MfgE
2024-25

ASSESSMENT MANUAL

NDSU INDUSTRIAL AND MANUFACTURING ENGINEERING DEPARTMENT
MANUFACTURING ENGINEERING PROGRAM

Industrial and Manufacturing Engineering Department

Contents

Glossary

- Assessment: Processes that identify, collect, and prepare data to evaluate the attainment of student outcomes
- Evaluation: Processes for interpreting the data and evidence accumulated through assessment processes
- Program Educational Objectives (PEOs): Broad statements that describe what graduates are expected to attain within a few years of graduation
- Program-level Student Outcomes (SOs): Statements that describe what students are expected to know and able to do by the time of graduation.
- Performance Indicators: Specific, measurable statements identifying the performance(s) required to meet student outcomes.
- Rubric: a scoring guide which provides descriptions of student work of varying quality.
- Course Learning Objectives: Statements that articulate the knowledge and skills you want students to acquire by the end of the course
- Curriculum Map: shows how curriculum supports attainment of student outcomes
- Assessment Methods: methods for data collection that facilitate the program assessment process
- Assessment Schedule: a six-year assessment, evaluation, and implementation cycle for the program-level student outcomes

New Language and Definitions approved by the EAC October 20, 2017, Applicable beginning in the 2019-20 cycle

The Engineering Accreditation Commission of ABET recognizes that its constituents may consider certain terms to have certain meanings; however, it is necessary for the Engineering Accreditation Commission to have consistent terminology. Thus, the Engineering Accreditation Commission will use the following definitions in applying the criteria:

Basic Science – Basic sciences are disciplines focused on knowledge or understanding of the fundamental aspects of natural phenomena. Basic sciences consist of chemistry and physics and other natural Sciences including life, earth, and space sciences.

College-level Mathematics – College-level mathematics consists of mathematics that requires a degree of mathematical sophistication at least equivalent to that of introductory calculus. For illustrative purposes, some examples of college-level mathematics include calculus, differential equations, probability, statistics, linear algebra, and discrete mathematics.

Complex Engineering Problems - Complex engineering problems include one or more of the following characteristics: involving wide-ranging or conflicting technical issues, having no obvious solution, addressing problems not encompassed by current standards and codes, involving diverse groups of stakeholders, including many component parts or sub-problems, involving multiple disciplines, or having significant consequences in a range of contexts.

Engineering Design – Engineering design is a process of devising a system, component, or process to meet desired needs and specifications within constraints. It is an iterative, creative, decision making process in which the basic sciences, mathematics, and engineering sciences are applied to convert resources into solutions. Engineering design involves identifying opportunities, developing requirements, performing analysis and synthesis, generating multiple solutions, evaluating solutions against requirements, considering risks, and making trade-offs, for obtaining a high-quality solution under the given circumstances. For illustrative purposes only, examples of possible constraints include accessibility, aesthetics, codes, constructability, cost, ergonomics, extensibility, functionality, interoperability, legal considerations, maintainability, manufacturability, marketability, policy, regulations, schedule, standards, sustainability, or usability.

Engineering Science – Engineering sciences are based on mathematics and basic sciences but carry knowledge further toward creative application needed to solve engineering problems. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other.

Team – A team consists of more than one person working toward a common goal and should include individuals of diverse backgrounds, skills, or perspectives.

Changes in Criterion 3 - Student Outcomes

Criterion 3. Seven Student Outcomes

The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program.

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Replacing outcomes, a, e, and k)
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. (Replacing outcomes c and k)
3. an ability to communicate effectively with a range of audiences. (Replacing outcomes g)
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. (Replacing outcomes f, h, j)
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. (Replacing outcomes d)
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. (Replacing outcomes b and k)
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies. (Replacing outcomes i)

Introduction

The Department of Industrial and Manufacturing Engineering (IME) at North Dakota State University (NDSU) has put in place this Assessment Manual for assessment of the student outcomes in the Industrial Engineering and Management Bachelor of Science degree program, based on the requirements of the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (EAC-ABET).

The success of an educational program can be measured in terms of the ability of its graduates to satisfy the needs of its constituents. The measurement of a program's level of success requires the ongoing evaluation and assessment of the program and its graduates. To be fully effective, this assessment must fulfill three purposes: (1) evaluate the effectiveness of the program in meeting the desired student outcomes, (2) assess the relevance of these outcomes as they pertain to the needs of the program's constituents, and (3) identify how corrective measures can be taken for continuous improvement of the program. These guidelines form the foundation for the assessment plan developed and implemented by the Department of Industrial and Manufacturing Engineering at North Dakota State University.

The IME Department has implemented a rigorous and comprehensive assessment plan that utilizes both direct and indirect measures to assess student learning and achievement. The purpose of the IME Assessment Plan is to provide both qualitative and quantitative measures of student learning with respect to the student outcomes, and to identify areas of potential weakness within the curriculum. The overall intent is to enable the department to identify specific areas in the curriculum in need of improvement so that the intended outcomes can be achieved. For the purposes of assessment, the constituents of the IME department include; alumni, alumni employers, graduating and current students, and faculty. Assessment instruments were developed to solicit feedback from each constituent group.

The IME Department utilizes several assessment tools for measuring student performance and achievement. These tools include both direct measures (techniques which directly measure student performance in specific areas) as well as indirect measures (techniques which gauge the opinions of the department's constituents in meeting student outcomes). The assessment tools collect information from all the department's constituents: current students, alumni, faculty, employers, and the Industrial Advisory Board (IAB).

Although numerous assessment measures are utilized by the department, the primary method that is used to directly measure the skills, knowledge, and behaviors that students acquire as they progress through the program is the course-outcomes assessment process. This assessment tool was adopted by the IME Department based on the recognition that any improvements to the program must ultimately be implemented at the course level. In establishing this methodology, specific outcomes were first defined for each course in the IME curriculum, and the relationships between the course outcomes and student outcomes were then identified. This process provides a mechanism by which the contribution of each course in meeting the student outcomes can be defined, measured, and evaluated. Through implementation of this process, any deficiencies in achieving the student outcomes can not only be determined, but specific courses can be identified for improvement to rectify the problems. A Continuous Improvement process is utilized to assist the department in implementing the results and findings obtained from our assessment and evaluation mechanism implemented.

The program educational objectives listed in the next section serve as guiding principles for the Department in our efforts to prepare graduates to attain the professional and personal goals they aspire to achieve, reflect the mission and core values of North Dakota State University, and address the evolving needs of people and industries locally, regionally, nationally, and globally.

As the student outcomes relate to the skills, knowledge, and behaviors that students acquire as they progress through the program, assessment data pertaining to the achievement of these outcomes is collected at multiple points throughout the students' educational experiences. In addition, data is collected at the time of graduation, as well as a few years after graduation, to determine how perceptions of the level of attainment change as students are integrated into the workforce.

Program Educational Objectives[1]

The IME Department has identified four key constituencies of the program:

1) Current students, faculty, and staff.
2) Alumni of the program.
3) Employers of graduates from the program.
4) Department Industrial Advisory Board (IAB).

In support of the mission of the university, college, and department, the IME Department has developed a set of Program Educational Objectives (PEOs) for the Manufacturing Engineering (MfgE) program. PEOs are crafted in terms of career progression and personal growth. Thus, these PEOs are crafted to reflect student's capabilities for career success within a few years after graduation. Specifically, within a few years of their formal commencement, graduates of the MFGE program at NDSU will be expected to…

1. Have established a successful career in various fields, including but not limited to industrial and manufacturing engineering, and beyond, by demonstrating professionalism and ownership of their work with increasing responsibility, positive impact, effective communication, and team participation.
2. Have acquired new knowledge and expertise through professional development and/or higher education as a part of their life-long learning and innovative education, professional growth, learning strategies, and community outreach.
3. Have demonstrated commitment to uphold higher ethical and professional standards in the workplace and appreciate the impact of diverse opinions and solutions in a global, economic, environmental, and societal context.
4. Be a productive and engaged citizen by committing to serve their profession and communities at all appropriate levels.

IME department faculty periodically review the PEOs to maintain consistency in institutional response to evolving technological and societal changes. The program educational objectives are presented to department constituents and discussed at various levels among faculty and Industrial Advisory Board (IAB) members of the department to ensure consistency with accreditation criteria and the mission of the institution.

Process for Review of the Program Educational Objectives

The IME Department has established a process to periodically review and revise the program educational objectives to ensure they remain relevant to the needs of the program's constituencies. For this purpose, the department has relied heavily on the IME Industrial Advisory Board for input and guidance. The IAB is made up of industry representatives from a broad cross-section of regional and national companies that routinely recruit and hire our students. In addition, most of these members are alumni of our program.

[1] PEOs last updated in Fall 2023

Thus, the IAB provides a critical and convenient mechanism for the periodic review of the educational objectives. Combined with input from the department faculty and students, all key constituencies have an opportunity to help shape the direction of the program.

Student Feedback

Student feedback on the PEO's is obtained each semester from students graduating during the exit interview. Students are asked to provide feedback on the PEO's as they relate to their career goals and aspirations, as well as the adequacy of our curriculum in preparing students to achieve these career objectives. This feedback is compiled each semester and provided to the IME faculty for review.

Faculty Review of PEO's

At the annual fall retreat of the IME Department, the faculty review assessment data collected during the prior year, listen to recommendations from the faculty about course/curriculum improvements, and offer additional discussion and suggestions for program improvement. As part of this process, faculty members review the data collected from students concerning the PEO's, and conduct a thorough review of the program educational objectives approximately every 3 years to ensure they remain relevant to the needs and aspirations of the students.

IAB Review of PEO's

The IME Industrial Advisory Board meets with the department faculty once a year. At this meeting, one of the recurring agenda items is to review program assessment results and the success of the program in meeting the educational objectives and student outcomes. As part of this process, the program educational objectives are subjected to a thorough review approximately every 3 years, to ensure they remain relevant to the evolving needs of industry. The IAB feedback on PEO was last obtained during Spring 2021 advisory board meeting.

Student Outcomes

The following list of student outcomes was chosen by the MfgE faculty members to support the program educational objectives.

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.

Table 1 illustrates how the MfgE PEOs are related to the student outcomes:

Table 1: Correlation of MfgE Student Outcomes with PEOs.

Student Outcomes	PEOs			
	1	2	3	4
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	X			X
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	X			X
3. An ability to communicate effectively with a range of audiences	X			
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	X	X	X	X
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			X	X
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	X			X
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies		X		

Assessment Processes

Direct Measures

1) Course-Outcomes Assessment

This is the primary method by which the IME Department directly assesses student learning and achievement. This method of assessment provides immediate feedback from students and faculty in the department. With this technique, specific course outcomes are tied to the broader student outcomes. By measuring student performance within each core course, quantitative feedback is obtained for both the course outcomes and the associated student outcomes every semester. Thus, this method provides each faculty member with an immediate assessment of student learning in their own course, as well as providing the whole department a broader measure of its success in meeting the student outcomes. The details of implementation for this assessment measure are summarized below.

Implementation of the Course-Outcomes Assessment Process

Any modifications to the curriculum performed in response to a shortcoming in meeting student outcomes must ultimately be initiated at the course level; i.e., improvements in the program arise through improvements to individual courses. Thus, a program must have in place a method for identifying not only what shortcomings exist, but also how these shortcomings can be mitigated through individual course improvements. This is the intent of the course-outcomes assessment process, which is implemented through the following steps:

- For each of the program's student outcomes (which are rather broad objectives as defined by ABET), the IME Department defined several "performance indicators," as shown in Table 2 which provide more specific expectations of student performance that can be individually assessed and evaluated. These performance indicators are specific to the program curriculum. By assessing the performance indicators directly, we can obtain a much clearer picture of student success in meeting the broader programmatic outcomes.

Table 2. Student outcomes and performance indicators.

Student Outcome	Performance Indicator
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	▪ Defines and understands the problem ▪ Identifies constraints and develops solution strategies ▪ Proposes solutions/hypotheses ▪ Applies knowledge of mathematics (e.g., statistics, differential mathematics, linear algebra) ▪ Applies knowledge of science (e.g., mechanics, chemistry, physics) ▪ Applies knowledge of IE&M (e.g., quality assurance and control, manufacturing systems, inventory control, simulation, facilities layout) ▪ Implements solution and evaluates 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	▪ Develops a design strategy based on project and client needs and constraints ▪ Identifies the constraints in the design problem, and establishes criteria for acceptability and desirability of solutions ▪ Takes into consideration the public health, safety, and welfare, as well as global , cultural, and social, environmental, and economic factors ▪ Selects appropriate techniques and skills (such as modeling, simulation, experimentation, measurement, and data analysis) for a specific engineering task ▪ Supports the design procedure with documentation and references
3. an ability to communicate effectively with a range of audiences	▪ Demonstrate effective oral presentation skills, organization, content, and delivery ▪ Demonstrate effective written communication skills, style, organization, use of graphs and tables
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	▪ Understands professional responsibility (e.g., safety, environmental, legal, regulatory, intellectual property, project management, risk management) and applies related issues to practical situations ▪ Understands and applies engineering code of ethics to practical situations ▪ Demonstrates respect for diversity of peoples, ideas, and cultures ▪ Understand the influence of societal, global, and environmental issues in engineering problem formulation and solution ▪ Demonstrate knowledge of contemporary issues, current trends, complex problems, and career opportunities in his/her field of study
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	▪ Contributes to team meetings ▪ Facilitates contributions of team members ▪ Contributes individually outside of team meetings ▪ Fosters constructive team climate ▪ Responds to conflict
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	▪ Designs experiments by selecting appropriate methods, equipment, materials, and protocols ▪ Conducts experiments and collects data in accordance with applicable protocols ▪ Uses laboratories and equipment appropriately, safely, and in a way that enhances solutions to problems or completion of a project ▪ Uses appropriate tools to analyze data ▪ Verifies and validates experimental results including the use of statistics to account for possible experimental error
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	▪ Participates in learning activities outside of the classroom, including participation in professional and technical societies and meetings, learning communities, industry experiences, etc. ▪ Recognizes how the college experience contributes to understanding the need to continuously update professional skills to solve new problems

- Performance Indicators (PI) are concrete measurable performances students must meet as indicators of achievement of the outcome. Each of the student outcomes have been defined by a few high-level performance indicators so that they can be communicated to students, integrated into the curriculum, and measured in a consistent and reliable manner. Table 2 shows the PIs for each outcome. Since the IME department faculty have a direct impact only on the courses taught within our program, the integration of student outcomes is guaranteed in the program courses alone. Student learning in math, basic sciences and in the disciplines offered by other engineering departments within the College of Engineering enhances the achievement of the program learning out-comes, but the program faculty have no direct way of influencing changes in courses taught outside of our program.
- Once the performance indicators were defined, a summary of direct and indirect tools to assess student outcomes were determined as shown in Table 3.

Table 3. Summary of direct and indirect tools for assessment of student outcomes

Assessment Tool	Direct Assessment	Indirect Assessment	Source
Capstone rubric scoring by industry panel	**X**		Industry Panel
Capstone rubric scoring by faculty	**X**		Faculty
Course-level assessment	**X**		Faculty
Capstone student survey		**X**	Students
Student exit interview		**X**	Students

Specific courses were selected to be used as key milestones in the curriculum for the assessment of each student outcome. Faculty identify the student outcomes which are more prominently covered in their respective courses and in their syllabus. While numerous courses often contribute to the total student learning associated with an outcome, several key courses were selected as important points for measurement (i.e., every outcome does not need to be assessed in every course). The basis of the course selection (curriculum map, shown in Table 4) was made using the following criteria:

- Importance of outcomes/performance indicators in the course.
- Distribution of measurement milestones at key points throughout the curriculum.
- Maintaining a balanced schedule of course assessments during a three-year cycle.

Through this course assignment process, every course in the IME curriculum is associated (for assessment purposes) with at least one program-level student outcome, ensuring that each course will be assessed at least once during the three-year program assessment cycle.

The assessment process takes a multilevel approach that incorporates various proven assessment tools and practices. While informal feedback is routinely obtained from student surveys, student forums, and comments by faculty and students, we use three sources of direct, formal measurements: a capstone rubric scoring by industry panel, a capstone rubric scoring by faculty, and a course-level assessment by instructor in a selected number of required courses. Data are collected from different types of measurements as shown in Table 4 at two different levels: capstone and core course levels.

The capstone-level assessment uses senior-level information from all students in the culminating capstone courses. The course-level assessment uses information from students in selected required courses according to the information provided in the Curriculum Maps (Appendix A). Student learning is assessed using assignments that focus on specific outcomes of interest.

In addition, we use three sources of indirect measurements: capstone student survey, student rating of instructions, and student exit surveys. Capstone student surveys and student exit surveys are used to assess all student outcomes. In accordance with NDSU's Policy 332, Assessment of Courses and Instructions, each instructor may develop additional items to include in the Student Rating of Instructions form. This opportunity is used occasionally to assess the attainment of student outcomes in a selected number of required courses by including questions related to the outcomes assesses in these courses.

Table 4. Coverage map of the direct measures for assessment of student outcomes (MFGE)

Direct Assessment Tool	ABET Student Outcomes						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Capstone rubric scoring by industry panel	×	×	×	×	×	×	×
Capstone rubric scoring by faculty	×	×	×	×	×	×	×
Course-based rubric scoring by instructor							
IME311: Work/Station Design		x	x	×	x		
IME330: Manufacturing Processes	x	×	x			x	
IME380: CAD/CAM for Mfg	x	x	x	x	x	x	x
IME430: Process Engr	x	x	x		x	x	
IME431: Production Engr	x	x				x	
IME440: Engineering Economy	x			x		x	
IME456: Program and Project Mgmt.		x	×	×	×		×
IME460: Evaluation of Engineering Data	×					×	
IME461: Quality Assurance and Control	×			x		×	
IME480: Production Inventory Control	×	x	×	x	x	x	x
IME482: Automated Mfg Systems	x	x			x	x	x
IME489: Capstone Experience	x	×	x	x	x	×	x

Outcomes Assessed

- For each required course offered by the IME Department, several course outcomes have been identified. The course outcomes represent measurable skills that each student should possess upon completion of the course. Each course outcome is linked to one or more of the performance indicators of the student outcomes identified for the program as shown in Table 2. Note that the course outcomes are standardized for each course, and are thus independent of the instructor.
- Instructor assessment of course outcomes is performed by identifying specific exam questions, quizzes, projects, homework assignments, etc. that target each outcome. This may be a single problem or group of questions on an exam, an entire quiz, a design project, etc. There must be at least one assessment indicator identified for each outcome. The scores for each indicator are recorded individually and the averages normalized to a 1 – 5 scale at the end of the semester, resulting in a quantitative measurement for each course outcome. The assessment rubric for each topic/skill equivalent to a scale of 1-5 includes:

  Exceed expectations: Student response/solution or performance is complete or perfect; response or solution does not need to be changed.

  Fully met expectations: Student response/solution or performance is complete or has only very minor errors; response or solution can stand without modification.

  Met expectations: Student response/solution or performance is appropriate for profession; any errors or deficiencies are relatively minor and can be corrected with no more than moderate effort and/or minimal supervision or intervention.

  Marginally met expectations: Student response/solution or performance tries to employ correct practices but contains serious deficiencies that would require significant effort or rework to rectify with substantial supervision or intervention.

Did not meet expectations: Student response/solution or performance is flawed and/or of such low quality that a complete rework would be necessary.

- Once all the assessment data have been collected for each course outcome, a total score is calculated for each performance indicator of the affected student outcome by averaging the scores from all relevant course outcomes. The results from each course may then be averaged to generate a final composite score for each performance indicator, or alternatively the data from each course can be analyzed independently.
- To close the assessment loop, each instructor is required to examine the assessment scores from their classes, identify any shortcomings, and propose corrective actions to be implemented to rectify the shortcomings if necessary. The process is reported in the Faculty Course Assessment Report or FCAR (shown in Appendix D) for that course after the completion of the semester. By analyzing the course-outcomes assessment results that correspond to a student outcome, potential areas of improvement in the curriculum can be identified at the course level. Suggested modifications can then be discussed within each of the course curriculum. Thus, corrective actions in response to program shortcomings are implemented at the course level.

Indirect Measures

3) Alumni Surveys

Alumni surveys are distributed every 3 – 5 years, typically targeted towards alumni who graduated in the past 3 – 5 years. These alumni are targeted because it gives them enough time in the workplace to measure the value of their education in their current employment, without having their educational experiences washed out by their work experiences. In some instances, however, a broader spectrum of alumni has been surveyed to gain a better understanding of how attitudes change with time. The surveys request the alumni to rate the importance of each outcome in their current job, as well as the effectiveness of their education in meeting each outcome. The alumni surveys are distributed electronically, and the results are collected and compiled through a website administered by the Group Decision Center (GDC) at NDSU.

4) Employer Surveys

Employer surveys are distributed along with the alumni surveys (targeted towards the specific supervisors of the NDSU IME alumni) every 3 – 5 years. Alumni of the program who receive the surveys are asked to forward the attached employer surveys to their immediate supervisor. These surveys allow for an independent assessment of the skills of NDSU graduates in the areas important to the employer. Similar to the alumni survey, the employer survey requests each supervisor to rate the importance of each outcome and the initial skill level of the NDSU graduate for that outcome. The employer surveys are distributed electronically, and the results are collected and compiled through a website administered by the GDC at NDSU.

5) Graduating Senior "Exit Interviews"

Every graduating senior takes part in an "exit interview" with the department chair to collect their opinions and suggestions for improvement in the program. As part of these exit interviews, the students are requested to provide feedback concerning the effectiveness of their education in meeting the student outcomes. In addition, the graduating seniors are asked to provide feedback on several additional aspects of the program, such as the PEOs, the quality of advising, laboratory facilities, technical elective offerings, math and science courses, etc. These additional questions provide the department valuable information

on the subtler aspects of the program that cannot necessarily be ascertained through the limited assessment of student outcomes.

6) *IME Department Industrial Advisory Board (IAB) Feedback*

The IME IAB is comprised of practicing engineers who provide guidance to the department on educational matters. The IAB provides valuable input on the direction of the department (setting objectives and outcomes), as well as the success of the program in meeting those objectives. The IAB meets once or twice per year with the IME faculty. During these meetings, IAB members discuss the current and future needs of industry, review and evaluate program assessment data, assess the strengths and weaknesses of IME graduates, and provide suggestions to the faculty to ensure the curriculum stays relevant to the evolving needs of industry.

Expected Level of Attainment for the Student Outcomes

In using the course-outcomes assessment method, alumni and employer surveys, and graduating senior exit-interviews, all student outcomes are measured on a normalized 5-point scale. This allows for efficient comparison of the data among the various assessment techniques. In using these metrics, an achievement goal of 3.5 on the 5-point scale has been adopted by the IME Department for each student outcome. This value equates to a score of 70%, which has traditionally corresponded to a grade of C on a standard grading scale. As described in the curriculum guide, the IME Department requires all students to attain a grade of C or better in all Math and Science course and recommends a minimum of C grade for all core courses based on GPA. Thus, the metric goal of 3.5 in the assessment process illustrates the minimum level of effectiveness expected of the program in preparing graduates to attain the student outcomes.

It should be emphasized here that a score of 3.5 represents the *minimum* acceptable level of achievement for any student outcome in the IME Department. However, the department continually strives for program improvement regardless of the scores obtained through the assessment process. If a score drops below 3.5 during any assessment period, that outcome is specifically targeted for improvement during the next period. In addition, the overall set of assessment data is continually monitored and evaluated to identify areas in the program that can be strengthened, regardless of the individual scores obtained for each student outcome.

Curriculum Mapping

The Curriculum Mapping tables are included in **Appendix A**. In these tables, the courses in the Industrial Engineering and Management curriculum are mapped to show where and when the program-wide Student Outcomes are covered and assessed. The objective is to show how the Industrial Engineering and Management curriculum supports attainment of Student Outcomes by relating individual course-level learning objectives to the program-wide Student Outcomes. **Appendix B** includes a set of direct and indirect assessment instruments for use in the assessment of student outcomes.

Assessment Schedule

To reduce the unnecessary workload on faculty and to enable the program to focus on the evaluation and continuous improvement of outcomes in an efficient and sustainable way, a systematic data collection process based on a six-year assessment cycle for the program's student learning outcomes is utilized. Each outcome is assessed two times within the 6-year cycle, each year either two or three outcomes are assessed.

Table 5. Six-year Data Collection Cycle

Student Outcomes	6-Year ABET Cycle					
	1	2	3	4	5	6
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics		X			X	
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	X			X		
3. An ability to communicate effectively with a range of audiences		X			X	
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			X			X
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		X			X	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	X			X		
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies			X			X

As a part of the continuous improvement process, during the 3-year sub-cycle, each outcome is assessed in Year 1, the results are evaluated and implemented in Year 2. FCARs provide for a faster mechanism to improve curriculum and course content as the identified recommendations are implemented in the syllabus by the following semester the course is taught and the outcome measured.

The following is the schedule for assessment and evaluation of student outcome for the current ABET cycle.

Table 6. Six-year Assessment and Evaluation Schedule

Courses Where Student Outcomes are	Student Outcomes Collected for							
	F19/S2		F20/S21			F21/S22		
Where data is collected	2	6	1	3	5	4	7	1
Student exit survey	x	x	x	x	x	x	x	x
IME489: Capstone rubric scoring by industry panel	x	x	x	x	x	x	x	x
IME489: Capstone rubric scoring by faculty	x	x	x	x	x	x	x	x
IME489: Capstone student survey	x	x	x	x	x	x	x	x
IME311: Work/Station Design				x		x		
IME330: Manufacturing Processes	x		x					
IME 380: CAD/Cam for Mfg	x		x			x	x	
IME 430: Process Engineering		x	x					x
IME 431: Production Engineering	x		x					x
IME 440: Engineering Economy			x			x		x
IME450: Systems Engineering and Manage-	x	x				x	x	
IME456: Program and Project Mgmt.				x		x	x	
IME460: Evaluation of Engineering Data		x	x					
IME461: Quality Assurance and Control		x	x			x		
IME470: Operations Research I			x					x
IME472: Simulation of Business and Ind.				x	x			
IME480: Production Inventory Control			x	x	x	x	x	
IME482: Automated Mfg Systems	x						x	
IME485: Facilities Layout and Design	x					x	x	

Table 7. Six-year Assessment and Evaluation Schedule

Courses Where Student Outcomes are	Student Outcomes Collected for the										
	F22/S23				F23/S24				F24/S25		
Where data is collected	2	6	4	1	1	3	5	6	4	7	
Student exit survey	x	x			x	x	x		x	x	
IME489: Capstone rubric scoring by industry panel	x	x			x	x	x		x	x	
IME489: Capstone rubric scoring by faculty	x	x			x	x	x		x	x	
IME489: Capstone student survey	x	x			x	x	x		x	x	
IME311: Work/Station Design						x			x		
IME330: Manufacturing Processes	x				x						
IME 380: CAD/Cam for Mfg	x	x			x				x	x	
IME 430: Process Engineering	x	x			x						
IME 431: Production Engineering	x				x						
IME 440: Engineering Economy		x			x				x		
IME450: Systems Engineering and Manage-	x								x	x	
IME456: Program and Project Mgmt.						x			x	x	
IME460: Evaluation of Engineering Data		x			x						
IME461: Quality Assurance and Control		x			x				x		
IME470: Operations Research I	x			x	x						
IME472: Simulation of Business and Ind. Sys-						x	x				
IME480: Production Inventory Control		x			x	x	x		x	x	
IME482: Automated Mfg Systems	x	x								x	
IME485: Facilities Layout and Design	x		x						x	x	

Assessment Matrices

The student outcome assessment matrix is a recap of important information about the assessment of the student outcome. The matrix includes information about the student outcome, performance indicators, educational strategies, assessment method(s), where and when data are collected. The matrix includes thresholds (or targets) for acceptable performance. In setting a target for a performance indicator, attention was given to 1) the cognitive level - i.e., knowledge, comprehension, application, analysis, synthesis, evaluation, and 2) curriculum support -the more courses that support student performance for each indicator, the more likely it is that students will achieve the anticipated performance. The matrices for all Student Outcomes for the IME Industrial Engineering and Management program are shown in **Appendix C**.

Appendix A: Curriculum Mapping (2023-2024 Academic Year)

Curriculum Map for Student Outcome 1) an ability to identify, formulate, and solve complex engineering problems

	Freshman	Sophomore	Junior	Senior
Fall	CHEM121/L: General Chem I/Lab	COMM110: Fund of Public Speaking	IME380: CAD/CAM for Mfg	ENGR 327: Ethics, Engr, & Techn.
	ENGL110/120: College Composition	IME330: Manufacturing Processes	IME430: Process Engr	IME480: Production Inventory Control
	MATH165: Calculus I	MATH128: Intro to Linear Algebra	IME460: Eval. Engineering Data	IME482: Automated Mfg. Systems
	Computer Science Elective	MATH259: Multivariate Calculus	ENGL321: Writing in Tech Profession	Gen Ed Elective
		ME222: Engineering Mechanics II	IME456: Program and Project Mgmt.	Technical Elective
		ME223: Mechanics of Materials	Wellness Elective	
Spring	IME111: Introduction to IME	IME311: Work/Station Design	IME431: Production Engr	IME489: IME Capstone
	MATH166: Calculus II	MATH266: Intro to Diff. Equations	IME461: Quality Assurance and Control	Engr Sci Elective
	ME212: Fundamentals of Visual Comm.	PHYS252/L: University Physics II/Lab	IME440: Engineering Economy	Gen Ed Elective
	ME221: Engineering Mechanics I	ME331: Materials Science & Eng	ME 350: Thermodynamics/Heat Transfer	Tech Elective
	CHEM122: General Chemistry II	CE309: Fluid Mechanics	Gen Ed Elective	Tech Elective

Outcome covered Outcome assessed

Curriculum Map for Student Outcome 2) An ability to apply engineering design to produce solutions that meet specified needs

	Freshman	Sophomore	Junior	Senior
Fall	CHEM121/L: General Chem I/Lab	COMM110: Fund of Public Speaking	IME380: CAD/CAM for Mfg	ENGR 327: Ethics, Engr, & Techn.
	ENGL110/120: College Composition	IME330: Manufacturing Processes	IME430: Process Engr	IME480: Production Inventory Control
	MATH165: Calculus I	MATH128: Intro to Linear Algebra	IME460: Eval. Engineering Data	IME482: Automated Mfg. Systems
	Computer Science Elective	MATH259: Multivariate Calculus	ENGL321: Writing in Tech Profession	Gen Ed Elective
		ME222: Engineering Mechanics II	IME456: Program and Project Mgmt.	Technical Elective
		ME223: Mechanics of Materials	Wellness Elective	
Spring	IME111: Introduction to IME	IME311: Work/Station Design	IME431: Production Engr	IME489: IME Capstone
	MATH166: Calculus II	MATH266: Intro to Diff. Equations	IME461: Quality Assurance and Control	Engr Sci Elective
	ME212: Fundamentals of Visual Comm.	PHYS252/L: University Physics II/Lab	IME440: Engineering Economy	Gen Ed Elective
	ME221: Engineering Mechanics I	ME331: Materials Science & Eng	ME 350: Thermodynamics/Heat Transfer	Tech Elective
	CHEM122: General Chemistry II	CE309: Fluid Mechanics	Gen Ed Elective	Tech Elective

Outcome covered Outcome assessed

Curriculum Map for Student Outcome 3) an ability to communicate effectively with a range of audiences

	Freshman	Sophomore	Junior	Senior
Fall	CHEM121/L: General Chem I/Lab	COMM110: Fund of Public Speaking	IME380: CAD/CAM for Mfg	ENGR 327: Ethics, Engr, & Techn.
	ENGL110/120: College Composition	IME330: Manufacturing Processes	IME430: Process Engr	IME480: Production Inventory Control
	MATH165: Calculus I	MATH128: Intro to Linear Algebra	IME460: Eval. Engineering Data	IME482: Automated Mfg. Systems
	Computer Science Elective	MATH259: Multivariate Calculus	ENGL321: Writing in Tech Profession	Gen Ed Elective
		ME222: Engineering Mechanics II	IME456: Program and Project Mgmt.	Technical Elective
		ME223: Mechanics of Materials	Wellness Elective	
Spring	IME111: Introduction to IME	IME311: Work/Station Design	IME431: Production Engr	IME489: IME Capstone
	MATH166: Calculus II	MATH266: Intro to Diff. Equations	IME461: Quality Assurance and Control	Engr Sci Elective
	ME212: Fundamentals of Visual Comm.	PHYS252/L: University Physics II/Lab	IME440: Engineering Economy	Gen Ed Elective
	ME221: Engineering Mechanics I	ME331: Materials Science & Eng	ME 350: Thermodynamics/Heat Transfer	Tech Elective
	CHEM122: General Chemistry II	CE309: Fluid Mechanics	Gen Ed Elective	Tech Elective

Outcome covered Outcome assessed

Curriculum Map for Student Outcome 4) an ability to recognize ethical and professional responsibilities in engineering situations

	Freshman	Sophomore	Junior	Senior
Fall	CHEM121/L: General Chem I/Lab	COMM110: Fund of Public Speaking	IME380: CAD/CAM for Mfg	ENGR 327: Ethics, Engr, & Techn.
	ENGL110/120: College Composition	IME330: Manufacturing Processes	IME430: Process Engr	IME480: Production Inventory Control
	MATH165: Calculus I	MATH128: Intro to Linear Algebra	IME460: Eval. Engineering Data	IME482: Automated Mfg. Systems
	Computer Science Elective	MATH259: Multivariate Calculus	ENGL321: Writing in Tech Profession	Gen Ed Elective
		ME222: Engineering Mechanics II	IME456: Program and Project Mgmt.	Technical Elective
		ME223: Mechanics of Materials	Wellness Elective	
Spring	IME111: Introduction to IME	IME311: Work/Station Design	IME431: Production Engr	IME489: IME Capstone
	MATH166: Calculus II	MATH266: Intro to Diff. Equations	IME461: Quality Assurance and Control	Engr Sci Elective
	ME212: Fundamentals of Visual Comm.	PHYS252/L: University Physics II/Lab	IME440: Engineering Economy	Gen Ed Elective
	ME221: Engineering Mechanics I	ME331: Materials Science & Eng	ME 350: Thermodynamics/Heat Transfer	Tech Elective
	CHEM122: General Chemistry II	CE309: Fluid Mechanics	Gen Ed Elective	Tech Elective

Outcome covered Outcome assessed

Curriculum Map for Student Outcome 5) an ability to function effectively on a team

	Freshman	Sophomore	Junior	Senior
Fall	CHEM121/L: General Chem I/Lab	COMM110: Fund of Public Speaking	IME380: CAD/CAM for Mfg	ENGR 327: Ethics, Engr, & Techn.
	ENGL110/120: College Composition	IME330: Manufacturing Processes	IME430: Process Engr	IME480: Production Inventory Control
	MATH165: Calculus I	MATH128: Intro to Linear Algebra	IME460: Eval. Engineering Data	IME482: Automated Mfg. Systems
	Computer Science Elective	MATH259: Multivariate Calculus	ENGL321: Writing in Tech Profession	Gen Ed Elective
		ME222: Engineering Mechanics II	IME456: Program and Project Mgmt.	Technical Elective
		ME223: Mechanics of Materials	Wellness Elective	
Spring	IME111: Introduction to IME	IME311: Work/Station Design	IME431: Production Engr	IME489: IME Capstone
	MATH166: Calculus II	MATH266: Intro to Diff. Equations	IME461: Quality Assurance and Control	Engr Sci Elective
	ME212: Fundamentals of Visual Comm.	PHYS252/L: University Physics II/Lab	IME440: Engineering Economy	Gen Ed Elective
	ME221: Engineering Mechanics I	ME331: Materials Science & Eng	ME 350: Thermodynamics/Heat Transfer	Tech Elective
	CHEM122: General Chemistry II	CE309: Fluid Mechanics	Gen Ed Elective	Tech Elective

Outcome covered Outcome assessed

Curriculum Map for Student Outcome 6) an ability to develop and conduct appropriate experimentation, analyze and interpret data

	Freshman	Sophomore	Junior	Senior
Fall	CHEM121/L: General Chem I/Lab	COMM110: Fund of Public Speaking	IME380: CAD/CAM for Mfg	ENGR 327: Ethics, Engr, & Techn.
	ENGL110/120: College Composition	IME330: Manufacturing Processes	IME430: Process Engr	IME480: Production Inventory Control
	MATH165: Calculus I	MATH128: Intro to Linear Algebra	IME460: Eval. Engineering Data	IME482: Automated Mfg. Systems
	Computer Science Elective	MATH259: Multivariate Calculus	ENGL321: Writing in Tech Profession	Gen Ed Elective
		ME222: Engineering Mechanics II	IME456: Program and Project Mgmt.	Technical Elective
		ME223: Mechanics of Materials	Wellness Elective	
Spring	IME111: Introduction to IME	IME311: Work/Station Design	IME431: Production Engr	IME489: IME Capstone
	MATH166: Calculus II	MATH266: Intro to Diff. Equations	IME461: Quality Assurance and Control	Engr Sci Elective
	ME212: Fundamentals of Visual Comm.	PHYS252/L: University Physics II/Lab	IME440: Engineering Economy	Gen Ed Elective
	ME221: Engineering Mechanics I	ME331: Materials Science & Eng	ME 350: Thermodynamics/Heat Transfer	Tech Elective
	CHEM122: General Chemistry II	CE309: Fluid Mechanics	Gen Ed Elective	Tech Elective

Outcome covered Outcome assessed

Curriculum Map for Student Outcome 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

	Freshman	Sophomore	Junior	Senior
Fall	CHEM121/L: General Chem I/Lab	COMM110: Fund of Public Speaking	IME380: CAD/CAM for Mfg	ENGR 327: Ethics, Engr, & Techn.
	ENGL110/120: College Composition	IME330: Manufacturing Processes	IME430: Process Engr	IME480: Production Inventory Control
	MATH165: Calculus I	MATH128: Intro to Linear Algebra	IME460: Eval. Engineering Data	IME482: Automated Mfg. Systems
	Computer Science Elective	MATH259: Multivariate Calculus	ENGL321: Writing in Tech Profession	Gen Ed Elective
		ME222: Engineering Mechanics II	IME456: Program and Project Mgmt.	Technical Elective
		ME223: Mechanics of Materials	Wellness Elective	
Spring	IME111: Introduction to IME	IME311: Work/Station Design	IME431: Production Engr	IME489: IME Capstone
	MATH166: Calculus II	MATH266: Intro to Diff. Equations	IME461: Quality Assurance and Control	Engr Sci Elective
	ME212: Fundamentals of Visual Comm.	PHYS252/L: University Physics II/Lab	IME440: Engineering Economy	Gen Ed Elective
	ME221: Engineering Mechanics I	ME331: Materials Science & Eng	ME 350: Thermodynamics/Heat Transfer	Tech Elective
	CHEM122: General Chemistry II	CE309: Fluid Mechanics	Gen Ed Elective	Tech Elective

Outcome covered Outcome assessed

Appendix B: Direct and Indirect Assessment Tools

Direct Assessment Tools

CAPSTONE SURVEY– INDUSTRY PANEL

Dear industry panel member: Please complete this survey based on your overall assessment of the IME489 capstone projects and presentations.

Name (*optional*):_____

Scoring Range*:	1	2	3	4	5
	Did Not Meet Expectations	Marginally Met Expectations	Met Expectations	Fully Met Expectations	Exceeded Expectations

** Please use the attached rubrics to help with scoring student learning outcomes*

CRITERION	SCORE
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	
1a. Define and understand the problem	
1b. Identify constraints and develop solution strategies	
1c. Propose solutions/hypotheses	
1d. Apply knowledge of mathematics (e.g., statistics, differential mathematics, linear algebra)	
1e. Apply knowledge of science (e.g., mechanics, chemistry, physics)	
1f. Apply knowledge of MFGE (e.g., quality assurance and control, manufacturing systems, inventory control, simulation, facilities layout)	
1g. Implement solution and evaluates 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	
1a. Develop a design strategy based on project and client needs and constraints	
2b. Identify the constraints in the design problem, and establishes criteria for acceptability and desirability of solutions	
2c. Take into consideration the public health, safety, and welfare, as well as global , cultural, and social, environmental, and economic factors	
2d. Select appropriate techniques and skills (such as modeling, simulation, experimentation, measurement, and data analysis) for a specific engineering task	
2e. Support the design procedure with documentation and references	
3. an ability to communicate effectively with a range of audiences	
3a. Demonstrate effective oral presentation skills, organization, content, and delivery	
3b. Demonstrate effective written communication skills, style, organization, use of graphs and tables	
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	
4a. Understand professional responsibility (e.g., safety, environmental, legal, regulatory, intellectual property, project management, risk management) and applies related issues to practical situations	
4b. Understand and applies engineering code of ethics to practical situations	
4c. Demonstrate respect for diversity of peoples, ideas, and cultures	

4d. Understand the influence of societal, global, and environmental issues in engineering problem formulation and solution	
4e. Demonstrate knowledge of contemporary issues, current trends, complex problems, and career opportunities in his/her field of study	
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	
5a. Contribute to team meetings	
5b. Facilitate contributions of team members	
5c. Contribute individually outside of team meetings	
5d. Foster constructive team climate	
5e. Respond to conflict	
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
6a. Design experiments by selecting appropriate methods, equipment, materials, and protocols	
6b. Conduct experiments and collects data in accordance with applicable protocols	
6c. Use laboratories and equipment appropriately, safely, and in a way that enhances solutions to problems or completion of a project	
6d. Use appropriate tools to analyze data	
6e. Verify and validate experimental results including the use of statistics to account for possible experimental error	
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	
7a. Participate in learning activities outside of the classroom, including participation in professional and technical societies and meetings, learning communities, industry experiences, etc.	
7b. Recognize how the college experience contributes to understanding the need to continuously update professional skills to solve new problems	

Provide at least one positive aspect, if any, of IME Capstone course

Provide one negative experience, if any, of IME Capstone course

Provide at least one suggestion, if any, for improvement/change in the IME Capstone course

EVALUATION BY CAPSTONE INSTRUCTOR

Scoring Range*:	1	2	3	4	5
	Did Not Meet Expectations	Marginally Met Expectations	Met Expectations	Fully Met Expectations	Exceeded Expectations

** Please use the attached rubrics to help with scoring student learning outcomes*

CRITERION	SCORE
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	
1a. Define and understand the problem	
1b. Identify constraints and develop solution strategies	
1c. Propose solutions/hypotheses	
1d. Apply knowledge of mathematics (e.g., statistics, differential mathematics, linear algebra)	
1e. Apply knowledge of science (e.g., mechanics, chemistry, physics)	
1f. Apply knowledge of MFGE (e.g., quality assurance and control, manufacturing systems, inventory control, simulation, facilities layout)	
1g. Implement solution and evaluates 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	
1a. Develop a design strategy based on project and client needs and constraints	
2b. Identify the constraints in the design problem, and establishes criteria for acceptability and desirability of solutions	
2c. Take into consideration the public health, safety, and welfare, as well as global , cultural, and social, environmental, and economic factors	
2d. Select appropriate techniques and skills (such as modeling, simulation, experimentation, measurement, and data analysis) for a specific engineering task	
2e. Support the design procedure with documentation and references	
3. an ability to communicate effectively with a range of audiences	
3a. Demonstrate effective oral presentation skills, organization, content, and delivery	
3b. Demonstrate effective written communication skills, style, organization, use of graphs and tables	
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	
4a. Understand professional responsibility (e.g., safety, environmental, legal, regulatory, intellectual property, project management, risk management) and applies related issues to practical situations	
4b. Understand and applies engineering code of ethics to practical situations	
4c. Demonstrate respect for diversity of peoples, ideas, and cultures	
4d. Understand the influence of societal, global, and environmental issues in engineering problem formulation and solution	
4e. Demonstrate knowledge of contemporary issues, current trends, complex problems, and career opportunities in his/her field of study	
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	
5a. Contribute to team meetings	

5b. Facilitate contributions of team members	
5c. Contribute individually outside of team meetings	
5d. Foster constructive team climate	
5e. Respond to conflict	
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
6a. Design experiments by selecting appropriate methods, equipment, materials, and protocols	
6b. Conduct experiments and collects data in accordance with applicable protocols	
6c. Use laboratories and equipment appropriately, safely, and in a way that enhances solutions to problems or completion of a project	
6d. Use appropriate tools to analyze data	
6e. Verify and validate experimental results including the use of statistics to account for possible experimental error	
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	
7a. Participate in learning activities outside of the classroom, including participation in professional and technical societies and meetings, learning communities, industry experiences, etc.	
7b. Recognize how the college experience contributes to understanding the need to continuously update professional skills to solve new problems	

Indirect Assessment Measures

CAPSTONE STUDENT SURVEY

Dear Student: Please complete this survey based on your overall learning experience in the IME489 capstone project.

Name:_____ Team: _____

Major: (circle one) Industrial Engineering and Management/Manufacturing Engineering

Scoring Range*:	1	2	3	4	5
	Did Not Meet Expectations	Marginally Met Expectations	Met Expectations	Fully Met Expectations	Exceeded Expectations

** Please use the attached rubrics to help with scoring student learning outcomes*

CRITERION	SCORE
1. In your opinion, are you able to …	
1a. Define and understand engineering problems	
1b. Identify constraints and develop solution strategies	
1c. Proposes solutions/hypotheses	
1d. Applies knowledge of mathematics (e.g., statistics, differential mathematics, linear algebra)	
1e. Applies knowledge of science (e.g., mechanics, chemistry, physics)	
1f. Applies knowledge of engineering in IME related disciplines: – IE&M students: quality assurance and control, inventory control, simulation, facilities layout, manufacturing systems and processes, inventory control, simulation – MfgE students: manufacturing systems and manufacturing processes, process and production engineering, CAD/CAM, automation	
1g. Implement solution and evaluate outcome	
2. In your opinion, are you able to …	
1a. Develop a design strategy based on project and client needs and constraints	
2b. Identify the constraints in the design problem, and establishes criteria for acceptability and desirability of solutions	
2c. Take into consideration the public health, safety, and welfare, as well as global , cultural, and social, environmental, and economic factors	
2d. Select appropriate techniques and skills (such as modeling, simulation, experimentation, measurement, and data analysis) for a specific engineering task	
2e. Support the design procedure with documentation and references	
3. In your opinion, are you able to …	
3a. Demonstrate effective oral presentation skills, organization, content, and delivery	
3b. Demonstrate effective written communication skills, style, organization, use of graphs and tables	
4. In your opinion, are you able to …	
4a. Understand professional responsibility (e.g., safety, environmental, legal, regulatory, intellectual property, project management, risk management) and applies related issues to practical situations	
4b. Understand and applies engineering code of ethics to practical situations	
4c. Demonstrate respect for diversity of peoples, ideas, and cultures	

4d. Understand the influence of societal, global, and environmental issues in engineering problem formulation and solution	
4e. Demonstrate knowledge of contemporary issues, current trends, complex problems, and career opportunities in his/her field of study	
5. In your opinion, are you able to …	
5a. Contribute to team meetings	
5b. Facilitate contributions of team members	
5c. Contribute individually outside of team meetings	
5d. Foster constructive team climate	
5e. Respond to conflict	
6. In your opinion, are you able to …	
6a. Design experiments by selecting appropriate methods, equipment, materials, and protocols	
6b. Conduct experiments and collects data in accordance with applicable protocols	
6c. Use laboratories and equipment appropriately, safely, and in a way that enhances solutions to problems or completion of a project	
6d. Use appropriate tools to analyze data	
6e. Verify and validates experimental results including the use of statistics to account for possible experimental error	
7. In your opinion, are you able to …	
7a. Participate in learning activities outside of the classroom, including participation in professional and technical societies and meetings, learning communities, industry experiences, etc.	
7b. Recognize how the college experience contributes to understanding the need to continuously update professional skills to solve new problems	

Provide at least one positive aspect, if any, of your learning experience in capstone project

Provide one negative experience, if any, of your learning experience in capstone project

Provide at least one suggestion, if any, for improvement/change in the capstone project

Student Rating of Instructions (SROI)

NDSU's Policy 332, Assessment of Courses and Instructions, provides direction for faculty in their ongoing efforts to improve the quality of instruction, and to improve student learning. According this policy, every section of every class offered at North Dakota State University is evaluated each term by the students using, as a minimum, the university-wide set of rating items. In addition, each instructor, unit or college may develop additional items to include as a part of the evaluation. This opportunity is used by the faculty of the department to assess the attainment of student outcomes by including questions related to the particular outcome assesses in their classes.

Graduating Student Exit Survey

Since 2005, graduating students are expected to complete an exit survey as part of the interview process. The department carries out this assessment activity using the resources of the NDSU's Group Decision Center (GDC, www.ndsu.edu/gdc). The questions related to the program-wide student outcomes in the online survey form is shown below.

> **Question 22**: *Solve complex engineering problems*: Program courses and laboratories have given me opportunities to solve complex engineering problems. I can define and understand the problem, identify constraints and develop solution strategies. I can develop a hypothesis and propose a solution. The IME programs provide ample opportunities to apply knowledge of math, science, and engineering. I can employ general principles, theories, concepts, and/or formulas from mathematics, science, and engineering in the solution of a wide range of problems related to my engineering program. I can implement solutions and evaluate outcomes.
>
> **Question 23**: *Application of Engineering Design*: I am able to develop a design strategy based on clients' needs and constraints, taking into consideration the public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. As part of my education, I am able to use skills such as modeling, simulation, experimentation, measurement, and data analysis. I am also able to supports the design procedure with documentation and references.
>
> **Question 24**: *Effective communication*: The program helped me to improve my communication skills. The program emphasizes both oral and written communication and organization. Delivery of a professional oral presentation along with sounds writing styles were emphasized in all my classes.
>
> **Question 25**: *Ethical and professional responsibilities*: I belong to a professional society in my field and I understand the engineering code of ethics and I recognize my professional responsibilities. I was encouraged by the faculty to join a professional society. Ethical considerations covered/addressed in some of the engineering courses. The coverage of ethics was adequate. I welcome and respect diversity. The use of periodicals, both technical and non-technical to learn about contemporary issues was emphasized in my program. Reading topics outside of the IME field and related to contemporary issues was encouraged by faculty.
>
> **Question 26**: *Function effectively on a team*: The program offered many opportunities to work in teams. In general, teamwork experiences in all of my undergraduate courses were positive. I have a conceptual understanding of group dynamics and team project experiences have given me the skills and strategies that will make any future teamwork successful. I can participate effectively as member of multi-disciplinary team, working with people who bring different skills, expertise, and perspectives to a project. I can resolve conflicts and contribute positively to team climate. The instruction and guidance in teamwork I have received from professors in IME was adequate.

Question 27: *Develop and conduct experimentation*: The NDSU educational experiences promoted my ability to design and conduct experiments. My program provided opportunities to increase my ability to design and conduct experiments according with appropriate protocols. I am adequately prepared to use laboratories and equipment safely. I can measure, record and present raw and summary data and analyze those data for the purposes of understanding and explaining the data. I ca verify and validate experimental results including the use of statistics to account for possible experimental error.

Question 28: Apply new knowledge: My education at NDSU has prepared me to acquire and apply new knowledge as needed using appropriate learning strategies. It contributed to my understanding of the importance of professional and technical societies and meetings, teaching and learning communities, and industry experiences. I realize now how my college experience contributes to understanding the need to continuously update professional skills to solve new problems.

APPENDIX C: Student Outcome Assessment Matrices

Table 3. Student outcome (1): an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Performance Indicators	Educational strategies	Method of assessment	Data collected in	Assessment Year	Target for performance
1a. Defines and understands the problem 1b. Identifies constraints and develops solution strategies 1c. Proposes solutions/hypotheses	ME212, ME221, ME222, ME223, ESR, IME111, IME311, IME330, IME380, IME461, IME480, IME482, IME489	Faculty developed assessment SRoI	IME380	Year 2 Year 5	70% (3.5 on the 1-5 scale)
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		
1d. Applies knowledge of mathematics (e.g., statistics, differential mathematics, linear algebra)	MATH128, MATH165, MATH166, MATH259, MATH266, IME430, IME4361, IME440, IME460, IME461, IME480, IME489	Faculty developed assessment	IME430	Year 2 Year 5	70% (3.5 on the 1-5 scale)
		Faculty developed assessment	IME431		
		Faculty developed assessment	IME440		
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		
1e. Applies knowledge of science (e.g., mechanics, chemistry, physics)	CHEM121/L, CHEM122, ME221, ME222, PHYS252/L, Eng.Sci.Req. IME 489	Student exit survey Scoring by industry panel Scoring by faculty Capstone student survey	GDC online survey	Year 2 Year 5	70% (3.5 on the 1-5 scale)
1f. Applies knowledge in the IE&M-specific engineering disciplines (e.g., quality assurance and control, manufacturing systems, inventory control, simulation, facilities layout)	IME311, IME330, IME440, IME461, IME456, IME480, IME482, IME489	Faculty developed assessment	IME461	Year 2 Year 5	70% (3.5 on the 1-5 scale)
		Faculty developed assessment	IME480		
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		
1g. Implements solution and evaluates outcome	ME212, ME221, ME222, ME223, ESR, IME111, IME311, IME330, IME460, IME461, IME480, IME482, IME456, IME489	Faculty developed assessment SRoI	IME460	Year 2 Year 5	70% (3.5 on the 1-5 scale)
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		

Table 4. Student 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.

Performance Indicators	Educational strategies	Method of assessment	Data collected in	Assessment Year	Target for performance
2a. Develops a design strategy based on project and client needs and constraints 2b. Identifies the constraints in the design problem, and establishes criteria for acceptability and desirability of solutions	ME212, IME330, IME311, IME 4310, IME482, IME456, IME489	Faculty developed assessment	IME330	Year 1 Year 4	70% (3.5 on the 1-5 scale)
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		
2c. Takes into consideration the public health, safety, and welfare, as well as global, cultural, and social, environmental, and economic factors	IME111, IME311, IME456, IME489	Student exit survey Scoring by industry panel Scoring by faculty Capstone student survey	GDC online survey	Year 1 Year 4	70% (3.5 on the 1-5 scale)
2d. Selects appropriate techniques and skills (such as modeling, simulation, experimentation, measurement, and data analysis) for a specific engineering task	Comp.Sci.Elect., ME212, ME221, IME330, IME311, IME380, IME430, IME431, IME460, IME461, IME482, IME456, IME480, IME489	Faculty developed assessment	IME380	Year 1 Year 4	70% (3.5 on the 1-5 scale)
		Faculty developed assessment	IME431		
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		
2e. Supports the design procedure with documentation and references	ME212, IME330, IME311, IME482, IME456, IME489	Faculty developed assessment	IME482	Year 1 Year 4	70% (3.5 on the 1-5 scale)
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		

Table 5. Student outcome (3): an ability to communicate effectively with a range of audiences.

Performance Indicators	Educational strategies	Method of assessment	Data collected in	Assessment Year	Target for performance
3a. Demonstrate effective oral presentation skills, organization, content, and delivery 3b. Demonstrate effective written communication skills, style, organization, use of graphs and tables	UNIV189, ENGL110/120, ME212, ENGL321, IME311, IME456, IME480	Faculty developed assessment	IME311	Year 2 Year 5	70% (3.5 on the 1-5 scale)
		Faculty developed assessment	IME456		
		Faculty developed assessment	IME480		
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		

Table 6. Student 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.

Performance Indicators	Educational strategies	Method of assessment	Data collected in	Assessment Year	Target for performance
4a. Understands professional responsibility (e.g., safety, environmental, legal, regulatory, intellectual property, project management, risk management) and applies related issues to practical situations 4b. Understands and applies engineering code of ethics to practical situations	IME111, ENGR402, IME456, IME489	Faculty developed assessment	IME456	Year 3 Year 6	70% (3.5 on the 1-5 scale)
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		
4c. Demonstrates respect for diversity of peoples, ideas, and cultures 4d. Understand the influence of societal, global, and environmental issues in engineering problem formulation and solution	IME111, IME311, IME440, IME430, IME489	Faculty developed assessment	IME311		
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		
4e. Demonstrate knowledge of contemporary issues, current trends, complex problems, and career opportunities in his/her field of study	IME111, IME330, IME311, IME 431, IME461, IME482, IME456	Faculty developed assessment	IME461		
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		

Table 7. Student 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.

Performance Indicators	Educational strategies	Method of assessment	Data collected in	Assessment Year	Target for performance
5a. Contributes to team meetings 5b. Facilitates contributions of team members 5c. Contributes individually outside of team meetings 5d. Fosters constructive team climate Responds to conflict	UNIV189, IME111, IME330, IME311, IME480, IME489	Peer rating of team members	IME330	Year 2 Year 5	70% (3.5 on the 1-5 scale)
		Course-based rubric scoring	IME480		
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		

Table 8. Student outcome (6): an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Performance Indicators	Educational strategies	Method of assessment	Data collected in	Assessment Year	Target for performance
6a. Designs experiments by selecting appropriate methods, equipment, materials, and protocols 6b. Conducts experiments and collects data in accordance with applicable protocols 6c. Uses laboratories and equipment appropriately, safely, and in a way that enhances solutions to problems or completion of a project 6d. Uses appropriate tools to analyze data Verifies and validates experimental results including the use of statistics to account for possible experimental error	CHEM121L, PHYS252L, IME330, IME380, IME311, IME430, IME460, IME461, IME480, IME489	Faculty developed assessment;	IME430	Year 1 Year 4	70% (3.5 on the 1-5 scale)
		Faculty developed assessment	IME460		
		Faculty developed assessment	IME461		
		Scoring by industry panel Scoring by faculty Capstone student survey	IME489		
		Student exit survey	GDC online survey		

Table 9. Student outcome (7): an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Performance Indicators	Educational strategies	Method of assessment	Data collected in	Assessment Year	Target for performance
7a. Participates in learning activities outside of the classroom, including participation in professional and technical societies and meetings, learning communities, industry experiences, etc.	IME111, IME440, IME430, IME482, IME489	Faculty developed assessment	IME440	Year 3 Year 6	70% (3.5 on the 1-5 scale)
		Faculty developed assessment	IME482		
		Scoring by faculty Capstone student survey	IME489		
7b. Recognizes how the college experience contributes to understanding the need to continuously update professional skills to solve new problems		Student exit survey	GDC online survey		

APPENDIX D: Faculty Course Assessment Report Template

Faculty Course Assessment Report
IME XXX Course Title – xxxxxxx # 3 credits
Spring/Fall Semester 201X – Instructor Name

Catalog Description:

Prerequisites:

Grade Distribution

A	B	C	D	F	W	Total

Modifications Made to Course: (*Changes made the previous semester or year from FACR DETAIL (S) semester and year (YY))…*

Student Learning Outcomes covered (mapped to ABET outcomes 1-7):

At the successful completion of this course, the students should be able to:

IME Criterion Program Outcomes Based on ABET Criterion 3
Upon graduation, the NDSU IME program graduates demonstrate the following: 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.

	Level of Contribution to Student Outcome Using the Scale shown Below: **⑤ very high ④ high ③ average ② low ① very low ⓪ not applicable**						
Student Outcome	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Contribution Level	0	0	0	0	0	0	0

Communications Component:

Ethics Component:

SCES Evaluations:

Field	Min	Max	Mean	SD	VA	#Res
Q1. Instructor provided well-defined course objective						
Q2. Instructor provided clear & well-organized content, materials						
Q3. I understood how my grades were assigned in this course						
Q4. I met or exceeded the course objectives given for this course						
Q5. Instructor was available to assist students outside of class						
Q6. Instructor provided feedback to me in a timely manner						
Q7. Instructor provided relevant feedback that helped me learn						
Q8. Instructor set and maintained high standards						
Q9. The physical environment was conducive to learning						

Student Feedback:

Personal Reflection:

Course changes proposed including the method of assessing these changes after implementation:

1) Clearly detail any (if) assessment(s) of student outcome(s) that prompts a proposed change.

2) Propose changes to address the shortcoming(s) including when (SYY) the changes should be implemented and how along with any plan to assess these changes. The implementation should be assessed at the end of the semester when they are implemented.