A Review of Industrial Engineering Curriculum: 2015-2025

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Abstract

In this paper, we present a curriculum review of ABET-accredited industrial engineering programs in the United States, continuing an important analysis initiated with Fraser 2005 [1] and Fraser 2015 [2]. We show the descriptive analyses of these programs' curricula, including required core industrial engineering courses, other required engineering courses, mathematics and science courses, and general education courses. We compare the findings to the 2005 and 2015 benchmarking of these programs. We also highlight how the evolution of artificial intelligence is influencing the industrial engineering curriculum.

Introduction

The industrial engineering curriculum is one of the most versatile engineering programs. Some institutions teach the general industrial engineering program, while others tend to focus on areas such as operations research and management sciences. Courses offered in each program vary according to the focus areas. However, some courses are offered across all the programs to address the industrial engineering niche and Accreditation Board for Engineering and Technology (ABET) accreditation requirements. These courses generally cover the areas of systems analysis and design, operations planning, process improvement, productivity analysis, engineering science, and engineering design. Some of these areas are taught under core industrial engineering courses such as operations research, human factors and ergonomics, probability and statistics, quality and reliability, and engineering economy. Others are covered as basic sciences and mathematics, such as chemistry, physics, life sciences, earth sciences, space sciences, calculus, differential equations, linear algebra, and discrete mathematics. A broader education component and a culminating engineering design courses are also required. Given the intricacy of the many variations of industrial engineering programs, we present a summary of 111 programs accredited by ABET in the United States from 2015 to 2025 to inform industrial engineering educators how the curriculum landscape is evolving. The summary can also be used as a reference document for institutions that are planning to establish new industrial engineering programs, as it provides a big picture analysis of ABET-accredited programs as well as an overview of the curricular evolution of these programs over the last thirty years.

The data collection process was performed between June and September of 2025, based on ABET's list of accredited programs at the time (we remark that ABET updates its list every year). To obtain the list, the authors used the Find Programs search engine with the search term "industrial engineering" and filters "Bachelor Degree" and "United States". Please see the Find Programs tool on the ABET 2026 [3] website. Based on this list, the authors searched for each university's course catalogue.

Following similar analysis conducted in 2005 (see Fraser 2005 [1]) and 2015 (see Fraser 2015 [2]), we focused only on undergraduate programs at the bachelor's level. Noting the difficulties and inconsistencies in obtaining valid data regarding the programs' faculty size discussed in Fraser 2015 [2], we opted not to include this type of analysis in our work. We also note that the focus of this paper is to offer an additional point for the longitudinal study of ABET-accredited industrial engineering programs initiated by Fraser 2005 [1], highlighting trends and discussing the evolution of the ABET-accredited industrial engineering curriculum. Hence, more specific and/or detailed analyses are out of scope of this work.

The data were collected from various undergraduate degree programs varying in their names. These are Industrial Engineering (69 programs), Industrial and Systems Engineering (30 programs), Industrial and Management Engineering (2 programs), Industrial Engineering and Management (2 programs), Industrial and Entrepreneurial Engineering (2 programs), Industrial Engineering and Engineering Management (1), Industrial and Management Systems Engineering (1), Industrial and Operations Engineering (1 program), Industrial and Robotics Engineering (1 program), Industrial Engineering and Operations Research (1 program), Systems and Industrial Engineering, and Process Engineering (1 program).

In the following sections, we show descriptive analyses of mathematics or science courses, required engineering courses, required industrial engineering courses, general education courses, and highlight how the evolution of artificial intelligence is influencing the industrial engineering curriculum. We compare the findings of 2025 to the 2005 and 2015 benchmarking of these programs presented by Fraser 2015 [1]. Our analysis includes 111 universities, whereas Fraser examined 92 institutions in 2005 [1] and 89 in 2015 [2].

Mathematics or Science Courses

There is a strong consensus among the ABET-accredited programs in terms of the basic mathematics and science courses required in industrial engineering programs. Table 1 shows the percentage of ABET-accredited programs that require each of the mathematics and science courses listed according to the benchmark years. Calculus is still a required course for all the programs. A physics course is still overwhelmingly required with the exception of only one program. It is worth mentioning that although the one program does not explicitly require a physics course, it requires 7 to 8 credits of industrial engineering approved science classes, which may include physics.

Table 1. Percentage of mathematics or science courses

Course	**2005**	**2015**	**2025**
Calculus	100%	100%	100%
Physics	100%	100%	98%
Chemistry	98%	96%	91%

Differential Equations, and/or Linear Algebra	74%	67%	81%
Mathematics or Science Elective	22%	30%	43%

Notice that the percentage of programs requiring a chemistry course declined further while the percentage of programs requiring mathematics and science electives increased, highlighting a potential general trend of departments giving students a higher level of flexibility in building their degree as well as a potential specific trend of industrial engineering programs diversifying their skillsets. In previous benchmark analyses, differential equations and linear algebra were put in the same field. Table 1 shows some variation in the percentage of programs that require one or both courses. A specific analysis of the requirements of each course would provide an important insight into the program structures. For instance, we note that, in our analysis, Differential equations was a required course in only 69% of the programs whereas linear algebra was a required course in 82% of the programs. Notice that linear algebra is generally a prerequisite for operations research, which is one of the essential areas of industrial engineering whereas differential equations is already an advanced topic which is generally not a prerequisite for any industrial engineering specific course. Analysis of how these two courses were represented in the previous benchmarks would provide a more complete picture of the changes in the industrial engineering curriculum in the last two decades.

Required Engineering Courses

Among the 111 recognized industrial engineering programs analyzed, every one of them required engineering courses outside of industrial engineering. The breadth of these courses and diversity in offerings reflects a lack of consensus throughout the education system as to which courses should round out industrial engineering education. Benchmarking required engineering courses beyond industrial engineering against curriculum from 2005 and 2015 are represented in Table 2.

Table 2. Percentage of required engineering courses

Course	**2005**	**2015**	**2025**
Computing	90%	92%	95%
Introduction to Engineering	57%	56%	74%
Engineering Mechanics	84%	78%	72%
Materials	76%	54%	56%
Computer Graphics	63%	57%	54%
Technical Elective	68%	63%	50%
Circuits	82%	64%	45%
Thermodynamics	51%	33%	23%

Over time, there has been a trend towards requiring less traditional engineering coursework. Courses in legacy engineering bodies of knowledge including mechanics, circuits, materials, graphics, and thermodynamics have all declined in the percentage of programs requiring them from 2005 to 2025. Computing courses and introduction to engineering courses have both increased in the same period. In addition to introduction to engineering, 41% of industrial engineering programs now have an engineering orientation course. These additional courses focused on introductory engineering topics and educational orientation may indicate a shift in the overarching higher education process, placing emphasis on topics such as classroom preparation and major selection.

In addition, it is possible that these changes towards fewer required courses in traditional engineering disciplines are due to an increased presence of computing requirements, likely reflecting industry trends towards the role of industrial engineering with data analysis and software utilization. Industrial engineering programs often have significant presence of computer based applied analytics courses, such as simulation, and there is an increasing presence of software solutions for advanced statistical analysis, which is relevant for core industrial engineering courses such as quality engineering.

Core Industrial Engineering Courses

Table 3 summarizes the progression of the traditional industrial engineering courses. The vast majority of programs require probability and statistics, operations research, senior design project, engineering economic analysis, simulation, production planning and control, quality, human factors and ergonomics, manufacturing, facilities planning, and industrial engineering electives. Probability and statistics, operations research, and senior design are required by almost all programs. The only program that does not require operations research focuses on process engineering, and less optimization. A program that does not require a senior design project course offers multiple design-related courses.

Table 3. Percentage of core industrial engineering courses

Course	**2005**	**2015**	**2025**
Probability or Statistics	98%	98%	100%
Operations Research	100%	99%	99%
Senior Design Project	86%	93%	99%
Engineering Economics	96%	96%	97%
Simulation	87%	89%	95%
Production Planning and Control	74%	75%	95%
Quality	86%	87%	94%
Work Methods, Human Factors, or Ergonomics	95%	90%	91%
Industrial Engineering Elective	45%	40%	81%
Manufacturing Processes	71%	57%	73%
Facilities, Layout, Material Handling	65%	56%	60%
Systems Analysis and Design	20%	17%	48%
Introduction to Industrial Engineering	46%	45%	47%

Engineering Management or Project Management	23%	36%	46%
Information Systems	22%	16%	34%
Computer Aided Manufacturing or Robotics	41%	25%	33%
Experimental Design	18%	16%	32%

The offering of industrial engineering elective courses doubled during the last decade. This increase can be attributed to the breadth and depth of the industrial engineering program enhancement. There is also an increase in systems engineering courses offered. This may be due to industrial engineering programs changing names to industrial and systems engineering. The Institute of Industrial Engineers also changed to the Institute of Industrial and Systems Engineers during this time. An increase in information systems and experimental design may be a result of the need for large-scale data analytics. The course descriptions of production planning and control, and supply chain and logistics are very similar, thus the latter courses are counted under the former category in our analysis.

Other General Education Courses

Table 4 shows the evolution of other general education courses over the three decades. While the percentage of programs offering general education electives is decreasing from 100% to 92%, it is notable to see how the percentage of programs allowing free electives is increasing substantially from 25% to 47%. Also, it is important to note that the percentage of programs requiring English and/or technical writing has increased in large proportion (English from 81% to 95% and technical writing from 35% to 56%). A potential explanation is the fact that employers consistently rank communication (both written and oral) among the most desired skills in new engineering hires. Additionally, the ABET has updated their student outcomes to include "an ability to communicate effectively with a range of audiences". This provides a formal incentive for industrial engineering programs to integrate these skills into their curriculum. The number of programs now allowing free electives has increased from about 25% in the two previous decades to about 50% in the last decade. Finally, there is a notable drop in the percentage of industrial engineering programs requiring a course in accounting and a course in ethics. It is important to note that these topics can be within one or multiple courses.

Table 4. Percentage of other general education courses

Course	**2005**	**2015**	**2025**
General Education Elective	98%	100%	92%
English	86%	81%	95%
Economics	41%	36%	32%
Technical Writing	39%	35%	56%
Speech or Communication	40%	39%	43%
Free Elective	28%	25%	47%
Accounting	26%	18%	11%
Ethics	18%	24%	17%

Evolution of Artificial Intelligence in Industrial Engineering Curriculum

The introduction of artificial intelligence into the industrial engineering curriculum is not a new phenomenon. In fact, artificial intelligence is a bedrock of the field, as operations research is one of its core areas. However, improvements in computational resources and the abundance of data require changes to the content of some program courses, particularly where forecasting is desired. These changes will improve the quality of information acquired for decision-making. It is not uncommon to use Excel spreadsheets for data analytics. Spreadsheets work well for small to medium-sized problems. However, larger datasets can be handled more effectively with scalable platforms such as Python supported by libraries including Pandas, scikit-learn, TensorFlow, Keras, and PyTorch.

Algorithms used in machine learning are also not new to industrial engineering. Least-squares analytical methods and gradient descent iterative methods are commonly taught in optimization courses. It is important to point out that optimization-related courses are required by all of the industrial engineering programs we have analyzed. What is missing is the introduction of courses that address the scalability of these algorithms. These courses have generally come under names such as machine learning and deep learning. Our analysis shows that less than 10% of the undergraduate industrial engineering programs require one or more similar courses. Table 5 below shows courses that are offered either as a required or an elective. We would like to note that similar content may also be covered an undergraduate industrial engineering program under different course names other than the names listed in Table 5, mainly where forecasting is taught such as supply chain and operation planning courses.

Table 5. Example of machine learning courses offered as required or elective

Course	**Required/Elective**
Machine Learning	Elective
Introduction to Machine Learning and Data Analytics; Machine Learning and Data Analytics II	Electives
Introduction to Machine Learning	Elective
Artificial Intelligence for Industrial Engineers	Required
Big Data and Analytics	Required
Business Applications of Machine Learning	Elective
Artificial Intelligence and Data Mining for Engineering Applications	Required
Python Programming and Machine Learning for Industrial Management	Required
Introduction to Machine Learning for Engineering Applications	Elective
Introduction to Machine Learning in Engineering Applications; Applied Machine Learning	Required
Advanced Data Analysis and Machine Learning	Required
Data Mining	Required
Artificial Intelligence in Decision Making	Elective
Data-Mining and Applied Machine Learning	Required

Introduction to Artificial Intelligence and Machine Learning in Engineering	Elective

Given the complexity and relevance of large-scale data analytics tools, it would be advisable to introduce a machine learning course earlier in the industrial engineering curriculum. That way, students can effectively utilize those tools in subsequent courses. For example, when they get to a forecasting chapter in a course, they would focus on practical applications of the underlying problem rather than spending a significant amount of time learning machine learning tools and algorithms. Given the popularity of Python in machine learning, it is recommended to make a Python course a prerequisite for the machine learning course. Probability and statistics, as well as computational linear algebra courses can be offered as corequisites.

Conclusions and Recommendations

We presented an overview of industrial engineering programs based on descriptive analysis of the courses offered across universities. There is a strong consistency among schools in the courses they offer. Over the last three decades, calculus and physics have remained at the top of the mathematics and science courses, respectively. Computer programming is also a sought-after course for almost all programs. There is enormous consensus on probability and statistics, operations research, and senior design project as core industrial engineering courses. An increase in industrial engineering electives and in free electives is also noticed. The general education electives are also highly regarded by the programs. The integration of the recent machine learning breakthroughs into the curriculum appears to be minimal, given the high adaptability of the industrial engineering curriculum in general.

Going forward, it would be beneficial to conduct analyses of the course descriptions for all core industrial engineering courses. In addition, proposing a baseline curriculum framework would be beneficial. Inconsistency in naming courses across programs and poor website design were some of the challenges in finding an up-to-date curriculum to collect data for this paper. A similar issue was reported by Fraser in 2015 and 2005. We hope that readers of this paper will revisit their program's website design in order to make changes to optimize user experience.

References

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