6 de febrero de 2023

Dra. Viviana Cesaní, Directora
Departamento de Ingeniería Industrial
Colegio de Ingeniería
Universidad de Puerto Rico
Recinto Universitario de Mayagüez

Estimada doctora Cesaní:

Me complace informarle que se aprobó la revisión curricular solicitada por su departamento, cuya copia adjunto, según lo establece la Guía General para la Preparación y Trámite de Propuestas de Cambio Académico de la Vicepresidencia en Asuntos Académicos e Investigación 2020.

Esta revisión curricular será efectiva desde el Primer Semestre 2023-2024 y aplicarán a estudiantes que ingresen desde el Primer Semestre del año académico 2023-2024 en adelante.

Cordialmente,

Betsy Morales Caro, Ph.D.
Decana

iot

c: Decano, Registradora, Catálogo

CERTIFICACIÓN NÚMERO 22-94

La que suscribe, Secretaria del Senado Académico del Recinto Universitario de Mayagüez de la Universidad de Puerto Rico, **CERTIFICA** que, en la reunión ordinaria celebrada el martes, 20 de diciembre de 2022, este organismo **APROBÓ** la **REVISIÓN CURRICULAR DEL PROGRAMA DE BACHILLERATO EN CIENCIAS EN INGENIERÍA INDUSTRIAL** del Colegio de Ingeniería.

La petición propone reducir los créditos del currículo del 175 a 150 de forma que el promedio de créditos por semestre sean 15 (en 10 semestres) en un esfuerzo por ofrecer un currículo que mejor sirva a sus estudiantes de los cuales sólo 2% a 3% logra graduarse en los 5 años del currículo y se gradúan en un promedio de 7.2 años.

La revisión curricular propone lo siguiente:

1. Reducir los créditos de Química General de 8 a 4 créditos. Se elimina QUIM 3132 y QUIM 3134.
2. En el área de Ciencias Sociales, Humanidades, Ciencia de la Conducta y Educación, se reduce de 15 a 9 créditos, donde 3 créditos deben ser en el área de ética.
3. En las secuencias de 12 créditos de lenguaje en inglés, existen tres posibles pasos: 1. estudiantes que entran a inglés básico, 2. estudiantes que entran a inglés intermedio y 3. estudiantes que entran a inglés avanzado. Las secuencias 1 y 3 permanecen igual. Los estudiantes de secuencia 2 deberán tomar INGL 3250 “Public Speaking” o INGL 3256 “Technical Communication”.
4. En los cursos de fundamentos de ingeniería se reduce de 37 a 25 créditos de los cuales 19 son requeridos y 6 son electivas recomendadas dentro de una lista definida.
5. Se elimina el curso ECON 3021 de la lista de cursos requeridos.
6. Los créditos de especialidad se redujeron de 50 a 49 créditos. Hubo reorganización de cursos y temas. Además, se añadió el curso ININ 4999: Introducción al proyecto de diseño, donde los estudiantes preparan la propuesta para el curso ININ 4079: Proyecto de Diseño. Todos los cambios en los cursos fueron aprobados por el Senado Académico del Recinto Universitario de Mayagüez.
7. En caso de lenguaje de español la secuencia propuesta es ESPA 3131-ESPA 3132 o ESPA 3101-ESPA 3102. (Según aprobado por el Decanato de Asuntos Académicos acorde con lo establecido en la Guía General para la Preparación y Trámite de Propuestas de Cambio Académico de la Vicepresidencia en Asuntos Académicos e Investigación 2020).

La propuesta se hace formar parte de esta certificación.

Y para que así conste expido y remito la presente certificación a las autoridades universitarias correspondientes, bajo el Sello de la Universidad de Puerto Rico a los veintiún días del mes de diciembre del año dos mil veintidós, en Mayagüez, Puerto Rico.

Carmen A. Negrón Moure
Secretaria

nav

Anejo

5 de diciembre de 2022

Miembros del Senado Académico
Recinto Universitario de Mayagüez

REVISIÓN CURRICULAR: PROGRAMA DE BACHILLERATO DE CIENCIAS EN INGENIERÍA INDUSTRIAL

El Comité de Asuntos Curriculares recibió ante su consideración la propuesta de revisión curricular del bachillerato de Ingeniería Industrial.

La petición propone reducir los créditos del currículo del 175 a 150 de forma que el promedio de créditos por semestre sean 15 (en 10 semestres) en un esfuerzo por ofrecer un currículo que mejor sirva a sus estudiantes de los cuales sólo 2% a 3% logra graduarse en los 5 años del currículo y se gradúan en un promedio de 7.2 años.

Características principales de esta propuesta:

- Mantiene el mismo perfil del egresado.
- Cumple con los criterios de la agencia acreditadora (ABET).
- Provee las bases (trabajo de cursos) necesarias para aprobar el examen de fundamentos de ingeniería (reválida fundamental).
- Conserva los 12 créditos en electivas libres.
- Reduce de 175 a 149 (150) créditos número totales para completar el grado.
- Disminuye de 194 a 164 horas contacto permitiendo a los estudiantes involucrarse en más actividades extracurriculares.
- Cumple con la Certificación 19-20-02 del Colegio de Ingeniería, sobre los cursos básicos que todo programa de ingeniería debe tener.

Las fuentes principales para fundamentar dicha propuesta son:

- El resultado del avalúo sistemático de los cursos de especialidad.
- Los criterios de acreditación del programa (ABET).
- Retro comunicación de los empleadores por medio de encuestas y entrevistas.
- Reuniones con el Consejo Asesor de la Industria.
- Reuniones departamentales donde se discutió la revisión curricular donde participaron los profesores y los representantes estudiantiles.

- Se hizo inter-comparación con los principales programas de ingeniería industrial de Estados Unidos de América.
- Se presentó y discutió la revisión con los estudiantes y se recogió su opinión sobre los cambios a través de un cuestionario.

Resumen de cambios propuestos:

- Reducir los créditos de Química General de 8 a 4 créditos. Se elimina QUIM 3132 y QUIM 3134.
- En el área de ciencias sociales, humanidades, ciencias de la conducta y educación se reduce de 15 a 9 créditos, donde 3 créditos deben ser en el área de ética.
- En las secuencias de 12 créditos de lenguaje en inglés, existen tres posibles pasos: 1. estudiantes que entran en inglés básico, 2. estudiantes que entran en inglés intermedio y 3. estudiantes que entran en inglés avanzado. Las secuencias 1 y 3 permanecen igual. Los estudiantes de secuencia 2 deberán tomar INGL 3250 "Public Speaking" o INGL 3236 "Technical Communication".
- En los cursos de fundamentos de ingeniería se reduce de 37 a 25 créditos de los cuales 19 son requeridos y 6 son electivas recomendadas dentro de una lista definida.
- Se elimina el curso ECON 3021 de la lista de cursos requeridos.
- Los créditos de especialidad se redujeron de 50 a 49 créditos. Hubo reorganización de cursos y temas. Además, se añadió el curso de ININ 4999 Introducción al proyecto de diseño, donde los estudiantes preparan la propuesta para el curso ININ 4079 Proyecto de Diseño. Todos los cambios en los cursos fueron aprobados por el Senado Académico del Recinto Universitario de Mayagüez.
- En caso de lenguaje de español la secuencia propuesta es ESPA 3331-ESPA 3132 ó ESPA 3101-ESPA 3102

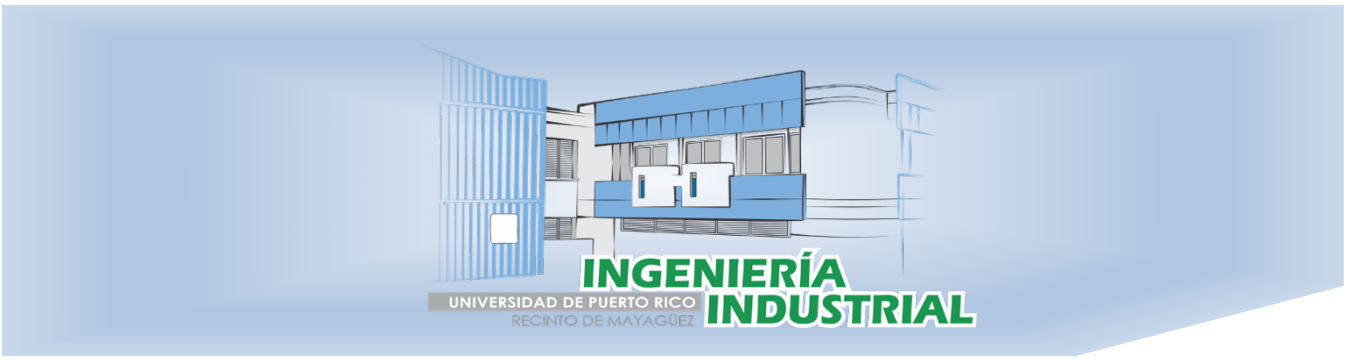
Los detalles de los cambios propuestos se anejan en la propuesta sometida por el Departamento de Ingeniería Industrial y además, hay una presentación que resume dichos cambios. El Departamento se comunico con todos los departamentos afectados para informarle sobre los cambios propuestos. Se aneja una tabla que resume dichas comunicaciones y las reacciones de los departamentos.

De la revisión de la documentación sometida se desprende que el Departamento hizo un análisis profundo y ponderado de la revisión curricular propuesta. Por esta razón el Comité de Asuntos Curriculares recomienda al Senado Académico aprobar esta propuesta. Se incluyen anejados todos los documentos considerados por el comité relacionados con la misma.

Cordialmente,

Prof. Jaime Sepúlveda Rivera
Co-Presidente Comité Asuntos Curriculares

Dr. Omell Pagán Parés
Co-Presidente del Comité de Asuntos Curriculares



Curricular Revision Bachelor of Science in Industrial Engineering

I. Introduction

a. Program Title

Bachelor of Science in Industrial Engineering (program number 0503)

b. Degrees

Bachelor of Science in Industrial Engineering (program number 0503)

c. Program Description

The Bachelor of Science in Industrial Engineering (BSIE) is a five-year program, which prepares professionals for the practice of Industrial Engineering in Puerto Rico and elsewhere. The total of credits to obtain the BSIE degree is 175 credits. General education credits are currently 51 credits and free electives are 12 credits. Overall engineering credits are 87, of which 56 are within the industrial engineering specialty.

d. Justification

Graduates from the industrial engineering program are instrumental in planning, designing, implementing, and evaluating products, services, and systems, which integrate people, materials, equipment, and information for the improvement in the quality of life. They ensure that these products, services, or systems can be provided economically with the required level of quality necessary for satisfying society's needs. The industrial engineer draws upon knowledge and skills mostly from the areas of mathematics and the physical, social, physiological and computer sciences, together with principles and methods of engineering analysis and design.

Approved by the UPRM Academic Senate on December 20, 2022.

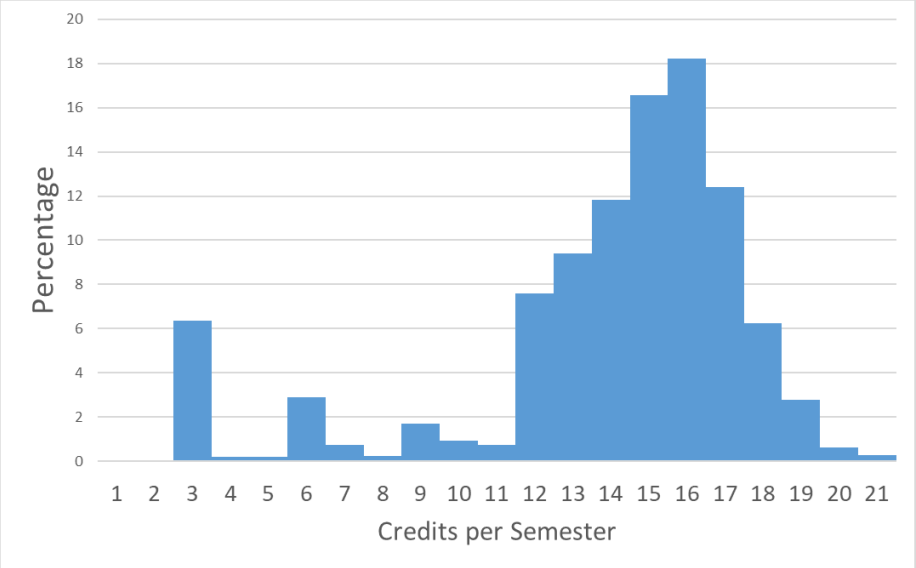
Graduates from the Industrial Engineering program are prepared to work in manufacturing, service, and governmental organizations. Employers of some of our industrial engineering graduates include:

- Manufacturing industries such as pharmaceutical, textile, food processing, electronics, clothing and shoes, health, and hospital-related products
- Services industries such as banks, hospitals, supermarket chains, furniture chains, communications, managerial consultants, system developers, public utilities, and cooperative organizations
- Government agencies

The UPRM Industrial Engineering Program is instrumental for Puerto Rico to become and remain competitive. It is crucial to have a continuous stream of industrial engineering graduates entering the workforce every year, coming from a program that demonstrates excellence in education, research, and processes. The program graduates, on average, 63 students every year (using as reference commencements from 2015 to 2020), with an average placement rate of 74.78% at the time of graduation. The proposed 149-credits curriculum aims to maintain the academic excellence of the graduates while:

- **Decreasing the time required to complete the degree**. The commencement ceremonies from 2015 through 2021 show that students require 7.24 years, on average, to complete the degree requirements. In addition, most of the IE students at UPRM take between 15 and 16 credits per semester (see Figure 1 for details). By providing a program of study that more adequately matches the typical course load for a student in the last five years, the proposed curricular revision aims to increase the number of students that complete the degree requirements on time.

Figure 1 Total number of credits per semester (2011-2021)



- **Decreasing the cost for students**. The proposed reduction of credits (24-27 credits) will result in a 13.7-15.4% reduction in registration costs associated to credit hours, roughly $3,480 to $3,915 based on 2021-2022 costs per credit[1]. Moreover, it is expected that this reduction in credit hours will also translate into a reduction of one year of the cost of living, which is estimated to be between $18,635 to $22,852 under the assumption that the student will enroll full-time each semester[1]. An important fact is that students can receive the Federal Pell Grant for no more than 12 terms or the equivalent (roughly six years) and 80% of UPRM students depend on this financial aid.

- **Increasing graduation rates**. Graduation rates are measured using the federal guideline of 7.5 year based on 150% target for a 5-year program. In the past five graduation ceremonies, between 80% and 85% of graduates completed the BS in IE in 7.5 years (150% of time for completion) and only 2.53% of graduates, on average, completed within the five-year mark. It must be noted that the percentage of students completing the degree within the five-year mark has been experimenting a decrease since the 2017 commencement. At that time, 4% of graduates completed the degree requirements on time, while no student in the 2020 commencement ceremony completed the degree requirements on time. It is expected that by reducing the number of credit hours, more students will be able to graduate within the five-year mark.

- **Reducing the number of credits to obtain a bachelor's degree gap when compared to competitive industrial engineering programs nationwide**. The

[1] https://www.uprm.edu/asistenciaeconomica/wp-content/uploads/sites/268/2021/07/Costos-de-Estudio-2021-2022.pdf

current BSIE program requires 175 credits, far over nationwide benchmark. The proposed curriculum will require 149 credits. Table 1 shows some of the examples of credits requirement using as benchmark competitive programs nationwide and the Polytechnic University of Puerto Rico.

Table 1 Benchmark on required credits for a bachelor's degree in Industrial Engineering

University	Degree	Credits
UC Berkeley	BS IE OR	124
Purdue	BS IE	123
University of Buffalo	BS IE	128
University of Michigan	BS ISE	128
Georgia Tech	BS IE	128
Penn State	BS IE	129
Northwestern	BS IE	144 (48 units, if all are three-credit courses)
Polytechnic University of Puerto Rico	BS IE	146
University of Puerto Rico Mayagüez	BS IE	149

II. Accreditation

a. Professional Accreditation

The Bachelor of Science Program in Industrial Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The department was first accredited in 1970, and the most recent accreditation occurred in 2021 and it is valid until 2027.

b. Requirements for Practice of Industrial Engineering Profession

The practice of the industrial engineering profession is regulated in some states. In Puerto Rico, Law 173 of 1988 requires engineering practitioners to be licensed by Puerto Rico's State Department (https://estado.pr.gov/en/engineers-and-surveyors/). Although most companies in PR do not require IE graduates to have a professional engineer (PE) license, those IEs employed by the government are required to hold a PE license to have an engineering title and receive its corresponding compensation.

III. Framework

a. Mission

To develop industrial engineering leaders known for their commitment, integrity, and respect. We serve the Puerto Rican and international communities with excellence by:

- providing an educational experience that nurtures industrial engineering professionals known for their solid technical capabilities, critical thinking skills, and social responsibility through a rigorous educational experience;
- creating knowledge by performing basic and applied research;
- stimulating and influencing the efficiency of governmental processes and services;
- supporting and improving manufacturing and service industries.

b. Program Goals

Program Educational Objectives

The Program Educational Objectives of the Industrial Engineering undergraduate program established that few years after graduation, graduates of this program will accomplish the following:

- To be known as assertive, ethical, and independent critical thinkers.
- Make contributions to their organizations based on experience that builds on their IE education.
- Adapt to changing needs in their profession.
- Achieve leadership roles in their organizations.

The IE program educational objectives contribute directly to the Institution's Mission, as evidenced in the Departmental Plan for the Assessment of Student Learning, Section V.

Program Strategic Objectives 2013-2020

1. To institutionalize a culture of strategic planning and assessment
2. To lead higher education throughout Puerto Rico while guaranteeing the best education for our students
3. To increase and diversify the Department's sources of revenue
4. To implement efficient and expedient administrative procedures
5. To strengthen competitive research
6. To positively impact our Puerto Rican society
7. To strengthen school sense of belonging and "Orgullo Colegial"

UPR Mayagüez Strategic Objectives 2012-2022

1. To institutionalize a culture of strategic planning and assessment

2. To lead higher education throughout Puerto Rico while guaranteeing the best education for our students
3. To increase and diversify the Institution's sources of revenue
4. To implement efficient and expedient administrative procedures
5. To strengthen research and competitive creative endeavors
6. To impact our Puerto Rican society
7. To strengthen school spirit, pride, and identity

Comparing the program's strategic objectives to UPR Mayagüez's strategic objectives, there is a direct alignment between them.

c. Student Outcomes

Graduates of the program will have the ability to:

1. Analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions.
2. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
3. Communicate effectively in a variety of professional contexts.
4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
5. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
6. An ability to apply security principles and practices to the environment, hardware, software, and human aspects of a system.
7. An ability to analyze and evaluate systems with respect to maintaining operations in the presence of risks and threats.

d. Graduate's Profile

The Industrial Engineering program prepares professionals in Industrial Engineering with the capacity to apply their knowledge, skills, attitudes, and the most recent technological developments to the solution of problems in our society. The profile of the IE graduate states the following:

> Graduates from the Industrial Engineering undergraduate program are instrumental in planning, designing, implementing, and evaluating products, services, and systems, which integrate people, materials, equipment, and information for the progress and improvement of the quality of life. They ensure that these products, services, or systems can be provided economically with the required level of quality necessary for satisfying society's needs. The Industrial Engineer draws upon knowledge and skills, mostly from the areas of mathematics, and the physical, social, physiological, and computer sciences, together with principles and methods of engineering analysis and design.

IV. Proposed Curriculum

The proposed curriculum is the result of combining inputs and feedback from several sources including the IE Industry Advisory Board, College of Engineering Industry Advisory Boards, employers (USA and PR), benchmarking process with other IE curriculums, faculty experience, student representatives, and research in contemporary topics and best practices in the IE profession. The design of the proposed curriculum, took as a binding requirement, the compliance with the current graduates' profile. Hence, **the proposed curriculum does not change the current graduates' profile.**

In the following subsections, highlights the changes to the current curriculum. Table 2 provides a summary of the proposed course changes to the current curriculum grouped by general topics. The coursework of the proposed curriculum is included in the rightmost columns. The next subsection contains the justification of changes following the same categories as in Table 2.

Table 2 Summary of changes to the current curriculum

Change	Category	Courses in Current Curriculum		Courses Eliminated		Courses Added		Courses in Proposed Curriculum	
		Course	**cr.**	**Course**	**cr.**	**Course**	**cr.**	**Course**	**cr.**
I	Mathematics	MATE 3005	5					MATE 3005	5
		MATE 3031	4					MATE 3031	4
		MATE 3032	4					MATE 3032	4
		MATE 3063	3					MATE 3063	3
		MATE 4145	4					MATE 4145	4
	Sub-Total:		*20*						*20*
II	Sciences	QUIM 3131	3					QUIM 3131	3
		QUIM 3132	3	QUIM 3132	3			QUIM 3133	1
		QUIM 3133	1						
		QUIM 3134	1	QUIM 3134	1				
		FISI 3171	4					FISI 3171	4
		FISI 3172	4					FISI 3172	4
		FISI 3173	1					FISI 3173	1
		FISI 3174	1					FISI 3174	1
	Sub-Total:		*18*		*4*		*0*		*14*
III	Social Sciences & Humanities	Social Sciences & Humanities	15	Social Sciences & Humanities	9	Elective in Ethics	3	Social Sciences & Humanities & Elective in Ethics	6 3
	Sub-Total:		*15*		*9*		*3*		*9*
IV	Languages	[ENGLISH]		[ENGLISH]		[ENGLISH]		[ENGLISH]	
		Basic Level:		Basic Level:		Basic Level:		Basic Level:	
		INGL 3101	3					INGL 3101	3
		INGL 3102	3					INGL 3102	3
		INGL 3201	3					INGL 3201	3
		INGL 3202 or INGL 3209 or INGL 3289 or INGL 3295	3					INGL 3209 or INGL 3289 or INGL 3295	3
		Intermediate Level:		Intermediate Level:		Intermediate Level:		Intermediate Level:	
		INGL 3104	3	INGL 2nd Year Electives	3	Select 3 credits from:	3	INGL 3103 (3)	3
		INGL 3103	3			INGL 3236 (3) or		INGL 3104 (3)	3
		INGL 2nd Year Elective	6			INGL 3250 (3)		Select 3 credits from:	3
								INGL 3236 (3) or INGL 3250 (3) or INGL 2nd Year Elective	3
		Advanced Level:		Advanced Level:		Advanced Level:		Advanced Level:	
		INGL 3211	3					INGL 3211	3
		INGL 3212	3					INGL 3212	3
		[SPANISH]				[SPANISH]		[SPANISH]	
		ESPA 3101	3			ESPA 3131	3	ESPA 3131 or 3101	3
		ESPA 3102	3			ESPA 3132	3	ESPA 3132 or 3102	3
	Sub-Total:		*18*		*3*		*3*		*18*

Change	Category	Courses in Current Curriculum		Courses Eliminated		Courses Added		Courses in Proposed Curriculum	
		Course	**cr.**	**Course**	**cr.**	**Course**	**cr.**	**Course**	**cr.**
V	Engineering Fundamentals	INGE 3011	2	INGE 3016	3	INEL 4078	4	INGE 3011	2
		INGE 3016	3	INGE 3032	3	[CIIC 3011 (3) or		[CIIC 3011 (3) or	
		INGE 3031	3	INGE 4001	3	CIIC 3015 (4) or INGE 3016 (3)]	4	CIIC 3015 (4) or INGE 3016 (3)]	4
		INGE 3032	3	INGE 4011	3			INGE 3031	3
		INGE 4001	3	INEL 4075	3			INEL 4078	4
		INGE 4011	3	INEL 4076	3			ININ 4010	3
								ININ 4015	3
		INEL 4075	3	INEL 4077	1	Electives (min. 6 cr.) from:	6	Electives (min. 6 cr.) from:	6
		INEL 4076	3	INME 4045	3	CIIC 3075 (3)		CIIC 3075 (3)	
		INEL 4077	1	INME 4055	3	CIIC 4010 (4)		CIIC 4010 (4)	
		INME 4045	3	INME 4056	1	INEL 4205 (3)		INEL 4205 (3)	
		INME 4055	3			[INGE 4001 (3)[2] or		INGE 3032 (3)	
		INME 4056	1			INME 4108 (3)]		[INGE 4001 (3)[2] or	
		ININ 4010	3			[INGE 4011 (3) or		INME 4108 (3)]	
		ININ 4015	3			INGE 4019 (4)]		[INGE 4011 (3) or	
						INGE 4015 (3)[1]		INGE 4019 (4)]	
						INGE 4035 (3)		INGE 4015 (3)[1]	
						INGE 5015 (3)		INGE 4035 (3)	
						[INME 4045 (3) or		INGE 5015 (3)	
						INME 4001 (3)]		[INME 4045 (3) or	
						INME 4065 (3)		INME 4001 (3)]	
						INCI 4005 (3)		INME 4055 (3)	
								INME 4056 (1)	
								INME 4065 (3)	
								INME 4055 (3)	
								INCI 4005 (3)	
	Sub-Total:		*37*		*26*		*8*		*25*
VI	Engineering – Specialty	ININ 4009	4	ININ 4077	4	ININ 4071	3	ININ 4017	3
		ININ 4017	3	ININ 4009	4	ININ 4072	3	ININ 4020	3
		ININ 4018	3	ININ 4018	3	ININ 5025	4	ININ 4021	3
		ININ 4020	3	ININ 4150	4	ININ 4021	3	ININ 5025	4
		ININ 4027	3			ININ 4999	1	ININ 4027	3
		ININ 4040	3					ININ 4040	3
		ININ 4057	3					ININ 4057	3
		ININ 4077	4					ININ 4071	3
		ININ 4078	3					ININ 4072	3
		ININ 4079	3					ININ 4078	3
		ININ 4087	4					ININ 4079	3
		ININ 4150	4					ININ 4087	4
		ININ 4155	4					ININ 4155	4
		Electives (6)	6					ININ 4999	1
								Electives (6)	6
	Sub-Total:		*50*		*15*		*14*		*49*
VII	Physical Education	Physical Education	2					Physical Education	2
	Sub-Total:		*2*						*2*

Change	Category	Courses in Current Curriculum		Courses Eliminated		Courses Added		Courses in Proposed Curriculum	
		Course	cr.	Course	cr.	Course	cr.	Course	cr.
VIII	Free Electives	Free Electives	12					Free Electives	12
	Sub-Total:		*12*						*12*
IX	Economy Requisite	ECON 3021	3	ECON 3021	3				
	Sub-Total:		*3*		*3*				*0*
	Grand Total:		***175***						***149***

Notes:

[1] *Requires to have approved INGE 3032*

[2] *Requires QUIM 3132 and/ or QUIM 3134 as requisite*

Justification of Changes in Coursework

Change I: Mathematics

No changes are proposed in this area.

Change II: Sciences

Eliminate QUIM 3132 *General Chemistry II* and QUIM 3134 *General Chemistry Laboratory II*, from the list of required courses

Exposition to chemistry topics and assigned credit hours on the subject in the current program almost doubles when compared to engineering programs across the USA and Puerto Rico. The proposed curriculum decreases the number of credit hours from 8 to 4 to stay competitive with other bachelor programs. Elimination of chemistry fundamentals is not a feasible option for the IE faculty considering the significant number of biopharmaceutical companies recruiting our students as COOPs and full-time employees. Hence, the department proposes revising the chemistry topics that IEs are required to take.

Most departments from the College of Engineering, including the Department of Industrial Engineering, have been working with the Department of Chemistry on the development of a single chemistry course with laboratory that will prepare students for all fundamental courses in engineering that require chemistry as a pre-requisite. In 2019, an exercise took place where all these departments identified the most relevant chemistry topics for their students, and now the Department of Chemistry is working on the petition for the single Chemistry course that will serve the needs of all engineering majors. While the Department of Industrial Engineering originally suggested a five-credit course, most departments from the College of Engineering prefer a four-credit course. As a result, the number of credits for the course is undergoing evaluation by the Department of Chemistry.

While this new course is being developed, most of the desired topics are covered in the current chemistry requirements for the first semester (QUIM 3131 *General Chemistry I* & QUIM 3133 *General Chemistry Lab I*). **As soon as the new course is available, the requirement will be switched to the new chemistry course for engineering majors.**

The ABET General Accreditation Criteria 2019-2020 requires programs to demonstrate they satisfy all the established General Criteria for Baccalaureate Level Programs. In the General Criterium 5, the curriculum requirements specified in item *(a) a minimum of 30 semester credit hours (or equivalent) of a combination of college-level mathematics and basic sciences with experimental experience appropriate to the program.* (Reference:https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2019-2020/#GC5, last accessed 2-14-2019).

The proposed curriculum has 34 credit hours on a combination of college-level mathematics and basic sciences with experimental experience, which satisfies ABET requirements.

Change III: Social Sciences and Humanities

Decrease the number of required electives in social sciences, humanities, behavioral sciences, and education to 6 credits (from 15), and increase the number of required electives in ethics to 3 (from 0). Proposed total credits in this area, 9.

The proposed curriculum will require at least nine credit hours in topics related to social sciences and humanities, three of which are required to explicitly address the topic of ethics. The department is proposing to require a formal course on ethics to guarantee that all graduates are exposed to this topic in their curricula. This requirement will address the first Program Educational Goal. The remaining required six credit hours in social sciences and humanities will be electives from a list of approved courses as is in the current curriculum. The list is published and can be access using the following link: https://www.uprm.edu/engineering/academic-affairs/accepted-socio-humanistics-2/

The of courses list to satisfy the ethics credits is available in the following link: https://www.uprm.edu/engineering/accepted-ethics-courses-faculty-of-engineering/

This list will be updated as new course options are approved.

Change IV: Languages

Additional course options are added to satisfy the "basic Spanish sequence" ESPA 3131 Academic Literacy I and ESPA 3102 Academy Literacy II

The proposed curriculum provides additional options for students to satisfy the basic Spanish sequence. Students are allowed to take during their first semester either ESPA 3131: Academic Literacy I or ESPA 3101: Basic Spanish I. Likewise, during the second semester they can choose either ESPA 3102: Academic Literacy II or ESPA 3102: Basic Spanish II. The approval of this curricular change was notified to Dr. Bienvenido Vélez, Dean of Engineering, in an official letter sent by Dr. Betzy Morales, Dean for Academic Affairs, on December 19, 2022.

Require students in the "intermediate sequence" to have at least 3 credits in INGL 3250 Public Speaking or INGL 3236 Technical Communication

---

The proposed curriculum will stress the need for students to receive additional exposure to topics related to technical communication. Challenges in communication, oral and written, is one recurring finding when evaluating our graduates. Industry Advisory Boards at both department and faculty levels have been especially emphatic in that the curriculum should include more exposition in communication, preferably in the English language.

Faculty agrees that students need to be better prepared in technical writing, as well as in public speaking. The sequences designed for industrial engineering students will keep the three-level structure currently in use but will use counseling efforts to further stress the needs for courses with a focus on technical communication. The only change proposed in this revision is in the intermediate sequence. Students in the intermediate sequence will be required to at least select three credits from INGL 3250 *Public Speaking* or INGL 3236 *Technical Communication*, for their second-year English electives requirements. (List available at https://www.uprm.edu/inci/wp-content/uploads/sites/158/2020/09/SECUENCIA-DE-INGLES.pdf)

The proposed sequences to satisfy the English Language requirements are provided next.

Basic level:
INGL 3101 *Basic course in English I*
INGL 3102 *Basic course in English II*
INGL 3201 *English Composition & Reading I*
INGL 3209 *Communication in Science*, INGL 3289 *Conversational English* or INGL 3295 *Principles of Speech Communication*

Intermediate level:
INGL 3103 *Intermediate English I*
INGL 3104 *Intermediate English II*
INGL 3250 *Public Speaking* or INGL 3236 *Technical Communication*
Second year elective course (3 credits), from approved list https://www.uprm.edu/inci/wp-content/uploads/sites/158/2020/09/SECUENCIA-DE-INGLES.pdf.

Advanced level:
INGL 3211 *Advanced English I*
INGL 3212 *Advanced English II*

An area of opportunity industrial engineering program's stakeholders are adamant on improving, is offering students in the advanced level, a coursework focused on technical communication. Developing and improving student's technical communication skills is important for all engineering students. However, there is no course selection available for students in the advanced level, that they can pursue towards the required 6-credits in English. In practice, this enforces students in the advanced level that wish to have the same opportunity to enrich their technical communication skills (as their intermediate level classmates), to register nine or more credits in the English department's courses (at least three more than the minimum). Hence, it is important to provide options, within the 6 credits English language requirements, that engineering students in the advance level can opt to deepen their knowledge in technical communication.

Change V: Engineering Fundamentals

Divide engineering fundamental courses in 19 required credits and 6 elective credits. Add elective courses. Overall, reduces the credits in the area from a total of 37, to a total of 25.

The number of required credit hours in engineering fundamentals has been reduced from 31 to 18-21 credits. The rationale for this reduction was based on several considerations:

a) ABET General Criterion 5. Curriculum.

The ABET General Accreditation Criteria 2019-2020 requires programs to demonstrate they satisfy all the established General Criteria for Baccalaureate Level Programs. In the General Criterium 5, the curriculum requirements specified in item *(b) a minimum of 45 semester credit hours (or equivalent) of engineering topics appropriate to the program, consisting of engineering and computer sciences and engineering design, and utilizing modern engineering tools.* (Reference https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2019-2020/#GC5, last accessed 03-10-2022)

The current curriculum has 87 semester credit hours of engineering topics, which is 193% of ABET required credits. The proposed curriculum shortens the gap by 28.9%. Still, the proposed curriculum has a strong focus on engineering topics appropriate for the industrial engineering program.

b) Professional Registration

Even though the number of IE students and graduates pursuing engineering registration in PR, i.e. Engineering in Training and Professional Engineer licenses, has markedly declined in the last ten years, the proposed curricular revision allows for students that want to pursue the Fundamentals of Engineering examination to do so.

As part of the requirements for the proposed curricular revision, it includes all mathematics and most IE-specific topics in the Fundamentals of Engineering (FE) exam

(https://ncees.org/wp-content/uploads/FE-Industrial-and-Systems-CBT-specs.pdf). Table 3, illustrates the degree in which the required courses under the current and proposed curriculum FE Exam are covered. It is important to highlight that engineering elective topics are not included in this analysis.

Table 3 FE Industrial and Systems Exam knowledge areas covered by required coursework, NCEES

		Covered in the required coursework	
Knowledge	**No. of Questions**	**Current Curriculum**	**Proposed Curriculum**
1. Mathematics	**6-9**		
A. Analytic geometry (e.g., areas, volumes)		Fully	Fully
B. Calculus (e.g., derivatives, integrals, progressions, series)		Fully	Fully
C. Linear algebra (e.g., matrix operations, vector analysis)		Fully	Fully
2. Engineering Sciences	**4-6**		
A. Thermodynamics and fluid mechanics		Not covered	Not covered
B. Statics, dynamics, and materials		Fully	Partially
C. Electricity and electrical circuits		Fully	Fully
3. Ethics and Professional Practice	**4-6**		
A. Codes of ethics and licensure		Partially	Fully
B. Agreements and contracts		Not covered	Not covered
C. Professional, ethical, and legal responsibility		Partially	Fully
D. Public protection and regulatory issues		Partially	Partially
4. Engineering Economics	**9-14**		
A. Discounted cash flows (e.g., nonannual compounding, time value of money)		Fully	Fully
B. Evaluation of alternatives (e.g., PW, EAC, FW, IRR, benefit-cost)		Fully	Fully
C. Cost analyses (e.g., fixed/variable, break-even, estimating, overhead, inflation, incremental, sunk, replacement)		Fully	Fully
D. Depreciation and taxes (e.g., MACRS, straight line, after-tax cash flow, recapture)		Fully	Fully
5. Probability and Statistics	**10-15**		
A. Probabilities (e.g., permutations and combinations, sets, laws of probability)		Fully	Fully
B. Probability distributions and functions (e.g., types, statistics, central limit theorem, expected value, linear combinations)		Fully	Fully
C. Estimation, confidence intervals, and hypothesis testing (e.g., normal, t, chi-square, types of error, sample size)		Fully	Fully

D. Linear regression (e.g., parameter estimation, residual analysis, correlation)		Fully	Fully
E. Design of experiments (e.g., ANOVA, factorial designs)		Fully	Fully
6. Modeling and Quantitative Analysis	**9-14**		
A. Data, logic development, and analytics (e.g., databases, flowcharts, algorithms, data science techniques)		Fully	Fully
B. Linear programming and optimization (e.g., formulation, solution, interpretation)		Fully	Fully
C. Stochastic models and simulation (e.g., queuing, Markov processes, inverse probability functions)		Fully	Fully
7. Engineering Management	**8-12**		
A. Principles and tools (e.g., planning, organizing, motivational theory, organizational structure)		Partially	Partially
B. Project management (e.g., WBS, scheduling, PERT, CPM, earned value, agile)		Partially	Partially
C. Performance measurement (e.g., KPIs, productivity, wage scales, balance scorecard, customer satisfaction)		Partially	Partially
D. Decision making and risk (e.g., uncertainty, utility, decision trees, financial risk)		Not covered	Not covered
8. Manufacturing, Service, and Other Production Systems	**9-14**		
A. Manufacturing processes (e.g., machining, casting, welding, forming, dimensioning, new technologies)		Fully	Not covered
B. Manufacturing and service systems (e.g., throughput, measurement, automation, line balancing, energy management)		Fully	Fully
C. Forecasting (e.g., moving average, exponential smoothing, tracking signals)		Fully	Fully
D. Planning and scheduling (e.g., inventory, aggregate planning, MRP, theory of constraints, sequencing)		Fully	Fully
E. Process improvements (e.g., lean systems, sustainability, value engineering)		Fully	Fully
9. Facilities and Supply Chain	**9-14**		
A. Flow, layout, and location analysis (e.g., from/to charts, layout types, distance metrics)		Fully	Fully

B. Capacity analysis (e.g., number of machines and people, trade-offs, material handling)		Fully	Fully
C. Supply chain management and design (e.g., pooling, transportation, network design, single-level/multilevel distribution models)		Fully	Fully
10. Human Factors, Ergonomics, and Safety	**8-12**		
A. Human factors (e.g., displays, controls, usability, cognitive engineering)		Partially	Fully
B. Safety and industrial hygiene (e.g., workplace hazards, safety programs, regulations, environmental hazards)		Not covered	Not covered
C. Ergonomics (e.g., biomechanics, cumulative trauma disorders, anthropometry, workplace design, macroergonomics)		Fully	Fully
11. Work Design	**7-11**		
A. Methods analysis (e.g., charting, workstation design, motion economy)		Fully	Fully
B. Work measurement (e.g., time study, predetermined time systems, work sampling, standards)		Fully	Fully
C. Learning curves		Fully	Fully
12. Quality	**9-14**		
A. Quality management, planning, assurance, and systems (e.g., Six Sigma, QFD, TQM, house of quality, fishbone, Taguchi loss function)		Fully	Fully
B. Quality control (e.g., control charts, process capability, sampling plans, OC curves, DOE)		Fully	Fully
13. Systems Engineering, Analysis, and Design	**8-12**		
A. Requirements analysis and system design		Fully	Fully
B. Functional analysis and configuration management		Partially	Partially
C. Risk management (e.g., FMEA, fault trees, uncertainty)		Not covered	Not covered
D. Life-cycle engineering		Not covered	Not covered
E. Reliability engineering (e.g., MTTF, MTBR, availability, parallel and series failure)		Partially	Partially

Note that one area strengthened by the proposed curriculum is in the ethics and professional practice section, as well as human factors. In terms of the Engineering Sciences, statics and the electrical engineering topics are included as requirements. Dynamics, materials, and thermodynamics are all offered as electives within the curriculum. Counseling will be enforced

to ensure all students interested in pursuing the FE examination know a priori which are the recommended engineering electives they should choose.

List of required courses: ININ 4010 (3), ININ 4015 (3), INGE 3011 (2), INGE 3031 (3), INEL 4078 (4), and [INGE 3016 (3) or CIIC 3015 (4)].

Elective courses (choose at least 6 credits from the list): Electives (6 cr.) from: CIIC 3075 (3), CIIC 4010 (4), INEL 4205 (3), INGE 3032(3), [INGE 4001 (3) or INME 4108 (3)], [INGE 4011 (3) or INGE 4019 (4)], INGE 4015 (3), INGE 4035 (3), INGE 5015 (3), [INME 4045 (3) or INME 4001 (3)], INME 4055 (3), INME 4056 (1), INME 4065 (3), INME 4055 (3), and INCI 4005 (3).

Change VI: Engineering Professional Specialty

Redistribution of topics in two subspecialty areas and addition of Capstone seminar course

---

The new curriculum proposes changes on the ININ 4077 *Work Systems Design* and the ININ 4009 *Work Measurement* courses. The methods component from ININ 4077 will be combined with the work measurement component from ININ 4009 to create a new three-credit required IE course, i.e. ININ 4072. In lieu of the new ABET requirements on human factors topics within the IE curriculum, the ergonomics component from ININ 4077 will be combined with human factor topics to create another new three-credit required IE course, i.e. ININ 4071. These new three-credit courses will altogether replace ININ 4077 and ININ 4009.

On the other hand, the ININ 4150 *Introduction to Models in Operations Research* that was recently introduced in the most recent minor curricular revision has led to high failure rates (up to 39% in recent semesters), with many students requiring at least two attempts to approve the course. Hence, it was deemed appropriate to go back to the former structure where deterministic and stochastic operations research were covered as separate topics in two different courses. The former course on deterministic operations research will be reinstituted – ININ 4021 *Deterministic Models in Operations Research*. Meanwhile, the former stochastic operations research course – ININ 4022 *Probabilistic Models in Operations Research* – will be combined with the simulation component from the ININ 4018 *Discrete-Event System Simulation* course. The resulting course will be a new four-credit required course titled ININ 5025 *Queueing Systems and Simulation* that will replace ININ 4022 *Probabilistic Models in Operations Research* and ININ 4018 *Discrete-Event System Simulation* course.

The IE department's Capstone course (ININ 4079 – *Design Project*) requires students to work on a real industrial engineering project. The project must comply with several requirements, including interactions with project's stakeholders and submission of solutions. The current timeline of events and the unguided process for the writing of project proposal charters and request for project, has proven to be unsustainable. For several students, this has resulted in a delayed submission of a sound

proposal, hampering the Capstone experience. To formally guide students and project stakeholders before the project's development phase, the proposed curriculum includes ININ 4999 *Capstone Design Project Seminar* as requisite for the Capstone course, ININ 4079 – *Design Project*. ININ 4999 is a seminar course designed to guide the student in the identification, preparation, and development of a strong proposal for an industrial engineering Capstone. It also serves the purpose of preparing students to comply with stakeholder's organization requirements, e.g. safety training, regulatory and compliance, legal paperwork, memorandum of understanding. The seminar course, ININ 4999, provides a formal venue for the department to match students with potential projects.

Change VII: Physical Education

No changes are proposed in this area.

Change VIII: Free Electives

No changes are proposed in this area.

Change IX: Economy Requisite

Removed ECON 3021 from required courses

The industrial engineering profession employs several techniques to estimate, manage, and control costs in engineering projects, as well as techniques of economic analysis related to decision making where time and money are the primary trade-offs including before and after-tax analysis, among other considerations. Some of the topics desired in the area are included in Table 2, Item 4. Given that these topics are covered in the seven credits of required coursework ININ 4087 *Cost Management* (4 credits) and ININ 4015 *Engineering Economic Analysis* (3 credits), ECON 3021 *Principles of Economics: Microeconomics* (3 credits) will be suggested as an elective rather than a required course.

Curriculum: Proposed versus current

In this section the current and proposed curriculum is presented "side-by-side" to facilitate evaluation. Tables 4.a to 4.f, show the curriculums in table format. Note that they include the courses, changes category in the "Δ" column, credit hours and contact hours.

Table 4.a Current and proposed curriculum with credit hours and contact hours for each course (First Year). "Δ" column indicates that the course has been changed (modified, eliminated, or added) and the justification is in the subsection indicated.

FIRST YEAR

CURRENT

First Semester

Δ	Number	Credits	Contact	Course
	* MATE 3005	5	5	Pre-Calculus
	QUIM 3131	3	3	General Chemistry I
	QUIM 3133	1	3	General Chemistry Laboratory I
	* INGL 3---	3	3	First year course in English
	* ESPA 3101	3	3	Basic course in Spanish I
	INGE 3011	2	4	Engineering Graphics I
		17	21	

Second Semester

Δ	Number	Credits	Contact	Course
	MATE 3031	4	4	Calculus I
II	QUIM 3132	3	3	General Chemistry II
II	QUIM 3134	1	3	General Chemistry Laboratory II
	* INGL 3---	3	3	First year course in English
	* ESPA 3102	3	3	Basic course in Spanish II
	** ELECTIVE	3	3	Socio-Humanistic Elective
	EDFI ----	1	1	Physical Education Elective
		18	20	

PROPOSED

First Semester

Δ	Number	Credits	Contact	Course
	* MATE 3005	5	5	Pre-Calculus
II	QUIM 3131	3	3	General Chemistry I
II	QUIM 3133	1	3	General Chemistry Laboratory I
	* INGL 3---	3	3	First year course in English
	* ESPA 3131 or ESPA 3101	3	3	Academic Literacy I or Basic Spanish I
		15	17	

Second Semester

Δ	Number	Credits	Contact	Course
	MATE 3031	4	4	Calculus I
	INGE 3011	2	4	Engineering Graphics I
	* INGL 3---	3	3	First year course in English
	** ELECTIVE	3	3	Socio-Humanistic Elective
	* ESPA 3132 or ESPA 3102	3	3	Academic Literacy II or Basic Spanish II
		15	17	

Approved by the UPRM Academic Senate on December 20, 2022.

Table 3.b Current and proposed curriculum with credit hours and contact hours for each course (Second Year). "Δ" column indicates that the course has been changed (modified, eliminated, or added) and the justification is in the subsection indicated.

SECOND YEAR

CURRENT

First Semester

Δ	Number	Credits	Contact	Course
	MATE 3032	4	4	Calculus II
	FISI 3171	4	4	Physics I
	FISI 3173	1	2	Physics Laboratory I
	INGL 3---	3	3	Second year course in English
V	INGE 3016	3	3	Algorithms and Computer Programming
	INGE 3031	3	3	Engineering Mechanics-Static
		18	19	

Second Semester

Δ	Number	Credits	Contact	Course
	MATE 3063	3	3	Calculus III
	FISI 3172	4	4	Physics II
	FISI 3174	1	2	Physics Laboratory II
V	INGE 3032	3	3	Engineering Mechanics-Dynamics
	ININ 4010	3	4	Probability and Statistics for Engineers
V	INGE 4001	3	3	Engineering Materials
	EDFI ----	1	1	Physical Education Elective
		18	20	

PROPOSED

First Semester

Δ	Number	Credits	Contact	Course
	MATE 3032	4	4	Calculus II
	FISI 3171	4	4	Physics I
	FISI 3173	1	2	Physics Laboratory I
V	CIIC 3015	4	5	Introduction to Computer Programming I
	INGL 3---	3	3	English Second Year or Elective
		16	18	

Second Semester

Δ	Number	Credits	Contact	Course
	MATE 3063	3	3	Calculus III
	FISI 3172	4	4	Physics II
	FISI 3174	1	2	Physics Laboratory II
	ININ 4010	3	4	Probability and Statistics for Engineers
	INGL 3---	3	3	English Second Year or Elective
	EDFI ----	1	1	Physical Education Elective
		15	17	

Table 3.c Current and proposed curriculum with credit hours and contact hours for each course (Third Year). "Δ" column indicates that the course has been changed (modified, eliminated, or added) and the justification is in the subsection indicated.

THIRD YEAR

CURRENT

First Semester

Δ	Number	Credits	Contact	Course
	MATE 4145	4	5	Linear Algebra and Differential Equations
	ININ 4020	3	3	Applied Industrial Statistics
VI	ININ 4077	4	5	Work Systems Design
V	INEL 4075	3	3	Fundamentals of Electrical Engineering
V	INME 4055	3	3	Manufacturing Processes
		17	19	

Second Semester

Δ	Number	Credits	Contact	Course
V	INME 4056	1	3	Manufacturing Processes Laboratory
V	INEL 4076	3	3	Fundamentals of Electronics
	ININ 4015	3	3	Engineering Economic Analysis
VI	ININ 4150	4	4	Introduction to Models in Operations Research
	INGL 3---	3	3	Second year course in English
VI	ININ 4009	4	5	Work Measurement
		18	21	

PROPOSED

First Semester

Δ	Number	Credits	Contact	Course
VI	ININ 4071	3	4	Ergonomics and Human Factors in Work Systems Design
	ININ 4020	3	3	Applied Industrial Statistics
	MATE 4145	4	5	Linear Algebra and Differential Equations
	INGE 3031	3	3	Engineering Mechanics Statics
	ININ 4015	3	3	Engineering Economic Analysis
		16	18	

Second Semester

Δ	Number	Credits	Contact	Course
VI	ININ 4021	3	3	Deterministic Models in Operations Research
VI	ININ 4072	3	4	Methods and Work Measurement
V	INEL 4078	4	5	Circuits and Electronics
	EDFI ----	1	1	Physical Education Elective
V ***	INGE/INME	3	3	Elective in General or Mechanical Engineering
		14	16	

Table 3.d Current and proposed curriculum with credit hours and contact hours for each course (Fourth Year). "Δ" column indicates that the course has been changed (modified, eliminated, or added) and the justification is in the subsection indicated.

FOURTH YEAR

CURRENT

First Semester

Δ	Number	Credits	Contact	Course
V	INGE 4011	3	3	Mechanics of Materials I
V	INME 4045	3	3	General Thermodynamics for Engineer
V	INEL 4077	1	3	Basic Electronics Laboratory
IX	ECON 3021	3	3	Principles of Economics I
	ININ 4155	4	4	Design and Analysis of Production Systems and Inventory Management
	ININ 4087	4	4	Cost Management
		18	20	

Second Semester

Δ	Number	Credits	Contact	Course
VI	ININ 4018	3	3	Discrete-Event System Simulation
	ININ 4027	3	3	Design and Analysis of Engineering Experiments
	ININ 4040	3	4	Facilities Layout and Design
	ININ 4078	3	4	Statistical Quality Control
	** ELECTIVE	3	3	Socio-Humanistic Elective
		15	17	

PROPOSED

First Semester

Δ	Number	Credits	Contact	Course
VI	ININ 5025	4	4	Queueing Systems and Simulation
	ININ 4155	4	4	Production and Inventory Management
	ININ 4078	3	4	Statistical Quality Control
	ININ ----	3	3	Industrial Engineering Elective
		14	15	

Second Semester

Δ	Number	Credits	Contact	Course
	ININ 4017	3	3	Computer-Based Information Systems
	ININ 4027	3	3	Design and Analysis of Engineering Experiments
	ININ 4040	3	4	Facilities Layout and Design
	** ELECTIVE	3	3	Socio-Humanistic Elective
VI	ININ 4999	1	1	Introduction to Design Project
	ELECTIVE	3	3	Free Elective
		16	17	

Table 3.e Current and proposed curriculum with credit hours and contact hours for each course (Fifth Year). "Δ" column indicates that the course has been changed (modified, eliminated, or added) and the justification is in the subsection indicated.

FIFTH YEAR

CURRENT

First Semester

Δ		Number	Credits	Contact	Course
		ININ 4017	3	3	Computer-based Information Systems
		ININ 4057	3	4	Real Time Process Control
		ININ 4079	3	3	Design Project
		ININ ----	3	3	Industrial Engineering Elective
	**	ELECTIVE	3	3	Socio-Humanistic Elective
		ELECTIVE	3	3	Free Elective
			18	19	

Second Semester

Δ		Number	Credits	Contact	Course
		ININ ----	3	3	Industrial Engineering Elective
III	**	ELECTIVE	6	6	Socio-Humanistic Elective
		ELECTIVE	9	9	Free Electives
			18	18	

PROPOSED

First Semester

Δ		Number	Credits	Contact	Course
		ININ 4079	3	3	Design Project
III	**	ELECTIVE	3	3	Elective in Ethics
		ELECTIVE	3	3	Free Elective
		ININ 4087	4	4	Cost Management
			13	13	

Second Semester

Δ		Number	Credits	Contact	Course
		ININ 4057	3	4	Real Time Process Control
		ININ ----	3	3	Industrial Engineering Elective
V	***	INGE/INME	3	3	Elective in General or Mechanical Engineering
		ELECTIVE	3	3	Free Elective
		ELECTIVE	3	3	Free Elective
			15	16	

Table 3.f Current and proposed curriculum with credit hours and contact hours for each course (summary and legend).

Δ column indicates that the course has been changed (modified, eliminated or added) and the justification is in the subsection indicated.	
CURRENT	**PROPOSED**
Total credits required for this program: 175 * Refer to the Academic Regulations section for information on Advanced Placement. ** The fifteen (15) credit hours of Socio-humanistic electives will be selected by the student, with the advisor's approval, from a list of recommended courses.	Total credits required for this program: 149 (148-151) * Refer to the Academic Regulations section for information on Advanced Placement. ** Six (6) credit hours in Socio-humanistic electives and three (3) credit hours in an ethics elective will be selected by the student, with the advisor's approval, from a list of recommended courses. *** A minimum of six (6) credit hours in engineering fundamentals selected by the student form this list: Elective courses (choose at least 6 credits from the list): CIIC 3075, CIIC 4010, INEL 4205, INGE 4001, INGE 4011, INGE 4012, INGE 4015, INGE 4035, INGE 5015, INGE 5016, INGE 5020, INGE 5066, INGE 5075, INGE 5085, INME 4045, INME 4055, INME 4056, INME 4065, INME 4107, INME 4055, INCI 4008, and INCI 4005. Minimum number of credit hours in engineering fundamentals (18) achieved by approving: INGE 3011 (2) + INGE 3016 (3) + INGE 3031 (3) + INEL 4078 (4) + two three-credit courses from the list. Maximum number of credit hours in engineering fundamentals (21) achieved by approving: INGE 3011 (2) + CIIC 3015 (4) + INGE 3031 (3) + INEL 4078 (4) + two four-credit courses from the list.

In terms of credits and contact-hours per semester, Figure 2 and Figure 3 show the contrast between the current and proposed curriculum. Figure 2 also marks the targeted average of 15 credits per semester. The proposed curriculum has four semesters with 15 credits, three with 16 credits, two with 14, and one with 13 credits. The 13-credit semester is also the one with the Capstone course (ININ 4079). Figure 3 marks the maximum desired contact hours to 18 contact-hours per semester. None of the proposed semesters has more than 18 contact hours.

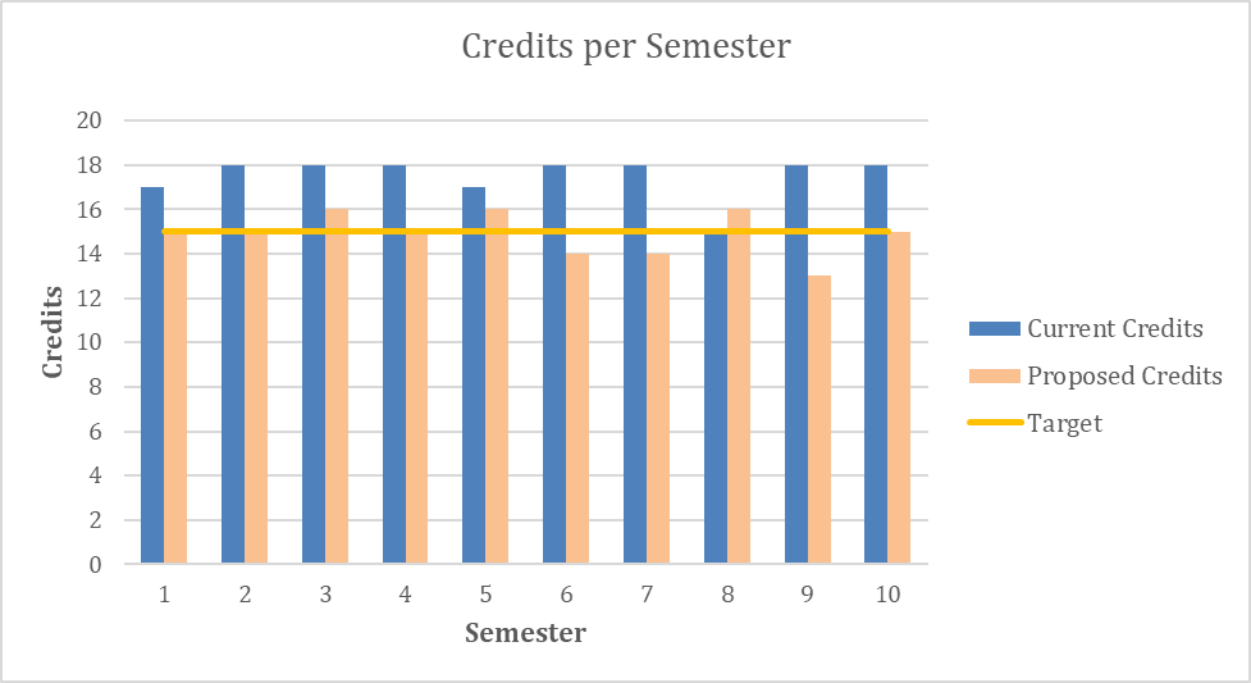


Figure 2 Current and proposed credits per semester

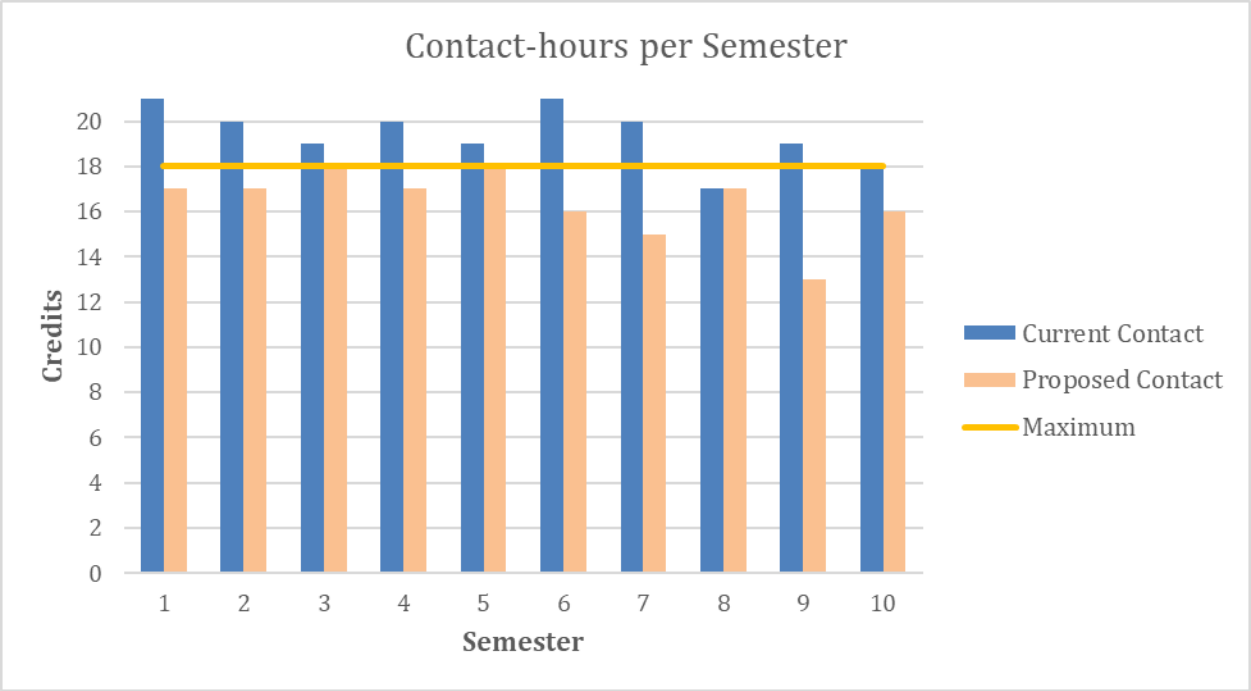


Figure 3 Current and proposed contact-hours per semester

Figure 4 has a visual representation of the curriculum with the critical path clearly marked (in red). Notice that the path is nine semesters long. Notice that the critical path is comprised by the courses shown in Table 5 List of courses in the critical path.

Table 5 List of courses in the critical path

Course	Year/Semester
MATE 3005	1/1st
MATE 3031	1/2nd
MATE 3032	2/1st
MATE 3063	2/2nd
MATE 4145	3/1st
ININ 4021	3/2nd
ININ 4155	4/1st
ININ 4040 and ININ 4999	4/2nd
ININ 4079	5/1st

Students could shorten the path to 8 or less semesters by:

- taking ININ 4021 and ININ 4155 during the same semester (although, it will not be recommended),
- starting earlier the path by entering in MATE 3031 in the first semester of studies and,
- taking courses of the critical path during a summer session (most courses in the critical path are usually offered in summer sessions).

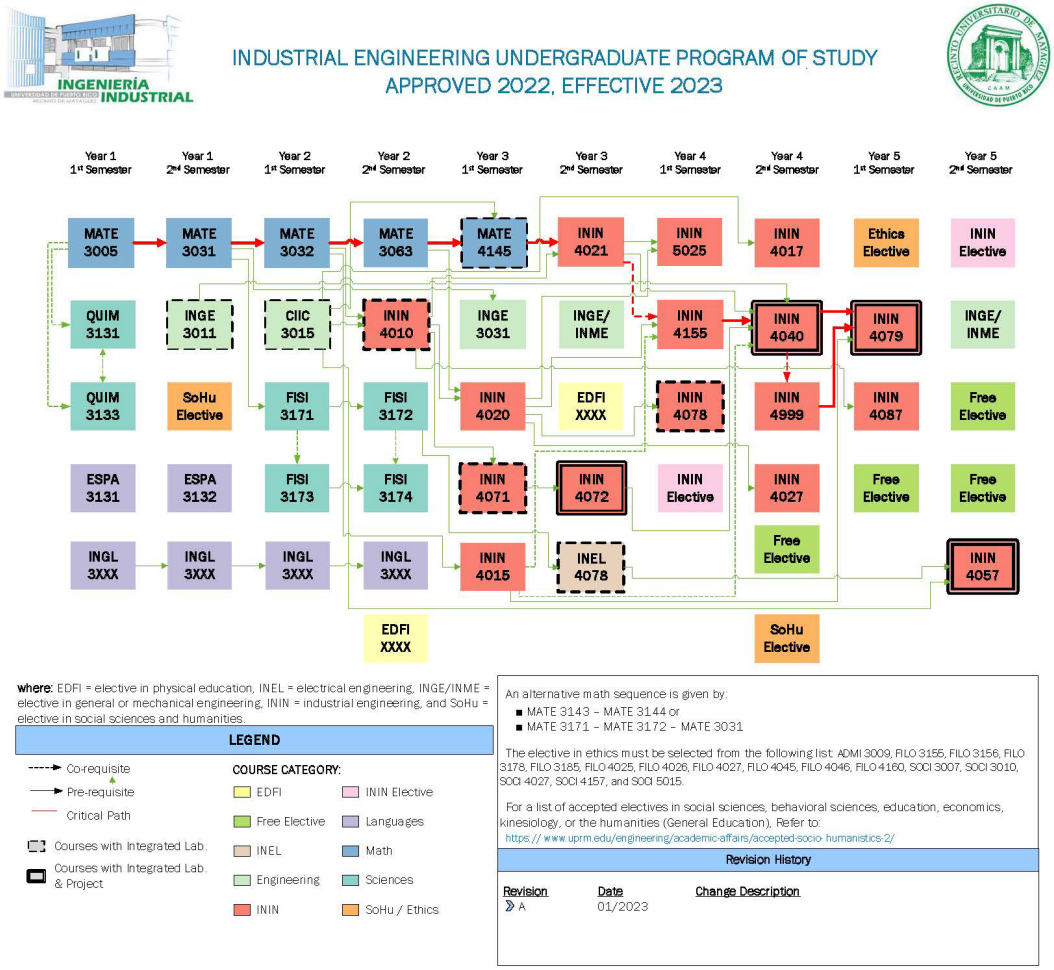


Figure 4 Flowchart view of the proposed curriculum with critical path and courses' requisite (provided as an example, other alternatives are available depending on the selection of courses)

V. Concluding Remarks

The proposed curriculum is the result of a thorough process that incorporated the input and feedback from our constituents including the IE Industry Advisory Board, Engineering Industry Advisory Board, employers (USA and PR), faculty, alumni, and students. The curriculum also integrates the suggestions and changes that arose from our systematic course assessment process, as well best practices in the IE profession, and a benchmarking process with other IE curriculums.

The major highlights of our proposed curriculum are:

- Graduates' profile does not change since the breadth and depth in IE areas is maintained as described in the student outcomes.
- The program continues to be a 5-year program that is highly valued by employers.
- Complies with ABET Criteria for Accrediting Engineering Programs.
- Students who want to pursue professional registration will have the necessary coursework to pass the Fundamental and Professional exams.
- There is no reduction in free electives (12 credit hours) and therefore students can pursue minor certifications or undertake the courses they choose for personal or professional development.
- The number of credits hours is reduced from 175 to 149 representing a reduction of 15% in credit hours.
- The number of contact hours is reduced from 194 to 164 representing a reduction of 15% in contact hours.
- The critical path is reduced from 10 semesters to 8-9 semesters, depending on the course sequence selected.
- A reduction in the total number of credit hours leads to a reduction in the total cost of education.