Industrial Engineering

Industrial Engineering Tuning Committee Members

Dr. David Wyrick, Committee Chair Texas Tech University Lubbock, Texas	Dr. Amarnath Banerjee, Committee Co-Chair Texas A&M University College Station, Texas
Dr. Araceli Ortiz THECB Liaison Texas Higher Education Coordinating Board Austin, Texas	Dr. Miguel Gonzalez The University of Texas Pan American Edinburgh, Texas
Dr. Rafael Gutierrez The University of Texas at El Paso El Paso, Texas	Dr. Tongdan Jin Texas State University San Marcos, Texas
Mariano Olmos El Paso Community College District El Paso, Texas	Dr. K. Jamie Rogers The University of Texas at Arlington Arlington, Texas
Bart Sheinberg Houston Community College System Houston, Texas	Dr. Victor Zaloom Lamar University Beaumont, Texas
Alejandra Gonzalez, Student Representative The University of Texas at El Paso	

Definition of Tuning

"Tuning" is a faculty-led pilot project designed to define what students must know, understand, and be able to demonstrate after completing a degree in a specific field, and to provide an indication of the knowledge, skills, and abilities students should achieve prior to graduation at different levels along the educational pipeline – in other words, a body of knowledge and skills for an academic discipline in terms of outcomes and levels of achievement of its graduates. Tuning provides an expected level of competency achievement at each step along the process of becoming a professional: expectations at the beginning of pre-professional study, at the beginning of professional study, and at the transition to practice. It involves seeking input from students, recent graduates, and employers to establish criterion-referenced learning outcomes and competencies by degree level and subject area. Through Tuning, students have a clear "picture" of what is expected and can efficiently plan their educational experience to

achieve those expectations. The objective is not to standardize programs offered by different institutions but to better establish the quality and relevance of degrees in various academic disciplines. An overview of Lumina Foundation for Education's "Tuning USA" Initiative is available at: http://www.luminafoundation.org/our_work/tuning/; an overview of Tuning work to date in Texas is available at: http://www.thecb.state.tx.us/tuningtexas.

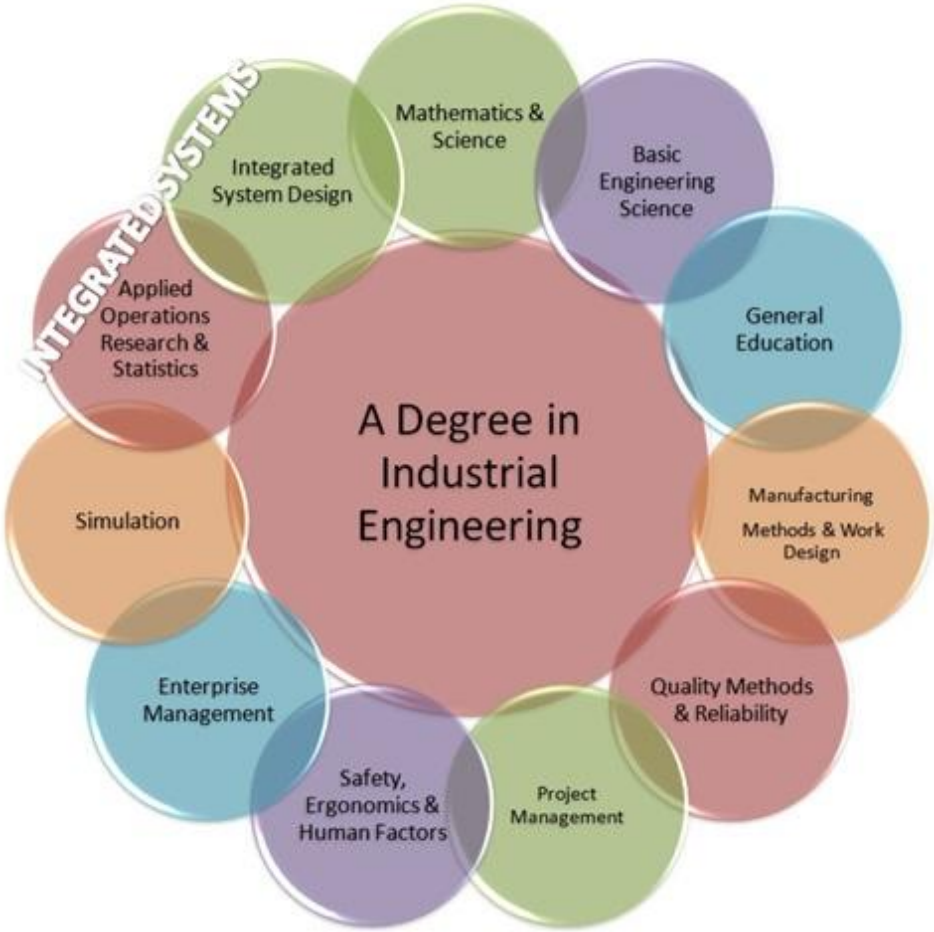
Definition of Industrial Engineering

Industrial engineering is a branch of engineering dealing with the optimization of complex processes or systems. It is concerned with the development, improvement, implementation, and evaluation of integrated systems of people, money, knowledge, information, equipment, energy, materials, analysis, and synthesis. The industrial engineer incorporates the mathematical, physical, and social sciences together with the principles and methods of engineering design to specify, predict, and evaluate the results to be obtained from such systems or processes.

Industrial and Systems Engineering is concerned with the design, improvement, and installation of integrated systems of people, materials, equipment, information, and energy. In short, Industrial Engineering makes things better, faster, and less expensive.

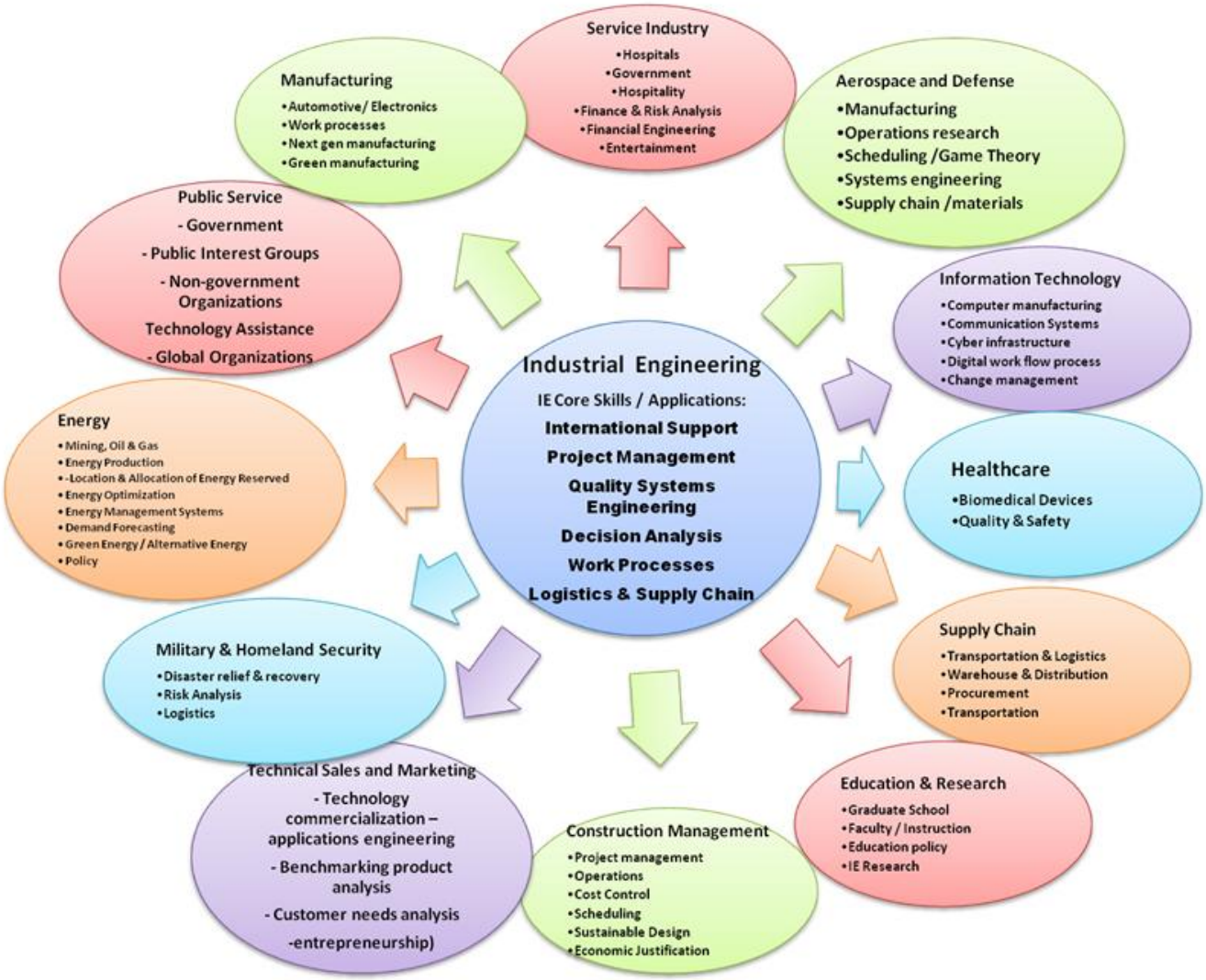
Industrial Engineering Expertise Profile

The expertise profile lists types of course work necessary for the completion of a baccalaureate degree in industrial engineering. Note: General undergraduate degree requirements (i.e., the core curriculum) are not considered for the purpose of tuning industrial engineering and this report.



Industrial Engineering Employment Profile

The employment profile lists 12 types of jobs available for industrial engineers.



Industrial Engineering Key Competencies Profile

The key competencies profile is a schematic diagram that is derived from the competency table. It lists for each learning outcome (columns) the required competency levels according to Bloom's taxonomy (rows) that have to be gained at each of five educational levels:

1. secondary education competencies, marked "HS"
2. pre-engineering competencies, marked "CC"
3. baccalaureate-level competencies, marked "BS"
4. post-graduate competencies, marked "G"
5. post-graduate/work experience competencies, marked "G/Ex"

Industrial Engineering Key Competencies Profile

Lumina Foundation Grant Industrial Engineering Committee

	Apply Mathematics, Science, and Engineering Knowledge	Design and Conduct Experiments	Design a System, Component, or Process	Multidisciplinary Teams	Solve Engineering Problems	Professional and Ethical Responsibility	Communication	Global Impact of Engineering Solutions	Lifelong Learning	Contemporary Issues	Engineering Tools	Integrated System Design
Evaluations											G/Ex	G/Ex
Synthesis		BS	BS		G				BS		G	G/Ex
Analysis		BS	BS	BS	BS	BS	BS	BS	BS	BS	BS	BS
Application	BS	BS	BS	BS	BS	BS	CC	BS	BS	BS	BS	BS
Comprehension	CC	CC	BS	BS	BS	CC	HS	BS	CC	CC	BS	BS
Knowledge	HS	HS	CC	HS	HS	CC	HS	HS	HS	HS	CC	BS

G/Ex	graduate and/or experience level competencies
G	graduate level competencies
BS	baccalaureate level competencies
CC	pre-engineering competencies
HS	secondary education competencies

The level of response for each of the Bloom's taxonomy levels are described through active verbs, for example (http://www.teach-nology.com/worksheets/time_savers/bloom/):

Knowledge	count, define, describe, draw, find, identify, label, list, match, name, quote, recall, recite, sequence, tell, write
Comprehension	conclude, demonstrate, discuss, explain, generalize, identify, illustrate, interpret, paraphrase, predict, report, restate, review, summarize, tell
Application	apply, change, choose, compute, dramatize, interview, prepare, produce, role-play, select, show, transfer, use
Analysis	analyze, characterize, classify, compare, contrast, debate, deduce, diagram, differentiate, discriminate, distinguish, examine, outline, relate, research, separate,
Synthesis	compose, construct, create, design, develop, integrate, invent, make, organize, perform, plan, produce, propose, rewrite
Evaluation	appraise, argue, assess, choose, conclude, critic, decide, evaluate, judge, justify, predict, prioritize, prove, rank, rate, select

Industrial Engineering Competency Table

The Industrial Engineering competency table has five learning outcome categories:

1. core competencies needed to enter higher education in industrial engineering,
2. pre-engineering competencies gained during first two years (associate's degree) of study,
3. baccalaureate-level engineering competencies
4. graduate-level engineering competencies
5. graduate and/or work experience level engineering competencies

The Industrial Engineering competency table has twelve learning outcome titles:

1. Math, Science, and Engineering
2. Experiments
3. Design a system, component, or process
4. Multidisciplinary teams
5. Engineering problem-solving
6. Professional and ethical responsibility
7. Communication
8. Global impact of engineering solutions
9. Lifelong Learning
10. Contemporary issues
11. Engineering tools
12. Integrated Systems Design

Explanation of Industrial Engineering Student Outcomes

---

1. **Apply Mathematics, Science, and Engineering Knowledge**

Note: ABET outcome a: Industrial engineers have an ability to apply knowledge of mathematics, science, and engineering to the solution of practical problems.

Engineering students are generally trained as problem solvers in the sense that they are capable of leveraging STEM (science, technology, engineering, mathematics) knowledge to develop new technologies, improve existing designs, and accomplish complex engineering projects. As the design complexity and system integration increase, engineering students are expected to be equipped with a broad spectrum of STEM knowledge as well as interdisciplinary trainings.

Industrial engineering students play a pivotal role in sustaining the technological advancement, process improvement, and betterment of human living quality. They have the capability to apply various analytical skills, including operations research and statistics, to model large and complex problems, identify the design constraints, and find the best comprised solution.

MATHEMATICS, SCIENCE, AND ENGINEERING				
Core Competencies Needed to enter Higher Education in Industrial Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Graduate Level Engineering Competencies	Graduate and/or Experience Level Engineering Competencies
Define key factual information related to mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science	Explain key concepts and problem-solving processes in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science	Solve problems in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science	*Intentionally left blank*	*Intentionally left blank*

2. **Design and Conduct Experiments**

Note: ABET outcome b): Industrial engineers have an ability to design and conduct experiments, as well as to analyze and interpret data.

Good engineering designs typically are established upon scientific theories along with solid experimental testing. Both the reliability and the performance of a new design can be verified and validated through laboratory experiments or field testing. Based on the outcome of the experiment, the product or system can be further enhanced by eliminating the design weakness, adopting new processes or technologies, or using new materials.

Industrial engineering students should be prepared with necessary skills for designing cost-effective experiments and performing data analysis using basic statistical tools and models. The purpose of the experiments is to identify key factors and/or their interactions which have major impact on the quality, reliability, and performance of the products. It is also important for industrial engineering students to carry out optimal experiments to obtain the necessary data sets while using minimum resources, costs, and energy.

EXPERIMENTS				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during first two years of study**	**Baccalaureate Level Engineering Competencies**	**Graduate Level Engineering Competencies**	**Graduate and/or Experience Level Engineering Competencies**
Identify the procedures and equipment necessary to conduct experiments, recognize the need to conduct experiment, formulate a hypothesis, and select an appropriate statistic to test the hypothesis and conduct the experiment	Explain the purpose, procedures, equipment, and practical applications of industrial engineering experiments; communicate the results of the experiment and suggest appropriate courses of action	Conduct industrial engineering experiments according to established procedures and report the results; implement the appropriate course of action dictated from an experiment and determine an appropriate process to monitor the stability of the solution as systemic behavior	*Intentionally left blank*	*Intentionally left blank*
		Conduct industrial engineering experiments according to established procedures and analyze and interpret the results; make decisions on course of action based on the monitoring of the system behavior		
		Design an industrial engineering experiment to meet a need, conduct the experiment, and analyze and interpret the resulting data; recognize the need for more extensive experimentation, formulating a designed experiment to optimize the system behavior		

3. **Design a System, Component, or Process**

Note: ABET outcome c): Industrial engineers have an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Design problems are typically ill-defined. The engineering design process is often an iterative process that may require the development of new knowledge. It can include the steps of problem definition, development of alternatives or design options, analysis, predictive comparison of options, selection of recommendations, implementation, and analysis of actual versus predicted performance.

For industrial engineers, the design process begins with understanding the needs (must-haves) and wants (nice-to-haves) of the customer, and the root causes of the true problem. Options will frequently have dimensions of money, time, quality, capacity, impact on workers, and physical characteristics such as size or weight. Recommendations should address the constraints of the problem. Typically, the recommendations are based on an analysis of tangible factors (such as economic, performance, and life cycle) and intangible factors (including acceptance by workers, environmental, political, and ethical).

DESIGN A SYSTEM, COMPONENT, OR PROCESS				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during first two years of study**	**Baccalaureate Level Engineering Competencies**	**Graduate Level Engineering Competencies**	**Graduate and/or Experience Level Engineering Competencies**
Intentionally left blank	Define engineering design; list the major steps in the engineering design process; list constraints that affect the processes and products of engineering design	Describe the engineering design process; explain how real-world constraints affect the processes and products of engineering design	*Intentionally left blank*	*Intentionally left blank*
		Design a simple component or process (e.g., an inventory policy) to meet a well-defined set of requirements and constraints		
		Design a system or process (e.g., an inventory system to reduce costs, out of stock, or average inventory levels) within a well-defined set of requirements and constraints		
		Design a complex system or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability		

4. **Multidisciplinary teams: Participate as an Effective Team Member**

Note: ABET outcome d): Industrial engineers have the ability to participate effectively as team members in group projects.

Industrial engineers are able to optimize group dynamics in order to maximize production by resolving problems efficiently. They will cooperate by accepting divergent ideas, encouraging active participation of team members, resolving conflicts, and taking active leadership roles.

Industrial engineers must possess an understanding of group dynamics; namely, how to create a group climate that encourages success, how to recognize and effectively utilize resources in group activities with minimal amount of activity/task overlap, and how to use communication strategies for dealing productively with conflicts. Industrial engineers must demonstrate the skills necessary to participate effectively as team members in long-term group projects. These skills include cooperating and keeping involved and updated, accepting divergent views/opinions, encouraging active participation of team members, resolving conflict, and taking leadership roles. Industrial engineers must show the skills necessary to work successfully with people performing a variety of functions within a group. These skills include exhibiting respect for people and the diversity in the group, accepting and incorporating appropriate thoughts/ideas from group members with different perspectives, and educating team members and sharing knowledge. Industrial engineers must report and share experiences from the group effort; namely, highlight positive experiences, discuss negative experiences, and propose ideas to improve productivity and avoid repetition of the experience for others.

MULTIDISCIPLINARY TEAMS				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during first two years of study**	**Baccalaureate Level Engineering Competencies**	**Graduate Level Engineering Competencies**	**Graduate and/or Experience Level Engineering Competencies**
List the key characteristics of an effective multidisciplinary team	*Intentionally left blank*	Explain the factors affecting the ability of a multidisciplinary team to function effectively	*Intentionally left blank*	*Intentionally left blank*
		Function effectively as a member of a multidisciplinary team		
		Organize an existing multidisciplinary team to accomplish a complex task		

5. Solve Engineering Problems

Note: ABET outcome e): Industrial engineers have an ability to identify, formulate, and solve engineering problems.

Engineering problems require the appropriate use of science, mathematics, and technology to address some need. Engineers must be able to combine background knowledge, critical thinking, and creativity to understand the conditions leading to this need and define the constraints and requirements of the problem. Engineers must be able to translate this understanding into an appropriate problem statement. Engineers then must apply their skills and tools to identify feasible solutions and make recommendations based on experimentation and analysis, as appropriate.

Industrial engineers typically work with problems that improve efficiency, increase quality, optimize the use of resources, enhance worker safety and well-being, and improve the competitive position of an organization. Industrial engineers frequently work closely with people to identify opportunities for improvement and recognize and resolve unmet needs. Industrial engineers understand how systems and processes work to make things better and to increase the quality of a service experience. In addition to a firm grasp of engineering fundamentals and analytical techniques, industrial engineers can design experiments to provide new understanding and solve new problems.

ENGINEERING PROBLEM-SOLVING				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during first two years of study**	**Baccalaureate Level Engineering Competencies**	**Graduate Level Engineering Competencies**	**Graduate and/or Experience Level Engineering Competencies**
Intentionally left blank	Able to identify and communicate the existence of an engineering problem and determine an appropriate general course of action to take in finding a solution to the problem	Formulate the problem from the abstract description to scientific/mathematical models and specify at least one solution methodology	Determine innovative methodologies to solve and implement solutions to engineering problems leading to discoveries in the field	*Intentionally left blank*
		Find and implement a solution specifying and controlling the costs and technical validity of the solution		
		Specify multiple solution methodologies if they exist and determine the best course of action based on a set of selected criteria		

6. **Understand Professional and Ethical Responsibility**

Note: ABET outcome f): Industrial engineers have an understanding of professional and ethical responsibility

Engineers must be trained in (i) identifying professional and ethical challenges that frequently come up during their professional careers, and (ii) making informed decisions to resolve such problems.

Industrial engineers must demonstrate an ability to make informed ethical choices in solving industrial engineering problems. Industrial engineers must demonstrate knowledge of the industrial engineering professional code of ethics. Industrial engineers must demonstrate an ability to evaluate the ethical dimensions of professional practice in solving industrial engineering problems and implementing solution procedures in industry. Industrial engineers must demonstrate ethical and professional behaviors in dealing with peers, faculty, and sponsors. Industrial engineering graduates must successfully complete the engineering ethics course.

PROFESSIONAL AND ETHICAL RESPONSIBILITY				
Core Competencies Needed to enter Higher Education in Industrial Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Graduate Level Engineering Competencies	Graduate and/or Experience Level Engineering Competencies
Intentionally left blank	List the professional and ethical responsibilities of an engineer	Apply standards of professional and ethical responsibility in a relatively clear-cut situation to determine an appropriate course of action	*Intentionally left blank*	*Intentionally left blank*
	Explain the professional and ethical responsibilities of an engineer	Analyze a complex situation involving multiple conflicting professional and ethical interests to determine an appropriate course of action		

7. Communication

Note: ABET outcome g): Industrial engineers have an ability to communicate effectively in written and verbal forms.

Industrial engineers will demonstrate an ability to communicate effectively any piece of information about a given project. Environmental protection, use of expert systems, and process optimization are topics of great importance for the industrial engineers of today. Being able to explain constraints, advantages, disadvantages, benefits, or simply to provide accurate information about the field is of vital importance to any industrial engineer. Stakeholders should have no difficulty understanding the message being conveyed by the industrial engineer. An industrial engineer shall possess a parallel vocabulary between technical and non-technical terms. Most of the time, industrial engineers need to explain technical aspects of a project in practical and understandable English. However, industrial engineers will also have to collect raw data from stakeholders in order to define, formulate, and implement a solution to a given problem.

Communication skills have to be constantly improved for an industrial engineer to be able to position him/her self at a competitive level. Verbal, written, virtual, and graphical communication skills need to be growing as the individual develops through a college education. The use of expert systems is inevitable, but it is also a great tool for industrial engineers to sharpen these skills. For example, Project Manager is a program tool that necessarily helps students to develop all communication skills. Industrial engineers input all sorts of parameters into Program Manager, and the program produces a number of graphs, charts, and tools that provide the industrial engineer with useful analytical tools. At the same time, the industrial engineer has to stay in control of the project and remain willing and ready to inform any stakeholder about any issue at any time.

Ideally, students should be involved as early as possible in all aspects of the profession. Attending conferences, hosting workshops, and writing professional reports are ways by which students can work their way up to success.

COMMUNICATION				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during first two years of study**	**Baccalaureate Level Engineering Competencies**	**Graduate Level Engineering Competencies**	**Graduate and/or Experience Level Engineering Competencies**
List the characteristics of effective verbal, written, and graphical communications	Correctly apply the rules of grammar and composition in verbal and written communications; apply appropriate graphical standards in preparing engineering drawings, flow charts, and other forms of graphical communications	Organize and deliver effective verbal, written, and graphical communications	*Intentionally left blank*	*Intentionally left blank*
Describe the characteristics of effective verbal, written, and graphical communications				

8. **Understand Global Impact of Engineering Solutions**

Note: ABET outcome h): Industrial engineers have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

Life in nearly every part of the world is affected by the human development made possible by engineering. Engineered products and services impact society, the environment, the economic prosperity of individuals and nations, and have ramifications on Earth and beyond.

Industrial engineers play a key role by managing supply chains that reach around the world, improving the quality of workers' lives, integrating activities and systems in multiple countries, and increasing the wealth of people and organizations worldwide. Industrial engineers possess a broad foundation of social sciences and the humanities to engineer products and services that satisfy the needs of a sustainable planet.

IMPACT OF ENGINEERING SOLUTIONS				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during first two years of study**	**Baccalaureate Level Engineering Competencies**	**Graduate Level Engineering Competencies**	**Graduate and/or Experience Level Engineering Competencies**
Identify global, economic, environmental, and societal impacts of engineering solutions	*Intentionally left blank*	Explain the global, economic, environmental, and societal impacts of engineering solutions	*Intentionally left blank*	*Intentionally left blank*
		Determine the global, economic, environmental, and societal impacts of a specific, relatively-constrained engineering solution		
		Analyze a complex engineering solution to determine its global, economic, environmental, and societal impacts		

9. **Engage in Lifelong Learning**

Note: ABET outcome i): Industrial engineers have the broad education necessary to recognize the need for, and an ability to engage in, professional development in industrial engineering.

Industrial engineers are expected to demonstrate an ability to engage in lifelong learning throughout their professional careers to keep up with technological advances in the field and use the skills for career advancement.

Industrial engineers must demonstrate the ability to use critical information-seeking tools that enable them to continue to stay up-to-date in the profession. These tools should include internet resources, professional and technical journals, handbooks, etc. Industrial Engineering graduates must show a degree plan in which elective courses have been selected based on professional goals and aspirations. Industrial engineers must demonstrate active involvement in the profession through the membership in engineering societies, achievement and maintenance of professional registration for engineers, involvement in continuing education, etc. Industrial engineers must express both a full appreciation of the need for, and the motivation to pursue, further education and training, not only in engineering, but also in areas outside engineering, math, and science.

LIFELONG LEARNING				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during first two years of study**	**Baccalaureate Level Engineering Competencies**	**Graduate Level Engineering Competencies**	**Graduate and/or Experience Level Engineering Competencies**
Define lifelong learning	Explain the need for lifelong learning and describe the skills required of a lifelong learner	Demonstrate the ability to learn on one's own, without the aid of formal instruction	*Intentionally left blank*	*Intentionally left blank*
		Analyze a complex problem to differentiate between aspects that are already known and aspects that must be learned in order to solve the problem		
		Develop a plan to acquire the expertise necessary to solve a complex problem		

10. **Knowledge of Contemporary Issues**

Note: ABET outcome j): Industrial engineers have the ability to adapt to the current socio-economic, political, and environmental global contexture, and to be able to participate in the development of technical solutions.

Engineers are expected to be informed about contemporary issues, which includes not only math, science, and engineering skills and knowledge, but also advances in domain-specific rules and regulations, government and international rules and regulations, public policy, and a variety of other disciplines.

Industrial engineers must show that they have taken and performed adequately in a variety of university courses that are concerned with contemporary issues and/or the context for understanding those issues, including courses in the humanities, performing arts, and social sciences. Industrial engineers must demonstrate the ability to evaluate the socio-economic, political, and environmental implications of proposed technical solutions.

CONTEMPORARY ISSUES				
Core Competencies Needed to enter Higher Education in Industrial Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Graduate Level Engineering Competencies	Graduate and/or Experience Level Engineering Competencies
List contemporary issues that affect engineering problems	Explain how contemporary issues affect the identification, formulation, and solution of engineering problems	Incorporate specific contemporary issues into the identification, formulation, and solution of a specific industrial engineering problem	*Intentionally left blank*	*Intentionally left blank*
		Analyze the global, regional, and local situation to determine which contemporary issues will affect the identification, formulation, and solution of an industrial engineering problem		

11. **Engineering Tools**

Note: ABET outcome k): Industrial engineers have the ability to put into practice techniques, skills, and modern engineering tools learned in school.

The curriculum must prepare graduates to apply techniques, skills, and engineering tools appropriate to generate feasible solutions to problems. The curriculum must include instruction in information technology, manufacturing, and human factors. Software and equipment should be introduced and its use developed through the curriculum.

Industrial engineers work in a wide variety of settings to make things better, faster, and less expensive. Industrial engineers use information technology and modeling software to find optimal solutions and integrate systems. They understand manufacturing processes so they can design better ways to make products faster and more cost-effectively. They keep people and the environment safe by finding better ways to work. In practice, industrial engineers continue to learn to develop and use new tools, skills, and techniques.

ENGINEERING TOOLS				
Core Competencies Needed to enter Higher Education in Industrial Engineering	Pre-Engineering Competencies gained during first two years of study	Baccalaureate Level Engineering Competencies	Graduate Level Engineering Competencies	Graduate and/or Experience Level Engineering Competencies
Intentionally left blank	Identify the techniques, skills, and modern engineering tools that are necessary for engineering practice	Explain how these techniques, skills, and modern engineering tools are used in engineering practice	Create new or improve techniques and tools to solve a complex problem	Evaluate the effectiveness of techniques and tools that have been developed to solve a complex problem
		Apply relevant techniques, skills, and modern engineering tools to solve a simple problem		
		Select and organize the relevant techniques, skills, and modern engineering tools to solve a complex problem		

12. Create Integrated Systems Designs

Note: ABET outcome l): Industrial engineers have a breadth of technical knowledge required to create integrated systems designs.

The curriculum must prepare graduates to design, develop, implement, and improve integrated systems that include people, materials, information, equipment, and energy. The curriculum must include in-depth instruction to accomplish the integration of systems using appropriate analytical, computational, and experimental practices.

Industrial engineering design problems typically involve creating or improving systems or processes that include people, materials, information, equipment, and energy. The design process starts with defining the problem or the objective to be achieved. Then constraints on costs, space, equipment, work rules, etc. must be determined. Alternative designs are created and evaluated. This entire design process, from problem definition to evaluation of alternatives, is iterative in nature and should involve a multidisciplinary approach with consideration of user acceptability, user friendliness, economy, reliability, maintainability, and quality. Hence, a breadth of technical knowledge is required to create integrated systems designs.

INTEGRATED SYSTEMS DESIGN				
Core Competencies Needed to enter Higher Education in Industrial Engineering	**Pre-Engineering Competencies gained during first two years of study**	**Baccalaureate Level Engineering Competencies**	**Graduate Level Engineering Competencies**	**Graduate and/or Experience Level Engineering Competencies**
Intentionally left blank	*Intentionally left blank*	Define key factual information in a specialized area of industrial engineering	*Intentionally left blank*	Design complex systems or processes or create new knowledge within a specialized area of industrial engineering
		Explain key concepts and problem-solving processes in a specialized area of industrial engineering		Evaluate the design of a complex system or process, or evaluate the validity of newly-created knowledge within a specialized area of industrial engineering
		Solve simple problems in a specialized area of industrial engineering		
		Analyze a complex system or process involving a specialized area of industrial engineering		

The chart below shows how these outcomes align with ABET criteria.

EXPLANATION OF INDUSTRIAL ENGINEERING STUDENT OUTCOMES

Program Outcomes	ABET Reference
1. Apply Mathematics, Science, and Engineering Knowledge	a) an ability to apply knowledge of mathematics, science, and engineering to solve industrial engineering problems in varied sectors of industry
2. Design and Conduct Experiments	b) an ability to design experiments, collect data, analyze data, and interpret results obtained;
3. Design a System, Component, or Process	c) an ability to obtain client requirements, and design a system, component, or process related to industrial engineering to meet client requirements;
4. Multi-disciplinary teams: Participate as an Effective Team Member	d) an ability to obtain client requirements, and design a system, component, or process related to industrial engineering to meet client requirements;
5. Solve Engineering Problems	e) an ability to identify, formulate, and solve industrial engineering problems;
6. Understand Professional and Ethical Responsibility	f) an understanding of professional and ethical responsibility;
7. Communicate Effectively	g) an ability to communicate effectively in written and verbal forms;
8. Understand Global Impact of Engineering Solutions	h) the broad education necessary to understand the impact of engineering solutions in a global and societal context;
9. Engage in Life-long Learning	i) a recognition of the need for, and an ability to engage in professional development in industrial engineering;
10. Knowledge of Contemporary Issues	j) familiarity with current and emerging topics in industrial engineering
11. Skills for Engineering Practice	k) an ability to put into practice techniques, skills, and modern engineering tools learnt in school.
12. Create Integrated Systems Designs.	l) industrial engineers have a breath of technical knowledge required to create integrated systems designs.