problems is not enough for students to succeed and get good grades in this course.

**Improvement:** With the help of Textbook- McGraw Hill online learning management service, I assigned 10% credits to students who completes the Reading Assignments for each chapter. In addition to the Homework, students started spending time and solving reading assignment problems which helps understand the conceptual knowledge.

**Result:** Including the Reading Assignments under the final grades significantly increased the student participation in solving the textbook problems and very well understood the conceptual knowledge for each chapter. The student participation in completing reading assignment was 30% in the previous semester which jumped up to 80% in the Summer 2023 semester. This way students got better conceptual understand and improved the ability to solve homework and exam problems.

#### **Course Improvement 39 - INEN 2373 Engineering Economics (Summer 2023)**

**Identification:** Students tend to forget the homework due dates and don't quite remember what needs to be done on weekly basis.

**Improvement:** The instructor created a simple to read To-Do list with bullet points on blackboard. Each weekly folder has its own To-Do List with a list of things to do for the week including the due dates and Click Here links to help them easily navigate to the right content of the course.

**Results:** Students developed a habit of referring to the To-Do List to simply keep track of their weekly tasks and activities on the course. I did notice that most students tend to complete the homework way before the due date, rather than submitting their work at the last minute in the previous semesters.

#### **Course Improvement 40- INEN 4380 Project Management Software Delivery (Fall 2023)**

**Identification:** INEN 4380 "Project Management" is for the online BSIE, BSIE 2+2 and BSIT programs. This course has been introduced as special topic course. Using MS Project Software is the main purpose of the course. Availability of MS Project to all students was the main concern. The instructor realized that students had problems for the installation of the software. they were usually late to install the software and they were getting low grade for their assignments since the assignments includes the usage of the MS Project.

**Improvement:** Instructor provided the MS project installation very early stages at the course and troubleshoot with the students.

**Result of Improvement:** Majority of the students were using the MS project on time and their homework grades were improved.

#### **Course Improvement 41 - INEN 4315 Industrial Management (Fall 2023)**

**Identification:** Students were struggling when they are answering questions for quizzes and tests since the answers look similar to them and cannot separate the choices.

**Improvement:** Instructor created live sessions to just focus on the quiz and test questions for each chapter. Live sessions were delivered during nighttime since many of the students had full time jobs or might have another class Attendance was not mandatory for this session, but the session was recorded via collaborate ultra. In this case, students can watch the live session video before taking the quizzes and tests.

In addition, instructor provided two attempts to all quizzes and students can see the correct answers immediately.

**Result of Improvement:** The students are positive about these changes. They were able to review the videos about quiz and test questions. Their quiz and test results were improved.

#### **Course Improvement 42 – INEN 4323 / 4385 Senior Design Leadership (2024 Spring)**

**Identification:** Based on 2024 assessment for outcome 5, our students have issues with teamwork. Senior design is a two-semester sequence of INEN 4323 and INEN4385 where students work in teams to create a capstone project that demonstrates their capabilities as engineers. The course requires students to develop and showcase a wide range of skills including both technical skills and soft skills. The course provides some scaffolding for the students, but it intentionally gives them more freedom that they normally have in a university project so they can experience soft skill challenges and improve them. The instructor taught senior design since 2020 and over that time the instructor have observed an increase in frequency of problems relating to communication, delegation, task responsibility, disagreement over project direction, schedule conflicts, and similar soft skill related issues as demonstrated by our assessment process for outcome 5. At that same time, the instructor has heard an increasing call from industry leadership for engineering students with good soft skills from our advisory council and others. While there are likely multiples sources for the problem and multiple ways to resolve it, the instructor and faculty believe the most effective way to improve the student outcomes for the course and to assist them in their future engineering careers is to incorporate leadership training into senior design.

**Improvement:** Part of the current scaffolding for senior design includes tools and assignments for project management, but there is a difference between management and leadership. Management provides the foundation for efficient and productive work, but it does not address the individual mindset of the team members. Leadership addresses the vision of the team; it helps teams to create a single vision for the project and to make team members feel unified as part of a group with shared norms and values. Many problems that the instructor have observed can be traced to a lack of single vision for the team and to team members feeling isolated. The instructor will incorporate leadership training into senior design next year. The approach to leadership training will be developed in summer 2024.

**Result:** Results will be updated after implementation of the course improvement.



### **Course Improvement 43 – Capacity Planning in Production and Inventory Control (2024)**

**Identification:** Due to the relatively poor performance on the program review test used in our assessment process, capacity planning and vocabular are weak areas for students.

**Improvement:** Additional capacity planning questions especially simple analysis of systems with defects will be added to exams and homework with a focus. Vocabular will have additional focus on exams. The number of exams will be increased from 2 to 3 to aid in retention of basic facts.

**Result:** Improvement will be implemented in fall 2024.

## Appendix A. Rubrics

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

Area / Score	4 - Exemplary	3 - Acceptable	2 – Marginal	1 – Unacceptable
<b>Math, Science and Engineering Concepts</b>	Explanation shows good understanding of the math and engineering concepts used to solve the problem(s).	Explanation shows some understanding of the math and engineering concepts used to solve the problem(s).	Explanation shows little understanding of the math and engineering concepts needed to solve the problem(s).	Explanation shows very limited understanding of the underlying concepts needed to solve the problem(s)
<b>Math and Engineering Formulation</b>	Translates complex real problems into math and science.	Translates simple problems into math and science.	Some ability to translate problems into math and science.	No evidence of translating real problems to math.
<b>Diagrams and Sketches Use</b>	Diagrams and/or sketches are clear and easy to understand.	Diagrams and/or sketches are somewhat difficult to understand.	Diagrams and/or sketches are difficult to understand	No diagrams and/or sketches used.
<b>Terminology and Notation</b>	Correct terminology and notation are usually used, making it fairly easy to understand what was done.	Correct terminology and notation are used, but it is sometimes not easy to understand what was done.	There is little use, or a lot of inappropriate use, of terminology and notation.	There is no appropriate use, of terminology and notation.
<b>Strategy and Procedures</b>	Typically, uses an effective strategy to solve the problem(s).	Sometimes uses an effective strategy to solve problems, but does not do it consistently.	Rarely uses an effective strategy to solve problems.	Never uses an effective strategy to solve problems.
<b>Constraints</b>	Identifies and uses problem constraints in the design process.	Some identification and use of problem constraints in the design process.	Limited identification and use of problem constraints in the design process.	No identification and use of problem constraints in the design process.
<b>Objective and Goals</b>	Identifies and uses a clear multicriteria objective in the design process.	Identifies and uses a single objective in the design process.	Does not clearly state an objective in the design process.	No objective in the design process.
<b>Regulations and Standards</b>	Identifies government regulations (ADA, HIPPA, Stark, EEOC,...) and accepted engineering design standards related to the problem.	Some reference to and use of government regulations (ADA, HIPPA, Stark, EEOC,...) and accepted engineering design standards related to the problem.	Limited reference to and use of government regulations (ADA, HIPPA, Stark, EEOC,...) and accepted engineering design standards related to the problem.	No reference to and use of government regulations (ADA, HIPPA, Stark, EEOC,...) and accepted engineering design standards related to the problem. Any issues with IRB for human subject requires an evaluation of 0, review by the full department, and reporting to the correct on campus resources.

Outcome 2 Rubric. 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

Area / Score	4 – Exemplary	3 – Acceptable	2 – Marginal	1 - Unacceptable
<b>Global and Welfare</b>	Describes the global impact of solution in detail having gathered pertinent facts. Ascertains exactly what must be decided	Identifies the global impact, including pertinent facts, and ascertains what must be decided	Has a vague idea of the global impact and is uncertain what must be decided	Does not recognize the global impact and does not identify what has to be decided
<b>Economic</b>	Describes the economic impact of solution in detail having gathered pertinent facts. Ascertains exactly what must be decided	Identifies the economic impact, including pertinent facts, and ascertains what must be decided	Has a vague idea of the economic impact and is uncertain what must be decided	Does not recognize the economic impact and does not identify what has to be decided
<b>Environmental</b>	Describes the environmental impact of solution in detail having gathered pertinent facts. Ascertains exactly what must be decided	Identifies the environmental impact, including pertinent facts, and ascertains what must be decided	Has a vague idea of the environmental impact and is uncertain what must be decided	Does not recognize the environmental impact and does not identify what has to be decided
<b>Societal</b>	Describes the societal impact of solution in detail having gathered pertinent facts. Ascertains exactly what must be decided	Identifies the societal impact, including pertinent facts, and ascertains what must be decided	Has a vague idea of the societal impact and is uncertain what must be decided	Does not recognize the societal impact and does not identify what has to be decided
<b>Health and Safety</b>	Identifies and effectively includes health and safety in the design process.	Some identification and inclusion of health and safety in the design process.	Limited identification and inclusion of health and safety in the design process.	No identification and inclusion of health and safety in the design process.
<b>Cultural</b>	Identifies and effectively includes culture in the design process.	Some identification and inclusion of culture in the design process.	Limited identification and inclusion of culture in the design process.	No identification and inclusion of culture in the design process.

Outcome 3 Rubric. 3. an ability to communicate effectively with a range of audiences

Written Area / Score	4 - Exemplary	3 - Acceptable	2 – Marginal	1 - Unacceptable
<b>Organization</b>	Information is very organized with well-constructed paragraphs and subheadings.	Information is organized with well-constructed paragraphs.	Information is organized, but paragraphs are not well-constructed.	The information appears to be disorganized.
<b>Amount of Information</b>	All topics are addressed and all questions answered with at least 2 sentences about each.	All topics are addressed and most questions answered with at least 2 sentences about each.	All topics are addressed, and most questions answered with 1 sentence about each.	One or more topics were not addressed.
<b>Quality of Information</b>	Information clearly relates to the main topic. It includes several supporting details and/or examples.	Information clearly relates to the main topic. It provides 1-2 supporting details and/or examples.	Information clearly relates to the main topic. No details and/or examples are given.	Information has little or nothing to do with the main topic.
<b>Mechanics</b>	No grammatical, spelling, or punctuation errors.	Almost no grammatical, spelling, or punctuation errors	A few grammatical, spelling, or punctuation errors.	Many grammatical, spelling, or punctuation errors.
<b>Paragraph Construction</b>	All paragraphs include introductory sentence, explanations or details, and concluding sentence.	Most paragraphs include introductory sentence, explanations or details, and concluding sentence.	Paragraphs included related information but were typically not constructed well.	Paragraphing structure was not clear and sentences were not typically related within the paragraphs.
<b>Diagrams and Illustrations</b>	Diagrams and illustrations are neat, accurate and add to the reader's understanding of the topic.	Diagrams and illustrations are accurate and add to the reader's understanding of the topic.	Diagrams and illustrations are neat and accurate and sometimes add to the reader's understanding of the topic.	Diagrams and illustrations are not accurate OR do not add to the reader's understanding of the topic.

Outcome 3 rubric Oral skills.

Oral Area / Score	4 - Exemplary	3 - Acceptable	2 - Marginal	1 - Unacceptable
<b>Speaks Clearly</b>	Speaks clearly and distinctly all (100-95%) the time, and mispronounces no words.	Speaks clearly and distinctly all (100-95%) the time, but mispronounces one word.	Speaks clearly and distinctly most ( 94-85%) of the time. Mispronounces no more than one word.	Often mumbles or cannot be understood OR mispronounces more than one word.
<b>Posture and Eye Contact</b>	Stands up straight, looks relaxed and confident. Establishes eye contact with everyone in the room during the presentation.	Stands up straight and establishes eye contact with everyone in the room during the presentation.	Sometimes stands up straight and establishes eye contact.	Slouches and/or does not look at people during the presentation.
<b>Content</b>	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
<b>Volume</b>	Volume is loud enough to be heard by all audience members throughout the presentation.	Volume is loud enough to be heard by all audience members at least 90% of the time.	Volume is loud enough to be heard by all audience members at least 80% of the time.	Volume often too soft to be heard by all audience members.
<b>Preparedness</b>	Student is completely prepared and has obviously rehearsed.	Student seems pretty prepared but might have needed a couple more rehearsals.	The student is somewhat prepared, but it is clear that rehearsal was lacking.	Student does not seem at all prepared to present.
<b>Enthusiasm</b>	Facial expressions and body language generate a strong interest and enthusiasm about the topic in others.	Facial expressions and body language sometimes generate a strong interest and enthusiasm about the topic in others.	Facial expressions and body language are used to try to generate enthusiasm, but seem somewhat faked.	Very little use of facial expressions or body language. Did not generate much interest in topic being presented.
<b>Organization</b>	Student presents information in logical, interesting sequence which audience can follow.	Student presents information in logical sequence which audience can follow.	Audience has difficulty following presentation because student jumps around.	Audience cannot understand presentation because there is no sequence of information.
<b>Graphics</b>	Student's graphics explain and reinforce screen text and presentation.	Student's graphics relate to text and presentation.	Student occasionally uses graphics that rarely support text and presentation.	Student uses superfluous graphics or no graphics.
<b>Elocution</b>	Student uses a clear voice and correct, precise pronunciation of terms so that all audience members can hear presentation.	Student's voice is clear. Student pronounces most words correctly. Most audience members can hear presentation.	Student's voice is low. Student incorrectly pronounces terms. Audience members have difficulty hearing presentation.	Student mumbles, incorrectly pronounces terms, and speaks too quietly for students in the back of class to hear.

**Outcome 4 Rubric.** 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.

<b>Area / Score</b>	<b>4 – Exemplary</b>	<b>3 – Acceptable</b>	<b>2 – Marginal</b>	<b>1 - Unacceptable</b>
<b>Ethical and professional responsibilities</b>	Demonstrates ethical and professional responsibilities in project.	Some demonstrates of ethical and professional responsibilities in project with no major issues.	Limited demonstrates of ethical and professional responsibilities in project with no major issues.	Demonstrates a lack of ethical or professional responsibilities in the project.
<b>Identifies global, economic, environmental, and societal issues</b>	Describes the dilemma in detail having gathered pertinent facts. Ascertains exactly what must be decided	Identifies the dilemma, including pertinent facts, and ascertains what must be decided	Has a vague idea of what the dilemma is and is uncertain what must be decided	Does not recognize the dilemmas and does not identify what has to be decided
<b>Considers Stakeholders</b>	Determines who should be involved in the decision making process and thoroughly reflects on the viewpoints of the stakeholders	Determines who should be involved in the decision making process and accurately identifies all the stakeholders	Is unsure as to who should be involved in the decision-making process	Does not recognize who should be involved in the decision-making process

Outcome 5 Rubric. 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.

Area / Score	4 – Exemplary	3 - Acceptable	2 – Marginal	1 - Unacceptable
<b>Contributions</b>	Routinely provides useful ideas when participating in the group and in classroom discussion. A definite leader who contributes a lot of effort.	Usually provides useful ideas when participating in the group and in classroom discussion. A strong group member who tries hard!	Sometimes provides useful ideas when participating in the group and in classroom discussion. A satisfactory group member who does what is required.	Rarely provides useful ideas when participating in the group and in classroom discussion. May refuse to participate.
<b>Quality of Work</b>	Provides work of the highest quality.	Provides high quality work.	Provides work that occasionally needs to be checked/redone by other group members to ensure quality.	Provides work that usually needs to be checked / redone by others to ensure quality.
<b>Problem-solving</b>	Actively looks for and suggests solutions to problems.	Refines solutions suggested by others.	Does not suggest or refine solutions, but is willing to try out solutions suggested by others.	Does not try to solve problems or help others solve problems. Lets others do the work.
<b>Attitude</b>	Never is publicly critical of the project or the work of others. Always has a positive attitude about the task(s).	Rarely is publicly critical of the project or the work of others. Often has a positive attitude about the task(s).	Occasionally is publicly critical of the project or the work of other members of the group. Usually has a positive attitude about the task(s).	Often is publicly critical of the project or the work of other members of the group. Often has a negative attitude about the task(s).
<b>Preparedness</b>	Brings needed materials to class or work sessions and is always ready to work.	Almost always brings needed materials to class or work sessions and is ready to work.	Almost always brings needed materials but sometimes needs to settle down and get to work.	Often forgets needed materials or is rarely ready to get to work.
<b>Pride</b>	Work reflects this student's best efforts.	Work reflects a strong effort from this student.	Work reflects some effort from this student.	Work reflects very little effort on the part of this student.
<b>Working with Others</b>	Almost always listens to, shares with, and supports the efforts of others. Tries to keep people working well together.	Usually listens to, shares, with, and supports the efforts of others. Does not cause "waves" in the group.	Often listens to, shares with, and supports the efforts of others, but sometimes is not a good team member.	Rarely listens to, shares with, and supports the efforts of others. Often is not a good team player.
<b>Time-management</b>	Routinely uses time well throughout the project to ensure things get done on time. Group does not have to adjust deadlines or work responsibilities because of this person's procrastination.	Usually uses time well throughout the project, but may have procrastinated on one thing. Group does not have to adjust deadlines or work responsibilities because of this person's procrastination.	Tends to procrastinate, but always gets things done by the deadlines. Group does not have to adjust deadlines or work responsibilities because of this person's procrastination.	Rarely gets things done by the deadlines and group has to adjust deadlines or work responsibilities because of this person's inadequate time management.
<b>Focus on the task</b>	Consistently stays focused on the task and what needs to be done. Very self-directed.	Focuses on the task and what needs to be done most of the time. Other group members can count on this person.	Focuses on the task and what needs to be done some of the time. Other group members must sometimes nag, prod, and remind to keep this person on-task.	Rarely focuses on the task and what needs to be done. Lets others do the work.
<b>Leadership</b>	Team had clear leadership and direction.	Team had acceptable leadership and direction.	Team had leadership and direction issue.	Major issues with leadership.
<b>Mentor / Instructor</b>	Team had clear direction and mission.	Team had acceptable direction and mission.	Team had poor direction and mission.	Major issues in project scope or goals.

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

Area / Score	4 – Exemplary	3 – Acceptable	2 – Marginal	1 - Unacceptable
<b>Data Collection</b>	Data was collected several times. It was summarized in a way that clearly describes what was discovered.	Data was collected more than one time. It was summarized in a way that somewhat describes what was discovered.	Data was collected more than one time. It did not clearly summarize what was discovered.	Data was collected only once and it did not summarize what was discovered.
<b>Variables</b>	Identified and clearly defined which variables were going to be changed (independent variables) and which were going to be measured (dependent variables).	Identified which variables were going to be changed (independent variables) and which were going to be measured (dependent variables). Some variables not clearly defined.	Vaguely identified and defined which variables were going to be changed (independent variables) and which were going to be measured (dependent variables).	Did not identify or define almost all the variables.
<b>Description of Procedure</b>	Procedures were outlined in a step-by-step fashion that could be followed by anyone without additional explanations.	Procedures were outlined described in a summary fashion that required knowledge of the project to understand.	Procedures were vaguely outlined and had 1 or 2 gaps that required explanation that was not provided	Procedures were not outlined or were seriously incomplete or not sequential.
<b>Hypothesis Development</b>	Developed a hypothesis well-substantiated by a literature review and observation of similar phenomena.	Developed a hypothesis somewhat substantiated by a literature review and observation of similar phenomena.	Hypothesis is somewhat vague and weakly substantiated by a literature review or observation of similar phenomena.	Hypothesis not given and a basic literature review was not provided.
<b>Conclusion/Summary</b>	Student provided a detailed conclusion clearly based on the data and related to previous research findings and the hypothesis statement(s).	Student provided a somewhat detailed conclusion clearly based on the data and related to the hypothesis statement(s).	Student provided a conclusion with some reference to the data and the hypothesis statement(s).	No conclusion was apparent OR important details were overlooked.



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

Area / Score	4 - Exemplary	3 – Acceptable	2 – Marginal	1 – Unacceptable
<b>Recognize need to learn</b>	Describes the needs for learning in detail having specified strategies for implementation.	Identifies the needs for learning and has vague strategies for implementation	Has a vague idea of the need for learning, but does not have a strategy for implementation	Does not recognize the need for lifelong learning and does not have a strategy for implementation
<b>Ability to learn</b>	Project shows strong evidence that learning influenced the strategies.	Project shows some evidence that learning influenced strategies.	Project shows little evidence that learning influenced strategies,	Project shows no evidence that learning influenced strategies,
<b>Citation</b>	Clear description of how information was gathered with citation.	Some description of how information was gathered with citation.	Limited description of how information was gathered with citation.	Significant problems with citation and attribution of information gathering.

Outcome 8 Rubric. (I) to design, develop, implement, and improve integrated systems that include people, materials, information, equipment and energy.

Area / Score	4 - Exemplary	3 - Acceptable	2 – Marginal	1 - Unacceptable
<b>Reasoning</b>	Clearly demonstrates ability to apply clear, sound reasoning in preparing a design solution	Demonstrates some ability to apply clear, sound reasoning in preparing a design solution	Demonstrates minimal ability to apply clear, sound reasoning in preparing a design solution	Does not demonstrate ability to apply clear, sound reasoning in preparing a design solution
<b>Alternative exploration</b>	Clearly demonstrates ability to explore reasonable alternative design options, evaluate design alternatives, identify and choose the final design	Demonstrates some ability to explore reasonable alternative design options, evaluate design alternatives, identify and choose the final design	Demonstrates minimal ability to explore reasonable alternative design options, evaluate design alternatives, identify and choose the final design	Does not demonstrate ability to explore reasonable alternative design options, evaluate design alternatives, identify and choose the final design
<b>Design Development</b>	Clear evidence of testing and refinements based on data and scientific principles.	Clear evidence of testing and refinements.	Some evidence of testing.	No testing or refinements.
<b>Design Improvement</b>	Clearly demonstrates ability to improve results based on the new design	Demonstrates some ability to improve results based on the new design	Demonstrates minimal ability to improve results based on the new design	Does not demonstrate ability to improve results based on the new design
<b>Design Consideration</b>	Design clearly incorporates people, materials, information, equipment, and energy	Design somewhat incorporates people, materials, information, equipment, and energy	Design minimally incorporates people, materials, information, equipment, and energy	Design does not incorporate people, materials, information, equipment, and energy

Outcome 9 Rubric. (m) The in-depth instruction to accomplish the integration of systems using appropriate analytical, computational, and experimental practices.

Area / Score	4 – Exemplary	3 - Acceptable	2 – Marginal	1 - Unacceptable
<b>Design Elements to Form an Integrated Solution</b>	Clearly demonstrates ability to apply sound analysis techniques in preparing an integrated solution	Demonstrates some ability to apply sound analysis techniques in preparing an integrated solution	Demonstrates minimal ability to apply sound analysis techniques in preparing an integrated solution	Does not demonstrate ability to apply sound analysis techniques in preparing an integrated solution
<b>Computation for System Integration</b>	Clearly demonstrates ability to compute data and arrive at an integrated solution	Demonstrates some ability to compute data and arrive at accurate solutions	Demonstrates minimal ability to compute data and solutions are not entirely	Does not demonstrate ability to compute data and solutions are not accurate
<b>Experimental Practices to Achieve System Integration</b>	Clearly demonstrates ability to apply experimental approaches to process integration	Demonstrates some ability to apply experimental approaches to process integration	Demonstrates minimal ability to apply experimental approaches to process integration	Does not demonstrate ability to apply experimental approaches to process integration
<b>System Integration</b>	System is completely integrated and functions seamlessly	System is mostly integrated and functions almost seamlessly	System is minimally integrated and functions with a few disconnects	System is not integrated and functions with a many disconnects

